Lecture Notes in Electrical Engineering 525

Rinaldo Rinaldi · Romeo Bandinelli
Editors

Business Models and ICT Technologies for the Fashion Supply Chain

Proceedings of IT4Fashion 2017 and IT4Fashion 2018

Springer

Lecture Notes in Electrical Engineering

Volume 525

Lecture Notes in Electrical Engineering (LNEE) is a book series which reports the latest research and developments in Electrical Engineering, namely:

- Communication, Networks, and Information Theory
- Computer Engineering
- Signal, Image, Speech and Information Processing
- Circuits and Systems
- Bioengineering
- Engineering

The audience for the books in LNEE consists of advanced level students, researchers, and industry professionals working at the forefront of their fields. Much like Springer's other Lecture Notes series, LNEE will be distributed through Springer's print and electronic publishing channels.

More information about this series at http://www.springer.com/series/7818

Rinaldo Rinaldi · Romeo Bandinelli
Editors

Business Models and ICT Technologies for the Fashion Supply Chain

Proceedings of IT4Fashion 2017 and IT4Fashion 2018

Springer

Editors
Rinaldo Rinaldi
University of Florence
Florence, Italy

Romeo Bandinelli
University of Florence
Florence, Italy

ISSN 1876-1100 ISSN 1876-1119 (electronic)
Lecture Notes in Electrical Engineering
ISBN 978-3-319-98037-9 ISBN 978-3-319-98038-6 (eBook)
https://doi.org/10.1007/978-3-319-98038-6

Library of Congress Control Number: 2018951198

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The IT4Fashion is an industrial and scientific conference where fashion companies, brand, researchers, and software houses, from all the Europe, have the chance to discuss IT technologies as applied to the field of fashion and luxury.

The first edition was in 2011, and the event has constantly grown in terms of numbers, visibility, and importance for the operators in the sector.

Managing fashion products is challenging, not only for creatives and stylists, but also for supply-chain managers. More and more, customers demand broad product varieties and innovative products, and the competition in the fashion industry is ever more centered on the ability to react in a timely manner to changes in the customers' desires. Therefore, fashion companies have to balance the need to reduce lead times of collections, minimize stocks and obsolescence risks, acquire information from big data coming from digital and social media channels, guarantee a high level of quality, and get the customer involved in the processes of product development. Starting from a multidisciplinary approach, the IT4Fashion conference aims to collect and present new or improved supply-chain business models and technologies applied to the fashion industry, to share knowledge among practitioners and researchers, and, in summary, to increase knowledge in the areas of Product Lifecycle Management (PLM) and Supply Chain Management (SCM) in the industry.

The 7th edition, organized in 2017, was carried out over 3 full days—with plenary and parallel sessions. The first 2 days were dedicated to experts' keynotes and industrial case studies carried out by fashion companies and worldwide vendors. The third day was entirely dedicated to the scientific conference. During that day, researchers, practitioners, and students discussed the main challenges of IT solutions applied to the fashion industry. The 8th edition, organized in the 2018, was divided into 2 different days, without a clear separation between industrial and scientific contributions.

This volume collected 13 selected papers presented during the 2 years of the conference. The topics ranged from *product development* (design) to its *management after sale*, with strong attention to the new dynamics linked to the use of e-commerce and social media.

The conference dealt with the following themes:

- Fashion new product development
- Fashion design
- New materials for fashion products
- Product lifecycle management
- Wearable technologies
- Corporate social responsibility
- Business models and entrepreneurship
- E-commerce and omni-channel management
- Social and digital strategies for the fashion system
- Fashion operations and supply chains
- Challenges for the retail industry
- Brand management and strategy
- Mix of theoretical and practical education
- Fashion business, technology, and innovation
- Fashion marketing and communication strategy
- Business cases of fashion companies

Sincere thanks go to all authors, participants, and those who helped to organize and run the conference:

Hamideh Afsarmanesh, University of Amsterdam, The Netherlands
Gaetano Aiello, University of Florence, Italy
Kate Armstrong, University of Greenwich, London, UK
Liz Barnes, University of Manchester, UK
Verónica Arribas Barreras, ISEM Fashion Business School, Navarra, Spain
Alessandro Brun, Politecnico of Milan, Italy
Luis M. Camarinha-Matos, New University of Lisbon, Portugal
Fethi Çalişir, Istanbul Technical University, Turkey
Federico Caniato, Politecnico of Milan, Italy
Ricardo A. Cassel, Universidade Federal do Rio Grande do Sul, Brasil
Elisabetta Cianfanelli, University of Florence, Italy
Donatella Corti, University of Applied Sciences and Arts of Italian Switzerland (SUPSI), Switzerland
Pamela Danese, University of Padova, Italy
Stefano Dotti, University of Bergamo, Italy
Raffaele Donvito, University of Florence, Italy
Marcello Fera, Second University of Naples, Italy
Jonathan Gander, University of the Arts London, UK
Nevin Cigdem Gursoy, Istanbul Technical University, Turkey
Patsy Perry, University of Manchester, UK
Antonio Rizzi, University of Parma, Italy
Matteo Montecchi, The British School of Fashion, GCU London, UK
David Romero, Tecnológico de Monterrey, Mexico

Klaus-Dieter Thoben, BIBA—Bremer Institut für Produktion und Logistik GmbH, Germany
Quan Yu, Norwegian University of Science and Technology (NTNU), Norway
Sergio Terzi, Politecnico of Milan, Italy
Yi Wang, University of Manchester, UK

Florence, Italy

Rinaldo Rinaldi
Romeo Bandinelli
Conference Chairs

Contents

Part I
NPD and Product Lifecycle in the Fashion Industry

Chapter 1
News Approaches (Insights) to NPD on the Fashion Segment: The Power of Social Networks and the System See Now Buy Now

Helen Tatiana Takamitsu and José Alcides Gobbo Junior

Abstract Digitization and social media have influenced retail advertising and created new forms of commerce, consumers are now accessing Facebook, Instagram, Snapchat and Twitter as well as various applications to make immediate product buying decisions. In this market scenario where consumer interaction and immediacy became important items to be considered by fashion brands, the "See Now Buy Now" (SNBN) business model emerges as a response to this new market. This change where the product is available for sale right after the runway show and collections launches causes changes in supply chain planning and the whole process of new product development, requiring a more flexible and adapted NPD (new product development) with new processes and timelines. Thus, this article aims to propose a holistic and hypothetical NPD model based on the Agile Stage-Gate theory, within the SEE NOW BUY NOW (SNBN) theme, with the lead user interaction as the leading process development metric.

Keywords Fashion · Network · New product development · Fashion manufacturing industry · Supply chain · Social influences · Social media

1.1 Introduction

The current fashion market is a reflection of the evolution of the aesthetic and symbolic thinking consumer and their consequent influence on the industry. Due to the power of influence and valorization of a product or brand, the fashion market is increasingly competitive and with a need to accelerate its entire marketing and production process, combining the speed and flexibility necessary to stay in the trend (Williams 2016).

Innovation emerges as a key factor for value creation. In this way, companies look for ways to gain competitive advantage in a competitive environment that is

H. T. Takamitsu (✉) · J. A. Gobbo Junior
São Paulo State University, São Paulo, Brazil
e-mail: helen.takamitsu@unesp.br

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_1

increasingly sensitive to innovation. The complexity of the knowledge age requires articulation and cooperation. To innovate one must be connected to the networks, be they formal or informal presential or virtual. The position that a company occupies in a network is a matter of great strategic importance and reflects its power and influence in that network.

The Internet reflects the opportunities that enable businesses to reach a much broader base of buyers, reduce the cost of buyer engagement, and efficiently create value for consumers. With the constant evolution of the environment where the big brands compete and act, they demand new strategies and managerial attitudes in order to portray this holistic scenario. Companies cannot simply do business as usual to ensure their growth sustainably, need to be aware of trends and new forms of trade.

One response to this immediacy and consumer interaction was the "see now buy now" (SNBN) model, this one started with some big brands and has been practiced by other smaller ones. This change where the product is available for sale after the fashion shows and collections releases, causes changes in the planning of the supply chain and the entire process of development of new products. New stakeholders, control factors and parameters should be identified and measured in the new product development (NPD) process. Many of the best practices may not perform satisfactorily in this new process.

Traditionally, luxury fashion brand shows were restricted events for the press and buyers (wholesalers), but with the rise of digital media the usual model became obsolete as events became accessible to the entire market, creating a expectation of purchase wish that was not met. The collections presented would be produced and marketed only a few months later (Hoang 2016). These changes have created an opportunity to build a closer connection between the experience created with the runways and the time when people can physically explore the collections for themselves. Developing an adapted NPD model for this transformation is key to enable end-to-end customer engagement, flexible and dynamic business models and supply chains.

In this new scenario, this article was developed through a detailed and systematic review with the objective of elaborating a holistic and hypothetical NPD model based on the Agile Stage-Gate theory, within the theme of SEE NOW BUY NOW (SNBN), taking into account supply chain identification and sustainability. To this end has formulated the following research question: How to develop a holistic and hypothetical NPD model based on the theory of Agile Stage-Gate, within the theme of the SEE NOW BUY NOW?

This paper is divided into three parts. First part is the literature review of NPD and See Now Buy Now. Second part is an overview of the holistic and hypothetical model. The final part is a brief analysis of results and suggestions for future researches.

1.2 Literature Review

In this section, the theoretical references of the subjects treated in this article were approached.

1.2.1 See Now Buy Now

Brun et al. (2016) defines the SNBN as an innovative business model where fashion products are immediately made available for sale after the launch show.

The SNBN is an insightful reaction to the volatile demand of the modern consumer, but presents a number of challenges to the supply chain due to changes in production schedules and product launch. This model needs to be in tune with the strategies of the communication and marketing department in order to adapt and ensure the alignment with this new immediacy. The Burberry brand was one of the first to join the SNBN, then came, Tom Ford, Tommy Hilfiger, Ralph Lauren, Michael Kors plus other smaller ones. Some brands adopted the SNBN for the entire collection, others for selected items only (Hoang 2016).

This new model (SNBN), where consumers can purchase their products almost immediately after launching on catwalks or fashion events, has accelerated and modified the entire NPD process, where agility and direct or indirect consumer participation became a rule (Vedsmand et al. 2016).

The Burberry brand exemplifies pioneering new ways of engaging consumers in the luxury market, joining male and female collections, applying SNBN, changing its supply chain and NPD. An example for such an approach is the timeline of the operational model (Fig. 1.1).

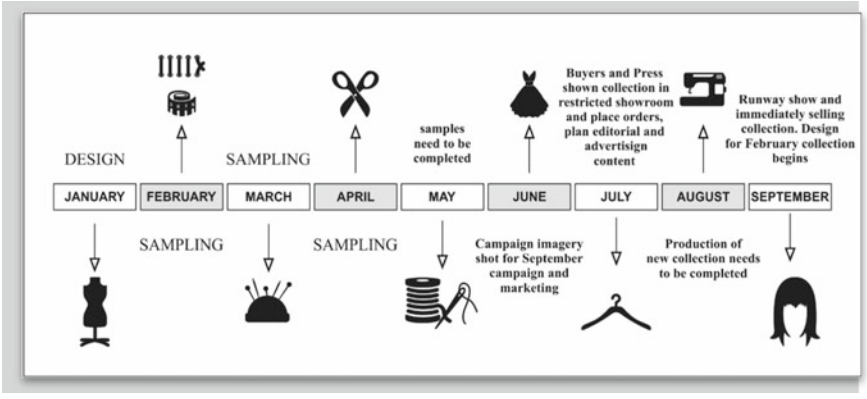


Fig. 1.1 Timeline of Burberry's new operating model (Hoang 2016)

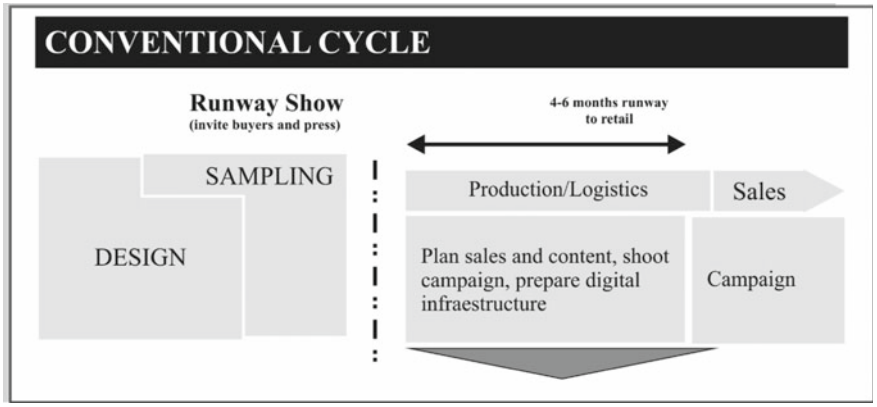


Fig. 1.2 Traditional cycle of fashion business (Atkearney 2017)

Williams (2016) comments that the Burberry brand to ensure the immediate availability of its products after the fashion show had to significantly change the product life cycle, starting with the design of the collection in January, sampling takes place in February, March and April and buyers and the press receive access to the collection during the month of July. While these steps, as well as marketing timing, are critical to product release in September, the NPD model brings with it a number of specific challenges.

Hoang (2016) cites the steps of the new SNBN model adopted by Burberry. Traditionally, luxury fashion brands begin designing a collection six months before a fashion show debut (Fig. 1.2). Burberry says it has changed its internal processes for several months—including design, development and production—to accommodate the new format, in which collections and shows will be simply described as "September" and "February" (Fig. 1.3). Usually in the traditional cycle, the collection that would be released in September, began to be projected in may. Through the SNBN model the designers start working in January.

As the collection was being designed, Burberry communicated production lead times and delivery times with its supply chain partners, usually the entire collection is designed, then launched, and then the supply chain begins to operate, now requires greater integration of the entire production chain.

The process begins with the design of the collection. Continuing the process, from each design a sample is made to be presented to buyers and the fashion press, before the samples were presented at the fashion show. In the new process, the samples are filmed and photographed for the advertising campaigns about three months before the launch (this step takes place in June or July).

Previously, shoppers and the press had been waiting until the launch season to see the new collection, then visited the showroom to order and order samples for photo shoots. In the SNBN model, a restricted and confidential presentation (with the signature of a non-disclosure agreement) is made with the main wholesale buyers

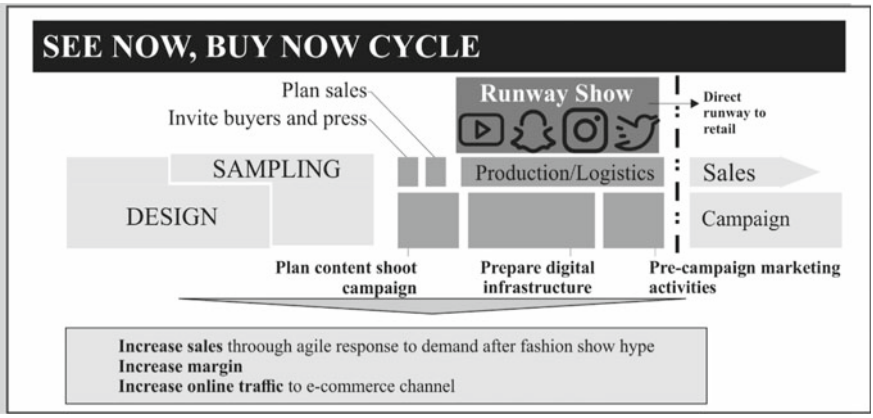


Fig. 1.3 Fashion business SNBN cycle (Atkearney 2017)

in July, referring to the fashion show that will be made in September. Once the orders are made by the buyers and an inventory estimate is defined (to meet their e-commerce and their own stores), the production is started, so that it is delivered in time to be available in stores soon after the launch (fashion show).

Some selected videos and images are available prior to the official release campaign, but the full campaign is officially launched only after the fashion show, to coincide with the availability of products in stores and advertising images. The fashion show is broadcast live on social networks, with attendance to serve customers who want to buy items from the collection; After the show the collection is already released to be sold. After the September launch starts the process again, with the design stage for the collection to be seen in February.

In SNBN, stakeholders (consumers, actors in the supply chain, digital influencers, and the fashion media) have a greater degree of importance in the NPD process, with time to market reduced. Stakeholder definition is a process where it identifies the parties whose interests should be taken into account when developing a policy or a program (Kozlowski et al. 2012). The direct or indirect participation of these stakeholders becomes extremely relevant to the success of the fashion collection, whether in acceptance or number of sales.

The H&M fashion group in its Conscious program, which is defined as a plan for a more sustainable fashion future, cites the importance of a healthy relationship with its stakeholders. The following stakeholders were identified and cited as important: Customers, Communities, Colleagues, Suppliers and their employees, Industry peers, Policy makers, NGOs and IGOs and Investors (H&M 2016).

Challenges and Benefits of the SNBN Model

In SNBN one of the big challenges in this business model is to anticipate demand for the new collection, how volumes are ordered from sellers before there is time for any critical consumer market reaction that allows direct influence on sales forecasting.

This raise the risk of oversupply or stockout, leading to a missed business opportunity, or creating a stock surplus that should then be sold with discount increasing declining margins. To counter this, companies should aim to gain prior consumer feedback through confidential forums or ensure that their suppliers are agile enough to facilitate reordering of the most popular lines. The SNBN will redefine the supply and demand of retailers, putting fast fashion producers (e.g. Zara) or smaller brands under pressure to react to catwalk trends in a matter of days, and thus release their collections as quickly as possible. While the luxury fashion industry has traditionally enjoyed long waiting times and is tied to a seasonal launch schedule, the early adoption of a agile supply chain strategy is essential. For those who demonstrate agility and predictability, the SNBN represents a significant business opportunity (Williams 2016).

Several designers are against the SNBN, because they believe that the model hinders the creation process, with this the product loses in quality and innovation. Thus, a product outside the high standards of the luxury market cannot be justified by the acceleration of the development process (Young 2016).

Morand (2016) says that another major challenge of SNBN is balancing the relationship of interactivity with its consumers/followers and digital influencers, since this system of co-creation allows an increase of process control by the consumer and influencer This balance is necessary, because the customer can create their own products and jeopardize brand innovation as consumers usually favor smooth and incremental change.

Another issue to consider is the economic factor, since the SNBN requires a lean and efficient organizational structure, the brand should be well capitalized, since the acceleration of the process presents greater financial risks (Brun et al. 2016; Morand 2016).

For Conlon (2016), in SNBN, besides the obvious benefit of selling a seasonal collection still at the station for which it was designed, it has the following positive points: increased connection with the customer; agile response to consumers; independent aesthetics and greater protection against copying immediately released parts. The negatives: an impact on exclusivity; increased costs for brands that do not have their own supply chain and tight deadlines for the press and for the stylist.

1.2.2 New Product Development

A product can be a service or a physical object and according to Roozenburg and Eeckels (1995), it is used as an "instrument in human action" to fill a series of values and needs of a person or an organization. Kotler (2012) argues that the product may be tangible or intangible. However, the focus of this research is on physical products, also known as artifacts (Bramklev 2007).

A second central theme in product development is the process followed when design the product. A process is a well-defined set of interrelated activities connected

through the transformation of inputs into outputs (Ljungberg and Larsson 2001; Melan 1993).

The New Product Development Process (NPD) includes idea generation, product design, prototype, production and marketing steps, and other market-specific components. These are combinations of existing products and technologies, mixed with a little bit of novelty where multiple actors interact and work together to develop something new. Companies in their NPD process have a wide variety of partners: such as users, customers, suppliers, distributors, intermediaries and even competitors, and can participate in a variety of collaborative arrangements: such as alliances, joint ventures, collective research, informal networks, social networks, contests, co-operative processes, and others (Leenders and Dolfsma 2016).

A central idea in product development is the ability to generalize the product development process, i.e., describe the generic process of product development.

Development Process SNBN + Agile-Stage-Gates

In SNBN the lead time is compressed, since the delivery of the products in the stores must coincide with the fashion show, but the development process cannot be very anticipated, in their initial phases, when analyzes of trends and styles should coincide with the schedule of materials research and exhibitions.

This means the introduction of specific methodologies such as "lean techniques, agile philosophy" with the specific objective of reducing development and delivery times, not only in the manufacturing, purchasing and sampling processes, but also in the design phases. This requires a very high degree of control over the development process, so as to ensure that the time for each activity is respected, it must works as an event-production system rather than separate steps (Brun et al. 2016).

A model of NPD structured in stages has as benefits: allow management to select the best ideas and projects with more insights and knowledge; reduce the risk and the costs of project failure and increase the chance of new products success (Vedsmand et al. 2016).

Cooper and Sommer (2016) comment that new studies and evidence shows that Agile methods, previously used primarily for IT development, can be integrated with traditional approaches to generate significant benefits for manufacturers of physical products. The authors suggest integrating the Agile system with the traditional Stage-Gates product development process to meet the needs of a specific physical product development project. The two systems have different approaches: Stage-Gate is a comprehensive system of "idea-to-launch system" and macro-planning, while Agile is a micro-planning project management methodology. Agile-Stage-Gate has been adopted by some companies for the development of physical products, with design cycles with fast validation from customers.

The main difference from Agile-Stage-Gate versus traditional gating systems is the flexibility in dealing and recognize that many projects, especially the most innovative, have high levels of ambiguity and uncertainty in the beginning, and it is often impossible to predict all the variables at the start of the system. Thus uncertainties about concrete products are managed by acceptance and even support for changes in product and project scope, as long as those changes do not affect the

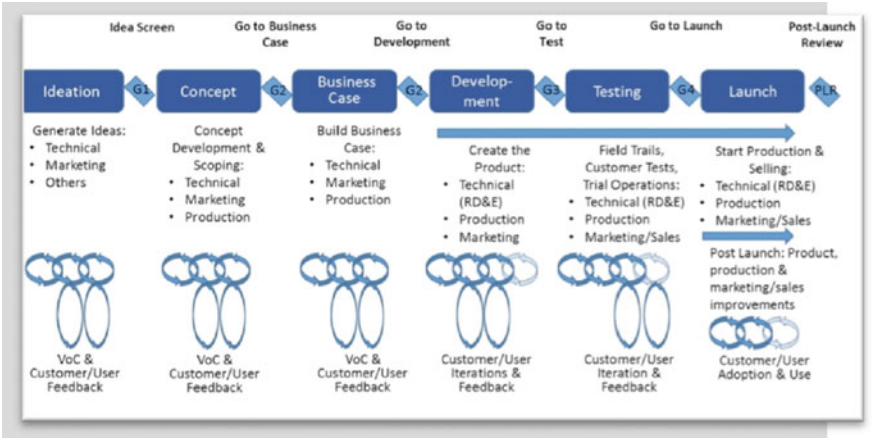


Fig. 1.4 The integrates Agile-Stage-Gate hybrid model (Cooper and Sommer 2016)

overall project objective, budget, and financial attractiveness (Cooper and Sommer 2016).

Agile is a set of software development methodologies based on iterative and incremental processes in which requirements and solutions evolve through collaboration between self-organized and multifunctional teams. In practice, the agile development stage typically consists of several short development cycles, known as sprints, with each sprint performed by a project team. The result of each sprint must be a functional product (executable code) that can be demonstrated to stakeholders (customers, for example) (Cooper 2016).

Stage-Gate is a robust product and process development strategy that creates the discipline necessary to prevent wasted resources on projects with lower potential. The projects are separated in several stages (Stages) followed by decision points (Gates) where it is re-evaluated (Go/Kill) whether or not it should continue. It is a tool developed over years from good practice studies of leading companies in new product development (Vedsmand et al. 2016).

In the hybrid model (Fig. 1.4), proposed by Cooper and Sommer (2016), Agile is simply inserted in the stages of development and testing. Stage-Gates remain in the same structure: decision points remain in the same places, deliveries are checked and re-evaluation is done.

In NPD for physical products, Agile-Stage-Gate includes sprints similar to the Agile-Scrum model of Information Technology. At each step the spirals are present, which is a series of build-test-feedback-revisions that make the system more adaptable with the presence of voice-of-the-client (VoC). At the conclusion of the sprints, some version of the product—a protocept—must be demonstrated to the stakeholders (customers and management) representing the outcome of a completed task. Each sprint is planned in real time, so the process is highly responsive and adaptable. The presence of dedicated teams according to Cooper (2016) is essential to accelerate

the process and ensure that it works well. Sprints move efficiently "gate to gate", it is necessary to use visual tools such as graphics and diagrams to engage the team and demonstrate the process.

Gates and stages remain part of the process, with gates being the Go/Kill decision points—eliminating weak projects and providing focus on the development pipeline. The stages provide a high-level overview of the main phases of the project as well as insights into the required activities and expected outcomes at each stage (Cooper and Sommer 2016).

Some of the reported benefits of this Agile-Stage-Gate Hybrid model include: considering Voice-of-the-Client (VoC) continuously, with the goal of getting the right product, respond quickly to customer needs, dealing with uncertainties and ambiguities (often characteristics of more innovative developments), flexibility in design, improved productivity, communication and coordination among the project team, and improved focus on the project prioritizing the most valuable items (Cooper and Sommer 2016).

1.3 Hypothetical NPD in SNBN

Due to the novelty of the analyzed subject, it is observed in the academic literature a shortage of papers that approach the theme of the NPD of fashion products that are developed according to the model SNBN, considering these premises justifies the choice of the context and object of analysis.

To construct the proposed NPD model (Fig. 1.5) approaching the Agile State-Gate in the SNBN, it was considered the sequence and the timeline deadlines from the operational model of SNBN (Fig. 1.1), according to the SNBN fashion business cycle (Fig. 1.3). At the Agile Stage-Gate spiral stage, VoC (consumer voice) was replaced by the LEAD USERS group, according to Von Hippel (2017), these are more likely than average users to develop higher value products and are the first to provide valuable information and data on emerging business opportunities. Berthon et al. (2007) comments that they are "customers who adapt, modify, or transform a proprietary offering".

LEAD USERS are those that current needs will become general in a market within months or years in the future. Once the leading users are familiar with the current scenarios that will be the future for most others, they can serve as sources of forecast needs and trends for marketing research (Von Hippel 1986). In the case of the NPD proposed, the group of lead users to be addressed will be digital influencers and the key actors from fashion company. Digital influencers are defined according to the analysis of social media network, and the key actors from the company's stakeholders network.

Within the model was defined a lead users interaction line that becomes positive (increases) according to the proximity of the collection launch (runway show), this relationship is verified because the fashion show are presented in real time in the

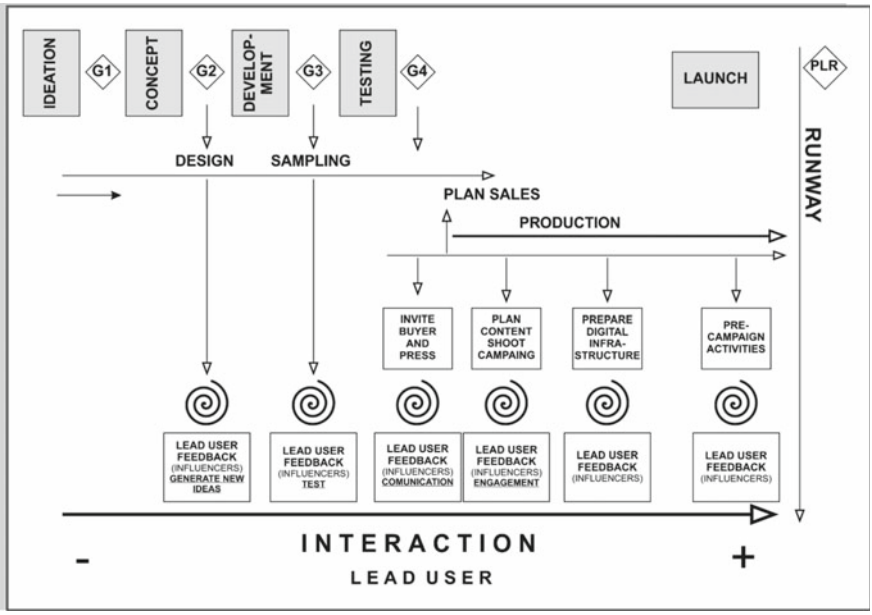


Fig. 1.5 Hypothetical model NPD—SNBN

social digital medias, with this the customers interaction increases considerably in this phase, through posts in Facebook, Instagram and Twitter.

In the testing phase, the use of 3D prototyping or virtual models accelerates the system and allows the users feedback, allowing the decision of what stays and what is discarded in the process.

1.4 Final Considerations

Impatience has become a way of life, a habit. And it is undeniable that the fashion industry has been completely transformed by social media networks and by emergence of new B2B and B2C platforms. Developing and launching products faster and faster at a lower cost and anticipating competing actions is a challenge and at the same time a necessity for the organization survival. Delivering more projects, with reduced resources, in a uncertainties environment that are inherent in innovation product projects, underscores NPD reference model importance considering the SNBN.

The model proposed by this article had as main objective to bring insights to the deadlines change and the new business model that emerged from the SNBN in the fashion market (in particular for the luxury market) and the needs for new NPD processes, more agile, more interactive, aiming to balancing the customer's desires

and designer's talent in creating innovative products in line with the company's objectives, strategy and the available supply chain. The big challenge for the designer is to manage the deadlines that have been changed in the SNBN with the supply chain and in particular with retailers and suppliers that have the launch of products and supplies still tied to the traditional fashion calendar.

The lead users (influencers) have a power of interference and presence that is unquestionable, the challenge is to optimize this influence in the NPD process as a whole.

The SNBN emerges as a challenge for the brands, both for the larger and smaller, since developing the products in this new model requires greater synchronicity and financial investment, another point to be considered is a brand communication plan to act in social networks, takeing opportunities and advantages to know how to deal with the challenges that interactivity provides.

Several fashion brands from the luxury market and designers are against SNBN model, but the pratice of SNBN model in many fashion weeks all around the planet as Germany (Atkearney 2017), Brazil (Tolipan 2017), Portugal (Fashion network 2017), France (Howland 2017), among others, confirms the model structuring and the requirement for anothers NPD academic studies and the supply chain required for this business model.

Therefore, future quantitative and qualitative research through case studies could prove the conceptual analyzes and insights about the SNBN and the applicability of the hypothetical NPD model proposed in this article.

References

Atkearney. (2017). Der Laufsteg wird zum Kaufsteg. Retrieved March 15, 2017, from http://www.atkearney.de/consumer-products-retail/featured-article/-/asset_publisher/S5UkO0zy0vnu/content/der-laufsteg-wird-zum-kaufsteg.

Berthon, P. R., Pitt, L. F., McCarthy, I., et al. (2007). When customers get clever: Managerial approaches to dealing with creative consumers. *Business Horizons, 50*(1), 39–47.

Bramklev, C. (2007). *Towards integrated product and package development*. Department of Design Sciences, Faculty of Engineering, Lund University.

Brun, A., Castelli, C., & Karaosman, H. (2016). See now buy now: A revolution for luxury supply chain management. *Workshop on business models and ICT technologies for the fashion supply chain* (pp. 33–46). Cham: Springer.

Conlon, S. (2016). See-now, buy-now: What have we learnt? How did brands handle the fashion revolution this year? Retrieved March 15, 2017, from http://www.vogue.co.uk/article/see-now-buy-now-what-have-we-learnt.

Cooper, R. G., & Sommer, A. F. (2016). Agile-Stage-Gate: New idea-to-launch method for manufactured new products is faster, more responsive. *Industrial Marketing Management*. https://doi.org/10.1016/j.indmarman.2016.10.006.

Cooper, R. G. (2016). Agile–Stage-Gate hybrids: The next stage for product development blending agile and Stage-Gate methods can provide flexibility, speed, and improved communication in new-product development. *Research-Technology Management, 59*(1), 21–29.

Fashion network (2017) 'See now, buy now' invade Portugal Fashion. Retrieved March 24, 2017, from http://pt.fashionnetwork.com/news/-See-now-buy-now-invade-PortugalFashion,808206.html#.WNcnyDsrK00.

H&M (2016) H&M conscious actions. Retrieved March 10, 2017, from http://sustainability.hm.com/.

Hoang L (2016) How burberry is operationalising 'see now, buy now'. Retrieved March 10, 2017, from https://www.businessoffashion.com/articles/intelligence/how-burberry-is-operationalising-see-now-buy-now.

Howland D (2017) H&M to debut 'see now, buy now' collection at Paris fashion week. Retrieved March 10, 2017, from http://www.retaildive.com/news/hm-to-debut-see-now-buy-now-collection-at-paris-fashion-week/434940/.

Kotler, P. (2012). *Kotler on marketing*. New York City: Simon and Schuster.

Kozlowski, A., Bardecki, M., & Searcy, C. (2012). Environmental impacts in the fashion industry: A life-cycle and stakeholder framework. *The Journal of Corporate Citizenship, 45,* 17.

Leenders, R. T., & Dolfsma, W. A. (2016). Social networks for innovation and new product development. *Journal of Product Innovation Management, 33*(2), 123–131.

Ljungberg, A., Larsson, E. (2001). Processbaserad verksamhetsutveckling.

Melan, E. H. (1993). *Process management: Methods for improving products and service*. New York: McGraw-Hill.

Morand P (2016) Op-Ed the problem with 'buy now'. Retrieved March 10, 2017, from https://www.businessoffashion.com/articles/opinion/op-ed-the-problem-with-buy-now.

Roozenburg, N. F., & Eekels, J. (1995). *Product design: Fundamentals and methods*. Chichester: Wiley.

Tolipan, H. (2017). SPFW—Paulo Borges sobre o "see now, buy now": Toda mudança gera um pouco de medo. Retrieved March 24, 2017, from http://www.jb.com.br/heloisa-tolipan/noticias/2017/03/15/spfw-paulo-borges-sobre-o-see-now-buy-now-toda-mudanca-gera-um-pouco-de-medo/.

Vedsmand, T., Kielgast, S., & Cooper, R. G. (2016). *Integrating agile with stage-gate-how new agile-scrum methods lead to faster and better innovation*. SE: Innovation Management.

Von Hippel, E. A. (2017). *Free innovation*. Cambridge, MA: MIT Press.

Von Hippel, E. (1986). Lead users: A source of novel product concepts. *Management Science, 32*(7), 791–805.

Williams R (2016) Comment: 'See now, buy now' trend is forcing a fashion retail revolution. Retrieved March 10, 2017, from https://www.retailgazette.co.uk/blog/2016/09/comment-see-now-buy-now-trend-is-forcing-a-fashion-retail-revolution.

Young, S. B. (2016). 3 ways see-now, buy-now is challenging the fashion industry. Retrieved March 10, 2017, from http://footwearnews.com/2016/business/retail/see-now-buy-now-fashion-industry-challenges-business-analysis-259202/.

Chapter 2
When Product Development Meets Luxury: A Case Study Analysis in Fashion, Food and Furniture Companies

Elisa d'Avolio, Claudia Pinna, Romeo Bandinelli, Rinaldo Rinaldi and Sergio Terzi

Abstract The luxury market segment includes different industries in its aura of high quality and price. The Italian excellence is ascribable to the three F (food, fashion and furniture), that have in common the attention they are paying to the Product Development process. The objective of the present study is to explore product development and the need for ICTs in fashion, furniture and food companies belonging to the luxury market segment. Strategies, activities, issues in process management and the most used ICTs are analysed. Comparing these sectors, the authors have been able to identify commonalities and differences. With the aim to investigate also improvement areas, several best practices and cross fertilization are discussed.

2.1 Introduction

The luxury market segment includes different industries in its aura of high quality and price: apparel, leather goods, furniture, food, hotels, automotive, nautical and so on. According to a statistic carried out in 2015 by the journal "Il Sole 24 ore", the Italian excellence is ascribable to the three F: food, fashion and furniture. These sectors have the highest growth potential, which has been evaluated through economic and marketing parameters.

E. d'Avolio · R. Bandinelli (✉) · R. Rinaldi
Department of Industrial Engineering, University of Florence, Florence, Italy
e-mail: romeo.bandinelli@unifi.it

C. Pinna · S. Terzi
Department of Management, Economics and Industrial Engineering, Politecnico Di Milano, Milan, Italy

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_2

Resilience—i.e. the ability of organizations to anticipate, respond and adapt to incremental change and sudden disruptions in order to survive and prosper—authenticity and product excellence are allowing the 3F to be competitive and internationally recognized.

Hence, these sectors are not simply producing and selling premium food, fashion and furniture products, but they also belong the luxury market segment, which gives specific undertones on the way these products are perceived by the market and on the way enterprises are organized.

When innovative companies want to improve their new product success rates, one of the first and also most important step is to redesign and to reorganize the PD processes and structures. This redesign activity aims at understanding the critical success factors (CSFs) that make the difference between winning and losing in new products. According to Cooper and Kleinschmidt (2007), CSFs are a limited number of key variables or conditions which have an impact on how successfully and effectively an organization meets its mission or the strategic goals or objectives of a program or project. In addition, CSFs are used to define key activity areas and strategic indicators of the company.

Moreover, Brun and Castelli (2013) identify the following CSFs for luxury companies: (i) premium quality in all the products in the line and along the whole Supply Chain (SC), (ii) heritage of craftsmanship, (iii) exclusivity, (iv) uniqueness, (v) emotional appeal of the products, (vi) global reputation of the brand, (vii) recognizable style and design, (viii) association with a country of origin and (ix) creation of a lifestyle. In many cases, luxury companies are not simply limiting their offer to premium products, but they are more and more trying to combine also luxury experiences, so that the imprint of the brand is enriched and eternalised.

In the particular cases of fashion, food and furniture companies, product development (PD) represents the core process around whom need for innovation and market pressure are revolving. It is considered the domain of creativity, style, ideas where the most value added tasks take place, in particular in the sectors analysed. Consumers' needs, merchandise planning, margin settings and production constraints are merged and balanced to develop a set of products (i.e. a collection, for fashion and furniture companies) that is aligned with the definition of luxury and ensures long-term competitiveness.

Moreover, PD in fashion, food and furniture industries is emphasizing the importance of craftsmanship and tailor-made products.

These sectors are also managing "made-to-measure" (MTM) products: MTM represents a business model that is translated in several peculiarities in terms of process management and has to be properly integrated within the overall strategy. The interface with design, manufacturing and customer care has to be planned and managed with the objective to deliver a unique premium product to a consumer that is trusting to the brand and has decided to invest time and money in the name of a loyalty.

The different "shades" of product development may slow down it, therefore losing control over timing is a typical issue.

Information and Communication Technologies (ICTs) are supporting product development in the fashion, food and furniture industries since at least a decade. CAD (Computer Aided Design), Product Lifecycle Management (PLM) solutions, creative suites, 3D printing and scanning are helping 3F companies to best manage all the information related to prototyping, sampling and testing.

Given this background, the objective of the present study is to explore PD and the need for ICTs in fashion, furniture and food companies belonging to the luxury market segment. We will examine the strategies, the activities, the issues in process management and the most used ICTs tools. Comparing these sectors, we have been able to identify commonalities and differences. With the aim to investigate also improvement areas, several best practices and cross fertilization are discussed.

The remainder of this paper is organized as follows. The second section describes the relevant literature on the research topics. The third section analyses the research methodology that has allowed to reach the goal of the present study. The fourth section presents the main results and the sixth section is a discussion of the already analysed findings. Conclusions and further research developments are then debated in the sixth section.

2.2 Literature Review

The first step of the research has been a literature review, aiming to gather as much information as possible on the strategies, activities and ICTs typical of the 3F.

The main keywords that we have typed in search engines like Scopus and Scholar are related to the luxury market segment, product development and ICTs. Unfortunately, literature is lacking of contributions about PD in the luxury market segment and also in fashion, food and furniture industries.

Many studies investigate how ICTs support the PD process by helping to improve companies' critical factors and the corresponding performances (José Barbin Laurindo and Monteiro de Carvalho 2005; Urwin and Young 2014; Wu et al. 2014; Arsenyan and Büyüközkan 2016, MacCormack et al. 2001).

The greatest contribution from literature concerns the CSFs for luxury companies (Brun and Castelli 2013; Heine 2010; Walley et al. 2013). While, just few authors have dealt with the need for alignment between business strategy and information systems in luxury companies (Oh and Pinsonneault 2007; Siguaw et al. 2000).

We have also carried out a research to deepen the topic of MTM, but no relevant contributions have been found. Indeed, MTM is a niche within specific industries and an examination of processes and information is still missing.

In order to fill the literature gap, the authors designed an appropriate methodology to conduct a case study analysis and reach the objective of the present study.

Table 2.1 Research sample

Case	Sector	Main product	Main distribution channel	Interviewee
Case 1	Fashion	Leather goods	Retail	Chief operations officer
Case 2	Furniture	Home accessories	Retail	Chief operations officer
Case 3	Food	Premium pasta	Wholesale	R&D manager

2.3 Methodology

The methodology that supported this research is a case study analysis (Yin 2003). A semi-structured questionnaire was developed and used as a research tool in order to gather the interested data. The questionnaire was designed with common sections for the sectors analysed, in order to keep the results comparable.

Concerning the sample, one company was selected to represent each sector. After that, the questionnaire was administered and several interviews were conducted to deepen the topics and focus on particular issues. Finally, the main information were collected, organised and validated by the interviewees.

In Table 2.1, the core information about the companies have been summarized. We believe that a background is important to provide context information and to better illustrate the results, specifically:

- The company one sells leather goods and is an iconic brand, internationally recognised.
- The company two sells home accessories and is a small enterprise conducting internally all the business processes.
- The company three sells premium pasta through a luxury wholesale channel.

All these companies control the major part of their activities and focus their attention on product development, representing the core business process.

Interviewees identified for the purpose of this research are Chief Operations Officer and R&D Manager: both have demonstrated a good knowledge of PD.

Concerning the production activity, it is always retained internally, but all the companies purchase raw materials (as leather, bronze, crystal and wheat). They have also shown a difference concerning the manufacturing strategy: Fashion and Furniture companies produce against periodic orders (Make To Order environment); while the food company produces large amounts of pasta in stock (Make To Stock environment) and deliver batches basing on the wholesale constraints.

Table 2.2 Fashion industry analysis

Fashion			
Process	Department	IT	Issue
Collection planning	Merchandise	PLM	Communication
Prototype design	Product development	Creative solution	Timing
Prototype development	Product development	PLM, creative solution	Timing
Prototype manufacturing	Production	Office automation	Quality, timing
Prototype fitting	Product development	PLM, creative solution	Timing
Product details	Product development	PLM	Timing
Material development	Material research	PLM	Quality, timing
Sample development	Product development	PLM	Timing
Sample manufacturing	Production	ERP	Quality, timing
Collection review	Merchandise	PLM	Communication
Costing	Costing	PLM	Communication
Technical analysis	Engineering	PLM	Timing
Engineering	Engineering	PLM, creative solution	Timing
Collection show	Merchandise	PLM, creative solution	Communication
Order entry	Production	ERP	Timing
Production	Production	ERP	Quality, timing

2.4 Results

The research results concern: (i) the CSFs, (ii) the PD process phases, (iii) the department involved in the process, (iv) the IT solutions supporting each PD process phase and (v) the issues related to the PD process.

Concerning the CSFs, from the analysis of the interviews emerges that *quality* is a strategic lever for the three sectors. In fact, the luxury segment they belong to, force them to reach high quality levels and to invest and focus on quality aspects. Furthermore, *timing* is a strategical factor for both furniture and fashion companies. They are subjected to the pressure from customers and, in order to be competitive on the market, they have to reduce lead times and time to market. Other CSFs are secondary and more related to the specific case, than generalizable to the industries we have analysed. Nevertheless, strategies as innovating, be recognised for the brand reputation or for craftsmanship are essential. Thus, as a primary result, the list of CSFs has been validated through the literature and has allowed to acknowledge the predominance of quality.

The results related to processes, departments, ITs and related issues are summarized in Tables 2.2, 2.3 and 2.4, respectively for Fashion, Furniture and Food industries.

Table 2.3 Furniture industry analysis

Furniture			
Process	Department	IT	Issue
Collection planning/customer acquisition	Sales	Office automation	Planning, IT
Order entry	Customer service	Office automation	Communication, IT
Prototype design	Product development	CAD	Timing
Prototype development	Product development	CAD	Timing
Product details	Product development	ERP	Timing
Material development	Product development	CAD	Timing
Material supply	Operations	Office Automation	Timing, quality, IT
Material quality control	Logistics	ERP	Quality
Material storage	Logistics	ERP	Timing
Costing	Operations	ERP	Communication
Engineering	Operations	CAD, office automation	Communication
Packaging design	Product development	CAD, Office automation	Timing
Packaging manufacturing	Product development	Office automation	Timing, quality
Production	Production	ERP	Quality, timing
Quality control	Operations	ERP	Quality
Packing	Logistics	ERP	Timing

As a second step to the analysis, we have compared the main activities within product development. Figure 2.1 illustrates all the common activities: the only task that is typical just of fashion and furniture companies is "customer feedback", because they need to present the collection to customers and collect orders. Manufacturing is performed in different moments: for example, fashion companies produce prototypes and samples and only when these are approved, production can start; furniture companies produce directly the finished product; while, in the food industry, the production stage is forerun by the recipe testing.

Then, depending on the need to sell to a retail channel or directly to the customer, order entry might be managed at the earliest stage of product development or later.

Hence, the analysis has demonstrated that, even if several processes are common, they could be framed in different time windows.

Coming to the analysis of the ICTs, we have noticed that PLM is implemented just from the fashion company, which also adopts office automation and creative solutions.

Table 2.4 Food industry analysis

Food			
Process	Department	IT	Issue
Marketing analysis	Marketing	Office automation	IT
Product features definition	Marketing/R&D	Office automation	IT, Communication
Idea feasibility analysis	Marketing/R&D/finance	Office automation	IT, Communication
Recipe development	R&D	Office automation	IY
Recipe test and feasibility	R&D	Office automation	Quality, IT
Prototype design	R&D/operations	CAD	Timing
Prototyping development	R&D/operations	CAD	Timing
Product feasibility	R&D	Office automation	Quality, IT
Suppliers selection	Purchasing	ERP	Quality, IT
Engineering	Operations	Office automation	Timing
Industrial tests	Operations	ERP	Quality, IT
Quality tests	R&D/Operations	ERP	Quality, IT
Transportation tests	Logistics	ERP	Quality, IT
Quantitative tests	R&D/Operations	ERP	Quality, IT
Check issues related to a small production	Operations	ERP	Quality, IT
Production	Operations	ERP	Timing

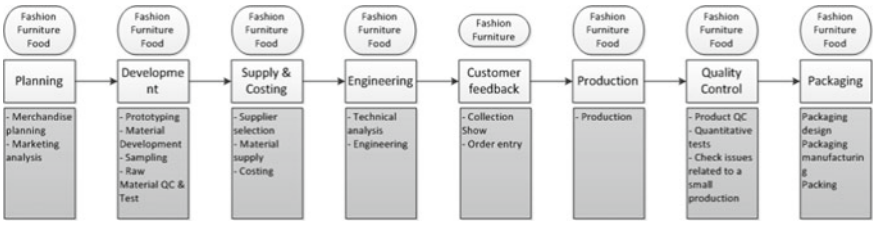


Fig. 2.1 PD process: commonalities and differences

The food company is not managing product data with an integrated approach, so it simply uses office automation. CAD and ERP are then used respectively for the upstream and downstream activities within product development.

The furniture company focuses on orders, hence the core ICT is an extended ERP solution. Product data are stored in spreadsheets within shared folders. 3D and 2D CAD support the design activity.

These different choices in terms of ICTs are due to two main causes:

(1) The driving force for data management: the product centrality lead fashion and food companies to manage product data; while, the importance of customer orders in furniture companies triggers the adoption of an extended ERP.
(2) The need to innovate through ICTs: several companies prefer to afford on office automation and renounce to implement PLM because they need a high level of flexibility. While, other companies have decided to change their processes and their information jointly through appropriate ICTs and to invest in innovation.

Coming to the issues analysis, we have noticed that the most critical one faced in process management, is quality. Controlling whether or not a product has the target quality is crucial. Timing is another issue for these companies: it makes them more competitive but also more stressed by the continuous market needs. Communication and IT issues are more related to the specific cases and less generalizable. For example, the need of ICTs is an issue for the furniture and food companies, because they have not yet adopted an integrated approach to data management.

2.5 Discussion

In conclusion, we have underlined the main improvement areas for the three industries, that also allow us to generalize the results. Comparing different industries means, first of all, to understand weaknesses and strengths of each company. Since these firms belong to the luxury market segment, a cross fertilization is possible. Hence, the authors have acknowledged the points that might be stressed to be more competitive on the market, that are PLM, product innovation and change management.

The fashion case teaches that a structured approach to data management allows to streamline product development and to respect the collection scheduling. The other two industries may learn from this point and improve information management, implementing a PLM solution.

Product innovation may be a key to success for luxury companies, that are already famous and stable in terms of craftsmanship. The food company has learned this lesson, considering innovation one of its main strengths. In fact, product innovation is revealed in the use of new ingredients, associating a meaning to the product itself and customizing it for the referring market segment. The food company, in order to be competitive, has been able to understand and satisfy the customer needs. Indeed, the innovation factor adds a plus value to the product itself, allowing food companies to achieve market success.

Change management, finally, is an important lever to be competitive. A company has to proactively change from the existing organizational structure to the future one. Whichever is the innovation to be introduced, change has to be evaluated, analysed and managed. The furniture company, that is the smallest one, has introduced lots of successful innovation keeping in mind the importance of change management.

2.6 Conclusions and Further Developments

This research has analysed three particular sectors within the luxury market segment: food, fashion and furniture. Despite the differences, above all in terms of product, that characterize these industries, they share the same interest to product development, as the core activity in the overall set of business processes.

The objective of the present study has been to explore, for the above-mentioned industries, several key features in product development: strategies, activities, issues in process management and the most used ICTs.

First of all, a literature review has been conducted, in order to recognise what has been already discussed about the topics and about the 3F. Very little is known about food, fashion and furniture industries, above all concerning product development and the related ICTs. With the aim to fill this gap, a precise methodology has been designed and a case study analysis has been conducted.

Three companies, each one belonging to a sector, have been interviewed and a questionnaire, properly designed to allow a cross-industry comparison, has been administered.

The research has shown that the most common strategies are related to quality and timing: luxury cannot renounce to ensure a premium quality product and, on the other hand, companies has to be proactive, anticipating market needs to be competitive. Then, the main activities within the product development process has been identified in Fig. 2.1. The use of ICTs has demonstrated to be related to the specific company, basing on its approach to data management and on its need to innovate through proper enterprise systems.

A cross fertilization within the three sectors has been focused on three main topics: PLM, product innovation and change management. Each of these aspects has been well managed by a company, which has shown all the related benefits.

As further developments, more cases within each sector might be involved. Then, other cross-industry topics could be identified, as a common set of performance indicators, several PLM functionalities, the need for process improvement and a sectorial approach to lean thinking.

In the end, other industries could be analyzed on the same topic, in order to recognize commonalities and differences with the 3F.

References

Arsenyan, J., & Büyüközkan, G. (2016). An integrated fuzzy approach for information technology planning in collaborative product development. *International Journal of Production Research, 54.* IFAC. https://doi.org/10.1080/00207543.2015.1043032.

Brun, A., & Castelli, C. (2013). The nature of luxury: A consumer perspective. *International Journal of Retail & Distribution Management, 41*(11–12), 823–847.

Cooper, R. G., & Kleinschmidt, E. J. (2007). Winning businesses in product development: The critical success factors. *Research Technology Management, 50*(3), 52–66.

Heine, K. (2010). The personality of luxury fashion brands. *Journal of Global Fashion Marketing, 1*(3), 154–163.

José Barbin Laurindo, F., & Monteiro de Carvalho, M. (2005). Changing product development process through information technology: A Brazilian case. *Journal of Manufacturing Technology Management*, *16*(3), 312–327. https://doi.org/10.1108/17410380510583626.

MacCormack, A., Verganti, R., & Iansiti, M. (2001). Developing products on "internet time": The anatomy of a flexible development process. *Management Science, 47*(1), 133–150. https://doi.org/10.1287/mnsc.47.1.133.10663.

Oh, W., & Pinsonneault, A. (2007). On the assessment of the strategic value of information technologies: Conceptual and analytical approaches. *MIS Quarterly: Management Information Systems, 31*(2), 239–265.

Siguaw, J. A., Enz, C. A., & Namasivayam, K. (2000). Adoption of information technology in U.S. hotels: Strategically driven objectives. *Journal of Travel Research, 39*(2), 192–201.

Urwin, E. N., & Young, R. I. M. (2014). The reuse of machining knowledge to improve designer awareness through the configuration of knowledge libraries in PLM. *International Journal of Production Research, 52*(2), 595–615. https://doi.org/10.1080/00207543.2013.839894.

Walley, K., Custance, P., Copley, P., & Perry, S. (2013). The key dimensions of luxury from a UK consumers' perspective. *Marketing Intelligence and Planning, 31*(7), 823–837.

Wu, Z. Y., Ming, X. G., Wang, Y. L., & Wang, L. (2014). Technology solutions for product lifecycle knowledge management: Framework and a case study. *International Journal of Production Research, 52*(21), 6314–6334. https://doi.org/10.1080/00207543.2014.935823.

Yin, R. K. (2003). Case study research. In: Design and methods. SAGE Publications. https://doi.org/10.1097/FCH.0b013e31822dda9e.

Chapter 3
Big Data Analysis Techniques for Supporting Product Lifecycle Management in the Fashion Industries

Enrico Vezzetti, Marco Alemanni, Corinna Balbo and Andrea Luigi Guerra

Abstract A peculiar characteristic of fashion companies is their natural predisposition to transformation. In fact, they design new collections at least two times per year. Introducing new collections means developing simultaneously hundred of new products that has to match customer's tastes/trends that evolve very fast. By acquiring and monitoring customers' information from social and digital channels, fashion industries can capture customer's tastes/trends picture. This requires analyzing a huge amount of heterogeneous data, such as feelings, positions, etc. In this scenario, the use of big data analytics can provide new insights on customer's tastes/trends. Hence, the objective of this research is to examine how some of the most important and sophisticated applications of Big Data Analytics could increase customers' satisfaction and bring advantages to the New Product Development process itself.

3.1 Introduction

Fashions companies deal with millions of data (i.e. Big Data) and these data have a value, both intrinsic and potential (Vezzetti et al. 2017). The actual challenge in the fashion industry is to be able to exploit this data. In fact, the possibility of having the right data at the right time (by means of insights from social media, market reports, internal sales data and customer buying patterns) allows having a greater insight. For example, this possibility allows predicting the right pricing, by analyzing competitors' price and demand elasticity; it allows as well to refine the local assortment planning and select the right merchandise for each channel, as, by knowing where a customer is, allows delivering relevant real-time offers based on that location. Moreover it is possible to optimize inventory across multiple channels, to improve logistics by using for example real-time traffic and weather data to re-route shipments and avoid delays, and to predict customer shopping behavior and

E. Vezzetti (✉) · M. Alemanni · C. Balbo · A. L. Guerra
Politecnico di Torino, Turin, Italy
e-mail: enrico.vezzetti@polito.it

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_3

offer relevant, enticing products to influence him/her to expand the shopping list (Vezzetti et al. 2014).

This is why the analysis of these Big Data through Analytics seems a profitable activity (La Valle et al. 2011) for the fashion industries during the long and complex new product development process (Kwon et al. 2014). Following this intuition, idea, this paper focuses on various Big Data analytics methods. The objective is to examine whether these methods can bring greater opportunities to the fashion sector.

The paper is structured as follows: Sect. 3.2 presents the role of big data analytics in fashion new product development process. After an overview of big data analytics methods, Sect. 3.3 describes methodologies; the last two sections end with results and conclusion.

3.2 The Role of Big Data Analytics in Fashion New Product Development Process

3.2.1 New Product Development Process Analysis

The first step in this analysis is the mapping of New Product Development (NPD) key processes (Guerra et al. 2015).

The model used is based on the work of (Vezzetti et al. 2015), which identified the following NPD process phases: developing, which includes planning and design; sourcing, characterized by all those activities linked to suppliers and materials management; production; and distribution, that consists of marketing and sales. For each of them the main challenges have been pointed out (Table 3.1).

3.2.2 Big Data Analytics Methods

When advanced analytic techniques are applied on huge amount of data, it is correct to refer to them as Big Data Analytics (BDA) (Chen et al. 2012).

Four Big Data analytics approach have been used in this study: Sentiment Analysis, Visual Sentiment Analysis, Intelligent Video Analysis and Geospatial Analysis.

3.2.2.1 Sentiment Analysis

Sentiment Analysis (SA) is the first application of Big Data Analytics studied. Its input is represented by a text in form of online reviews, blogs, and social network posts (Broß 2013). The task performed by SA is simply analyzing the texts that contain people opinions toward a specific entity (products, organizations, individuals, and events) (Aggrawal and Zhai 2012) in terms of: terms presence and frequency, parts of

Table 3.1 Principal phases of new product development process in the fashion sector

Process	Challenges
Developing	• Understanding customer needs • Speed up design process • Reduce samples' variability and testing • Change management → design reworks
Sourcing	• Lack of vertical integration result in scarce collaboration mechanisms • Decision on products to be produced must be quick • Knowledge management, meaning cataloguing and re-using information (suppliers track records) • Change management → variable duration and loss of pricing concessions
Production	• Sudden breakdowns and setups • Materials availability • Capacity management
Distribution	• Perform accurate forecasting to avoid out-of-stock conditions • Shipments timeliness • Efficient marketing campaign/promotions/prices • Develop a global perspective

Fig. 3.1 Sentiment analysis use

speech (e.g. adjectives), opinion words and phrases (e.g. good or bad, like or hate), negations (Medhat et al. 2014). Thus, it is possible to determine the consumer's attitude and opinion (positive or negative) and gives the relative score in real time (Wilson et al. 2005) (Fig 3.1).

3.2.2.2 Visual Sentiment Analysis

Visual Sentiment Analysis method takes as input images and photos posted on social networks (Facebook, Flickr, Pinterest, Instagram…). Then through artificial intelligence software (image recognition) it is possible to recognizing and describing the

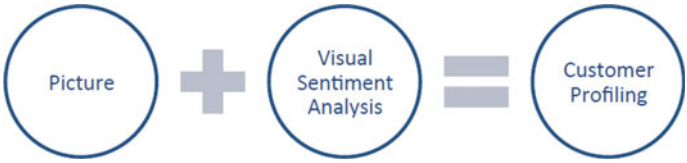


Fig. 3.2 Visual sentiment analysis use

Fig. 3.3 Intelligent video analysis use

content of photographs. Once they were limited to recognizing individual objects, now new software can identify entire scenes. The analysis can in fact determine the sentiments expressed in the image, the clothes brand wore, the location, etc. (Agostino and Sidorova 2016). If the image is also tagged, it is possible to find correlations between the publisher and the viewer affect concepts (Fig 3.2).

3.2.2.3 Intelligent Video Analysis

Intelligent Video Analysis (IVA) works more than image processing. With back-end analytics and management platform seamlessly integrated with front-end devices, intelligent video analytics can serve a variety of purposes to benefit business and organizations. Video Analytics input taken in this case is represented by the registration of videos through cameras in the shops. There are a variety of techniques, among which video camera, point of sales systems, Wi-Fi and Bluetooth-enabled mobile devices to monitor, analyze, and extract meaningful information from video, both real-time and prerecorded. Thanks to video analytics it is possible to study the entire group of people (e.g. family members who shop together), without missing data on those who do not interact with the store at the cash register. The analysis provides in fact information about the size of the group, the group's demographics, and the individual members' buying behavior (e.g. how shoppers move around the stores, what are their interests, what captures their attention, how long they stay in the shop…) (Janetzko et al. 2014) (Fig 3.3).

Fig. 3.4 Geospatial analysis use

3.2.2.4 Geospatial Analysis

Geospatial analysis (GA) is an approach to applying statistical analysis and other analytic techniques to data, which has a geographical or spatial aspect. Geospatial Analysis inputs taken by the this last technique are represented by GPS (Global Positioning System) devices, RFID (Radio Frequency Identification), customer address got through fidelity card, IP address provided by an anonymous web feedback geo-resolved, and bar-codes. Thanks to software capable of geospatial representation and processing, and use of geographic information systems, it is possible to select routes, examine the structure of relationships between social entities (persons, groups, web sites…). As a result, companies can get traffic sensor, road network, vehicle data, people location, diffusion of innovations and rumours, weather forecast (Fig 3.4).

3.3 Methodology

The research methodology has followed three steps (Fig. 3.5).

In the first step we have organized a focus group survey (Guerra et al. 2016), together with desk analysis, involving experts from the fashion domain and Big Data Analytics specialists. Starting from the NPD process (Vezzetti et al. 2015), the NPD fashion challenges have been formalized.

In the second step, by using Quality Function Deployment QFD (i.e. a design methods able to correlate orthogonal dimensions), the NPD challenges previously obtained have been mapped with Big Data specifications in order to provide the impact of Big Data Analytics Techniques on the different fashion challenges.

In the last step, using a multivariate analysis, a more holistic analysis has been conducted in order to understand the coverage power of Big Data Analytics techniques in a PLM perspective.

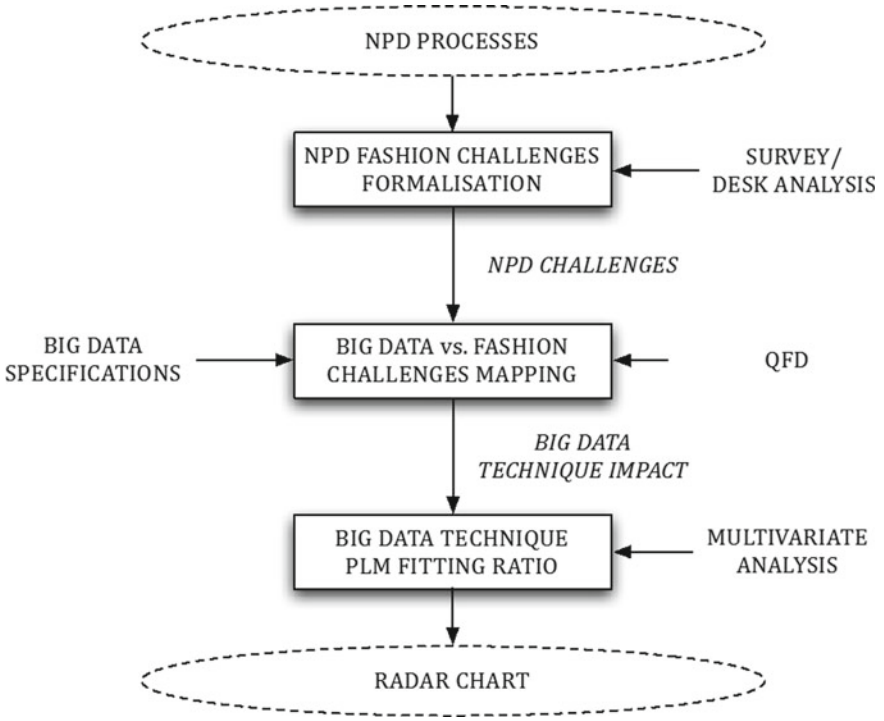


Fig. 3.5 The schema of the methodology used in this study

3.4 Results

3.4.1 Sentiment Analysis

Thanks to the results coming from the multivariate analysis, and reproduced on the radar chart in Fig. 3.6, it is possible to see that the main advantages brought by this method are related to the developing phase, thanks to the real-time and focused analysis of the main discussion topics that allows identifying new design opportunities, re-arrange and re-develop collections per customers' demand. Also, the sourcing and distribution phases can gain benefits because of the possibility, on one hand, to gain more information on the customers' preferred materials and subsequently select better and more efficient suppliers, and on the other hand to immediately catch changes in consumers' demand and preferences allowing focused promotions, inventory optimization and sales improvement.

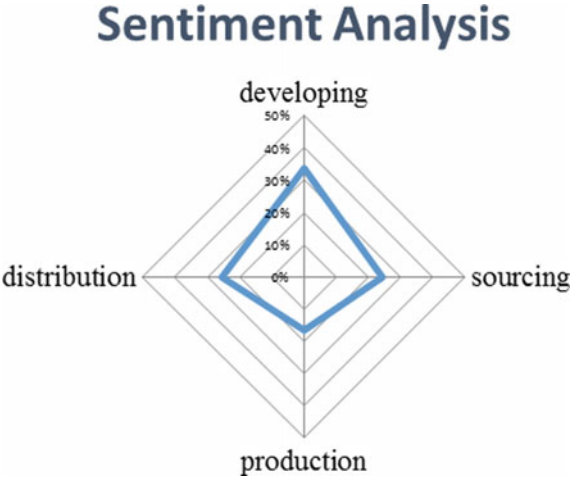


Fig. 3.6 Fitting ration of sentiment analysis in supporting the fashion product lifecycle

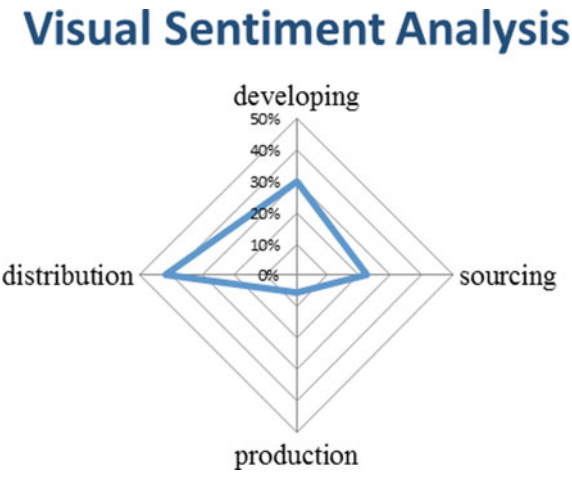


Fig. 3.7 (Below) Fitting ratio of visual sentiment analysis in supporting the fashion product lifecycle

3.4.2 Visual Sentiment Analysis

Having a look at the radar chart declined from the ranked provided by the multivariate in Fig. 3.7, the method has a great positive impact during the distribution phase. First, it allows determining which combinations of related products consumers are likely to buy together and subsequently develop upselling strategies, along with focused promotions. Second, it brings to a perfect segmentation of the market in terms of geographical locations, demographic groups and habits, which facilitates assortment and inventory optimization across the different regions.

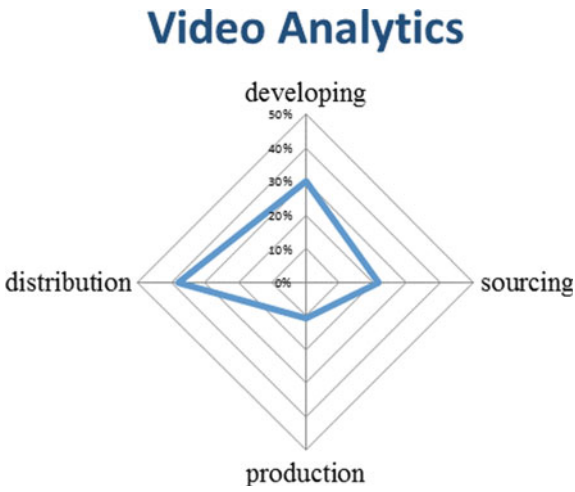


Fig. 3.8 Fitting ratio of video analysis in supporting the fashion product lifecycle

3.4.3 Video Analytics

From the radar chart in Fig. 3.8, it is evident that the distribution phase is the most supported: the opportunity to quickly understand what customers look for, in terms of trend, color, material allows to launch focused marketing campaigns, per the store location, and take more efficient decision on product placement, promotion design, layout optimization, and staffing.

3.4.4 Geospatial Analysis

Having a look to the rank provided by the multivariate analysis, it is again possible to affirm that distribution phase is the one that benefits the most. In this case, advantages are given by the possibility of: determining the optimal locations for stores and distribution centers, and differentiating better among customers based on their preferences caused by the geospatial location. In return companies, can properly balance inventory with demand, optimizing capacity, and better-forecast sales. Conversely to the other methods, the Geospatial Analysis one impacts the production phase because, thanks to the vehicle sensor information, can schedule predictive maintenance and maximize the life of business equipment (Fig 3.9).

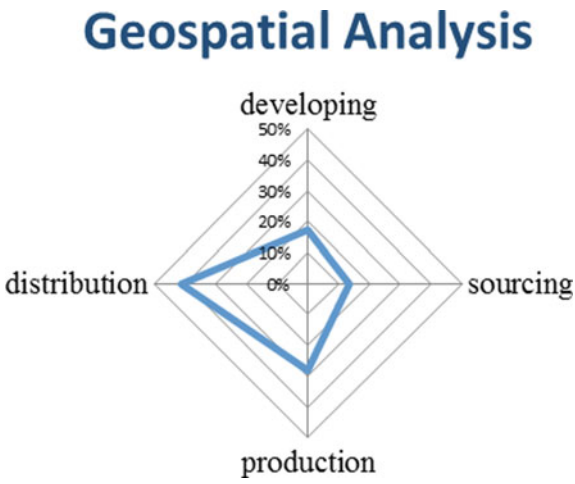


Fig. 3.9 Fitting ratio of geospatial analysis in supporting the fashion product lifecycle

3.5 Conclusions

The paper, rather than proposing a solution, aims to explore how could be possible to improve the fashion NPD process and to alleviate, where possible, some of its intrinsic criticalities, by means of Big Data 'revolution'.

Based on a deep research on some available analytics' solutions, it seems that the phases where Big Data Analytics can be useful are mainly those that somehow interact with the customers: planning, design, marketing and sales. Here in fact the main advantages given by methods such as Sentiment, Picture and Video Analyses are the deeper and faster customer insights, the possibility to find correlations between brands-sentiments-locations-demographics, which help shortening all the critical lead times (Time to Market, Time to React, Time to Serve).

Although the solutions presented appear to be applicable to the sector-specific situation, the analysis has one limitation, which is to be theoretical rather than practical. Therefore, the integration with the above-mentioned solutions should be done in concrete reality and tested in order to determine the effective performance improvement, the efficiency and the customer satisfaction.

In conclusion, we cannot exclude a priori that their integration could be constrained by financial, technological or human resources issues.

Nevertheless, it is undeniable that volume, variety and facility with which data can be found is now exceptional and any business has potentially the ability to capture, store, aggregate, combine and transform data into intelligence. This means that even the most creative businesses, like fashion, can easily improve their decision-making, thanks to the possibility of easily combining different data and convert them into insights.

References

Agostino, D., & Sidorova, Y. (2016). A performance measurement system to quantify the contribution of social media: New requirements for metrics and methods. *Measuring Business Excellence, 20,* 38–51. https://doi.org/10.1108/MBE-05-2015-0030.

Aggrawal, C. C., & Zhai C. X. (2012). *Mining text data*.

Broß, J. (2013). Aspect-oriented sentiment analysis of customer reviews using distant supervision techniques. Freie Universität Berlin, Freie Universität Berlin, Germany.

Chen, H., Chiang, R. H. L., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. *MIS Quarterly, 36,* 1165–1188.

Guerra, A. L., & Vezzetti, E. (2015). Digital intermediary objects: The (currently) unique advantage of computer-supported design tools. In *DS 80-5 Proceedings of the 20th International Conference on Engineering Design (ICED 15), Design Methods and Tools—Part 1*(Vol. 5). Milan, Italy, 27–30 July 2015.

Guerra, A. L., Gidel, T., & Vezzetti, E. (2016). Toward a common procedure using likert and likert-type scales in small groups comparative design observations. In *DS 84: Proceedings of the DESIGN 2016 14th International Design Conference* (Vol. 1, pp. 23–32).

Janetzko, H., Jäckle, D., & Schreck, T. (2014). Geo-temporal visual analysis of customer feedback data based on self-organizing sentiment maps. *International Journal on Advances in Intelligent Systems, 7,* 237–246.

Kwon, O., Lee, N., & Shin, B. (2014). Data quality management, data usage experience and acquisition intention of big data analytics. *International Journal of Information Management, 34,* 387–394. https://doi.org/10.1016/j.ijinfomgt.2014.02.002.

La Valle, S., Lesser, E., Shockley, R., Hopkins, M. S., & Kruschwitz, N. (2011). Big data, analytics and the path from insights to value. *MIT Sloan Management Review*.

Medhat, W., Hassan, A., & Korashy, H. (2014). Sentiment analysis algorithms and applications: A survey. *Ain Shams Engineering Journal, 5,* 1093–1113. https://doi.org/10.1016/j.asej.2014.04.011.

Vezzetti, E., Alemanni, M., & Macheda, J. (2015). Supporting product development in the textile industry through the use of a product lifecycle management approach: A preliminary set of guidelines. *International Journal of Advanced Manufacturing Technology, 79,* 1493–1504. https://doi.org/10.1007/s00170-015-6926-4.

Vezzetti, E., Alemanni, M., & Morelli, B. (2017). New product development (NPD) of "family business" dealing in the luxury industry: Evaluating maturity stage for implementing a PLM solution. *International Journal of Fashion Design, Technology and Education, 10,* 219–229. https://doi.org/10.1080/17543266.2016.1250286.

Vezzetti, E., Violante, M. G., & Marcolin, F. (2014). A benchmarking framework for product lifecycle management (PLM) maturity models. *International Journal of Advanced Manufacturing Technology, 71,* 899–918. https://doi.org/10.1007/s00170-013-5529-1.

Wilson, T., Wiebe, J., & Hoffmann, P. (2005). Recognizing contextual polarity in phrase-level sentiment analysis. In *Proceedings of the Conference on Human Language Technology and Empirical Methods in Natural Language Processing, HLT'05* (pp. 347–354). Association for Computational Linguistics, Stroudsburg, PA, USA. https://doi.org/10.3115/1220575.1220619.

Part II
Social Media and Data Analysis in the Fashion Industry

Chapter 4
Fashion #MadeinItaly: What Do You Mean?

Valentina Mazzoli, Diletta Acuti, Lorenzo Magherini, Romeo Bandinelli, Raffaele Donvito and Dinorá Eliete Floriani

Abstract

Purpose. This paper aims to define the overall Made in Italy perception within the on-line and off-line contexts. Particularly, authors attempt to consider three main aspects; the first one regards the key product categories linked to the Made in Italy production; the second aspect concerns the key characteristics linked to the Italy Country Image and the overall sentiment related to it. Finally, the research aims at identifying whether Italian brands enhance their Country of Origin (COO) image or not.

Methodology. With the purpose to achieve the goals of the paper, authors carried out a content analysis on social media posts related to #MadeinItaly and expected to confirm these preliminary results with a survey on a sample of 112 Made in Italy consumers in the specific context of the Brazilian market.

Findings. As expected, the survey confirms the content analysis outputs. Particularly, Fashion results as the first product category associated to the Made in Italy imaginary, strictly related to the design and prestige of the production. The overall sentiment toward the Italy County Image is positive. Moreover, the most renowned Italian brands belong to the fashion sector and enhance their Country of Origin (COO) image.

Practical implications. The analysis of social media confirms user-generated contents as important contributes for the Country Image construction. Indeed, the keys elements describing the Italy Country Image emerged from the web analysis as well as from the survey, allowing managers and practitioners to use it in their communication strategies.

V. Mazzoli · D. Acuti (✉)
University of Pisa, Pisa, Italy
e-mail: diletta.acuti@unifi.it

L. Magherini · R. Bandinelli · R. Donvito
University of Florence, Florence, Italy

D. E. Floriani
Universidade do Vale do Itajaì, Vale do Itajaì, Brazil

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_4

Keywords Country of origin · Country image · Made in Italy · Fashion Social media

4.1 Introduction

The concept of Country of Origin (COO) has changed over time increasing its centrality in the academia and the practitioners' arena, due to its ability to influence consumers' behavior, in a more and more competitive and globalized contest. The effect of COO has been studied for long time, especially on very well-known brands, such as luxury brands (Godey et al. 2012). However, the progressive accessibility of social communication even for small firms provides new spaces for studying this topic. Moreover, this wider accessibility allows to user-generated content (UGC) to contribute to the creation of the Country Image. Unfortunately, due to the positive power related to the Italy country image, even foreign brands that do not produce in Italy attempt to exploit this aspect in order to improve the value of their production. This phenomenon may reduce the positive associations related to the authentic Made in Italy products (Chakraborty 1996). In this context, this paper aims to define the overall Made in Italy perception within the on-line and off-line contexts. Particularly, authors attempt to consider three main aspects; the first one regards the key product categories linked to the Made in Italy production; the second aspect concerns the key characteristics linked to the Italy Country Image and the overall sentiment related to it. Finally, the research aims at identifying whether Italian brands enhance their Country of Origin image or not.

4.2 Literature Review

4.2.1 Country of Origin

The concept of Country-of-Origin has changed over time increasing its centrality in the academia and the practitioners' arena, because of its ability to influence consumers' behaviour. Indeed, nowadays many companies demonstrate to be able to adopt a branding mix composed by company brand and Country brand, to differentiate their offer (Bertoli and Resciniti 2013). The Country-of-Origin effect is created in the minds of consumers from individual's knowledge, experience, exposure and inclination towards a particular Country. It helps in reducing cognition load in consumers decision-making by becoming a proxy for quality, reliability and acceptability of products originating from a specific Country (Abraham and Patro 2014). As largely known, the first studies about COO were discussed at the end of '60s, when experts in the field began to think about COO as a variable able to facilitate the success of a product more than other marketing stimuli (Dichter 1962). One of

the first explicit formalization is due to Schooler (1965, 1971), who analysed and tried to scientifically prove the existence of a positive (or negative) COO effect on consumer behaviours. Of course, authors have proved that COO effect is affected by the demographic variables (Sharma et al. 1995); so demographic variables play important role for determining the effect of COO (Javed and Hasnu 2013).

On a theoretical level the paper refers to a part of the wide existent literature related to the relevance of Country Image (Pappu et al. 2007, pp. 726–45) in influencing the value that consumer gives to a product or a brand (Pappu et al. 2006; Aiello et al. 2009). Nagashima defines "image" as the representation, reputation, or stereotype of a specific Country, which consumers associate with the products (Nagashima 1970, 1977). According to Roth and Romeo (1992), a Country Image arises from different dimensions that qualify a nation in terms of its production profile. Such dimensions include the following aspects: innovative approach (superior, cutting-edge and technology); design (style, elegance and balance); prestige (exclusiveness and status of the national brands) and workmanship (reliability, durability and quality of national manufactures). The origin of a product, indeed, influences the choices of the consumers that, according to the Country stereotyping, evaluate the quality, the performance, the price and design (Baghi and Tedeschi 2012). The stereotype is made up of three components (Laroche et al. 2005): a cognitive component referred to social, cultural, political and economic aspects; an affective one that describes consumers' affective response to the Country and Country's people; a conative one, consisting of consumers' desired level of interaction with the sourcing Country. Moreover, the so called "Country Equity" can be modified in time; as known to that regard literature brings up two concepts: the halo and the summary effect (Min Han 1989). The first one is referred to the consumer that, at the time of the purchase, has not directly experienced any product of a certain Country yet and chooses accordingly to the image they have of that Country-of-Origin in order to evaluate the quality of the product; the second one is about the consumer who has already experienced some products of a certain Country.

As Country of Origin has been used by consumer to predict a products' quality and performance and to understand the rationality of their purchasing behaviour (Lin and Chen 2006), it could be argued that Country of Origin may influence consumers' evaluations on international branded fashion products as well. Of course, because of many forms that fashion items could take, it is extremely complicated to assess, learn about and understand the behaviour involved in buying clothing items. The discussion about the magnitude of the effect of the Country of Origin does not seem to be over, particularly when there is other intrinsic and extrinsic information about the fashion product available (Almeida et al. 2012).

Indeed luxury fashion brands made and designed in a particular Country, and fashion designers or celebrities who are originated from a certain Country are effective in attracting global fashion consumers (Jung et al. 2014). Well-known fashion cities and their corresponding countries (e.g. Paris in France, Milan in Italy, New York in the USA, and London in the UK) have great fashion equity too (Breward and Gilbert 2006).

The COO effect has been analysed by the academia not only as single concept, but also in a multiple-cue approach, that considers it as a complex system of multiple components: the Country of Origin, Country of Manufacture, Country of Design, Country of Brand Origin. In particular, referring to the Country of Design (COD) and Country of Manufacture (COM) (Samiee 1994; Nebenzahl et al. 1997; Jaffe and Nebenzahl 2001). Hamzaoui and Merunka (2006) have tested that, for products with high status symbolic meanings, consumers from emerging countries are more sensitive to COD than for not high-end goods, for which COM and COM/product fit are important. Therefore COO can constitute an important competitive advantage (Agrawal and Kamakura 1999), as it influences not only consumer's perceptions (Zeugner-Roth et al. 2015), but also the price a consumer is willing to pay for a product with a certain origin (Koschate-Fischer and Diamantopoulos 2012). For example, Wall and Heslop (1986) found Canadians willing to pay more to purchase Canadian products over imported products as long as the quality was equal. More recently Drozdenko and Fensen (2009) have demonstrated how consumers showed a positive bias (i.e. increased willingness to pay a higher price) toward products from developed countries relative to less developed countries. In that sense, Diamantopoulos et al. (2011) affirm that the consumer willingness to pay a certain price is greater for a given product originating in a Country with a more appreciated Country image, rather than one with a Country Image less appreciated.

4.2.2 User-Generated Contents

User-Generated-Contents (UGC) has grabbed the global attention, due to the rapid penetration of social media platforms into users' lives. Indeed, the growth in the usage of social networks has boosted a collaborative environment, where consumers create their own contents, stimulating more engagement from the part of consumers (Fernando et al. 2014).

Social media include a variety of websites and online platforms (i.e. blogs, review sites, media sharing, question-and-answer sites, social book-marking, social networking, social news, and wikis) on which users share their lives in different ways (Xiang and Gretzel 2010).

Since social media content is very often perceived to be more trustworthy than official sources or mass-media advertising (Fotis et al. 2012), UGC are able to influence other customers' perceptions on product and brand, thus shaping brand image, and more broadly brand knowledge (Keller 1993), through brand image associations (Virgo and de Chernatony 2006). Moreover, UGC can easily spread throughout the web harnessing E-Word of Mouth (EWOM) and potentially affecting consumers' brand knowledge. Brand knowledge has been defined as the personal meaning linked to a brand stored in consumers' mind (Keller 2003; Aaker 2003), built on brand associations, that are the product and non-product related attributes.

Brand associations can positively influence brand equity (Keller 2003), when there is an alignment between brand identity (internal brand associations defined by the

company), and brand image (external brand association perceived by external actors). Moreover, the construction of congruent and distinctive brand associations influences the results of brand differentiation strategy and, consequently, consumers' choices. Indeed, recently, as Zhang and Sarvary (2014) have empirically supported, ex ante identical firms can acquire differentiated market positions that spontaneously emerge from UGC. Thus, products and brands result on social media as user-generated depending on how users project them on social media platforms (Andéhn et al. 2014). As a consequence, UGC introduce a greater complexity in brand management, fostering the importance in considering both textual and visual contents to understand the complete structure of brand image formation in the online market space (Choi et al. 2007).

4.3 Methodology

With the purpose to achieve the goals of the paper, authors developed a content analysis on social media posts related to #MadeinItaly and expected to confirm these preliminary results with a survey on a sample of 112 Made in Italy consumers in the specific context of the Brazilian market.

Authors focused on the effect of COO on Italian production, analyzing perceptions related to Made in Italy.

Defining Made in Italy is not easy; in order to frame this concept, it is necessary to consider the multidimensional nature that qualify it. First of all, Made in Italy is a mark affixed to a product or its packaging that allows the consumer to attribute to Italy the origin of the product. Moreover, it means a complex of knowledge and traditions developed and consolidated over the years thanks to the cooperation of art, culture, territory, manufacturing, technologies, leading to the creation of an identity enriched until nowadays (Colli 2005). Contemporary Made in Italy is a phenomenon, born thank to these traditions, referring to companies formed in Italy in the period between the wars, during the economic miracle after the WWII, and in the Seventies (Curzio and Fortis 2000), definable as "all sectors operating in the areas of fashion, home furnishings, leisure, Mediterranean diet, to which must be added the mechanics sectors connected" (Fortis 2005). Made in Italy is addressed not only to Italian market but is largely requested by an international demand (Quintieri 2007); between the others one important market for Made in Italy firms is Brazil, where Italian machinery, services, fashion, food and interior design are highly appreciated.

Made in Italy thus expresses the culture and characteristics of the Italian spirit well, and its products represent significant symbols of Italy image (Varaldo 2001), contributing to the creation of a positive Country Image abroad (Aiello et al. 2015).

Recently, due to the positive power related to the Italy country image, even foreign brands that don't produce in Italy attempt to exploit this aspect in order to improve the value of their production. This phenomenon may reduce the positive associations related to the authentic Made in Italy products (Gentry et al. 2001).

For this reason, it is important to monitor the overall perception of Made in Italy. Thus, this paper aims to contribute providing a methodology useful for understanding consumer associations.

With this purpose, authors conducted a content analysis on social media posts. This analysis takes into account both images and textual communications. Then, authors run a survey, in order to confirms results of content analysis and provide more insights to the issue. The sample of images was collected using the software 4 K Stogram used to retrieve pictures on Instagram. Particularly, authors considered 500 images downloaded under the hashtag #MadeinItaly.

Instagram was chosen among the other social media because it offers plural advantages. Particularly, it is one of the most used social media all over the world with its 400 million active users which over 60% log in daily, making it the second most engaged social network after Facebook (Brandwatch 2016). Moreover, on Instagram, textual descriptions are overcome by images (Marwick 2015). This represents a relevant issue that differentiates Instagram from other social networks, considering that visual impressions are able to strongly influence long lasting human attitudes (Pilelienė and Grigaliūnaitė 2016). Furthermore, visual communication is part of the textual paralanguage communication, that is under-investigated, even if it is growing in its importance, as the computer-mediated communication has become more prevalent (Luangrath et al. 2017). Additionally, the structure of posts allows users to connect with other users, by "mentions" or by using specific tags called "hashtags" (words starting with a '#' character), useful to denote topics on Instagram and to make posts more easily accessible by the public (Small 2011). Authors developed two types of content analysis, namely the thematic and the affective one (Humphreys 2010). Thematic analysis compares changes in themes over time and examines changes in the Made in Italy has been represented by different entities (Matthes and Kohring 2008). Affective analysis tracks changes in language valence and emotion, providing insight into the sentiment with which Made in Italy has been represented.

Given the goals of the study authors follow a process of analysis carried out through different steps.

1. Development of the protocol of analysis for data collection;
2. Download of images characterized with #Madeinitaly;
3. Qualitative analysis of pictures filling the protocol of analysis;
4. Content analysis on hashtags associated to the pictures through the software Nvivo;
5. Quantitative analysis on frequency rates of hashtags through the software SPSS.

In order to detect the key product categories linked to the Made in Italy production, authors identify 6 categories, namely food and wine, fashion and accessory, automotive and machinery, consumer electronics and technology, and cars. Authors add a seventh category for the classification of images not related to the previous categories.

Considering the key characteristics linked to the Italy Country Image and the overall sentiment related to them, authors classify the most common hashtags in 4 traits, namely innovativeness, design, prestige, and workmanship.

Finally, regarding the brands that enhance their COO, authors detect them through the identification of posters' identity. In doing so, authors were able to provide a list of most frequent brands related to Made in Italy.

The results of social media analysis have been confirmed by a survey (Chisnall 2005) run on a sample of Brazilian consumers. Brazil represents a large potential market for Italian production because of its peculiar evolution of recent years: the population, that is 200 million of inhabitants, is mainly composed of young people (with age between 15 and 40), is characterized by a strong urban concentration (85% lives in big urban centres); furthermore, there is developing process of a new middle class that potentially regards a large portion of the total population).

The survey was provided in Portuguese, addressed to a convenience sample of 112 people resident in Brazil. Authors choose this Country because it has been for many years the most developed Country in Latin America, thanks to the wealth of natural and human resources characterizing the Country (Adrogué et al. 2010). Therefore, for this general reason and because of the long lasting presence of the Italian community in that Country, the economic relationship between Italy and Brazil has been leaving a positive moment.

The respondents taking part in the survey, distributed via e-mail, are professors and students of Univali (Universidade do Vale do Itajaí), University of Santa Caterina. The involvement of students and members of the academia as survey groups is consistent in social science researches for analysing marketing phenomena such as perception and levels of brands familiarity. According to Peterson (1994), students and scholars samples are relatively homogeneous in terms of demographics, socioeconomic background and education; the relevance of the Country Image investigation among young generation is demonstrated also by recent scientific analysis performed by international scholars (Jin et al. 2015).

Moreover, the sample respects the characteristics of the potential Brazilian consumers of Made in Italy. In fact, the territory where the University is located (Santa Caterina) is one of the richer Brazilian regions, open to international trade, with a growing urbanization and the second in Brazil for alphabetization rate. Finally, the sample appears to be coherent with the potential Brazilian consumer of Made in Italy products because of the social economic status usually related to the management students (above the Country average and coherent with the medium high positioned marketing value proposal). The questionnaire is composed of 45 items (mainly closed questions based on a four points Likert scale).

4.4 Main Findings

4.4.1 Instagram Analysis

Authors developed a content analaysis on a sample of 500 posts that include image, post title and hashtags, poster's identity. According to the thematic analysis developed on Instagram contents, the emerging categories of products related to #madeinitaly are mainly related to fashion and accessories (66%), design and furniture (14%) and food and wine (6%). The affective analysis reveals that the overall sentiment of Instagram posts is very positive both from the part of brands and consumers. The majority of posts included in the sample are brands-generated contents (81%) and user-generated contents (18%). Brands that include Instagram as promotion channel and use #madeinitaly are mainly small firms and brands with a low awareness but with an intrinsic high quality of products. In order to provide deeper insights to this qualitative and descriptive analysis, authors run a correspondence analysis on posts textual information. Particularly, the 50 most frequent words (hashtags) of the overall dataset and the 50 most frequent hashtags for each category of products have been selected. Figure 4.1 provide an overview of the combined most frequent hashtags resulting from the overall amount of posts included in the sample. According to this representation, hashtags that stress the traditional facet of Made in Italy (Roth and Romeo 1992), such as design (e.g. #design, #italiandesign), innovativeness (e.g. #new, #newcollection), prestige (e.g. #luxury, #amazing) and workmanship (e.g. #artigianato, #handcrafted).

Table 4.1 summarizes the results of correspondence analysis, while Fig. 4.2 collocates in a graph most frequent hashtags. Correspondence analysis is often used in marketing to investigate relationships between brands and attributes (Whitlark and Smith 2001). In this case, authors use correspondence analysis to explore associations between categories of products and Made in Italy imaginary, by using brands- and users-generated contents.

Table 4.1 Results of correspondence analysis

Dimension	Singular value	Inertia	Chi square	Sig.	Proportion of inertia		Confidence singular value	
					Accounted for	Cumulative	Standard deviation	Correlation
								2
1	0,580	0,337			0,245	0,245	0,009	0,043
2	0,553	0,306			0,223	0,468	0,007	
3	0,508	0,258			0,188	0,656		
4	0,452	0,204			0,148	0,804		
5	0,425	0,180			0,131	0,935		
6	0,298	0,089			0,065	1,000		
Totale		1,375	13897,57	0,000[a]	1,000	1,000		

[a] 294 Degrees of freedom

Fig. 4.1 Fifty most frequent hashtags related to made in Italy posts

Furthermore, correspondence analysis provides a visual representation of attribute-category related to #madeinitaly reducing the multidimensional frequency data into to 2 dimensional map. In Fig. 4.1, it is possible to observe the relative proximities of the frequently used hashtags and the seven categories (clusters). On the graph the horizontal axes (Dimension 1) accounts for 25% and vertical axes (Dimension 2) for 22%, thus the two dimensions explains the 47% of association of the frequent words and each category. Dimension 1 divides frequent hashtags in those that frequently appear in posts users-generated (right side) and those that frequently appear in posts brands-generated (left side). Equally, Dimension 2 divides hashtags in fashion related hashtags (high side) and no-fashion related hashtags (low side). Fashion related hashtags include also those hashtags usually used for contents related.

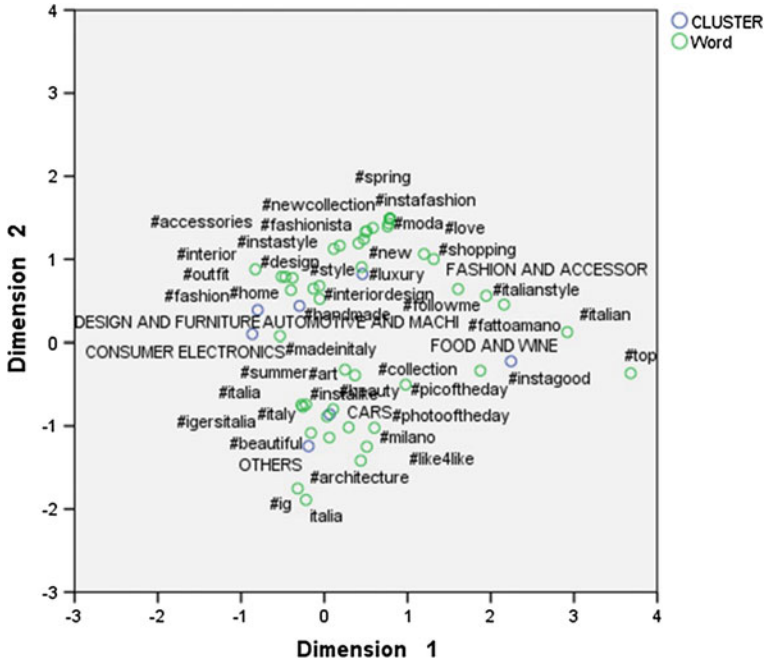


Fig. 4.2 Correspondence map for the frequent words related to #madeinitaly represented on 7 categories

4.4.2 Survey

In order di deepen results of the thematic and the affective analysis, authors have examined the output of the survey submitted to the sample of Brazilian consumers. The sample is composed by 45% of male respondents and 55% of female, with an age average of 33 years. Regarding the key product categories linked to the Made in Italy production, authors observe that Food and wine is the main field associated to Italian products (46.2%) followed by Fashion (35.9) and others (5.7). Surprisingly, Design and furniture has been indicated only by 0.9% of the sample (Table 4.2).

In order to investigate the sentiment linked to Made in Italy products, respondents have been asked to evaluate them from "very positive" to "very negative The general evaluation of Italian product (see Table 4.3) is positive for the 93.5% of the sample (the 28.7% of this percentage expresses a very positive evaluation and 64.8% a positive evaluation). Nobody declares to give a very negative evaluation to Italian products (see Table 4.4). This positive judgment is confirmed by the sample after the purchase too. Indeed, about half of respondents have declared that have changed positively their perception of Made in Italy products. Only 1% states that has changed the evaluation of Italian product in a negative way (Table 4.5).

Table 4.2 Product categories maily related to the made in Italy production

Product category	Percentage of the sample
Food and wine	46.2
Fashion	35.9
Others	6.6
Cars	3.8
Design and furniture	0.9
Consumer electronics and technology	0.9
Automotive-machinery	0

Table 4.3 The evaluation of Italian products

Evaluation of Italian products	%
Positively	64.8
Very positively	28.7
Negatively	6.5
Very negatively	0.0
Total	100.0

Table 4.4 The evaluation of Italian products after the purchase

Evaluation of Italian products	%
Yes, positively	49.0
Yes, negatively	1.0
No	50.0
Total	100.0

Table 4.5 Most renown brands related to the made in Italy production

Brands	No. of times mentioned	(%)
Gucci	31	15.66
Armani	30	15.15
D&G	23	11.61
Prada	22	11.11
Valentino	14	7.07
Versace	10	5.05
Ferragamo	10	5.05
Cavalli	9	4.54
Ferrari	6	3.03
Bulgari	5	2.53
Fendi	5	2.53

In order to identify whether Italian brands enhance their Country of Origin image or not, authors asked respondents which Italian brands they know (respondents could indicate a maximum of 5 brands) Table 4.3. The 51% of the sample mentioned at least one brand and 198 brand answers have been collected in total. 27 brands belong to the fashion sector and 5 come from the automotive world (Ducati, Ferrari, Fiat, Lamborghini, Pininfarina). The most mentioned brand is Gucci, quoted by 15.66% of the sample, followed by Armani, known by 15.15% and D&G, mentioned by 11.61% of respondents. The relevance of the fashion industry for the Italian economic system is confirmed by the empirical results gained: the 90% of the Italian brands known by the Brazilian respondents are active in the fashion industry.

4.5 Discussion

Results of the social media analysis and the survey are consistent with each other, however their differences could suggest to managers some considerations. Following the research questions, both the content analysis and the survey show Fashion and accessories as well as Food and wine the main key product categories linked to the Made in Italy production (RQ1). Moreover, according to the Instagram analysis and the Brazilian respondents perceptions, an overall positive perception of Made in Italy products seems to be steady. According to the textual analysis carried out on hashtags retrieved in the posts sample, the main facets of Made in Italy refer to design, workmanship, innovativeness and prestige, that are confirmed by the survey (RQ2).

According to research questions 3 (RQ3), the Instagram analysis reveals that #madeinitaly is used by firms with a low brand awareness. Indeed, the majority of them are high-end products that try to penetrate the market exploiting the value of the imaginary related to made in Italy claiming explicitly their authentic Italian production. However, no powerful fashion brands appear in the Instagram sample because they do not use the hashtag #madeinitaly. Obviously, Brazilian consumers usually associate to the Italian production powerful fashion brands with a high brand awareness (e.g., Salvatore Ferragamo, Gucci, Valentino, Prada, etc.).

4.6 Limitation and Future Research

This study provides an exploratory investigation of Country of Origin through the analysis of social media, allowing to observe content generated by users and associations linked to Made in Italy products. Moreover, results are deepen with a survey that confirms the majority of results of the social media analysis. Further researches could be developed in order to improve the analysis of Country of Origin on social media and associations to Made in Italy. Therefore, it could be interesting to observe

the data for a longer period, analyzing a wider number of images and replicate the survey for other Countries.

References

Aaker, D. (2003). The power of the branded differentiator. *MIT Sloan Management Review, 45*(1), 83.

Abraham, A., & Patro, S. (2014). 'Country-of-origin' effect and consumer decision-making. *Management and Labour Studies, 39*(3), 309–318. https://doi.org/10.1177/0258042X15572408.

Adrogué, R., Cerisola, M., & Gelos, G. (2010). Brazil's long-term growth performance: Trying to explain the puzzle. *Journal of Economic Studies, 37*(4), 356–376.

Agrawal, J., & Kamakura, W. A. (1999). Country-of-origin: A competitive advantage. *International Journal of Research in Marketing*, *16*(4), 255–267. https://doi.org/10.1016/s0167-8116(99)00017-8.

Aiello, G., Donvito, R., Godey, B., Pederzoli, D., Wiedmann, K., Hennigs, N., et al. (2009). An international perspectiveon luxury brand and country-of-origin effect. *Journal of Brand Management*, *16*(5–6), 323–337.

Aiello, G., Donvito, R., Grazzini, L., Halliburton, C., Wagner, B., Wilson J., et al. (2015). An international comparison of "Made in Italy" in the fashion, furniture and food sectors: An observational research study in France, Russia and The United Kingdom. *Journal of Global Fashion Marketing, 6*(2). https://doi.org/10.1080/20932685.2015.984822.

Almeida, C., Alves, H., & Rui, M. (2012). The importance of brand origin in fashion markets. In *International Marketing Trends Conference*. *Proceedings of 11th International Marketing Trends Conference 2012 Venice*, Paris-Venice Marketing Trends Association. www.marketing-trends-congress.com/papers. An international perspective on luxury brand and country-of-origin effect. *Journal of Brand Management*, *16*, 323–337. https://doi.org/10.1057/bm.2008.52.

Andéhn, M., Kazeminia, A., Lucarelli, A., & Sevin, E. (2014). User-generated place brand equity on Twitter: The dynamics of brand associations in social media. *Place Branding and Public Diplomacy, 10*(2), 132–144.

Baghi, I., & Tedeschi, M. (2012). L'effetto paese d'origine sul comportamento del consumatore verso i prodotti cause related: intenzione all'acquisto, disponibilità a pagare e valutazione delle iniziative di cause related marketing. *Mercati e competitività, 1,* 114–129. https://doi.org/10.3280/MC2012-001008.

Bertoli, G., & Resciniti, R. (2013). Made in Italy e Country of origin effect. *Mercati e Competitività, 2,* 13–36. https://doi.org/10.3280/MC2013-002002.

Breward, C., & Gilbert, D. (2006). *Fashion's world cities*. New York, NY: Berg.

Brandwatch. (2016). Retrieved from https://www.brandwatch.com/blog/37-instagram-stats-2016.

Chakraborty, G., Allred, A. T., & Bristol, T. (1996). Exploring consumers' evaluations of counterfeits: The roles of country of origin and ethnocentrism. *NA-Advances in Consumer Research Volume 23*.

Chisnall, P. M. (2005). *The essence of marketing research*. Prentice Hall.

Choi, S., Lehto, X. Y., & Morrison, A. M. (2007). Destination image representation on the web: Content analysis of Macau travel related websites. *Tourism Management, 28*(1), 118–129.

Colli, A. (2005). Il quarto capitalismo. *L'industria*.

Curzio, A. Q., & Fortis, M. (2000). Il Made in Italy oltre il 2000, Milano, Il Mulino, pp. 25.

Diamantopoulos, A., Schlegelmilch, B., & Palihawadana, D. (2011). The relationship between Country-of-Origin image and brand image as drivers of purchase intentions: A test of alternative perspectives. *International Marketing Review, 28*(5), 508–524. https://doi.org/10.1108/02651331111167624.

Dichter, E. (1962). The world customer. *Harvard Business Review, 40,* 34–41. https://doi.org/10.1002/tie.5060040415.

Drozdenko, R., & Fensen, M. (2009). Translating country-of-origin effects into prices. *Journal of Product & Brand Management*, *18*(5), 371–378. https://doi.org/10.1108/10610420910981855.

Fernando, A. G., Suganthi, L., & Bharadhwaj, S. (2014). If you blog, will they follow? Using online media to set the agenda for consumer concerns on "Greenwashed" environmental claims. *Journal of Advertising, 43*(2), 167–180.

Fortis, M. (2005). *Il Made in Italy nel "nuovo mondo: protagonisti, sfide, azioni*. Roma: Ministero delle Attività Produttive.

Fotis, J., Buhalis, D., & Rossides, N. (2012). *Social media use and impact during the holiday travel planning process* (pp. 13–24). Springer.

Gentry, J. W., Putrevu, S., II, C. S., & Commuri, S. (2001). How now Ralph Lauren? The separation of brand and product in a counterfeit culture. *NA-Advances in Consumer Research Volume 28.*

Godey, B., Pederzoli, D., Aiello, G., Donvito, R., Chan, P., Oh, H., et al. (2012). Brand and country-of-origin effect on consumers' decision to purchase luxury products. *Journal of Business Research, 65*(10), 1461–1470.

Hamzaoui, L., & Merunka, D. (2006). The impact of design and country-of-manufacture on consumer perceptions of bi-national products' quality: An empirical model based of the concept of fit. *Journal of consumer marketing, 23,* 145–155. https://doi.org/10.1108/07363760610663303.

Humphreys, A. (2010). Megamarketing: The creation of markets as a social process. *Journal of Marketing, 74*(2), 1–19.

Jaffe, E. D., & Nebenzahl, I. D. (2001). *National image and competitive advantage: The theory and practice of country-of-origin effects*. Copenhagen, Denmark: Copenhagen Business School Press.

Javed, A., & Hasnu, S. A. F. (2013). Impact of country-of-origin on product purchase decision. *Journal of Marketing and Consumer Research*, *1*.

Jin, Z., Lynch, R., Attia, S., Chansarkar, B., Gülsoy, T., Lapoule, P., et al. (2015). The relationship between consumer ethnocentrism, cosmopolitanism and product country image among younger generation consumers: The moderating role of country development status. *International Business Review*, *24*(3), 380–393. https://doi.org/10.1016/j.ibusrev.2014.08.010.

Jung, H. J., Lee, Y., Kim, H., & Yang, H. (2014). Impacts of country images on luxury fashion brand: Facilitating with the brand resonance model. *Journal of Fashion Marketing and Management, 18*(2), 187–205. https://doi.org/10.1108/JFMM-10-2013-0113.

Keller, K. L. (1993). Conceptualizing, measuring, and managing customer-based brand equity. *Journal of Marketing, 57*(1), 1–22.

Keller, K. L. (2003). Brand synthesis: The multidimensionality of brand knowledge. *Journal of Consumer Research, 29*(4), 595–600.

Koschate-Fischer, N., & Diamantopoulos, A. (2012). Are consumers really willing to pay more for a favorable country image? A study of country-of-origin effects on willingness to pay. *Journal of International Marketing, 20*(1), 19–41. https://doi.org/10.1509/jim.10.0140.

Laroche, M., et al. (2005). The influence of country image structure on consumer evaluations of foreign products. *International Marketing Review, 22*(1), 45–49. https://doi.org/10.1108/02651330510581190.

Lin, L. Y., & Chen, C. S. (2006). The influence of the country-of-origin image, product knowledge and product involvement on consumer purchase decisions: An empirical study of insurance and catering services in Taiwan. *Journal of Consumer Marketing, 23*(5), 248–265.

Luangrath, A. W., Peck, J., & Barger, V. A. (2017). Textual paralanguage and its implications for marketing communications. *Journal of Consumer Psychology*, *27*(1), 98–107.

Marwick, A. E. (2015). Instafame: Luxury selfies in the attention economy. *Public Culture*, *27*(1 (75)), 137–160.

Matthes, J., & Kohring, M. (2008). The content analysis of media frames: Toward improving reliability and validity. *Journal of Communication*, *58*(2), 258–279.

Min Han, C. (1989). Country image: Halo or summary construct? *Journal of Marketing Research*, *26*(2). https://doi.org/10.2307/3172608.
Nagashima, A. (1970). A comparison of Japanese and US attitudes toward foreign products. *Journal of Marketing, 34,* 68–74. https://doi.org/10.1002/tie.5060120304.
Nagashima, A. (1977). A comparative "made-in" product image survey among Japanese businessmen. *Journal of Marketing, 41*(3), 95–100.
Nebenzahl, I. D., Jaffe, E. D., & Lampert, S. I. (1997). Towards a theory of country image effect on product evaluation. *Management International Review, 37,* 27–49.
Pappu, R., Quester, P. G., & Cooksey, R. W. (2006). Consumer-based brand equity and country-of-origin relationships: Some empirical evidence. *European Journal of Marketing, 40*(5/6), 696–717. https://doi.org/10.1108/03090560610657903.
Pappu, R., Quester, P. G., & Cooksey, R. W. (2007). Country image and consumer-based brand equity: Relationships and implications for international marketing. *Journal of International Business Studies, 38*(5), 726–745. https://doi.org/10.1057/palgrave.jibs.8400293.
Peterson, R. A. (1994). A meta-analysis or Cronbach's coefficient alpha. *Journal of Consumer Research, 21,* 381–391. https://doi.org/10.1037/1082-989X.11.3.306.
Pilelienė, L., & Grigaliūnaitė, V. (2016). Influence of print advertising layout complexity on visual attention. *Eurasian Business Review*, *6*(2), 237–251.
Quintieri, B. (2007). Declino o cambiamento? Il (ri)posizionamento dell'industria italiana sui mercati internazionali, in convegno *Trasformazioni dell'industria italiana*, 14 giugno 2007.
Roth, M. S., & Romeo, G. B. (1992). Matching product category and country image perceptions: A framework of managing country-of-origin effects. *Journal of International Business Studies, 23,* 477–497. https://doi.org/10.1057/palgrave.jibs.8490276.
Samiee, S. (1994). Customer evaluation of products in a global market. *Journal of International Business Studies 25*(3), 579–604.
Schooler, R. D. (1965). Product bias in the central American common market. *Journal of Marketing Research*, *2*, 394–397. https://doi.org/10.1002/tie.5060080211.
Schooler, R. D. (1971). Bias phenomena attendant to the marketing of foreign goods in the U.S. *Journal of International Business Studies*, 71–80. https://doi.org/10.1057/palgrave.jibs.8490732.
Sharma, S., Shimp, T. A., & Shin, J. (1995). Consumer ethnocentrism: A test of antecedents and moderators. *Journal of the Academy of Marketing Science, 23*(1), 26–37.
Varaldo, R. (2001). Il marketing del made in Italy: Quadro d'insieme. In C. A. Pratesi (Ed.), Il marketing del Made in Italy. Nuovi scenari e competitivita'. Milano: Franco Angeli.
Virgo, B., & De Chernatony, L. (2006). Delphic brand visioning to align stakeholder buy-into the city of Birmingham brand. *Journal of Brand Management, 13*(6), 379–392.
Wall, M., & Heslop, L. (1986). Consumer attitudes toward Canadian-made versus imported products. *Journal of the Academy of Marketing Science, 14,* 27–36.
Whitlark, D. B., & Smith, S. M. (2001). Using correspondence analysis to map relationships. *Marketing Research*, *13*(3).
Xiang, Z., & Gretzel, U. (2010). Role of social media in online travel information search. *Tourism Management, 31*(2), 179–188.
Zeugner-Roth, K. P., Žabkar, V., & Diamantopoulos, A. (2015). Consumer ethnocentrism, national identity, and consumer cosmopolitanism as drivers of consumer behavior: A social identity theory perspective. *Journal of International Marketing*, *23*(2), 25–54. http://dx.doi.org/10.1509/jim.14.0038.
Zhang, K., & Sarvary, M. (2014). Differentiation with user-generated content. *Management Science, 61*(4), 898–914.

Chapter 5
Community Based Social Media Fashion Branding: Do Fashion Brands Heritage and Prestige Affect Consumers' Brand Loyalty Intention?

Gemma Nesi, Riccardo Rialti, Lamberto Zollo and Cristiano Ciappei

Abstract This research explores whether fashion brands heritage and prestige perceived by consumers affect their brand loyalty intention. Specifically, the research aims at investigating if heritage and prestige matter in branding strategist based on engaging consumers in social media brand communities. Social media brand communities initiated by fashion brands represent the setting of this research. In fact, it has been assessed that members of brand communities usually are more informed on brands products and value than the average consumer. In order to achieve the aim of the research, a moderated structural equation modeling analysis has been developed and tested. Results show that, on the one hand, heritage has a negative moderating effect on the relationship between consumers' engagement in online communities and brand loyalty intention; and, on the other hand, prestige showed a positive moderating effect on such a relationship. Managerial implications and suggestions for future researches are discussed.

Keywords Social media marketing · Social media brand communities
Consumer engagement · Brand loyalty intention · Heritage · Prestige
Fashion brands

G. Nesi
University of Florence, Florence, Italy
e-mail: gemma.nesi@gmail.com

R. Rialti (✉)
Dipartimento di Economia e Management, University of Pisa, Pisa, Italy
e-mail: riccardo.rialti@gmail.com

L. Zollo · C. Ciappei
DISEI - Dipartimento di Scienze per l'Economia e l'Impresa,
University of Florence, Florence, Italy
e-mail: lamberto.zollo@unifi.it

C. Ciappei
e-mail: cristiano.ciappei@unifi.it

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_5

5.1 Introduction

Over recent times, social media have emerged as fundamental channels for fashion marketing communications (Kim and Ko 2010, 2012). In particular, recent researches have pointed out that brand communities existing on social media—which have been defined as social media brand communities (Zaglia 2013)—are fundamental to engage consumers in online branding activities (Habibi et al. 2014a). Consequently, pertinent literature has deemed that engaging consumers in community activities may increase their brand loyalty intention, thus preventing them from switching their preferences toward products of other brands (Laroche et al. 2012; Habibi et al. 2014a).

However, scant attention has been paid to exploring whether fashion brands heritage (Napoli et al. 2014) and prestige (Kuenzel and Vaux-Halliday 2008) influence members' brand loyalty intention in social media brand communities. In order to cope with such a literature gap, the aim of this research is to explore how heritage and prestige of fashion brands as perceived by consumers may moderate the relationship between consumers' engagement in social media brand communities and brand loyalty intention—which refers to consumers' propensity for not switching their preferences toward products of another brand (Habibi et al. 2014a). Structural Equation Modeling (SEM) has been selected as the methodology of this research (Bagozzi and Yi 1988). In this sense, we proposed and tested a conceptual model by analyzing 155 surveys obtained from members of several fashion brand social media brand communities.

Apart from this introduction, the research is structured as follows. The second paragraph deals with the importance of brand community for fashion branding strategies and the role of heritage and prestige as moderating factors between consumers' engagement in the community and their brand loyalty intention. Next, the third paragraph presents the proposed conceptual model and the hypotheses underlying this research. The fourth paragraph describes the sampling procedure and the SEM methodology. Finally, conclusions and managerial implications are discussed in the last paragraph.

5.2 Fashion Brands Heritage and Prestige and Social Media Brand Community Based Branding Strategies

Social media brand communities are online communities whose members are consumers that share a common passion or interest toward a specific brand (Zaglia 2013). Over recent times, marketing scholars assessed that consumers being part of such a digital form of community show higher levels of brand loyalty intention due to their participation to the community activities (Laroche et al. 2012). Therefore, consumers engaged in brand community—which are consumers actively participating to community brand-related activities and deeply involved in community inner dynamics

(Algesheimer et al. 2005)—are less prone to switch their preference toward products or services offered by a competitor (Habibi et al. 2014a). Despite this noteworthy literature, scant attention has been paid to the exploration of the potential role of heritage and prestige in affecting the relations between consumers' engagement in social media brand communities and their brand loyalty intention. Hence, in this paragraph we firstly explore the potential of social media brand communities in online branding strategies. Then, we attempt to conceptualize the importance of heritage and prestige in influencing members' brand loyalty intention in social media brand communities.

5.2.1 The Emerging Importance of Social Media Brand Communities in Online Branding

Seminally, Muniz and O'Guinn (2001, p. 412) have defined brand communities as "non-geographically bound community, based on a structured set of social relations among admirers of a brand". In this sense, pertinent literature has assessed that brand communities are frequently composed by consumers sharing similar interest, passion or love toward the brand (Zaglia 2013). Traditionally, on the one hand marketing scholars have focused on exploring the factors triggering individuals' participation to brand communities (Muniz and O'Guinn 2001). Specifically, according to the Social Identity Theory (SIT; Ashfort and Mael 1989), consumers tend to join brand communities in order make themselves identifiable by other members of community through symbols and values related to the brand (Muniz and O'Guinn 2001). On the other hand, recent researches explored the potential of brand communities to engage consumers, foster consumers' loyalty, and collect consumers' opinion about products or services (Bagozzi and Dholakia 2006).

As a consequence of the recent digitalization of humans' interactions (Tiago and Verissimo 2014), brand communities have started to transform in a digital fashion (Habibi et al. 2014a). In particular, since social media have proven to be a fertile ground for the emergence of new communities (Zaglia 2013), the majority of brand communities currently existing have assumed the form social media brand communities (Habibi et al. 2014a). Such a form of digital communities has been defined by De Valck et al. (2009, p. 185) as "a specialized, non-geographically bound, online community, based on social communications and relationships among a brand's consumers". Social media brand communities differ in at least three aspects from the traditional offline brand community. Firstly, social media brand communities are fundamental for brand strategist to constantly dialogue with consumers (Habibi et al. 2014a). In fact, since social media allow bi-directional communication it is now possible to engage consumers in interactive conversations anytime (Rialti et al. 2016a, 2017). Second, social media brand communities differ from offline brand communities in regard to the number of members, with several social media brand communities having more than one million of members (Zaglia 2013). Finally, social media brand communities are often characterized by a more structured internal

organization. Actually, at least one social media manager usually manages the community (Cova and White 2010).

Admirers and *aficionados* of every typology of brand may potentially form a social media brand community (Zaglia 2013); however, such a phenomenon tends to occur quite frequently among consumers and admirers of fashion brands. As a consequence of fashion brands iconicity and exclusiveness, indeed, the admirers of those latter are more prone to aggregate in social media brand community to be identified by other consumers through the symbols and values of fashion brands (Habibi et al. 2014b). This phenomenon is coherent with the basic assumptions of SIT (Ashfort and Mael 1989). In fact, consumers tend to aggregate in online social media brand communities started by fashion brands to obtain hedonic value—which is a form of psychological well-being deriving from participation to a community and identification within a social group (Muniz and O'Guinn 2001)—due to their membership (Zaglia 2013).

Recently, fashion marketing literature has started to explore how fashion brands could benefit from social media brand community existence in their marketing strategies (Kim and Ko 2010; Phan et al. 2011). In particular, Kim and Ko (2010) have assessed that fashion brands social media activities targeting members of online communities may improve relations between brands and customers; consequently, this may positively influence consumers' purchase intention. Moreover, Kim and Ko (2012) have also explored how social media marketing may enhance consumers based brand equity. Hence, if brand strategists are able to manage consumers' online feedbacks and to engage customers in social media marketing strategies, social media marketing may increase brand equity and increase consumers' loyalty (Phan et al. 2011; Rialti et al. 2016a). Therefore, pertinent literature has mainly focused on identifying how consumers' identification and engagement in social media brand communities may foster consumers' loyalty and the consequent potential economic benefits for the brand (Kim and Ko 2012; Godey et al. 2016).

In spite of this researches, however, scant attention has been paid to the exploration of the importance of fashion brands heritage and prestige—which are consumers' personal perceptions concerning the brand (Boccardi et al. 2016)—in fostering members' brand loyalty intention in social media brand communities.

5.2.2 Fashion Brands Heritage and Prestige in Community Based Social Media Fashion Branding

Heritage has been defined as an ensemble of "features belonging to the culture of a particular society, such as traditions, languages, or buildings, which come from the past and are still important" (Merchant and Rose 2013, p. 2620). Traditionally, the concept of heritage has been explored by two streams of marketing literature. On the one hand, researchers have focused on cultural heritage marketing, which is the marketing of cultural heritage sites (Rialti et al. 2016b, c). On the other hand,

scholars have explored the notion of brand heritage, which is the capability of the brand to transmit the sense of a brand history and related values to the customers (Napoli et al. 2014). In this perspective, the notion of heritage has frequently been explored within the fashion brands literature (Boccardi et al. 2016; Ciappei et al. 2016).

Brand heritage perceived by customers, hence, has been considered a significant element related with customer-based brand authenticity (Napoli et al. 2014). Specifically, according to Napoli et al. (2014), brand heritage is related with a brand prestige, which is the sense of exclusivity of the brand perceived by customers (Kuenzel and Vaux-Halliday 2008). Brand prestige, similarly to brand heritage, is a fundamental brand characteristics capable to influence customers' overall perceptions of the brand (Hwang and Hyun 2012).

As a result, both heritage and prestige have recently emerged as relevant strategic levers for brand strategists of fashion brand (Boccardi et al. 2016). As a proof of that, fashion brands strategist and product managers have traditionally focused on the history of the brands in order to transmit customers a feeling of exclusivity and elitism (Hudson 2011). Since it has been deemed possible to 'put ahead the fire of the past instead of the ashes' by centering brands strategies on brand heritage, it is also possible to make the customers feel involved in the glorious past and in the historical exclusivity (Balmer 2011).

In spite of this attention toward heritage, however, pertinent literature has principally focused on how to transmit to consumers' heritage and prestige of the brand (Balmer 2011). Firstly, marketing scholars have stressed the use of recurrent narrative in advertising as fundamental to communicate heritage and prestige of the brand to the consumers (Boccardi et al. 2016). Second, pertinent literature has explored how the design and internal furniture of fashion boutiques may influence consumers' perceptions related with brands heritage and prestige (Ciappei and Surchi 2011). In this perspective, the majority of scholars has focused on exploring how consumers' sensorial and emotive experience are related with perceived heritage and prestige. It emerges how marketing scholars have predominantly focused on identifying the antecedents of heritage and prestige (Kuenzel and Vaux-Halliday 2008). Moreover, the potential of heritage and prestige perceived by consumers to influence consumers' intentions in a social media mediated environment has been scarcely explored (Boccardi et al. 2016).

Moving from these considerations, this research aims to explore the importance of heritage and prestige as factors capable to influence consumers' behavioral intentions in online contexts. In fact, since heritage and prestige have been associated with consumers' intention to purchase fashion brands products, those two factors may also influence brand loyalty intention (Napoli et al. 2014). Social media brand communities have been selected as the context of this research; to our best knowledge, few studies have explored the consumers' personal perceptions affecting brand loyalty intention in a social media mediated environment (Habibi et al. 2014a, b).

Thus, the research question guiding the present research is the following one: "*Do fashion brands heritage and prestige positively influence brand loyalty intention of social media brand communities members?*".

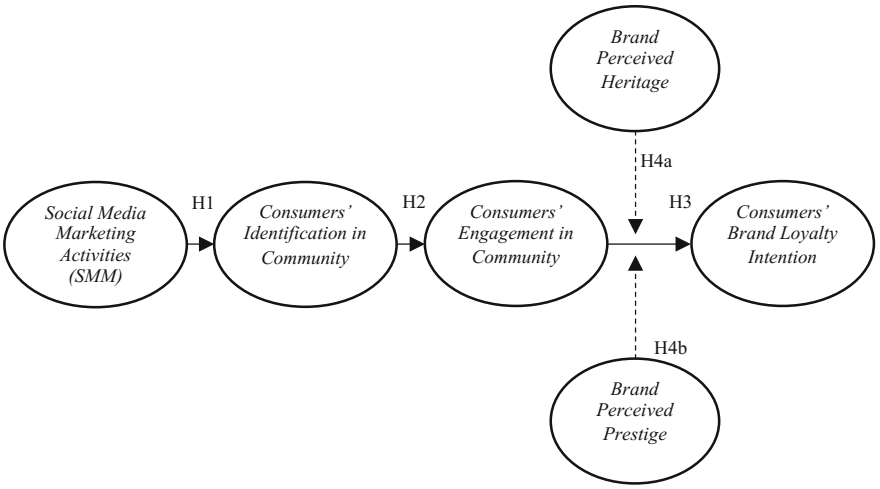


Fig. 5.1 Hypothesized model

5.3 Proposed Conceptual Model and Hypotheses

In order to answer the aforementioned research question, we have developed and tested the following conceptual model (see Fig. 5.1).

Social media marketing activities (SMMs) are a set of activities that may be undertaken by fashion brands to communicate with consumers on social media (Kim and Ko 2010, 2012). In order to be effective in reaching and influencing consumers, SMMs have to be interactive, capable to entertain consumers, customized, updated to the last news, and shareable on social media (Kim and Ko 2012).

According to Kim and Ko (2012), SMMs may improve the consumers-brand relation. Therefore, SMMs are relevant to dialogue with consumers and to transmit them information and values concerning the brand. Since consumers are more prone to identify in brands that emerge as interactive and trustworthy (Algesheimer et al. 2005), a positive relation between SMMs and consumers' degree of identification in brand community has been hypothesized. Hence, the following hypothesis is proposed:

H1: Fashion brands social media marketing activities are positively related with consumers' identification in fashion brand related social media brand communities.

Traditionally, consumers that identify with a brand community have been deemed as the most involved in brand community related activities (Algesheimer et al. 2005). According to SIT, in order to continue to be recognized over the time by other members as *aficionados* of the brand, those consumers have to constantly participate to the community activities and, eventually, shared rituals (Muniz and O'Guinn 2001). In this sense, consumers that identify with the community are more engaged in the community (Sashi 2012). Therefore, the following hypothesis is proposed:

H2: Consumers' identification in social media brand community is positively related with consumers' engagement in social media brand community activity.

Due to their participation to activities, consumers engaged in social media brand community tend to develop affective bond toward the brand. Therefore, consumers engaged in social media brand community tend to not switch their preferences and to be loyal to the brand of the community they are part of (Heere et al. 2011; Habibi et al. 2014a, b). Moving from these considerations, the following hypothesis is proposed:

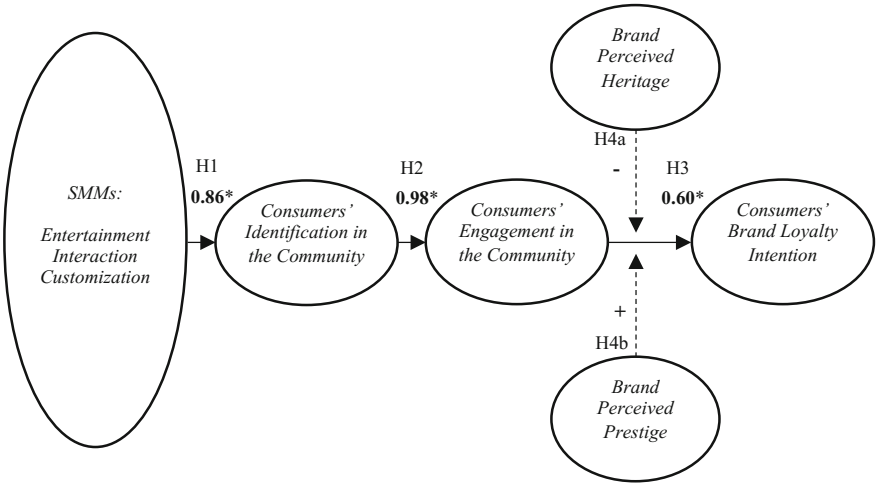
H3: Consumers' engagement in social media brand community is positively related with consumers' brand loyalty intention.

Apart from the community related factors such as identification and engagement, personal perceptions concerning the brand may affect consumers' brand loyalty intention. In particular, according to Napoli et al. (2014), perceived heritage may influence consumers' loyalty and purchase intention. Instead, Kuenzel and Vaux-Halliday (2008) assessed that the brand prestige perceived by consumers may be an antecedent of brand loyalty intention. Therefore, we have assumed that fashion brands heritage and prestige may moderate the relation between consumers' engagement in brand community and consumers' brand loyalty intention. Thus, the following hypothesis is proposed:

H4a: Fashion brand prestige perceived by consumers' moderates the relation between consumers' engagement in social media community and brand loyalty intention.
H4b: Fashion brand heritage perceived by consumers' moderates the relation between consumers' engagement in social media community and brand loyalty intention.

5.4 Method

In order to answer our research question, we have collected 155 surveys among members of social media brand communities of several fashion brands (see Table 5.1). Since the number of members of social media brand community may dramatically change overnight, traditional sampling procedures over time have proven not effective in the majority of social media oriented researches. In order to cope with this problem, we adopted a sampling procedure previously used by Bagozzi and Dholakia (2006) and Habibi et al. (2014a, b). Firstly, we asked respondents to enunciate the fashion brand they admire most; second, we asked respondents to name a community initiated by the fashion brand they admire most (Heere et al. 2011); finally, we asked respondents to select the social media used to follow the brand online. Building on this procedure, we were able to collect 155 usable results representing 32 worldwide social media brand community—from 11 brands—existing on 4 social media (Facebook; Twitter, Pinterest and Instagram). Gucci (20,1%), Chanel



* $p < 0.01$

Scales:

SMM: Kim and Ko (2010)

Identification: Algesheimer *et al.* (2005)

Engagement: Algesheimer *et al.* (2005)

Prestige: Kuenzel and Halliday (2008)

Heritage: Napoli *et al.* (2014)

Loyalty Intention: Algesheimer *et al.* (2005)

Model Fit:

Relative Chi-square: 2.125

GFI = 0.901 RMSEA = 0.076

CFI = 0.914 IFI = 0.904

NFI = 0.902 TLI = 0.913

Fig. 5.2 Structural model

(17,5%) and Luis Vuitton (16,9%) have emerged as the most followed brands by respondents composing our sample.

The collected surveys have been analyzed with a two-step SEM procedure (Bagozzi and Yi 1988). A confirmatory factor analysis was conducted using AMOS v. 22, an SPSS module (Arbuckle 2013) (see Table 5.2). The maximum likelihood function of AMOS was used to validate the hypotheses (Bagozzi and Yi 1988; Zollo et al. 2018). Finally, we have explored the relations among variables and the hypothesized moderation effects (See Fig. 5.2).

5.5 Results

For each of the six latent dimensions—SMM, Brand Identification, Brand Engagement, Prestige, Heritage, Brand Loyalty Intention—a CFA was implemented using AMOS (Arbuckle 2013). The first step of the procedure referred to estimating the fitting indexes of our proposed model (Bagozzi and Yi 1988). As far as concerns the absolute fitting indexes, the relative χ^2-test ($\chi^2/df = 1.925$), the Goodness of Fit

Table 5.1 Sample characteristics

Variable	Gender		Continent					Age			
	M	F	N. A.	S. A.	Europe	Asia	Oceania	19–29	30–39	40–49	>50
Freq.	29	126	23	11	112	7	2	100	32	17	6
Distr.	18.5	81.5	14.8	7	72.3	4.5	1.4	64.8	20.6	10.9	3.7

Table 5.2 Intercorrelations and reliabilities

	1	2	3	4	5	6	7	8
1. Entertainment	0.85							
2. Customization	0.82	0.81						
3. Interaction	0.79	0.78	0.87					
4. Identification	0.72	0.64	0.75	0.93				
5. Engagement	0.78	0.72	0.85	0.74	0.92			
6. Prestige	0.56	0.53	0.41	0.35	0.33	0.70		
7. Heritage	0.54	0.47	0.54	0.53	0.54	0.62	0.83	
8. Loyalty intention	0.58	0.46	0.51	0.59	0.67	0.47	0.54	0.79

Cronbach's alpha values are reported on the diagonal; all correlations show a p-value < 0.01

Index (GFI = 0.915), and the Root Mean Square Error of Approximation (RMSEA = 0.072) showed acceptable values. Concerning the relative indexes, the Comparative Fit Index (CFI; 0.924), the Incremental Fit Index (IFI; 0.937), the Normed Fit Index (NFI; 0.912), and the Tucker-Lewis Index (TLI; 0.921) were all higher than the required value of 0.9 (Bagozzi and Yi 1988).

Next, we built our proposed structural model in order to test the hypothesized relations. As shown in Fig. 5.2, all the fitting indexes of the model were acceptable. Moreover, all the hypotheses were supported ($p < 0.01$). Specifically, the interaction effects between Prestige_x_Brand Engagement ($p < 0.01$) and Heritage_x_Brand Engagement ($p < 0.01$) were significant, suggesting that moderation had occurred (Arbuckle 2013). Interestingly, the moderated SEM analysis showed a decreased effect of Brand Engagement on Brand Loyalty Intention for high levels of Heritage (the relation moved from $\beta = 0.60$, $p < 0.01$ without moderation to $\beta = 0.42$, $p < 0.01$ with moderation). This suggests that Heritage negatively moderates the relation between consumers' engagement and brand loyalty. Instead, Prestige resulted as a positive moderating variable, given the higher influence of Brand Engagement on Brand Loyalty Intention for high levels of Prestige (the relation moved from $\beta = 0.60$, $p < 0.01$ without moderation to $\beta = +0.75$, $p < 0.01$ with moderation). Hence, perceived prestige positively moderates the relation between consumers' engagement and brand loyalty.

5.6 Conclusion, Managerial Implication and Suggestion for Future Researches

This research contributes to the literature on online fashion brand management. Indeed, our results show how heritage and prestige affect consumers brand loyalty intention. Specifically, it has emerged how prestige of fashion brand positively moderates the relation between consumers' engagement in the community and their

brand loyalty intention. This phenomenon may be well explained considering the basic assumptions of SIT concerning the reasons why consumers join brand communities (Muniz and O'Guinn 2001). Since consumers join brand communities to be identified by others with the brand and, moreover, the more they identify in the community the more they are loyal to brand (Algesheimer et al. 2005), prestige of the brand may be considered a fundamental factor reinforcing the engagement-loyalty relation (Kuenzel and Vaux-Halliday 2008). Interestingly, heritage negatively moderated such a relation. A possible explanation may be that in modern online contexts heritage is not fully exploited yet, due to the scarce capability of online communication to transmit a brand heritage to consumers.

Two main managerial implications emerged from our results. Firstly, brand strategists should invest in transmitting consumers the sense of prestige of the brand online. By doing so, brand strategists may reinforce brand community members' loyalty toward the brand. Second, new strategies to communicate fashion brand heritage should be developed by brand strategists. Actually, by focusing on innovative social media strategy communications such as *mythopoiesis*—which may be defined as the recurrent narrative capable to adequately transmit the sense of heritage of the brand to modern consumers and markets (Boccardi et al. 2016)—brand strategists may improve consumers' emotive attachment to the brand past tradition and values, thus positively influencing their loyalty intention.

The present research presents some limitations which highlight possible avenues for future researches. Firstly, we were able to collect only a limited number of usable responses from online consumers. Second, we did not explore in depth the causes of the negative moderation of heritage on the engagement-loyalty relation. Future researches should better analyze such a phenomenon. In particular, we suggest scholars to investigate through qualitative methodologies which kind of communications are capable to transmit a brand sense of heritage. Moreover, we suggest scholars to compare traditional form of communication with online channels in order to understand which one is more capable to influence customers' brand loyalty intention.

References

Algesheimer, R., Dholakia, U. M., & Herrmann, A. (2005). The social influence of brand community: Evidence from European car clubs. *Journal of Marketing, 69*(3), 19–34.

Arbuckle, J. L. (2013). *Amos (Version 22.0). Computer Program*. Chicago: SPSS/IBM.

Ashforth, B. E., & Mael, F. (1989). Social identity theory and the organization. *Academy of Management Review, 14*(1), 20–39.

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science, 16*(1), 74–94.

Bagozzi, R. P., & Dholakia, U. M. (2006). Antecedents and purchase consequences of customer participation in small group brand communities. *International Journal of Research in Marketing, 23*(1), 45–61.

Balmer, J. M. (2011). Corporate heritage brands and the precepts of corporate heritage brand management: Insights from the British Monarchy on the eve of the royal wedding of Prince

William (April 2011) and Queen Elizabeth II's Diamond Jubilee (1952–2012). *Journal of Brand Management, 18*(8), 517–544.

Boccardi, A., Ciappei, C., Zollo, L., & Laudano, M. C. (2016). The role of heritage and authenticity in the value creation of fashion brand. *International Business Research, 9*(7), 135–143.

Ciappei, C., & Surchi, M. (2011). *La Mitopoiesi della Marca Moda. Strategie di brand building nelle imprese moda: Strategie di brand building nelle imprese moda*. Milano: FrancoAngeli.

Ciappei, C., Zollo, L., Boccardi, A., & Rialti, R. (2016). Customers' perception of heritage and authenticity in fashion fashion brand: A structural path diagram. In *Proceedings of the 2016 Global Marketing Conference at Hong Kong* (p. 438).

Cova, B., & White, T. (2010). Counter-brand and alter-brand communities: The impact of Web 2.0 on tribal marketing approaches. *Journal of Marketing Management, 26*(3–4), 256–270.

De Valck, K., Van Bruggen, G. H., & Wierenga, B. (2009). Virtual communities: A marketing perspective. *Decision Support Systems, 47*(3), 185–203.

Godey, B., Manthiou, A., Pederzoli, D., Rokka, J., Aiello, G., Donvito, R., et al. (2016). Social media marketing efforts of luxury brands: Influence on brand equity and consumer behavior. *Journal of Business Research, 69*(12), 5833–5841.

Habibi, M. R., Laroche, M., & Richard, M. O. (2014a). Brand communities based in social media: How unique are they? Evidence from two exemplary brand communities. *International Journal of Information Management, 34*(2), 123–132.

Habibi, M. R., Laroche, M., & Richard, M. O. (2014b). The roles of brand community and community engagement in building brand trust on social media. *Computers in Human Behavior, 37,* 152–161.

Heere, B., Walker, M., Yoshida, M., Ko, Y. J., Jordan, J. S., & James, J. D. (2011). Brand community development through associated communities: Grounding community measurement within social identity theory. *Journal of Marketing Theory and Practice, 19*(4), 407–422.

Hwang, J., & Hyun, S. S. (2012). The antecedents and consequences of brand prestige in fashion restaurants. *Asia Pacific Journal of Tourism Research, 17*(6), 656–683.

Hudson, B. T. (2011). Brand heritage and the renaissance of Cunard. *European Journal of Marketing, 45*(9/10), 1538–1556.

Kim, A. J., & Ko, E. (2010). Impacts of fashion fashion brand's social media marketing on customer relationship and purchase intention. *Journal of Global Fashion Marketing, 1*(3), 164–171.

Kim, A. J., & Ko, E. (2012). Do social media marketing activities enhance customer equity? An empirical study of fashion fashion brand. *Journal of Business Research, 65*(10), 1480–1486.

Kuenzel, S., & Vaux-Halliday, S. (2008). Investigating antecedents and consequences of brand identification. *Journal of Product & Brand Management, 17*(5), 293–304.

Laroche, M., Habibi, M. R., Richard, M. O., & Sankaranarayanan, R. (2012). The effects of social media based brand communities on brand community markers, value creation practices, brand trust and brand loyalty. *Computers in Human Behavior, 28*(5), 1755–1767.

Merchant, A., & Rose, G. M. (2013). Effects of advertising-evoked vicarious nostalgia on brand heritage. *Journal of Business Research, 66*(12), 2619–2625.

Muniz, A. M., & O'Guinn, T. C. (2001). Brand community. *Journal of Consumer Research, 27*(4), 412–432.

Napoli, J., Dickinson, S. J., Beverland, M. B., & Farrelly, F. (2014). Measuring consumer-based brand authenticity. *Journal of Business Research, 67*(6), 1090–1098.

Phan, M., Thomas, R., & Heine, K. (2011). Social media and fashion brand management: The case of Burberry. *Journal of Global Fashion Marketing, 2*(4), 213–222.

Rialti, R., Zollo, L., Caliandro, A., & Ciappei, C. (2016a). Social media strategies to protect brand image and corporate reputation in the digital era: A digital investigation of the Eni vs. *Report case. Mercati & Competitività, 4,* 65–84.

Rialti, R., Zollo, L., Boccardi, A., & Marzi, G. (2016b). L'impatto delle tecnologie digitali sulla personalizzazione dell'esperienza del cliente visitatore: il caso Mnemosyne. *Micro & Macro Marketing, 2,* 251–280.

Rialti, R., Zollo, L., Ciappei, C., & Laudano, M. C. (2016c). Digital cultural heritage marketing: The role of digital technologies in cultural heritage valorization. In *Proceedings of the 2016 Global Marketing Conference at Hong Kong* (pp. 1062–1063).

Rialti, R., Zollo, L., Pellegrini, M. M., & Ciappei, C. (2017). Exploring the antecedents of brand loyalty and electronic word of mouth in social-media-based brand communities: Do gender differences matter? *Journal of Global Marketing, 30*(3), 147–160.

Sashi, C. M. (2012). Customer engagement, buyer-seller relationships, and social media. *Management Decision, 50*(2), 253–272.

Tiago, M. T. P. M. B., & Veríssimo, J. M. C. (2014). Digital marketing and social media: Why bother? *Business Horizons, 57*(6), 703–708.

Zaglia, M. E. (2013). Brand communities embedded in social networks. *Journal of Business Research, 66*(2), 216–223.

Zollo, L., Yoon, S., Rialti, R., & Ciappei, C. (2018). Ethical consumption and consumers' decision making: The role of moral intuition. *Management Decision, 56*(3), 692–710.

Chapter 6
Fast-Fashion: Fast Enough to Satisfy Adolescent Girls' Expectations from Their Clothing

Emel O. Karaoglu, Cevza Candan, Burcu Guven and Guner Inan

Abstract Word-wide and also in Turkey, little research has been done on adolescents as a consumer market, especially regarding their evaluating criteria, expectations and problems relating to clothing. The research was therefore conducted to explore and describe the adolescent female consumers' expectations and evaluations related to her selection of clothing. In doing so, it mainly focused on the fit of cloths. The survey was applied to more than 200 adolescent girls who were randomly selected from the most populated areas of Istanbul. The participants were within the age range of 9–16. The data collected were analysed using IBM SPSS (23), based on the relevant statistical significance and data summary techniques. The chi-square analyses were also conducted to seek the similarities (or dissimilarities) between the age groups and their major clothing problems.

Keywords Adolescent · Fast-fashion · Apparel · Retail · Clothing

6.1 Introduction

The strong and keen competition in fashion retail sector governs the market conditions for apparel market, including adolescent wear. Due to both the high young population and birth rate in Turkey, she has been a focal point for national as well as international brands having children's clothing section. Global actors such as Zara,

E. O. Karaoglu · C. Candan (✉)
Faculty of Textile Technologies and Design, Istanbul Technical University, İstanbul, Turkey
e-mail: candance@itu.edu.tr

E. O. Karaoglu
e-mail: onderem@itu.edu.tr

B. Guven · G. Inan
LC Waikiki Corporate Academy, İstanbul, Turkey
e-mail: BURCU.GUVEN@Lcwaikiki.com

G. Inan
e-mail: GUNER.INAN@Lcwaikiki.com

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_6

H&M, Mango, Bershka, Benetton UCB, and Uniqlo have significant volumes of the market in Turkey. On the other hand, Turkish companies such as LC Waikiki, Defacto, Collezione, and Mavi Jeans have also achieved a significant market share and a strong position for children's wear in the local market while they have been competing with the other big retailers in the international arena, governed by the rules of fast changing fashion business.

6.2 Literature Survey

Adolescence is the period of development during which girls begin to form their emancipated identities (Gemelli 1996). Body awareness increases due to the physical changes that occur during this time, and clothing and appearance gain importance as adolescents' judge, and are judged, based on these outwardly visible factors (Macgillivray and Wilson 1997; Wooten 2006).

Adolescents are in the process of completing their rites of passage, with feelings of uncertainty and insecurity as to how to behave and how to evolve into new roles (e.g., Arnett 2004; Ozanne 1992). Rites of passage are personal and social experiences that are partially constructed through the use of material objects (Fischer and Gainer 1993). Fashion goods are such material objects (Gilles and Nairn 2011). For teenagers, clothes are used to express individuality and to form a sense of perspective (Piacentini and Mailer 2004).

Social phenomena underlying the identity influence the different styles of dress among adolescents. According to Solomon (2005), dress is one of the favourite modes of expression among adolescent groups. Teens have identified multiple attributes as important to their apparel purchase decisions, including the fit, look, style and price of the clothing (Taylor and Cosenza 2002). The fashionability of a garment and its capacity to enhance one's sexual attractiveness or recognition may contribute to teens' apparel purchase decisions as well (Chen-Yu et al. 2010; Chen-Yu and Seock 2002; Miles 1996). Likewise, brand name may play a significant role in teens' apparel purchase decisions (Beaudoin and Lachance 2006), in part, owing to the importance that this consumer group attaches to fashion and appearance (Kaiser 1997). Although teens often adopt clothing symbols for purposes of conformity or to "fit in" with a peer group (Piacentini and Mailer 2004), there is evidence that they may gravitate toward apparel products that support the expression of individuality (Carter 2011).

Scholars and marketers have long noticed the emergence of adolescent consumers and their consumption behaviours (Niu et al. 2012; Ogle et al. 2014; Yalkin and Rosenbaum-Elliott 2014). Several researchers have even ventured the idea of "global teens" (Arnett 2002; Kamaruddin and Mokhlis 2003), meaning to capture the explosive growth in adolescent consumption. Teen girls have been identified as a particularly "powerful consumer demographic" within the US economy (Salzman 2010), capturing the attention of marketers for a number of reasons. And, teens' roles as "future consumers" as well as their influence on family purchase decisions further expands their presence within the marketplace and their appeal to marketers (Taylor

and Cosenza 2002; Sutherland and Thompson 2003; Srivastava 2015). Of particular interest to teen girls is fashion (i.e. clothing and accessories), which accounts for up to 40% of teen budgets (Piper 2013), with girls spending more than do boys (Soard 2013). The trade literature provides considerable evidence of teen girls' spending on apparel, and the scholarly literature has established the salience of clothing to teen girls' identity and self-esteem (Kaiser 1997; Piacentini and Mailer 2004).

Word-wide and also in Turkey, little research has been done on adolescents as a consumer market, especially regarding their evaluating criteria, expectations and problems relating to clothing. Adolescence is the period in the individual's life when drastic changes at the physical, socio-psychological and cognitive levels are taking place. These can have significant implications on the problems, needs and expectations about the clothing of adolescent. Taking into account the physical changes, it could be argued that it could affect the fit of her clothes. She may also not be satisfied with the styles available in the children's or adult ranges (Badaoui et al. 2012; Han-Jen 2013). The result is a dissatisfied consumer and more returns to the dealer due to clothes that do not fit properly. The overall purpose of this research was thus to explore and describe the adolescent female consumer's expectations and evaluations related to her selection of clothing.

6.3 Methodology

After the analysis of a number of qualitative focus group reports on adolescent attitudes and market conditions, a survey was conducted to clarify the adolescent girls' expectations in more detail. The survey was applied to more than 200 adolescent girls who were randomly chosen from the pool of students within the age range of 9–16, living in different districts of İstanbul. The regions for the survey were selected such that they were the most populated areas in İstanbul, having the people coming from diverse economic and cultural backgrounds. Replies to the surveys were received reciprocally or via e-mail. Incomplete surveys were excluded from the pile and the results obtained for 170 respondents were taken into consideration for further evaluation.

The questionnaire was designed, with the support of LC Waikiki Company, in such a way that it contained 23 questions, three of which were Likert type, ten of which were closed-end, and ten of which were open-end ones. The questions mainly focused on fit and size problems, wearing comfort perceptions, factors influencing the style of clothing, and brand awareness. In addition to that, shopping habits of the participants were also questioned.

The data collected were analysed using IBM SPSS (23), based on the relevant statistical significance and data summary techniques. The chi-square analyses were also conducted to determine if the age groups had been chosen soundly in relation to the adolescent girls' body weight and height variations, and to seek the similarities (or dissimilarities) between the age groups and the major clothing problems experienced.

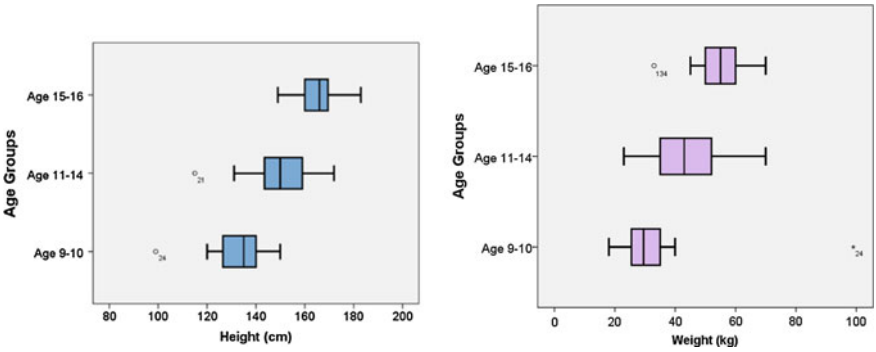


Fig. 6.1 Height and weight distributions of adolescent girls

6.4 Results and Discussion

The growth of an adolescent's body takes place relating to height, mass, bodily proportions and the development of secondary sexual characteristics. Girls' growth generally starts between the ages of nine and eleven years and peaks at about twelve and a half. The results of chi-square analysis showed that the three age groups corresponded to the distinctive levels of growing up and body change of the adolescent girls based on their weight and height distributions. The percentages of the number of respondents falling one of three groups were as follows: 14% of them were at the age of 9–10; 44% of them were at the age of 11–14 and 42% of them were at the age of 15–16 (Fig. 6.1).

6.4.1 Shopping Habits

The shopping frequencies of the adolescent girls showed differences in accordance with the age groups. As may be seen from Fig. 6.2, the age groups 11–14 and 15–16 stated that they tended to go shopping at least twice or three times a month. However, the shopping frequency for the age group 9–10 dropped up to once every six months. Furthermore, the survey results revealed that irrespective of the age group, the adolescent girls in Turkish market tended to go shopping with parents (mostly mothers and/or sisters) and/or relatives (mostly cousins), and that starting from the age of eleven, the adolescent girls heavily used social media, especially Instagram which influenced their buying decisions in terms of clothing styles. In addition, the survey also suggested that the adolescent girls from the age group 15–16 were significantly influenced by the way their favourite celebrities dressed.

Accordingly, it may be concluded that as adolescents grow older, they tend to exchange their dependence on their parents to the dependency on their peers, and thus the peers, together with social media, become the groups from whom the adolescent

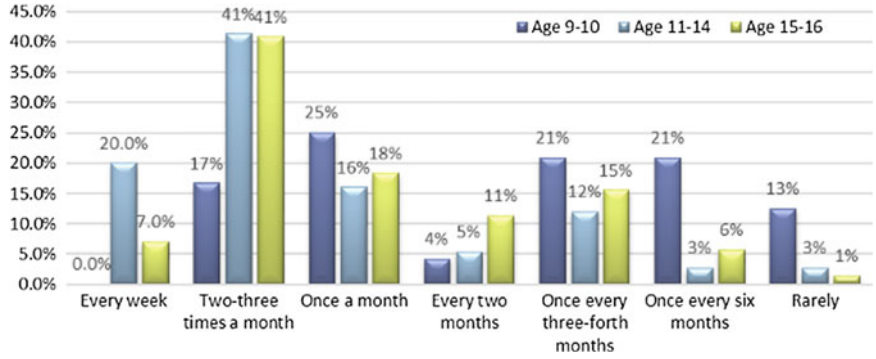


Fig. 6.2 Shopping frequencies of adolescent girls

girls received feedback about their clothing and general appearance in relation to fashion.

Figure 6.3 points out that irrespective of the age group, the fit and comfort of clothes were the major factors influencing the adolescent girls' buying decisions. 75% of the age group 9–10 noted "fitting" as a major factor for buying new cloths. This value for the age group 11–14 was increased by 81.3% whereas only 67.7% of the age group 15–16 pointed out "new purchasing due to fitting of cloths" as a major concern. During the growth stage the body might appear out of proportion. Girls' hips become broader, while the breasts are also developing markedly. It may be speculated that these physical changes could influence their evaluation of clothes regarding fit and comfort. For the age group 9–10, brand did also seem an important purchasing parameter. This could, however, be resulted from the fact that there were limited number of brands addressing the expectations of this very group.

When it came to the age group 11–14, the "quality", together with the fit and comfort of clothes, was evaluated by the adolescent girls. However, when the data obtained from the survey was comparatively analysed, it may be concluded that for the clothing consumers of this group (i.e. the ages 11–14), the quality was inferred from some extrinsic indicators such as brand name or store itself. Finally, for the age group of 15–16, the major buying factors expanded such that it involved price, style influenced by fashion, and design of clothes, in addition to fit and comfort.

6.4.2 Fitting Issues of the Adolescent Girls

Brown and Rice (1998) stated in their paper that more than 70% of the clothing that is relegated to stock clearance sales was the result of bad fitting or construction. The dissatisfaction with fit is still the most frequent problem with garment purchases, and the adolescent girls' clothing market is not an exception. As may be seen from Fig. 6.4, for 54.2% of the early adolescent girls (i.e. 9–10), "too long outer leg

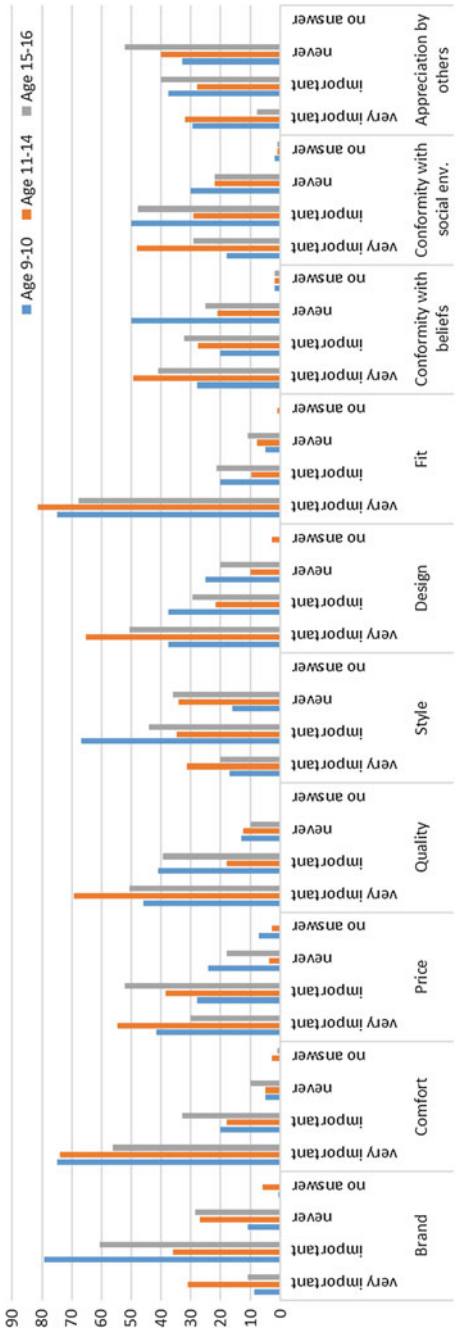


Fig. 6.3 Factors affecting buying decisions of adolescent girls

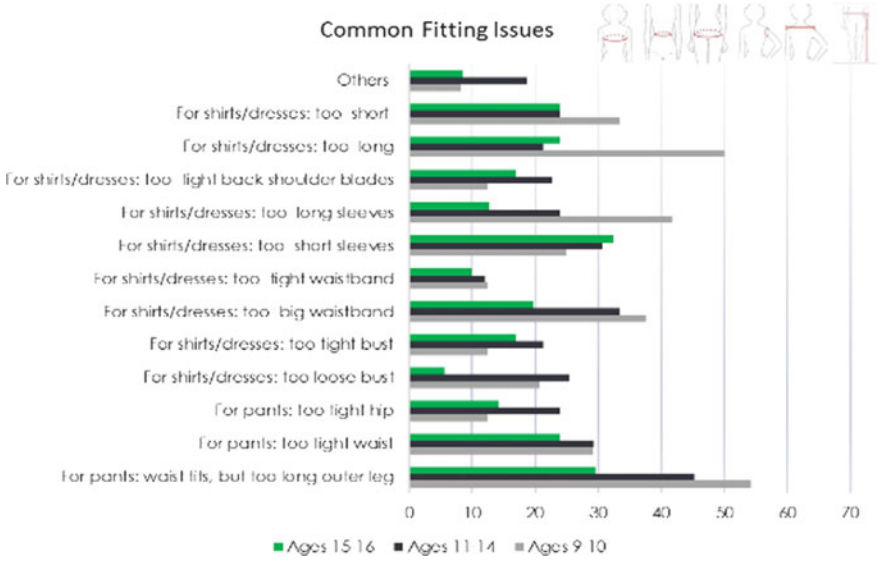


Fig. 6.4 Common fitting issues of adolescent girls

for pants" was a major fitting issue, which was followed by "too long sleeves for shirts/dresses" (41.7%) and "too big waistbands for shirts/dresses" (37.5%). For the age group 11–14, the very same problems were mentioned, with a difference that this group had the issue of "too short sleeves for shirts/dresses" (30.7%), rather than "too long sleeves for shirts/dresses". It was also the age group 11–14 who experienced more "waist, tight, and bust size related" fitting problems for the clothes they bought, when compared to the adolescent girls from the other age groups. Finally, the survey results showed that the length of pants/dresses was generally their major concern regarding the fit of cloths (Fig. 6.4).

The ultimate appearance and fit of clothes should not only be comfortable and functional, but also meet an adolescent girl's socio-psychological needs, since the adolescents tend to seek conformity with the peer group. Bearing that into mind, the style/design tastes of the adolescent girls were investigated using the templates given in Fig. 6.5.

As may be seen Tables 6.1 and 6.2, except for the age group 15–16 the style preferences of the adolescent girls did not coincide with the styles that they did buy. This may be partially because of the fact that fit is not only about freedom of movement, fabric and the size of a garment, but also about the choice of style/design that would complete a specific type of figure, and based on the figures in the relevant tables, it may be concluded that the clothing ranges offered for specific styles in the market did have difficulties to especially satisfy the early adolescent girls' unique requirements about the fit of cloths. The socio-economic backgrounds of the families may have also affected the buying decisions of the participants.

Fig. 6.5 Top rated styles by adolescent girls

Table 6.1 Top rated styles by adolescent girls

Age group	Romantic (%)	College (%)	Grunge/mono (%)	Active (%)	Boho (%)
9–10	**62**	25	25	25	37.5
11–14	25.3	10.7	**60**	13.3	18.7
15–16	11.3	2.8	**60**	5.6	36.6

Table 6.2 Common styles purchased by adolescent girls

Age group	Romantic (%)	College (%)	Grunge/mono (%)	Active (%)	Boho (%)
9–10	**41.7**	37.5	29.2	29.2	33.3
11–14	17.3	17.3	**37.3**	26.7	29.3
15–16	9.9	8.5	**53.5**	7	36.6

6.4.3 Brand Awareness of the Adolescent Girls

The survey demonstrated that the brand awareness of the early adolescent girls (i.e. 9–10) was almost limited to a few national brands, namely LC Waikiki, Koton, and Defacto whereas the number of brands named, including foreign brands, increased up to 15 for the participants of 11–16 years old (Fig. 6.6). The data collected did also show that the adolescents from the age group 9–10 as well as 11–14 mostly preferred LC Waikiki, Koton, and Defacto mostly due to their favourable price policies and the wearing comfort (functionality) of cloths. The brand preferences for the adolescents of 15–16 years old, however, followed an erratic pattern, though the participants were in favour of buying cloths from Koton, H&M, and Bershka when fashion style/design mattered.

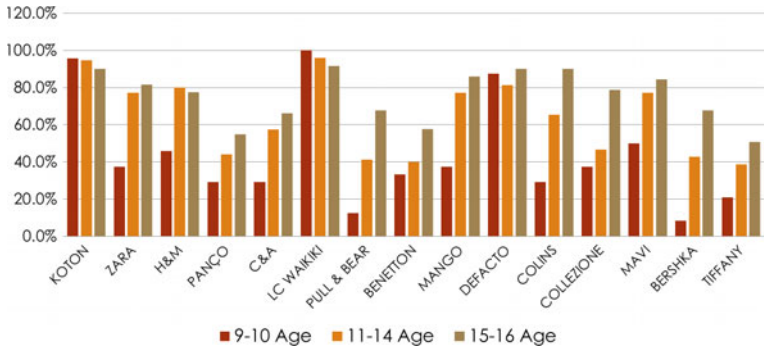


Fig. 6.6 Brand awareness of adolescent girls

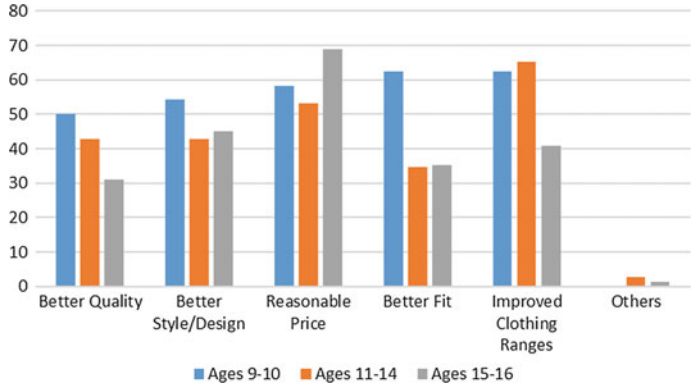


Fig. 6.7 Adolescent girls' expectations from brands

As a final note, the expectations of the participants from brands did vary from one age group to the other. For the age group 9–10, "better fit" and "improved clothing ranges" were scored the most whilst the 15–16 years old ones voted for "better style/design" as well as "reasonable price" (Fig. 6.7).

In the light of these findings, it may be argued that a specific brand name could cause the adolescents to gain social appreciation and develop positive self-esteem, even if the fit of cloths is not altogether correct.

6.5 Conclusions

In this paper, the adolescent girls' needs, problems and expectations regarding the fit of their clothing were discussed as a consumer group, because the adolescent market in general is one of the fastest growing clothing markets in Turkey. Based on the findings of the study, it may be concluded that the physical development of

the adolescent girls causes them to experience certain functional and appearance problems with the fit of her clothes, though the issue diminishes as they reach the ages of 15 or 16. Furthermore, it was observed that the brand name, price, and satisfying the norms set by their peer groups, social media, and/or current fashion trends appear to become significant for the adolescent and these factors influence not only the expectations that they have about the fit of clothes, but also their buying decisions.

References

Arnett, J. J. (2002). The psychology of globalization. *American Psychologist*, *57*, 774–783.

Arnett, J. J. (2004). *Adolescence and emerging adulthood: A cultural approach*. Upper Saddle River: Pearson Prentice Hall.

Badaoui, K., Lebrun, A., & Bouchet, P. (2012). Clothing style, music, and media influences on adolescents' brand consumption behavior. *Psychology and Marketing, 29*(8), 568–582.

Beaudoin, P., & Lachance, M. J. (2006). Determinants of adolescents' brand sensitivity to clothing. *Family and Consumer Sciences Research Journal*, *34*, 312–331.

Brown, P., & Rice, J. (1998). *Ready-to-wear apparel analysis* (2nd ed.). Upper Saddle River, New Jersey: Prentice Hall.

Carter, B. (2011). Marketing to tweens and teens: Insights, strategies, and tactics. *The Licensing Journal, 31*(7), 1–4.

Chen-Yu, J.H., Hong, K.-H. & Seock, Y.-K. (2010). Adolescents' clothing motives and store selection criteria: a comparison between South Korea and the United States. *Journal of Fashion Marketing Management*, *14*(1), 127–144.

Chen-Yu, J. H., & Seock, Y.-K. (2002). Adolescents' clothing purchase motivations, information sources, and store selection criteria: A comparison of male-female and impulse/non-impulse shoppers. *Family and Consumer Science Research Journal, 31*(1), 50–77.

Fischer, E., & Gainer, B. (1993). Baby showers: A rite of passage in transition. In M. A. Leigh & M. L. Rothschild (Eds.), *Advances in Consumer Research*, Vol. 20 (pp. 320–324). Provo: Association for Consumer Research.

Gemelli, R. (1996). *Normal Child and Adolescent Development*. Washington, DC, American Psychiatric Press.

Gilles, M., & Nairn, A. (2011). "We make the shoes, you make the story": Teenage girls' experiences of fashion: Bricolage, tactics and narrative identity. *Consumption Markets and Culture, 14*(1), 29–56.

Han-Jen, N. (2013). Cyber peers' influence for adolescent consumer in decision-making styles and online purchasing behaviour. *Journal of Applied Social Psychology, 43,* 1228–1237.

Kaiser, S. B. (1997). *The Social Psychology of Clothing: Symbolic Appearances in Context*. New York, NY, Fairchild Publications.

Kamaruddin, A. R., & Mokhlis, S. K. (2003). Consumer socialization, social structural factors and decision-making styles: A case study of adolescents in Malaysia. *International Journal of Consumer Studies*, *27*, 145–156.

Macgillivray, M. S., & Wilson, J. D. (1997). Clothing and appearance among early, middle and late adolescents. *Clothing and Textiles Research Journal, 15*(1), 43–50.

Miles, S. (1996). The cultural capital of consumption: understanding 'postmodern' identities in a cultural context. *Culture and Psychology*, *2*(2), 139–158.

Niu, H. J., Chiang, Y. S., & Tsai, H. T. (2012). An exploratory study of the otaku adolescent consumer. *Psychology & Marketing*, *29*(10), 712–725.

Ogle, J., Hyllegard, H. K., Yan, R., & Littrell, A. M. (2014). Segmenting the teen girl apparel market: differences in fashion involvement, materialism and social responsibility. *Young Consumers, 15*(2), 153–166.

Ozanne, J. L. (1992). The role of consumption and disposition during classic rites of passage: The journey of birth, initiation and death. In S. John & S. Brian (Eds.), *Advances in consumer research*, Vol. 19 (pp. 396–397). Provo: Association for Consumer Research.

Piacentini, M., & Mailer, G. (2004). Symbolic consumption in teenager's clothing choices. *Journal of Consumer Behaviour, 3,* 251–262.

Piper, J. (2013). *Piper Jaffray 25th semi-annual "Taking Stock with Teens" market research project*. http://www.piperjaffray.com/2col.aspx?id=287&releaseid=1805593&title=Piper+Jaffray+Completes+25th+Semi-Annual+%22Taking+Stock+with+Teens%22+Market+Research+Project (accessed 10 March 2017).

Salzman, M. (2010). *Study provides bridge to an elusive but powerful consumer demographic: teengirls*. PR Newswire, http://www.prnewswire.com/news-releases/study-provides-bridge-to-anelusive-but-powerful-consumer-demographic-teen-girls-86866797.html (accessed 10 March 2017).

Soard, C. (2013). *How much do American teenagers spend on clothes?* Available at: http://teens.lovetoknow.com/teen-fashion/how-much-do-american-teenagers-spend-clothes (accessed 10 March 2017).

Solomon, M. R. (2005). *Consumer behavior*, (6th ed.). Harlow: Pearson Education.

Srivastava, A. (2015). Consumer decision-making styles of Indian adolescents, contemporary management research, *11*(4), 385–408.

Sutherland, A. & Thompson, B. (2003). *Kidfluence: Why kids today mean business*. New York, NY, McGraw-Hill.

Taylor, S. L. & Cosenza, R. M. (2002). Profiling later aged female teens: mall shopping behavior and clothing choice. *Journal of Consumer Marketing*, *19*(5), 393–408.

Wooten, D. B. (2006). From labeling possessions to possessing labels: Ridicule and socialization among adolescents. *Journal of Consumer Research, 33*(2), 188–198.

Yalkin, C., & Rosenbaum-Elliott, R. (2014). Talking fashion in female friendship groups: Negotiating the necessary marketplace skills and knowledge. *Journal of Consumer Policy, 37,* 301–331.

Chapter 7
A Meta-Model for Fashion Retail Category Sales Forecasting

Enrico Armando and Giuseppe Craparotta

Abstract Companies working in fashion retail require scientific methods to transform the enormous amounts of data they collect into information that can be useful to predict future sales. Literature has presented a huge number of statistical/data-science based techniques, able to perform forecasting of time series, like the number of pieces—belonging to a certain brand or category—sold in retail stores. This paper aims to put together some of these methods to build a robust meta-model able to better understand the hidden relationships between data. Classical and more recent methods to compute a category level forecast are shown, giving particular attention to the modeling of price effect. Finally, we show that the use of a metamodel helps reducing the forecasting error on the yearly category forecast by 24%.

Keywords Fashion · Retail · Forecast · Modeling · Metamodel

7.1 Introduction

As in any industrial field, every phase of the production process—from raw materials to ready-to-sell products—requires accurate planning. Being able to forecast sales gives a great value to the management of a company, since it can add value while optimizing production. Forecasting, in the scientific field, means being able to apply statistical and mathematical methods to current and past information to predict the

E. Armando
Dip. di Scienze Matematiche, Politecnico di Torino Corso
Duca degli, Abruzzi 24, 10129 Torino, Italy

G. Craparotta (✉)
Dipartimento di Matematica "G. Peano", Università di Torino,
Via Carlo Alberto 10, 10123 Torino, Italy
e-mail: giuseppe.craparotta@unito.it; gcraparo@unito.it

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_7

future. In the fashion business this reflects into determining the sales of a certain product, in a particular sales channel, given the history of sales and many other possible variables.

Traditional systems use simple rules, based on past sales and stock level, and tune prices over the factory costs. These methods are suitable for stable and predictable product categories, not certainly for the fashion industry: usually managers have to respond to sudden changes of the demand levels, so they manually change prices and study *ad hoc* promotions and reassortment. Among the various factors that make the fashion retail so different from other business areas, we can highline:

- *Life cycle of an item*. Products with totally different characteristics can be found in the same mono-brand shop. One of them is the time spent between the first exposure of the product and the moment when it is sold or removed. Usually sales have an increasing phase, a stabilization and finally stop, so we can distinguish between *fashion items*, highly volatile according to the fashion trends, and *basic items*, continuously sold during a whole season. Obviously the limited uncertainty makes the second ones easier to forecast.
- *T*ime horizon. A short term prediction (a few weeks) is useful when the sales season has already started, to line out potential reorders and promotions; a long term prediction is instead helpful when getting ready for an entire sales season, planning a collection, ensuring stock levels and ordering new items. The length of the productive cycle must be kept into consideration, since usually it takes one year to transform an idea into a sellable garment.
- *A*ggregation level. Fashion retail items are very fragmented products: everyone of them has variants in terms of colour or size. Aggregation is useful for analysts and for the company itself to better catalogue and distinguish items. For every product category there is a related style, referring to a certain collection, part of a brand division. Under the SKU, size and colour can be found, for example. It is challenging to give a long-term or even a short-term forecast for a single SKU, while for a category it is much easier, thanks to the larger available information, in terms of time and number of items.
- *S*easonality. Every moment of the year has an influence on sales. Some items—like swimming costumes, flip-flops and shorts—are sold mostly during summer and hot days, while coats and scarfs are typical of winter and cold days. A third group, involving jeans, bags and accessories, doesn't show peculiar periods for increased sales likelihood. It is very important to care about this aspect, as it often represents the most important variable for the estimations.
- *E*xogenous factors. Other aspects can influence purchasing decisions: some are part of wider phenomena, like fashion trends, marketing campaigns, holidays, macro-economical context. Furthermore, other factors can have an enormous influence on sales, despite being impossible to control: weather conditions and competitors strategies belong to this group.

Many statistical techniques are nowadays used to forecast future sales (See Thomassey 2010; Thomassey and Happiette 2007), but the peculiarities of fashion industry suggest that relatively simple methods do not perform well by per se, or

can perform well for some categories or brands and bad for other ones. The goal of this paper is to give a framework to build a robust meta-model able to better understand the hidden relationships between data combining two or more base forecast models.

Section 7.2 introduces methods to compute a category level forecast, with particular attention to the modeling of price effect. These methods are both classical ones (like linear regression, seasonal pattern based, ARIMA, Holt-Winters) and more recent (like classical NN and autoregressive NN). Section 7.3 shows proposes a procedure to combine single forecasts and evaluate the combined model performance. Section 7.4 shows the results obtained when this procedure is applied to a particular fashion retailer. We show that the use of a metamodel helps reducing the forecasting error on the year category forecast by 24%. Section 7.5 proposes possible further developments.

7.2 Forecasting Models

Many of the models described in this section are already considered as classics, while others have been studied more recently. We will display theoretical basis, while applications will be discussed later.

7.2.1 Linear Regression

Linear regression is used to get an estimation of the expected value of a *dependent* variable Y, given the values of other *independent* variables, or *predictors* $X_1, ..., X_k$: $\mathbf{E}[Y|X_1, ..., X_k]$. The most simple case is given by $k = 1$ (bivariate regression), where the formula linking the variables is the line $Y = \beta_0 + \beta_1 X + \epsilon$, where ϵ is the error term with average 0 and constant (but unknown) variance, and β_i the model parameters. Given a n-sized population, the model becomes $Y_i = \beta_0 + \beta_1 X_i + \epsilon_i = f(X_i; \beta) + \epsilon_i, \forall i = 1, ..., n$. The parameter estimation is possible with methods like the *least squares*, identifying the β which minimize the quadratic interpolation error: $D(\beta) = \sum_{i=1}^{n} (Y_i - f(X_i; \beta))^2 = \|Y - f(X; \beta)\|^2$. The solution of the problem is given by the vector $\hat{\beta} = \text{argmin}_\beta D(\beta)$, allowing to write the *interpolated values* as $\hat{Y}_i = f(X_i; \hat{\beta}), \quad \forall i = 1, ..., n$. The *prediction* corresponds to $\hat{Y}_0 = f(X_0; \hat{\beta})$.

In this paper we use a seasonality-based multivariate linear regression model, the **lm_sy** model, where the response variable is `qty`, or the number of items sold, and `traffic, price, sy_qty`, representing the number of people entering a shop, the average price and the seasonality coefficient, are used as regressors.

7.2.2 Data Structure

The selected variables are: **txn_year**, the year of the purchases; **txn_week**; **category**, the group of items sharing similar characteristics; **qty**, the number of pieces sold; **price**, the average pocket price; **in_price**, the average full price; **disc**, the average discount; **unit_cost**, the average unitary cost.

The **lm_sy** method is currently implemented and gives as output, for every category, the number of pieces sold for the 52 weeks following the last observation. The values of regressors for the future weeks are also required: these variables—like unit cost and traffic—are independent, uncorrelated and subject to few changes over years. Setting X a regressor, and t a week, given data up to year y, the value $X_{t,y+1}$ is calculated as $X_{t,y+1} = \frac{1}{5}(X_{t-1,y} + 3 \cdot X_{t,y} + X_{t+1,y})$.

7.2.3 Seasonality

The sales curve creates a seasonality profile, which is replicated every year with a similar shape. Intensity can be different, but holidays and seasons have a great impact: therefore, an approximation of this profile can be very useful to predict the future. In our analysis the seasonality variable is calculated during the pre-processing step. For each week t and for each category C the seasonality factor is computed using historical data after removing the discount effect. Let us define $V_{C,y,t}$ and $md_{C,y,t}$ respectively the sales and the markdown for category C, year y, week t. We need to remove the discount effect, so a linear regression model is built: $V_{C,y,t} = \beta_0 + \beta_1 \cdot md_{C,y,t}$. Normalized sales are obtained as $V^{norm}_{C,y,t} = V_{C,y,t} - \beta_1 \cdot md_{C,y,t}$. Then the average over years $V_{C,t}$ is considered. The seasonality factor is then calculated with a moving average over 3 weeks: $S_{C,t} = (V^{norm}_{C,t-1} + 3 \cdot V^{norm}_{C,t} + V^{norm}_{C,t+1})/5$. Finally these factors are scaled in order to sum up to 52, the number of weeks in a year.

7.2.4 Seasonal Pattern Based

In order to forecast sales data affected by seasonality, a good approach already used in fahion is the Seasonal Pattern Based (SPB), introduced by Choi et al. (2014). A set of weekly observations of number of items sold and items in stock is considered. The method is based on identifying a seasonal demand pattern for each product category: this can be obtained by removing stockout effects, price changes and non-systematic past events, through a 6-steps algorithm.

(1) The unsatisfied demand is calculated using past week sales. Usually large companies ensure a high stock level.
(2) Some special events can affect sales volumes, and are treated according to their occurrence: *systematic* events occur every year in the same week, like Christ-

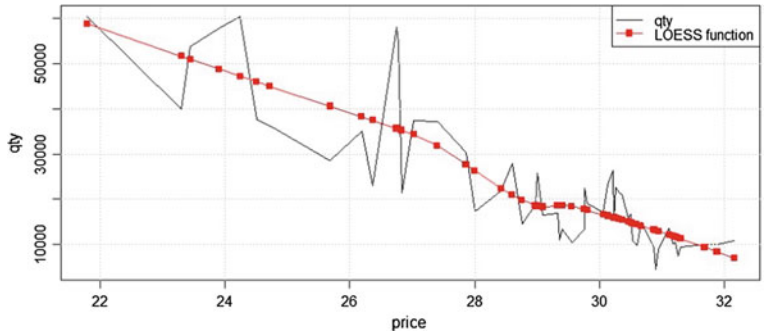


Fig. 7.1 Example of LOESS-fitted demand curve

mas or discount sales, so their effect is a natural component of the seasonal pattern; *non-systematic* events do not repeat every year during the same week—promotions or social/climatic events preventing stores openings—their effects distort the seasonal pattern, and data must be replaced with the closest weeks.

(3) In order to estimate the *p*rice effect, seasonality is ignored and a demand curve is defined from the relationship between price and pieces sold. Figure 7.1 shows an example plot where every dot represents a weekly observation of (X = price, Y = quantity); a decreasing trend is common, but not obvious. The irregularities of this curve are smoothed through interpolation, in two different ways:

- *L*OESS *local weighted scatterplot smoothing*: a kind of local regression, where a greater weight is assigned to points which are closer to the point to be estimated (so, easily correlated). A standard tri-cubic weight function $w(x) = (1 - |x|^3)^3$ is used, with x distance between point and interpolation curve. This model requires dense and numerous data to have a good performance, the result is not an analytic expression and calculation intensity can be heavy; on the other side, it is not necessary to specify a fit function.
- *S*pline: Given (x_i, Y_i), with $x_1 < x_2 < \cdots < x_n$, $i \in \mathbb{Z}$ a sequence of observation generated by $Y_i = f(x_i)$. A *smoothing spline* $\hat{f}$ estimation of the function f is defined as the minimizer (in the class of twice-differentiable functions) of:

$$\sum_{i=1}^{n} (Y_i - \hat{f}(x_i))^2 + \lambda \int_{x_1}^{x_n} \hat{f}''(x)^2 \, dx, \tag{7.1}$$

where $\lambda \geq 0$ is the smoothing parameter, balancing fidelity to data and irregularity of the function. If $\lambda \to 0$ the estimation converges to simple interpolation, while if $\lambda \to \infty$ the $\hat{f}$ gets closer to the least squares regression line.

For each price p the *price factor* $PF(p) = D(p)/D(\bar{p})$, is computed; $D(p)$ represents the demand typical of price p, and $D(\bar{p})$ the one relative to the average annual price $\bar{p}$.

(4) The price effect is removed from data, obtaining a *rough* seasonal pattern. Through this, data obtained at point 2 get de-seasonalized.
(5) De-seasonalized data are interpolated like at point 3, and used to calculate the *true price factors*.
(6) Like at point 4, the price effect given by true price factors is removed, and the definitive seasonal pattern remains.

The relations between price and quantity obtained with the seasonal pattern are used to determine pieces sold for a future price estimation. We implemented the two variants of this algorithm in R. In the following, the two models will be denoted by **spb_loess** and **spb_spline**.

7.2.5 Time Series

The dynamics of a phenomenon through time can be expressed with a set of ordered random variables called *time series*: indicating with Y the phenomenon, Y_t is the observation at time t, t an integer between 1 and T, the length of the series. While in standard statistics n independent observations are supposed to come from the same random variable, in time series they are supposed to come from n independent distributions. The inference on the time series aims then to bring the series back to the generating process.

The standard approach to time series analysis is a model like $Y_t = f(t) + u_t$, so the phenomenon is seen as composed of a deterministic part $f(t)$ and a sequence of random variables, a stochastic part. This part is considered as the result of three hidden components: a *t*rend—often a linear or quadratic function, a *c*ycle—fluctuations around the trend, and *s*easonality—variations found with the same intensity in particular periods of the year (Fig. 7.2).

Models describing time series can be represented through several stochastic processes: the most important are *auto-regressive* (AR) and *moving average* (MA) models, formalized by Box and Jenkins (1990).

In *A*R models, the response variable depends linearly from the previous observations and from a stochastic error. So we have the p-order autoregressive model $Y_t = c + \sum_{i=1}^{p} \varphi_i Y_{t-i} + \varepsilon_t$, with $\varphi_1, \ldots, \varphi_p$ the model parameters, c a constant and ε_t the error, called *white noise*. The simpler among these models, AR(0), doesn't consider the dependence between two consecutive observations; in the AR(1) case, instead, according to the values of the parameter φ, both configurations of noise only ($\varphi \sim 0$) and total dependence from the past ($\varphi \sim 1$) are possible. Once the parameters are estimated (through least squares, for instance), the AR model can forecast an arbitrary number of future values. Considering the model definition, t can be set

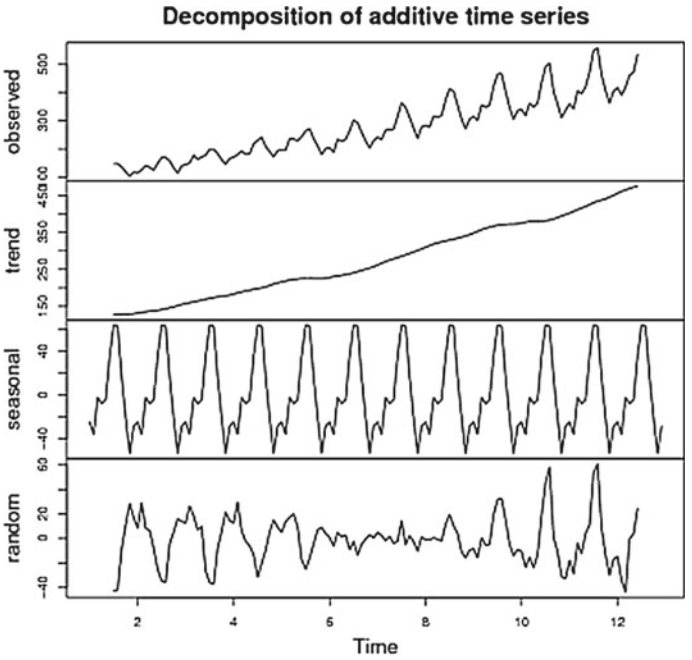


Fig. 7.2 Decomposition of a time series

as the first time when a prediction is needed; on the right side only observed values appear, while the ε_t can be neglected (0 expected value).

In the *MA* *moving average* model, the response variable is linearly dependent from past and current error terms. The q-order model MA(q) has the following configuration: $Y_t = \mu + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i}$, where μ the series average and $\theta_1, \ldots, \theta_q$ the parameters. It is essentially a finite-response filter to the impulse applied to white noise. The errors are directly propagated through consecutive times—but only for a finite number (q) of periods—differently from AR, where the propagation is indirect, therefore infinite. Non-linear fitting procedures are required to estimate the parameters.

A combination of these models is called *A*RMA(p,q), defined by: $Y_t = c + \varepsilon_t + \sum_{i=1}^{p} \varphi_i Y_{t-i} + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i}$. Another common model is the *A*RIMA(p,d,q) model, where d is the number of finite differences necessary to reach stationarity (e.g. the model variable becomes $y_t = Y_t - Y_{t-1}$ when $d = 1$).

A different approach is called *exponential smoothing*: the arithmetic average of n values $\bar{Y} = \frac{1}{n} \sum_{t=1}^{n} Y_t$ is replaced by a weighted average, with weights exponentially growing from the past to the present. The *smoothing parameter* $\alpha \in (0, 1)$ is the weight assigned to the last observation, $(1 - \alpha)$ to the previous, $(1 - \alpha)^2$ to the last but two, and so on. So the Y_t observed series is replaced by the *leveled* series $\ell_t = \alpha Y_t + (1 - \alpha)\ell_{t-1}$. This helps parting the trend component from the seasonal one. The complete formulation of this class of models goes under the name of *Holt-*

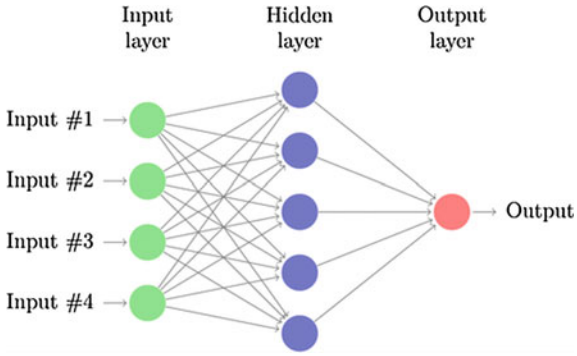


Fig. 7.3 A neural network scheme

Winters method, from the names of the statisticians who formalized it at the end of the 50's (Hyndman and Athanasopoulos 2014). These are very flexible models, as non-polynomial trends and non-constant seasonalities are not an obstacle.

In the early 2017 a new R package containing the new forecasting method *prophet* was presented by Taylor and Letham (2017) of the Facebook team. This model proposes a series additive decomposition into a term of *growth* $g(t)$—modeling aperiodic changes, a *seasonality* term $s(t)$, the *holiday effect* $h(t)$ and the normal error ε_t. A generalized additive model can be recognized, where the time is the only regressor and dependences are non-linear. Differently from AR and MA, missing values can be managed by this model, and the model parameters are well explanatory.

7.2.6 Neural Networks

In the machine learning field many data-analysis techniques have been developed, such as *neural networks*. The term was created to describe the mechanism behind the human brain: every node is a neuron, and edges represent synapses.

In Figure 7.3 p input variables are linked to q response variables through one (or more) hidden layers of r hidden variables, getting influence from the input and conditioning the output. A neural network is essentially a 2+ steps regression, generally non-linear. Naming input, hidden and output variables as x_h, z_j, y_k respectively, the scheme can be described as $z_j = f_0(\sum_{h=1}^{j} \alpha_{hj} x_h)$, $y_k = f_1(\sum_{j=1}^{k} \beta_{jk} z_j)$, with α_{hj} and β_{jk} parameters to be estimated. To complete the description, the *activation functions* f_0 and f_1 must be specified. In the regression problem we can introduce non-linearity choosing $f_0(u) = \frac{e^u}{1+e^u}$, $f_1(u) = u$. The parameters α and β are estimated minimizing the usual functional $D(\alpha, \beta) = \sum_i \|y_i - f(x_i; \alpha, \beta)\|^2$, with y_i the q-dimensional response vector of the i-th observation. More elaborate versions of the objective functions introduce a tuning parameter λ to avoid overfitting, therefore the minimization requires a process of numerical optimization. Updating the parameters when new data are added is possible through the *feed-forwarding* of the signal

and *back-propagation* to re-calculate the parameters. To sum up, the advantages of this technique are flexibility, finiteness and sequential updating of the parameters. Although, the need to set a-priori r and λ and the impossibility to see the hidden variables make this model quite obscure to interprete.

Zhang (2003) proposes a hybrid approach of neural networks and AR models, applying graphs over time series. If the relationship between variables is linear, autoregressive models are enough to determine parameters, otherwise neural networks are better. The notation of the *a*utoregressive neural network NNAR(p, k), in the implementation suggested by Hyndman and Athanasopoulos (2014), indicates that the last p observations are lagged in a neural network with k hidden variables. If data are affected by seasonality, the observations from a previous seasons can be used as input.

7.3 The Meta-Model

The forecasting process needs data as inputs: transactions—data-frames where each row represents a store receipt, stock levels—in stores and central warehouse—and store traffic. These data are merged into weekly aggregates and a forecasting method, like **lm_sy**, is applied. The results obtained at each aggregation level must be reconciled, so the same totals have to be reached: since this is not obvious, quantities are scaled with a *top-down* approach—starting from the highest aggregation level.

7.3.1 Pre-processing

In order to apply all the methods previously described, some transformations are needed, and some parameters regarding dates need to be fixed. Firstly we must set the day when data end and the forecast begins. Before computing the final forecast it is necessary to validate the models on a group of observations. Since we are considering supervised learning techniques, a large part of the dataset is used to train the model—*training set*—and a smaller one to test its goodness—*test set*. Moreover, one training set with one test set are not enough for a correct validation: we can build a moving window over weeks in order to use all available data.

For example, disposing of 130 weeks of data, we can have the test set 26 weeks = 6 months long, and finally want to validate 10 times, so the width of the moving window,—determining the length of the training set—is chosen as $130 - 26 - 10 + 10 = 95$ weeks: therefore at the first iteration weeks $1 \div 95$ are used to create the model tested on weeks $96 \div 121$, and so on, up to the last iteration where training set = $10 \div 104$, test set = $105 \div 130$. Figure 7.4 shows more examples of moving window; ours belongs to the top right category, with a 26 weeks horizon. For the test set weeks observed and predicted values are compared, according to the error metrics

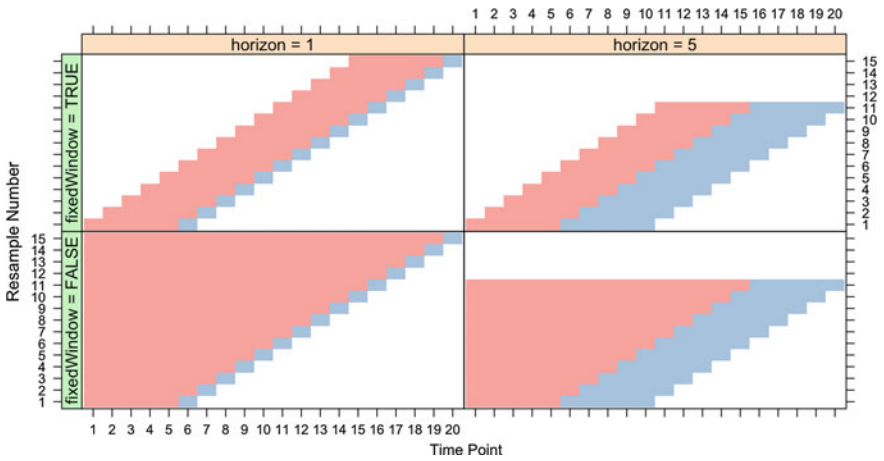


Fig. 7.4 Different configurations of a moving window. Training set is the training area, test set the blue one

described in Appendix. Missing weeks instead are filled with moving averages of observations from the previous weeks. In particular, a missing price is averaged on the nearest weeks, while a missing quantity is set to 1 (not 0, to avoid loss of significance).

7.3.2 Models Evaluation

Separately for each category, the validation of all the models described in Sect. 7.2 follows this algorithm:

(1) *Creation of a subset*: data belonging to a fixed category are isolated. Since we want to use all N_{tot} available weekly observations to forecast 52 future weeks, the parameters N_{train} and N_{test} (which have already been set) determine a loop of J iterations, with $J = N_{tot} - N_{train} - N_{test} + 1$.
(2) *Iteration* $j = 1, \ldots, J$: the data vectors from week j to week $j + N_{train} - 1$ is used to estimate the parameters of every model we described. The different models produce each a vector of length N_{test} weeks. Some methods require the creations of regressors for future data, obtained with simple estimations.
(3) *Error evaluation*: predicted data are compared with real data of the corresponding weeks (from $j + N_{train}$ to $j + N_{train} + N_{test} - 1$). For each couple of vector we calculate $MAPE$, MAE and $AvgRelMAE$. For the last one, the benchmark method is the **naif**, which is always computed.
(4) *Graphical interpretation*: for each iteration a plot showing the curves produced by the methods can be drawn. This is a first step to qualitatively evaluate the goodness of the models, beyond error indicators.

(5) *Error averaging*: through the iteration, every error metric is stored in a vector of J elements, one for every window. At the end of the loop, two indicators are considered:

- the *average*, allowing to evaluate the model over all the windows, through different weeks configurations (seasons, sales, missing data) becoming a global indicator;
- the *last* observed value, kept as the final forecast will be created using the last portion of data, significantly represented by this value. Also the last forecasted values are saved.

7.3.3 Creation of the Final Model

For each subset we dispose of goodness estimations. Trivially, many differences can occur between a category and another, due to data peculiarities and dependences between variables: each models can catch some of these dependences only. We use the error metrics to find the *best model* of each dataset: this is the true essence of the meta-model. In order to define the best model combination we have to group models in two categories:

- **acceptable** models: all those having $AvgRelMAE \leq 1$, so performing better than the **naif**, which is included by default to make sure at least one model is acceptable. Thresholds different from 1 can be set in order to make the selection more (<1) or less compelling (>1). The **naif** method we consider consists in determining the future quantity as an average of all weekly data from the previous years: it is simple, but a very used technique;
- **best** models: in the trivial case when only one model is acceptable, the latter is chosen as final model with weight 100%; otherwise, all acceptable models are considered by couples. For each of them we look for the combination "mix = $\alpha \cdot$ model$_1$ + $(1-\alpha) \cdot$ model$_2$", with $\alpha \in (0, 1)$ having the smaller $MAPE$. For the choice of the parameter, the R optimizer finds the optimal α. After finding the minimum for each couple, the best combination is those with the smallest $MAPE$. We check that the obtained final $MAPE$ is not lager than that of the only **lm_sy** model. A plot can be drown to compare the final mixed model and real data.

At the end of this process a new table collects the chosen model combination, e.g. "63% **lm_sy** + 37% **prophet**", accompanied by the error indicators. This structure is used as a guidance to create the final 52-weeks forecast.

7.4 Results

All methods are applied to all available categories. The goodness of fit can be evaluated analyzing the following plots, related to the last iteration of the loop we just described.

In these figures methods behave differently and data show different seasonalities. In Fig. 7.5a we see high constant sales for the first three months of the year, than decreasing. All models catch this behavior, but resulting though overestimating. In this case **prophet** and **spb_loess** are the closest to the actual data line during the represented 26 test weeks: in fact these two methods are characterized by a good understanding of seasonality. The meta-model's output for this category is in fact "100% prophet", with a 20% $MAPE$.

In Fig. 7.5b we can see the markdown effect on the first weeks of the year and the decreasing trend which follows. Most of the model curves have been able to predict the movements of the actual data curve since the first weeks. Observing the underestimating curve of **spb_loess**, we can think that winter sales customers reacted better in 2017 than in previous years, or that prices were not strongly discounted but people continued buying. In this example, the meta-model chooses a combination of the two best models, **lm_sy** and **nnet** (neural network), with a 14% $MAPE$. It is interesting to notice that in most of the cases these two models (along with **nnetar**, autoregressive neural network) always behaved similarly.

A quantitative analysis allows to evaluate the effectiveness of the meta-model, in particular we measure the improvement with respect to the standard **lm_sy** model. Figure 7.6 must be interpreted in this way: every point in the plot represents a category, the x coordinate is the percentage error ($MAPE$) obtained with the meta-model, while the ordinate shows the error without the meta-model, thus with the linear regression model only. Points lying on the bisector line are configurations where **lm_sy** was chosen as best model, while all points lying on top-left of the diagonal line are characterized by $x < y$, so have a smaller meta-model error. The lefter the point from the line, the greater the error shrinkage. Clearly in this figure the cloud of points parts from the bisector towards left, therefore the improvement is observable for most of the considered categories. Figure 7.7 shows the number of times a model was used to be part of the composition for the final model. The number varies significantly from a model to another: this means that some like **hw** (Holt-Winters) or **spb_spline** are not able to predict data with these peculiarities; in fact the **hw** is traditionally used to give a very short response vector.

Two other tables resume the quantitative improvement introduced with the meta-model: Table 7.1 reports the average $MAPE$ and a percentage of improvement, calculated as $\Delta\% = mean((MAPE_{\text{final}} - MAPE_{\text{lm-sy}})/MAPE_{\text{lm-sy}})$.

Finally, setting a value as an error margin (25% for example), we can see that with **lm_sy** alone, 34 of the 101 categories are below this threshold; with the meta-model instead 51 groups have $MAPE$ <25%.

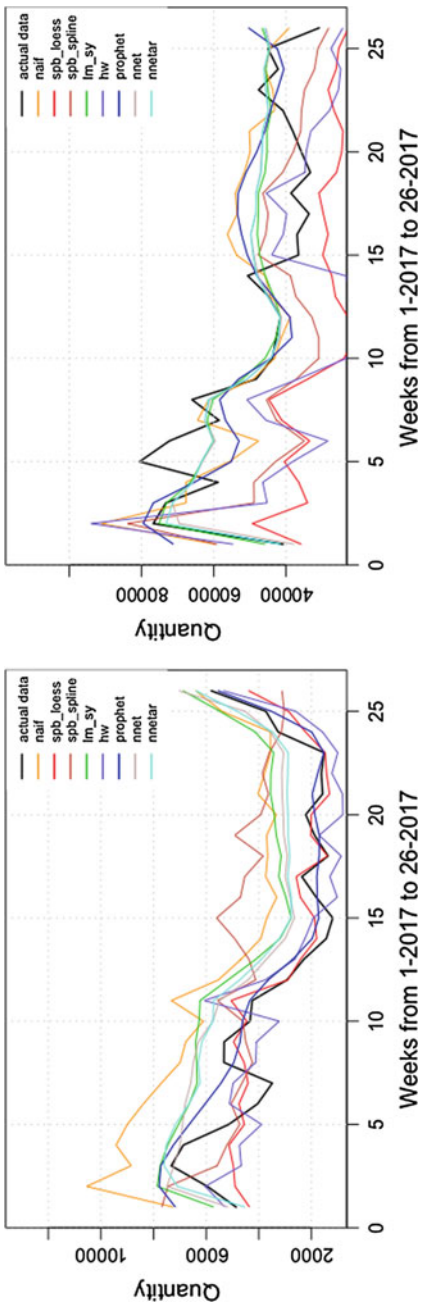


Fig. 7.5 Model comparison applied on two categories

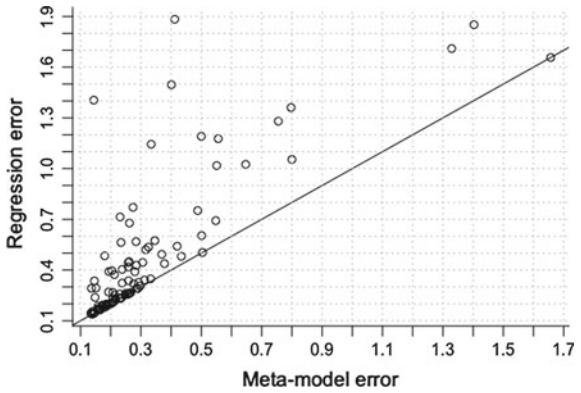


Fig. 7.6 Improving of forecasting error

model	occurrences in 101 cases
lm_sy	50
spb_loess	41
spb_spline	0
naif	3
hw	0
prophet	14
nnet	27
nnetar	25

Fig. 7.7 Models utilization

Table 7.1 Meta-model improvement results

# non-**lm_sy** models	MAPE old	MAPE new	avg Δ %
83 over 101 (%)	55.9	33.9	-24

7.5 Conclusions and Further Developments

A procedure to combine single forecasts and evaluate the combined model performance was proposed. Using data of an european fashion retailer, the use of the proposed metamodel reduces the forecasting error on the year category forecast by 24%.

The models we discussed are representative of many forecasting algorithms presented in literature; if we wanted to add a new method to the meta-model it would be easy to homologate the required data structures. The meta-model is actually comparable to a box, in which data and models can be added, and good predictions—more or less—are available. All the statements made on the peculiarity of forecast applied to the retail domain, along with the particularity of methods adapting to them, are repli-

cable and adaptable to many other data science fields, thus making the meta-model an extremely powerful tool.

Appendix: Main Forecast Error Measurements

Observed value of the i-th time series at time t: $Y_{i,t}$.
Predicted value of the i-th time series at time t: $F_{i,t}$.
Error of the single observation: $e_{i,t} = Y_{i,t} - F_{i,t}$.
Mean absolute error: $MAE_i = \sum_t |e_{i,t}|/n_i$. *Scale dependent.*
Percentage error: $p_{i,t} = (Y_{i,t} - F_{i,t})/Y_{i,t}$. *Requires* $Y_{i,t} \neq 0$.
Mean absolute percentage error: $MAPE_i = \sum_t |p_{i,t}|/n_i$. *Sensitive to* $Y_{i,t} \approx 0$.
Relative error between forecasts $F_{i,t}$ and $F^b_{i,t}$ (benchmark): $RE_{i,t} = e_{i,t}/e^b_{i,t}$.
Benchmark-scaled error: $q_{i,t} = e_{i,t}/MAE^b_i$.
Mean absolute scaled error: $r_i = \sum_t |q_{i,t}|/n_i = MAE_i/MAE^b_i$.
Average Relative MAE: $AvgRelMAE = \left(\prod_{i=1}^m r_i^{n_i}\right)^{\frac{1}{\sum_{i=1}^m n_i}}$. *Geometric mean of MAEs.*
$AvgRelMAE < 1 \Leftrightarrow MAE^a_i < MAE^b_i \Leftrightarrow$ Model A is more accurate than model B.

References

Box, G. E. P., & Jenkins, G. (1990). *Time series analysis: Forecasting and control*. Holden-Day.
Choi, T.-M., Hui, C.-L., & Yu, Y. (2014). *Intelligent fashion forecasting systems: Models and applications*. Springer.
Hyndman, R. J., & Athanasopoulos, G. (2014). *Forecasting: Principles and practice*. https://www.otexts.org/book/fpp.
Hyndman, R. J., & Koehler, A. B. (2006). Another look at measures of forecast accuracy. *International Journal of Forecasting*, *22*(4), 679–688.
Taylor, S., & Letham, B. (2017). *Forecasting at scale*. https://research.fb.com/prophet-forecasting-at-scale/.
Thomassey, S. (2010). Sales forecasts in clothing industry: The key success factor of the supply chain management. *International Journal of Production Economics*, *128*, 470–483.
Thomassey, S., & Happiette, M. (2007). A neural clustering and classification system for sales forecasting of new apparel items. *Applied Soft Computing*, *7*, 1177–1187.
Zhang, G. P. (2003). Time series forecasting using a hybrid arima and neural network model. *Neurocomputing*, *50*, 159–175.

Chapter 8
Resilience in the Fashion Industry Supply Chain: State of the Art Literature Review

S. Antomarioni, M. Bevilacqua, F. E. Ciarapica and G. Marcucci

Abstract In a complex and unpredictable world, nowadays classic risk management techniques are often nor sufficient neither adequate to face the occurring disruptive events. When black swans events (low probability—high impact events) take place, many supply chains are not qualified to tackle those happenings in an efficient way. A resilient approach can fill this expertise gap, providing the necessary know-how and mindset qualities to supply chain players in order to tackle those rising disruptions better. In particular, resilience is a key component in the fashion industry supply chain. In the last decades, many companies declined and retired, while several thrived. The resilience approach was one of the keys that divided successful firms from the unprofitable ones. This research provides a broad view of the literature review about resilience approach within the fashion industry supply chain. Furthermore, in ordimpact of possible disruptionser to assist academics and supply chain decision makers, this study will extensively show the state of the art of the current methodologies used to assess and measures resilience in one's supply chain.

8.1 Introduction

In order to survive in the present world turmoil, companies must seek to improve their processes, systems and technologies to be able to be dynamic and flexible to meet the ongoing changes in the market (Bevilacqua et al. 2017).

This is the case of fashion industry: an horizontal concept that crosses many sectors, like apparel, footwear, leather, jewelry, perfumes, and cosmetics (Brun et al. 2008).

Moreover, what characterizes the supply network of this industry is the complexity of the supply network: many actors are involved in production activities, hence the number of stakeholders is considerable (Macchion et al. 2015).

S. Antomarioni (✉) · M. Bevilacqua · F. E. Ciarapica · G. Marcucci
Dipartimento di Ingegneria Industriale e Scienze Matematiche, Università Politecnica delle Marche, Via Brecce Bianche, 60131 Ancona, Italy
e-mail: s.antomarioni@staff.univpm.it

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_8

Furthermore, several managers now decide to differentiate their product lines in order to build a sustainable future for their companies. Many companies, therefore, tend to carry out several product development projects (Ciarapica et al. 2016). This trend be found especially in the fashion sector (Dewi et al. 2015; Choy et al. 2009).

These phenomena result in the increasing pace of business globalization of the fashion sector. For example, the design process could be carried out in a country other than the ones where the garments are manufactured and sold (Čiarnienė and Vienažindienė 2014).

This strong connection built among these networks leads to the so called "domino effect" (Scheffer 2012), the easier propagation of disturbances due to the increased connectivity of companies and stakeholders—regardless of the physical distance between these subjects (Zhao et al. 2011).

This phenomenon increases the impact of possible disruptions that a company may suffer: in particular so-called black swans (high impact events) that can bring a company to its knees.

Supply chain policy makers have to face with the consequences of disruptions, hence they have to build a strategy to mitigate risks. To this purpose, they usually carry on risk management procedures. The more critical phase of this kind of process regards the risk assessment: indeed, it is always difficult to establish both the probability of an event and the severity of its happening. Unpredictable events-metaphorically referred as "black swan events"—represent risk management's greatest weakness: indeed, we are not able to prevent what we cannot predict.

A resilient Supply Chain can adapt itself to the uncertain environment and can allow supply networks to respond well to unexpected disruptions (Pettit 2008).

Resilience, as the "Oxford Advanced Learners Dictionary" states, *is the ability of a substance to return to its original shape after it has been bent, stretched or pressed.* This definition has been enriched by the contribution of many researchers, over the years. We can cite, for instance, Christopher and Peck (2004), who defined resilience as '*the ability of a system to return to its original state or move to a new, more desirable state after being disturbed*'; while Ponomarov and Holcomb (2009) stated that the essence of Supply Chain Resilience (SCR) is *designing supply chains to incorporate event readiness, provide an efficient and effective response, and be capable of recovering to their original state or even better post the disruptive event.*

Even if resilience is becoming a prerequisite for companies operating in this sector (Pal et al. 2014), to our knowledge there is little research about this topic applied into the fashion sector.

The purpose of this research is to conduct a literature review that can lay the basis for an extensive research into the fashion supply chain resilience.

The paper is structured as follows: in Sect. 8.2 we present our research process. In Sect. 8.3 we show the main results of this literature review. Section 8.4 provides an insight of the research state-of-the art by providing a list of main factors influencing Supply Chain Resilience cited among the literature cited in this paper.

Fig. 8.1 Research approach adopted

8.2 Research Approach

In order to conduct a literature review of works concerning supply chain resilience in fashion industry, the research approach represented in (Fig. 8.1) has been developed, according to the suggestions provided by Webster and Watson (2002).

Firstly, we selected the most relevant scientific and academic databases to extract the extant literature contributions. We decided to query EmeraldInsight, IEEExplore, ScienceDirect, Scopus, and Google Scholar.

Then, we defined the Research Field we would conduct our research into: we focused into the 10 most relevant to our research: Business Management and accounting, Chemical Engineering, Decision Science, Economics, Econometrics and finance, Energy, Engineering, Mathematics, Social Science.

As final step, we defined the search keywords in order to mine relevant papers related to our target industry. We divided this keywords into two categories: industrial sectors (Fashion, Textile, Apparel, Footwear, Leather, Jewelry, Perfumes and Cosmetics) and topic (Resilience, Risk Supply Chain, Disturbance and Disruption).

The research of existent literature was then performed as follows: topics, industrial sectors and research fields summarized in Table 8.1 were combined together through a Cartesian product (Eq. 1), in order to carry out all the possible tuples, and each of the obtained foursome was inserted into the selected databases.

$$U = A \times B \times C \times D \tag{1}$$

Equation 1: Cartesian Product

A total of 2000 foursome queries were conducted.

The following step consisted of filtering the results, with the aim of improving the relevance of the selected literature: publications prior to 2004 were excluded, but this did not cause a loss of generality. Indeed, according to (Kamalahmadi and Parast 2016b), the concept of supply chain resilience was not widely developed earlier.

Moreover, only articles written in English were taken into account. In order to verify whether the sample could have been enlarged and if any other relevant work should have been included in our literature survey, even references of the selected articles were analyzed.

Table 8.1 Industrial sectors, topics, research field and databases analyzed for the current literary review

A	B	C	D
Database	Research field	Industrial sector	Topic
Sciencedirect	Business	Fashion	Resilience
Scopus	Management and accounting	Textile	Risk
Google Scholar	Chemical engineering	Apparel	Supply chain
IEEE	Decision science	Footwear	Disturbance
Emerald Insight	Economics	Leather	Disruption
	Econometrics and finance	Jewelry	
	Energy	Perfumes	
	Engineering	Cosmetics	
	Mathematics		
	Social science		

After having identified the research sample, each paper was deeply reviewed and analyzed: any work that did not pass the last check was excluded from the analysis.

This procedure allowed us to shed the light on the current attitude in applying methodologies to measure supply chain resilience in the fashion, textile and apparel industry.

8.3 Results

As noted in previous sections, there is little research concerning resilience applied to fashion industry, hence the aim of the current work addresses this research gap.

The research approach described in section III and adopted in order to carry out the current literature review resulted to be very efficient. Indeed, several articles were analyzed and 73 of them were found to be relevant according to the predetermined criteria. Even though our search excluded publications prior to 2004 (Kamalahmadi and Parast 2016b), none of the selected papers was published before 2004. The upper time bound, instead, was posed to March 2017, hence any other work edited after that month was not considered.

As we can infer from Fig. 8.2 and according to Cetinguc et al. (2017), in 2014 a peak in publications (12) concerning supply chain management, risk management and fashion industry was registered. Even in 2008, 2015 and 2016 there was a considerable amount of paper production, respectively 11, 10 and 9 works. Since we only consider publications of the first quarter of 2017, we can hypothesize that, by the end of the year, the number of edited paper will considerably increase.

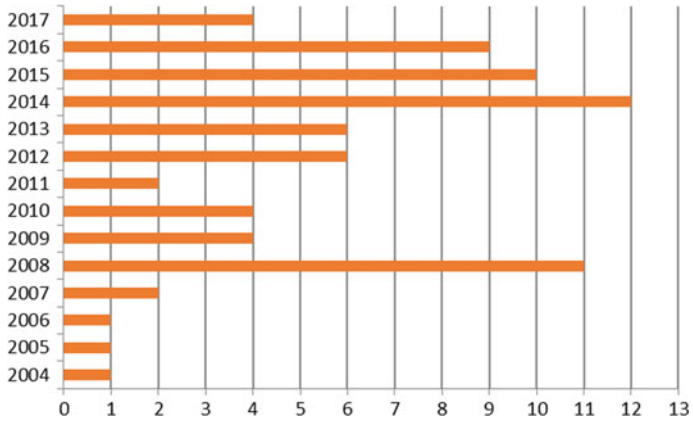


Fig. 8.2 Publications per year

During the analysis, the main topics of the reviewed works were classified into four clusters, as reported in Fig. 8.3. In order to deeply understand the classification considered, we define Supply Chain Management according to Mentzer et al. (2001): "the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole". Moreover, we considered Risk Management as the main topics of those works describing models, methods or conceptual frameworks to cope with Supply Chain Risk. It was found that 13 articles concerned Supply Chain Management and 14 were about Risk Management in fashion industries. However, the most common topic regards Factors influencing Fashion Supply Chains (45 papers), that is the set of decisions, pros and cons to take into consideration during the creation of a Supply Chain. Just one of the 73 papers included in the analysis did not belong to this classification (Cetinguc et al. 2017). Indeed, it regards a literature review on publications trends on Fashion industry and Supply Chain Management.

A further analysis was conducted to evaluate the approach applied in each paper: in particular, we were interested in differentiating within the case study approach and other techniques. As presented in Fig. 8.4, 15 (21%) out of the 74 articles were case studies.

8.4 Factors Influencing Supply Fashion Supply Chain Resilience

For the next phase, a more thorough research was conducted: we refined once more the results, in order to find and study the main factors influencing Fashion Supply Chain Resilience. Among the 73 papers analyzed for this literature review, indeed,

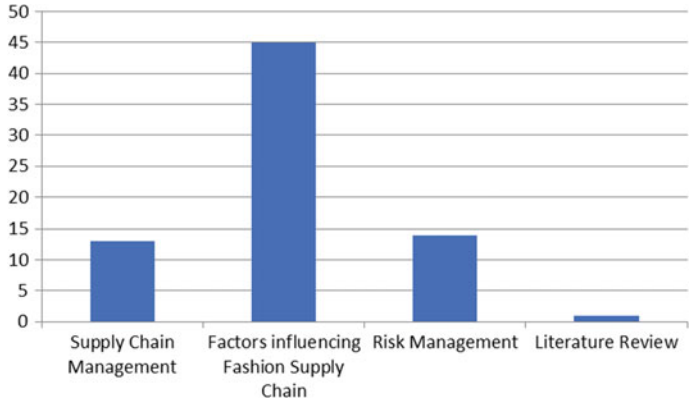
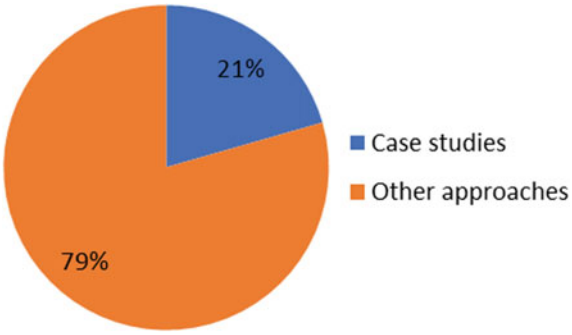


Fig. 8.3 Paper classification by topic

Fig. 8.4 Paper classification by methodology approach



we considered only the 45 articles presenting Factors influencing Fashion Supply Chain Resilience as a main topic and then we selected the 26 more relevant ones.

8.4.1 Factors Research

The first step consisted in the compilation of the raw factors table (see Table 8.2), in which we listed all the factors mentioned in the 26 papers selected: we can note that several authors evidenced the presence of common factors influencing fashion supply chain.

In particular, demand variability or uncertainty and customer needs and preferences are cited in almost all the selected papers as critical factors for the development of a robust supply chain. Considerations about product variety and life cycle are reported in the half of the selected articles.

Even competitors' behavior were found to have a relevant impact on supply chain resilience, according to nine out of the 26 authors. Moreover, SC characteristics such

Table 8.2 Factors within each paper

Source	Factors	#
Turker and Altuntas (2014)	Highly competitive market, pressure on costs, globalization, changes in market customer base, lean SC strategies, just-in-time sourcing	6
Li et al. (2014)	Pollution, over-consumption of energy, uncertainty of consumers' choices, environmental problem, regulatory capacity of governments, SC collaboration, SC visibility	7
Macchion et al. (2015)	Market competition, fragmentation of production activities, geographical dispersion, demand unpredictability, globalization, counterfeits	6
Mehrjoo and Pasek (2014)	Consumers' preferences, product variety, short product life cycles, perishability of products, demand highly volatile and uncertain	5
Venkatesh et al. (2015)	Globalization, complexity of SC, economic events, no SC coordination, infrastructural breakdown, delay in lead time, inaccurate forecasting, customer dissatisfaction, risk due to security and safety, financial risk	11
Čiarnienė and Vienažindienė (2014)	Volatility of demand, outsourced production, SC complexity	3
Caniato et al. (2012)	Environmental impact, time-based competition, high competitive pressures, short products life cycle	4
Li et al. (2016)	Industry eco-unfriendly, financial crisis, demand changes (due to environmental concerns)	3
Dewi et al. (2015)	Short product life cycle, competitive market, uncertain market demand, rapid change of customer needs, wide variety products, complex SC, long SC, lack of organizational structure, poor project management skills	9
Vaagen and Wallace (2008)	Globalization, increased levels of competition, short product life cycles, demanding customers, product variety, market uncertainty, excess inventory and stock-outs	8
Martino et al. (2016)	Wide product variety, short product life cycle, highly unpredictable demand, impulsive demand	4
Martino et al. (2015)	Market uncertainty, consumer behavior uncertainty, competitors' initiatives, many actors between company and market, lack of information from wholesalers, no interaction into the SC, forecasting error, poor virtual integration, long production LT, delays in LT, returns of entire lots in case of defects, many competitor, poor brand recognition abroad, lack of eco-design, long SC, waste production	16

(continued)

Table 8.2 (continued)

Source	Factors	#
Şen (2008)	Short product life cycles, high product variety, volatile demand, demand forecast ability, flexible production, SC collaboration	6
Hakan and Pal (2013)	Economic crises, financial performance, lack of alternate high-quality suppliers, low price competition, low flexibility in inventory management	5
Wang et al. (2012)	Volatile demand, loss of reputation risk, intense competition, global supplier selection, vendor selection problems, supply and demand coordination, terrorism, labor strikes	8
Chow et al. (2015)	SC visibility, SC cooperation	2
Li et al. (2015)	Financial crisis, fashion industry is a source of pollutants, risk of damage to brand evaluations, more volatile demands, Sustainability improve firms' image	5
Abylaev et al. (2014)	Low flexibility, low adaptation, economic shock, lack of raw materials, strikes, dependency of political changes, higher protectionist measures, selective embargo, tariff barriers, favorable international trade	10
Mehrjoo and Pasek (2016)	Deterioration, obsolescence, seasonality, technology progress, governmental regulations, environmental effects, uncertainty in demand, high product variety, increased customer expectations, more global competitions, complex SC, longer SC, short product life cycles, low predictability, high level of impulse purchases, high levels of price competition, delivery delays	17
Ait-Alla et al. (2014)	Demand uncertainties, rapid product obsolescence, production planning model	3
Guercini and Runfola (2010)	Knowledge sharing	1
Choy et al. (2009)	Short life cycles products, erratic customer preferences, impulsive purchasing, improving the information access	4
Marmo (2010)	Dust explosion	1
Pal et al. (2014)	Economic recessions, global trade conditions, financial fluctuations, legislation, changing customer requirements and demands, lack the necessary skills to pursue long-term strategies, continuity strategies, flexibility in strategic decision making	8

(continued)

Table 8.2 (continued)

Source	Factors	#
Escalona Orcao and Ramos-Pérez (2015)	Complex and extensive trans-national networks, unpredictable demand, efficient logistics	3
Shen et al. (2014)	Short life cycles products, SC coordination, Information sharing	3

as coordination, visibility, complexity and visibility plays a vital role in the evaluation of the resilience of the supply chain itself.

8.4.2 Concept Taxonomy

Analyzing the selected papers, a wide number of different factors was extrapolated. The aim of the current section is to classify them into clusters of concepts, according to already existent literature. Moreover, a combination of Delphi method and Cognitive Modelling Group criteria were applied to enhance and confirm the validity of the analysis.

In order to increase the relevance of this study, experiences and knowledge contributions from both the academic world and from fashion industry were considered to be fundamental. To this purpose, two academics whose main research field was Supply chain management and three Supply Chain managers participated to this classification. Their first task consisted of analyzing the factor list and to cluster them, with the aim of creating an effective list of concept to be included into the cognitive map.

A second phase regarded the discussion between these experts, in order to reach global approval. After 3 iterations of Delphi analysis, the classification was approved: 28 concepts (see Table 8.3) were considered sufficient to explain factors influencing Supply Chain, and to guarantee a clear comprehension of the analysis.

8.5 Conclusion

In every industry, management should be aware of their capacities, difficulties and priorities. An efficient information management in any organization can provide consistent advantages and create important financial and business benefits (Bevilacqua et al. 2015). Thus, combined with the application of Resilience concept to the Supply Chain Management can provide a guide survive to competitors' pressure. Indeed, through the understanding of the resource state and of their strengths, firms should recognize their potential expansion areas. Furthermore, an actual competitive advantage can be created considering not only strengths and positive aspects towards rivals,

Table 8.3 Concept taxonomy

#	Concept	Description	Factors
C1	Lean production characteristics	All practices connected to lean production	Lean SC strategies, just-in-time sourcing, excess inventory and stock-outs, low flexibility in inventory management, production planning model
C2	External financial risk	Risks linked to the financial sector in which the SC operates	Economic crisis (x6)
C3	Internal financial risk	Risks linked to the financial situation of the enterprises	Financial risk, financial performance, financial fluctuations
C4	Market volatility	Uncertainties linked to market developments	Customer dissatisfaction (x2), uncertainty of consumers' choices (x7), demand unpredictability (x9), demand changes (due to environmental concerns), product variety (x6), impulsive demand (x2)
C5	Market competition	Rivalry amongst players operating in the sector	Highly competitive market (x9), global competition, low price competition (x2)
C6	Market position	Status of a company or its products in specific markets	Poor brand recognition abroad, loss of reputation risk, risk of damage to brand evaluations
C7	Risk management culture	All of the risk management branches: prevention techniques, risk evaluation, reduction of action plans to face sudden disturbances	Lack the necessary skills to pursue long-term strategies, continuity strategies, flexibility in strategic decision making
C8	SC visibility	Knowledge of the state of the operations along the supply chain	SC collaboration (x5), SC visibility (x2), many actors between company and market, lack of information from wholesalers, poor virtual interaction, supply and demand coordination, knowledge sharing (x2)
C9	SC vertical integration	Degree of insourced operations	Outsourced production
C10	Deliberate threats	Intentional attacks aimed at disrupting operations	Risk due to security and safety, terrorism

(continued)

Table 8.3 (continued)

#	Concept	Description	Factors
C12	Government restrictions	National policies that apply to all sectors of free trade	Higher protectionist measures, selective embargo, tariff barriers, favorable international trade, global trade conditions
C13	Loss of infrastructure	Physical loss of infrastructures: productive plants, etc.	Infrastructural breakdown, dust explosion
C14	Materials flow interruption	Interruption of the normal flux of materials or final products	Delay in lead time (x3), returns of entire lots in case of defects, deterioration
C15	Manpower availability	Availability of human resources to carry on normal activities inside the SC	Labor strikes (x2)
C16	Energy sources availability	Availability of energy sources to carry on normal activities inside the SC	Over-consumption of energy
C17	Political economy	Level of intervention of public bodies on economy with the aim of modifying the macroeconomic system to reach the objectives	Regulatory capacity of governments, dependency of political changes
C18	Institutional policies	Formal restrictions regarding products in the fashion sector	Governmental regulations, legislation
C19	Organization	Human resource structures, policies, skills and culture	Lack of organizational structure, poor project management skills
C20	Technology dependence	Degree of dependence to external players	Technology progress
C21	Flexibility in sourcing	Ability to quickly change inputs or the mode of receiving inputs	Flexible production, lack of alternate high-quality supplier, global supplier selection, low flexibility, low adaptation, lack of raw material, efficient logistics
C22	Flexibility in order fulfillment	Ability to quickly change outputs or the mode of delivering outputs	vendor selection problems, low flexibility, low adaptation, efficient logistics
C23	SC length	Refers to how many players are parts of the SC	Long SC (x3)

(continued)

Table 8.3 (continued)

#	Concept	Description	Factors
C24	Degree of centralization of asset and/or facilities	Degree of concentration of supply chain assets	Fragmentation of production activities, geographical dispersion
C25	Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs	Environmental impact (x4), eco-friendly impact, lack of eco-design, waste production, fashion industry is a source of pollutants, sustainability improve firms' image
C26	SC complexity	Degree of complexity of the SC	Globalization (x4), SC complexity (x4), Complex and extensive trans-national networks
C27	Fast supply chain	Quick response supply chain structure	Short products life cycles (x5), perishability of products, time-based competition, obsolescence (x2), seasonality
C28	Counterfeits	Presence, in the market, of original product imitations	Counterfeits

but also weaknesses and potential threats: having a global view of the environment will help management to objectively evaluate risk and to prevent issues.

A global supply chain should provide high levels of collaboration between the different tiers. Moreover, a strong connection between and within firms belonging to the Supply Chain plays a vital role in the managing disruptions and difficulties related to the un-foreseeability of the environment.

References

Abylaev, M., Pal, R., & Torstensson, H. (2014). Resilience challenges for textile enterprises in a transitional economy and regional trade perspective—A study of Kyrgyz conditions. *International Journal of Supply Chain and Operations Resilience, 1*(1), 54.

Ait-Alla, A., Teucke, M., Lütjen, M., Beheshti-Kashi, S., & Karimi, H. R. (2014). Robust production planning in fashion apparel industry under demand uncertainty via conditional value at risk. *Mathematical Problems in Engineering, 2014,* 1–10.

Bevilacqua, M., Ciarapica, F. E., & Paciarotti, C. (2015). Implementing lean information management: The case study of an automotive company. *Production Planning & Control, 26*(10), 753–768.

Bevilacqua, M., Ciarapica, F. E., & De Sanctis, I. (2017). Lean practices implementation and their relationships with operational responsiveness and company performance: An Italian studye. *International Journal of Production Research, 55*(3), 769–794.

Brun, A., et al. (2008). Logistics and supply chain management in luxury fashion retail: Empirical investigation of Italian firms. *International Journal of Production Economics, 114*(2), 554–570.

Caniato, F., Caridi, M., Crippa, L., & Moretto, A. (2012). Environmental sustainability in fashion supply chains: An exploratory case based research. *International Journal of Production Economics, 135*(2), 659–670.

Cetinguc, B., Calik, E., & Calisir, F. (2017). Publication Trends in Supply Chain Management in the Fashion Industry. In R. Rinaldi & R. Bandinelli (Eds.), *Business models and ICT technologies for the Fashion supply chain* (Vol. 413, pp. 17–24). Cham: Springer.

Chow, P.-S., Wang, Y., Choi, T.-M., & Shen, B. (2015). An experimental study on the effects of minimum profit share on supply chains with markdown contract: Risk and profit analysis. *Omega, 57,* 85–97.

Choy, K. L., et al. (2009). A RFID-case-based sample management system for fashion product development. *Engineering Applications of Artificial Intelligence, 22*(6), 882–896.

Christopher, M., & Peck, H. (2004). Building the resilient supply chain.pdf. *The International Journal of Logistics Management, 15*(2), 1–13.

Ciarapica, F. E., Bevilacqua, M., & Mazzuto, G. (2016). Performance analysis of new product development projects: An approach based on value stream mapping. *Journal of Productivity and Performance Management, 65*(2), 177–206.

Čiarnienė, R., & Vienažindienė, M. (2014a). Agility and responsiveness managing fashion supply Chain. *Procedia-Social and Behavioral Sciences, 150,* 1012–1019.

Čiarnienė, R., & Vienažindienė, M. (2014b). Management of contemporary fashion industry: Characteristics and challenges. *Procedia-Social and Behavioral Sciences, 156,* 63–68.

Dewi, D. S., Syairudin, B., & Nikmah, E. N. (2015). Risk management in new product development process for fashion industry: Case study in hijab industry. *Procedia Manufacturing, 4,* 383–391.

Escalona Orcao, A. I. & Ramos-Pérez, D. (2015). Los transportes y la logística en las cadenas globales de producción del sector de la moda rápida: el caso de la empresa española Inditex. *Investigaciones Geográficas*, (85), 113–127.

Guercini, S., & Runfola, A. (2010). Business networks and retail internationalization: A case analysis in the fashion industry. *Industrial Marketing Management, 39*(6), 908–916.

Hakan, T. & Pal, R. (2013). Resilience in textile enterprises and supply chains.

Kamalahmadi, M., & Parast, M. M. (2016a). A review of the literature on the principles of enterprise and supply chain resilience: Major findings and directions for future research. *International Journal of Production Economics, 171,* 116–133.

Kamalahmadi, M., & Parast, M. M. (2016b). A review of the literature on the principles of enterprise and supply chain resilience: Major findings and directions for future research. *International Journal of Production Economics, 171*(1), 116–133.

Li, Y., Zhao, X., Shi, D., & Li, X. (2014). Governance of sustainable supply chains in the fast fashion industry. *European Management Journal, 32*(5), 823–836.

Li, W.-Y., Choi, T.-M., & Chow, P.-S. (2015). Risk and benefits brought by formal sustainability programs on fashion enterprises under market disruption. *Resources, Conservation and Recycling, 104,* 348–353.

Li, W.-Y., Chow, P.-S., Choi, T.-M., & Chan, H.-L. (2016). Supplier integration, green sustainability programs, and financial performance of fashion enterprises under global financial crisis. *Journal of Cleaner Production, 135,* 57–70.

Macchion, L., Moretto, A., Caniato, F., Caridi, M., Danese, P., & Vinelli, A. (2015). Production and supply network strategies within the fashion industry. *International Journal of Production Economics, 163,* 173–188.

Marmo, L. (2010). Case study of a nylon fibre explosion: An example of explosion risk in a textile plant. *Journal of Loss Prevention in the Process Industries, 23*(1), 106–111.

Martino, G., Fera, M., Iannone, R., Sarno, D., & Miranda, S. (2015). Risk identification map for a fashion retail supply chain. In *Proceedings of Summer School "Francesco Turco"*, *Senigallia, Italy*, pp. 208–216.

Martino, G., Yuce, B., Iannone, R., & Packianather, M. S. (2016). Optimisation of the replenishment problem in the Fashion Retail Industry using Tabu-Bees algorithm. *IFAC-PapersOnLine, 49*(12), 1685–1690.

Mehrjoo, M., & Pasek, Z. J. (2014). Impact of product variety on supply chain in fast fashion apparel industry. *Procedia CIRP, 17,* 296–301.

Mehrjoo, M., & Pasek, Z. J. (2016). Risk assessment for the supply chain of fast fashion apparel industry: A system dynamics framework. *International Journal of Production Research, 54*(1), 28–48.

Mentzer, J. T., et al. (2001). Defining supply chain management. *Journal of Business logistics, 22*(2), 1–25.

Pal, R., Torstensson, H., & Mattila, H. (2014). Antecedents of organizational resilience in economic crises—an empirical study of Swedish textile and clothing SMEs. *International Journal of Production Economics, 147,* 410–428.

Pettit, T. J. (2008). *Supply chain resilience: Development of a conceptual framework, an assessment tool and an implementation process*. The Ohio State University.

Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *The International Journal of Logistics Management, 20*(1), 124–143.

Scheffer, M., et al. (2012). Anticipating critical transitions. *Science*, *338*(6105), 344–348.

Şen, A. (2008). The US fashion industry: A supply chain review. *International Journal of Production Economics, 114*(2), 571–593.

Shen, B., Chow, P.-S., & Choi, T.-M. (2014). Supply chain contracts in fashion department stores: Coordination and risk analysis. *Mathematical Problems in Engineering, 2014,* 1–10.

Turker, D., & Altuntas, C. (2014). Sustainable supply chain management in the fast fashion industry: An analysis of corporate reports. *European Management Journal, 32*(5), 837–849.

Vaagen, H., & Wallace, S. W. (2008). Product variety arising from hedging in the fashion supply chains. *International Journal of Production Economics, 114*(2), 431–455.

Venkatesh, V. G., Rathi, S., & Patwa, S. (2015). Analysis on supply chain risks in Indian apparel retail chains and proposal of risk prioritization model using interpretive structural modeling. *Journal of Retailing and Consumer Services, 26,* 153–167.

Wang, X., Chan, H. K., Yee, R. W. Y., & Diaz-Rainey, I. (2012). A two-stage fuzzy-AHP model for risk assessment of implementing green initiatives in the fashion supply chain. *International Journal of Production Economics, 135*(2), 595–606.

Webster, J. & Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. *MIS Quarterly, 26*, xiii–xxiii.

Zhao, K., Kumar, A., Harrison, T. P., & Yen, J. (2011). Analyzing the resilience of complex supply network topologies against random and targeted disruptions. *IEEE Systems Journal, 5*(1), 28–39.

Chapter 9
Fast Fashion Retail: Dynamic Sub-models for Replenishment and Assortment Problem

Naila Fares, Maria Lebbar and Najiba Sbihi

Abstract With few historical data and quick response of the market, fast fashion apparel retailers should make decisions about replenishment policies and assortment strategies. Deciding the quantity to deliver for each point of sales, in term of quantity and assortment mixture, is one of the big retailers challenges, and keys of success. In this paper, our proposal is about a mathematical model, for fast fashion retail planning chain. Our model is a dynamic tool to make the loop on the assortment, replenishment and inventory quantities, to help decision makers delivering the right product in the right point of sales with the right quantity, by maximizing the profit. It constitutes a flexible tool, allowing retailer to add new items in the optimization process, or even to renew the product range regularly, for fast fashion retailers, who aim for just in time production models. The replenishment supply chain is fragmented into strategic, tactic and operational levels. Each level is modeled as an integer linear program. Looping is made from Head Quarters, through countries until stores. Chorological horizon is sub divided according to season collections, monthly and weekly basis. Our integer linear programs are developed and solved with IBM Cplex Optimizer. Model validation is established with random data instances, inspired from real case studies.

Keywords Fast fashion · Apparel retail · Replenishment · Assortment Mathematical model · Integer programming · Supply chain management

N. Fares (✉) · M. Lebbar · N. Sbihi
Analysis and Modeling of Smart Systems Laboratory, Ecole Mohammadia d'Ingénieurs (EMI), Rabat, Morocco
e-mail: naila.fares@gmail.com

M. Lebbar
Mines National Superior School of Rabat, Rabat, Morocco

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_9

9.1 Introduction

The fast fashion industry has been developed in the last few decades, and demonstrates a great success since consumers have a positive attitude towards fast fashion retailers due to the affordable prices (Cook and Yurchisin 2017). The fast fashion work frame of apparel supply chains requires fast turning models proposals and frequently changes in the displayed styles, with a large product range (Martino et al. 2017).

The phenomenon raises question marks about replenishment and assortment policies. In fact, this work makes the loop on replenishment and assortment model for a fast fashion retailer.

In a first place, a literature survey is presented in Sect. 9.2, followed by the problem definition in Sect. 9.3. The model formulation and validation are detailed respectively in Sects. 9.3.2 and 9.4. Finally, experimental results and model discussion are shown in Sect. 9.4.2 before concluding in Sect. 9.5 by opening the eventual work perspectives.

9.2 Literature Survey

Despite the present researches in the literature, working on retail supply chain (Martino et al. 2016), rare of them deal with a fast fashion industry framework (Iannone et al. 2013) or on fashion luxury (D'Avolio et al. 2015).

Martino (2016) presented an heuristic using Tabu-Bees algorithm for the replenishment problem. The authors quoted some references, such as Grewal et al. (2015) and Al-Zubaidi and Tyler (2004) who worked on the seasonality of the demand, Coelho and Laporte (2014) and Novotna and Varysova (2015) focused on deteriorating products replenishment problem; while Zhu (2013) and Bijvank et al. (2015) focused on price policies and supply chain mechanisms.

The authors named as well Abbott and Palekar (2008) in dealing with store multiproduct problem with shelf availability and display-space constraints, and Pan et al. (2009) in defining the optimal replenishment level for retailers. In this context, Yu and Kunz (2010) examined, in a framework of assortment diversity, the capability of minimizing the merchandising errors.

Generally, in fast fashion Heikki et al. (2002) sourcing, buying, and forecasting replenishment might have a powerful impact overall planning chain.

In this work frame, several works focused on replenishment problem linked to other pillars of decision-making (Dandeo et al. 2004) and (Mattila et al. 2002). This will lead us to stand on below researches in the literature:

- Spragg (2017) established a forecasting framework based on Newsvendor model and Bass Diffusion model, dedicated for fashion seasonal demand.

- Chaudhry and Hodge (2012) explored the applications of postponement strategy in the textile and apparel industry, with a particular focus on the supply chain structure.
- Cinar and Martinez-de-Albéniz (2013) worked on a dynamic programming formulation, as a support of decision-making. As an alternative of binary decisions (Caro and Martinez-de-Albéniz 2014), continuous feature of products values was introduced.
- Sefra (2013) presented in her thesis an integral approach for production and distribution planning in textile industry.
- Iannone et al. (2013) clothing categories on the basis of the trying speed (accessories, underwear …).
- Choi et al. (2014) suggested a fast fashion forecast tool with limited data size and time range.

To our knowledge, the replenishment problem of fast fashion retail has never been smoothly modeled as our proposal in this work paper.

9.3 The Problem Definition and Model Formulation

9.3.1 The Problem Definition

The study presented in this article is about a multi store, multi product and multi period retailer.

It focuses on international retailers model, that need to maximize their profit among an international stores network, not only replenishment and assortment decisions, but also inventory level modeling, on the basis of sales and consumer behavior forecasts. It is both art and science: our model stands on qualitative and quantitative features of data, dynamically hybridized in integer linear programs.

KPIs of the model are suggested below, to enhance functionally the customer demand learning through the season, and to make the loop on the main development areas accordingly.

9.3.2 The Model Formulation

We fragmented the program on 3 sub models. The subsequence is established between the 3 parts dynamically (Fig. 9.1).

We developed our model as an extension of Martino et al. (2016), based on the model they suggested.

In fact few papers in the literature focused on supply chain of fast fashion retail specifically, and namely on the replenishment problem in that field. Martino et al.

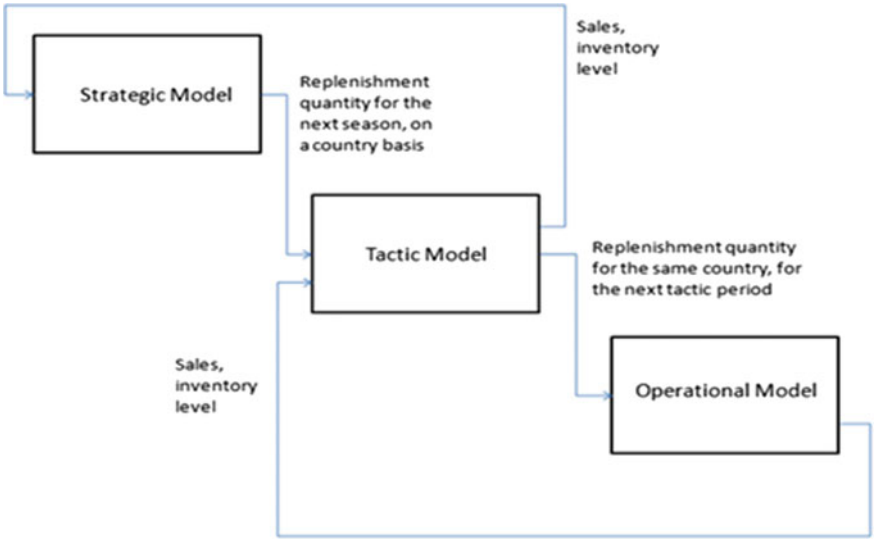


Fig. 9.1 The sub-models scope

(2016) presented in fact a dedicated research in this work frame, thus the choice of this research, and our ambition to present our work as its perspective.

The main goal of Martino et al. (2016) is to present a mathematical model, to determine the optimal quantity for replenishment, on model basis, in order to maximize the profit, and as per the relevant constraints.

Our work is a detailed multi-scope model, which presents the replenishment issues on all the stages, from central warehouses until the points of sales. It takes into consideration the specific constraints of each node of the supply; furthermore, it is resolved as integer model, by giving the exact mathematical model solution without any approximation.

While Martino et al. (2016) gave a general work frame for replenishment problem, approximately resolved using heuristics.

Thus the value added of our work.

9.3.2.1 Strategic Model

This part is the most global model scope. It might be run over head quarter (HQ) office functionally, chronologically once a semester or a quarter, to determine the replenishment and assortment policies globally during the next season on a country basis for items macro categories. At this first scope, we take into study:

Item macro categories replenishment quantities: pants, coats, t-shirts, shoes….

The storage capacity of each country central warehouse.

Combinations: set of products, separately sold but which correlation sales is extremely high, due to the design. They are composed of several macro categories elements, giving the customer a full combination suggestion.

The next table denotes the model nomenclature (Table 9.1):

While costs are defined as below:

- Average stock out cost: if the macro category is not displayed in a country while it is requested by its customer, it generates the below cost:

$$c_{s1} = \begin{cases} \sum_{i=1}^{I} c_{su1} * cu_i * \sum_{c=1}^{C} \sum_{t_1=1}^{T_1} (d_{ict_1} - Inv_{ict_1}) + \sum_{g=1}^{G} c_{su1} * cug * \sum_{c=1}^{C} \sum_{t_1=1}^{T_1} (d_{gct_1} - Inv_{gct_1}) & \text{if } d_{ict_1} > Inv_{ict_1} \text{ and } d_{gct_1} > Inv_{gct_1} \\ 0 & \text{if } d_{ict_1} \leq Inv_{ict_1} \text{ and } d_{gct_1} \leq Inv_{gct_1} \end{cases}$$

- Average purchase cost: the purchase cost of macro categories

$$C_{P1} = \sum_{i=1}^{I} cu_i \ * \ cu_i * \sum_{c=1}^{c} \sum_{t_{1=1}}^{T_1} Q_{ict_1} + \sum_{g=1}^{G} cu_i * \sum_{c=1}^{c} \sum_{t_{1=1}}^{T_1} Q_{gct_1}$$

- Average transport cost: the transport cost from HQ central warehouse to the countries central warehouses

$$C_{T1} = C * T_1 * c_{tf1} + c_{tv1} * \sum_{c=1}^{C} dist_c * \sum_{i=1}^{I} \sum_{t_1=1}^{T_1} Q_{ict_1} + c_{tv1} * \sum_{c=1}^{C} dist_c * \sum_{g=1}^{G} \sum_{t_1=1}^{T_1} Q_{gct_1}$$

- Average handling cost: handling cost in the countries central warehouses

$$C_{H1} = C * c_{hf1} + \sum_{i=1}^{I} c_{hv1,i} * cu_i \sum_{i=1}^{I} \sum_{t_1=1}^{T_1} \frac{Inv_{ict_1}}{t\_range\, t_1} + \sum_{g=1}^{G} c_{hv1,g} * cu_g \sum_{g=1}^{G} \sum_{t_1=1}^{T_1} \frac{Inv_{gct_1}}{t\_range\, t_1}$$

Since we are dealing with macro categories and not with the final product at exact level, and since the prices are at final product level, the costs are calculated on an average manner, based on average prices. Our decision variables are the quantity Q to replenish and the inventory level Inv, for every combination g and macro category i, in the defined time range. The strategic model is formulated as:

Decision variables:

$$\mathrm{Q}_{\mathrm{ict}_1}; \mathrm{Q}_{\mathrm{gct}_1}; \mathrm{Inv}_{\mathrm{ict}_1}; \mathrm{Inv}_{\mathrm{gct}_1}$$

Objective function:

$$\text{Maximize Profit} = R_{1i} + R_{1g} - (C_{S1} + C_{P1} + C_{T1} + C_{H1}).$$

Table 9.1 Strategic model nomenclature

g = 1 . . . G	Number of combinations	c = 1 . . . C	Number of countries
i = 1 . . . I	Number of items macro categories	t_1_*range*	Number of days in each time range t_1
$t_1 = 1 \ldots T_1$	Number of time ranges	B_Country	Total budget defined for the head quarter
$Capacity_{c1}$	Capacity of central warehouse of country c for initial inventory storage	$dist_{country}$	Distance of central warehouse of country c from HQ countries
$Capacity_{c2}$	Capacity of central warehouse of country c for new replenished products storage	C_{tv1}	Variable transport cost from HQ to central warehouses of countries
C_{tf1}	Fixed transport cost from HQ to central warehouses of countries	C_{su1}	Unitary stock out cost
		unc_1	Strategic forecast uncertainty
C_{hf1}	Fixed holding cost in countries central warehouses (logistic costs)	C_{hv1}	Variable holding cost in countries in central warehouses (logistic costs)
cu_i	Average purchase cost of the macro category i	pr_i	Average market price of the macro category i.
Cu_g	Average purchase cost of the combination g	pr_g	Average market price of the combination g
$f_{ic\,t_1}$	Forecast of the macro category sales for the macro category i in the country c during the t_1	d_{ict_1}	Market demand estimation of the macro category i in the country c during the time range t_1. It has a uniform distribution: $d_{ict_2} = \left[f_{ict_2} - unc_1; f_{ict_2} + unc_1\right]$
$Inv_{ic\,t_1}$	$Inv_{ict_2} = Q_{ict_2} - S_{ict_2} + Inv_{ic(t_2-t_1)}$		
R_{1i}	Revenue: $R_{1i} = \sum_{i=1}^{I} \sum_{c=1}^{C} \sum_{t_2=1}^{T_2} s_{ijt_2} * pr_i$	s_{ict_2}	Sales estimation: $s_{ict_2} = min\{Inv_{ict_2}; d_{ict_2}\}$
$f_{gc\,t_1}$	Sales forecast of combination g in the country c during the t_1	d_{gct_1}	Market demand estimation of the combination g in the country c during the time range t_1. It has a uniform distribution: $d_{gct_2} = \left[f_{gct_2} - unc_1; f_{gct_2} + unc_1\right]$
Inv_{gct_1}	$Inv_{gct_1} = Q_{gct_1} - s_{gct_2} + Inv_{gc(t_1-2)}$		
R_{1g}	Revenue: $R_{1g} = \sum_{g=1}^{G} \sum_{c=1}^{C} \sum_{t_1=1}^{T_2} S_{gct_2} * pr_g$	s_{gct_2}	Sales estimation: $s_{gct_2} = min\{Inv_{gct_2}; d_{gct_2}\}$

Subject to:

- $$\forall c \in [1; C], \forall t_1 \in [1; T1] \; : \sum_{i=1}^{I} Inv_{ict_1} + \sum_{g=1}^{G} \mathrm{Inv}_{\mathrm{gct}_1} \leq \mathrm{capacity}_{c1} \tag{9.1.1}$$
- $$\forall c \in [1; C], \forall t_1 \in [1; T1] \; : \sum_{i=1}^{I} Q_{ict_1} + \sum_{g=1}^{G} \mathrm{Q}_{\mathrm{gct}_2} \leq \mathrm{capacity}_{c2} \tag{9.1.2}$$
- $$C_{P1} \leq \mathrm{B\_Country} \tag{9.1.3}$$

where (9.1.1) and (9.1.2) define the capacity constraints and (9.1.3) defines the budget constraint.

9.3.2.2 Tactic Model

The second model scope focuses on the replenishment policies for each country. The model had as an output the replenishment and assortment decision, for every store on a weekly basis. At this stage, our model takes in consideration following points:

- The styles of macro categories: formal, casual, classic…
- The total storage capacity of each store, covering both store warehouse and sales area stocks.
- The weather parameters: at this stage, we have a better visibility on current quarter year weather forecast than like for like prediction. We define the weather parameters as segmentation of the weather state (windy, rainy…). We model them with Boolean variables, set in the model, and consider them for forecast.
- The capacity of each style: according to the store layout and potential customer profiles, each style had a special defined, to ensure a consistent supply and demand matching. Nomenclature is defined in below table (Table 9.2):

Similarly, average costs are defined as below:

- Average stock out cost: if we don't meet the customer need, or if the customer requests a product I in the store j at the time range j, and doesn't find it, it generates a cost represented as below:

$$C_{S2} = \begin{cases} \sum_{j=1}^{J} c_{su2} * cu_j * \sum_{s=1}^{S} \sum_{t_2=1}^{T_2} \left(weather_j * d_{jst_2} - Inv_{jst_2} \right) & d_{jst_2} > Inv_{jst_2} \\ 0 & d_{jst_2} \leq Inv_{jst_2} \end{cases}$$

- Average purchase cost: the cost for buying the products to the stores

Table 9.2 Tactic model nomenclature

j = 1 . . . J	Number of styles	s = 1 . . . S	Number of stores
$t_2 = 1 \ldots T_2$	Number of time ranges	B_Store	Budget defined for the store s
$Capacity - wh_s$	Warehouse of store s	$dist_{store}$	Distance of central warehouse of country c from the store s
C_{tf2}	The capacity of each style j		
C_{hf2}	Average fixed transport cost from central warehouse to stores for the set of style j	C_{tv_2}	Average variable transport cost from central warehouse to stores for the set of style j
C_{su2}	Average fixed holding costs in the store for the set of style j	C_{hv_2}	Average variable holding costs in the store s for the set of style j
C_{su2}	Unitary stock out cost: if the style is not displayed in a store while it is requested by its customer	unc_2	Tactic forecast uncertainty
		$weather_j = function(\alpha_{st_2}, \beta_{st_2}, \gamma_{st_2})$	Style weather parameters
		$\alpha_{st_2}, \beta_{st_2}, \gamma_{st_2}$	Time range weather parameters (Boolean variables)
cu_j	Average purchase cost of the style j	pr_j	Average market price of the style j
f_{jst_2}	Forecast of the macro category sales for style j in the store s during the t_2	d_{jst_2}	Market demand estimation of the style j in the store s during the time range t_2. It has a uniform distribution: $d_{ict_1} = \left[f_{ict} - unc_1; f_{ict_1} + unc_1\right]$
Inv_{jst_2}	$Inv_{jst_2} = Q_{jst_2} - s_{jst_2} + Inv_{js(t_2-1)}$	full_prm_j	
R_2	Revenue: $R_2 = \sum_{j=1}^{J} \sum_{s=1}^{S} \sum_{t_2=1}^{T_2} s_{jst_2} * pr_j$	s_{jst_2}	Sales estimation: $s_{jst_2} = min\left\{Inv_{jst_2}; d_{jst_2}\right\}$

$$C_{P2} = \sum_{j=1}^{J} cu_j * \sum_{s=1}^{S} \sum_{t_2=1}^{T_2} Q_{jst_2}$$

- Average transport cost:

$$C_{T2} = S * T_2 * c_{tf2} + c_{tv2} * \sum_{j=1}^{m} dist_j * \sum_{i=1}^{m} \sum_{t_2=1}^{T_2} Q_{jst_2}$$

- Average handling cost:

$$C_{H2} = S * c_{hf2} + \sum_{j=1}^{n} c_{hv2,j} * cu_j \sum_{s=1}^{S} \sum_{t_2=1}^{T_2} \frac{Inv_{jst_2}}{t_{range}}$$

This model decides similarly on the quantity of replenishment Q and the inventory level Inv. The tactic model is formulated as below:

Decision variables:

$$Q_{jst_2};\ Inv_{jst_2}$$

Objective function:

$$\text{Maximize}\, R_2 - (C_{S2} + C_{P2} + C_{T2} + C_{H2})$$

Subject to:

-

$$\forall s \in [1; S], \forall t_2 \in [1; T2] : \sum_{j=1}^{J} Inv_{jst_2} \leq capacity - wh_s \tag{9.2.1}$$

-

$$C_{p2} \leq \text{B\_Store} \tag{9.2.2}$$

where (9.2.1) denotes the capacity constraint and (9.2.2) defines the budget constraint.

9.3.2.3 Operational Model

Finally, this model is the most rich in data, due to the highly dependence to the shop floor, and short time period. The program might be run on a weekly basis by merchandisers or at head offices level and fed with field data from stores. It is expected that this level reports the most detailed needed features and run on a weekly basis.

Table 9.3 Operational model nomenclature

$m_j = 1 \ldots M_j$	Number of models m of the style j	pr_{mjxz}	The revenue of item k
x = 1 . . . X	Number of colors	z = 1 . . . Z	Number of sizes
C_{tf3}	Fixed transport cost from central warehouse to stores for the model j	C_{tv3}	Variable transport cost from central warehouse to stores for the model j
C_{hf3}	Fixed holding costs in the store s for the model j	C_{hv3}	Variable holding costs in the store s for the model j
C_{su3}	Unitary stock out cost: if the style is not displayed in a store while it is requested by its customer	unc_3	Operational forecast uncertainty
		pr_{mj}	Average market price of the model m
cu_{m_j}	Purchase cost of the model m of the style j	d_{mjxz}	Market demand estimation of the style m_j in the store s during the time range t_2. It has a uniform distribution: $d_{m_jxz} = \left[f_{m_jxz} - unc_3; f_{m_jxz} + unc_3\right]$
f_{m_jxz}	Forecast of the style m_j in the store s during the t_2		
Inv_{m_jxz}	$Inv_{m_jxz} = Q_{m_jxz} - s_{m_jxz} + Inv_{m_jxz}(t_2 - t_1)$		
R_3	Revenue: $R_3 = \sum_{m_j=1}^{M_j} \sum_{x=1}^{X} \sum_{z=1}^{Z} s_{m_jxz} * pr_{mjxz}$	s_{m_jxz}	Sales estimation: $s_{m_jxz} = min\{Inv_{m_jxz}; d_{m_jxz}\}$

Each model is run for a specific store considering:

- Colors and sizes.
- Fit (normal, slim…) and patterns (checked, stripped…).
- Fashion attractiveness: it is highly expected that a fast fashion retailer display very frequently new models. Products attractiveness decreases along they are displayed in the store. We determine the order of displaying according to the final products revenue (Caro et al. 2014).

We consider the same nomenclature considered in the tactic model, and add the below parameters (Table 9.3):

At this model, we are dealing at unique product reference level. Thus, the depth treatment of data is highly delicacy, and costs are exactly modeled not on an average basis. They are defined as below:

- Stock out cost:

$$C_{S3} = \left\{ \begin{array}{ll} \sum\limits_{m_j=1}^{M_j} C_{su3} * Cu_{m_j} * \sum\limits_{x=1}^{X} \sum\limits_{Z=1}^{Z} \left(d_{m_j xz} - Inv_{m_j xz}\right) & d_{m_j xz} > Inv_{m_j xz} \\ 0 & d_{m_j xz} \leq Inv_{m_j xz} \end{array} \right\}$$

- Purchase cost: the cost for buying the products to the stores

$$C_{P3} = \sum_{m_j=1}^{M_j} cu_{m_j} * \sum_{X=1}^{X} \sum_{Z=1}^{Z} Q_{m_j xz}$$

- Transport cost: C

$$C_{T3} = C_{tf3} + C_{tv3} * \sum_{m_j=1}^{M_j} dist_j * \sum_{m_j=1}^{M_j} \sum_{Z=1}^{Z} Q_{m_j xz}$$

- Handling cost:

$$C_{H3} = c_{hf3} + \sum_{m_j=1}^{M_j} c_{hv3,m_j} * cu_{mj} \sum_{x=1}^{X} \sum_{z=1}^{Z} \frac{Inv_{m_j xz}}{t_{range}}$$

The model, which decides on the replenishment quantity Q and the inventory level Inv, is formulated as below:

Objective function:

$$\text{Maximize}\, R_3 - (C_{S3} + C_{P3} + C_{T3} + C_{H3})$$

Decision variable:

$$Q_{m_j xz}; Inv_{m_j xz}$$

subject to:

-

$$\forall x \in [1; X], \forall z \in [1; Z] : \sum_{j=1}^{J} Inv_{mjxz} \leq capacity_s \tag{9.3.1}$$

-

$$C_{P3} \leq \text{B\_store} \tag{9.3.2}$$

where (9.3.1) and (9.3.2) define respectively: capacity and budget constraints.

9.3.3 The Framework Forecast KPIs

In order to gauge its inventory management, the retailer may refer to establish key performance indicators (KPIs) that measure the estimations exactitude toward real data. We suggest 4 KPIs according to the forecasts and terminal stock. Actually, forecast is initially analyzed based on historical sales, while it is mentored and might be frequently modified by decision makers above the 3 levels. Once the period passed, sales vs. forecast ratios will evaluate the decision makers forecast performance, and will led us to define the uncertainty forecast parameters to be set in the next period program.

Finally, the terminal stock, which indicates the remaining inventory at the end of the season, and the input that is the inventory level data of the next season, is a pillar of replenishment performance. Retailers should emphasis the transition period by mentoring the replenishment quantities, and injecting the markdown prices strategies, by having as an objective to tend the terminal stock value to 0.

- Initial forecast data KPI $= \frac{f_{ict_1}}{sales_{ict_1}}$
- Tactic forecast KPI $= \frac{f_{ist_2}}{sales_{ist_2}}$
- Operational forecast KPI $= \frac{fm_j xz}{scales\, m_j xz}$
- Terminal stock KPI $= Inv_{ic}(t_1 - 1)$.

9.4 Model Validation and Results

9.4.1 Data Instances Description

As per model validation purpose, we run the model with experimental data, inspired from real case studies. We test each program under 3 data configurations, leading to instances referring to low demand, average and high demand (Table 9.4). The test data are used for validation purpose; it does not affect the model or the case study. The data covers 3 countries, with 5 stores in each country, and 4 time periods from t1 to t4. It covers a range of 10 items macro categories, 5 item styles for each macro category and 100 models for each style.

9.4.2 Experimental Results and Model Discussion

In order to test the appropriateness of the models, they were programmed within Cplex IBM software.

The below figures indicate an extract of the replenishment results for strategic, tactic and operational models (Fig. 9.2).

Table 9.4 Extract of data: macro categories forecast

	f_{ict1}											
Time ranges	$t_1 = 1$			$t_1 = 2$			$t_1 = 3$			$t_1 = 4$		
MacroCategory i/country c	1	2	3	1	2	3	1	2	3	1	2	3
100000	12197	10909	14248	14912	10031	10493	12440	13544	10161	13441	13190	12893
200000	14532	14265	11425	14498	14198	14581	13110	10568	12096	12431	10100	13388
300000	11412	14442	10812	11031	14336	13805	11852	11424	12868	13252	12965	13744
400000	13054	12181	12492	13840	11704	14997	14689	12030	12840	10479	13308	10566
500000	12137	10806	10003	14727	14732	10899	10733	11105	13927	12588	14900	11144
600000	13488	13847	14095	10623	13418	14291	10231	14175	12781	13965	10581	12263
700000	14009	13584	11623	12828	12615	10568	14399	10906	10318	12451	11074	10402
800000	10869	14306	10537	14020	14281	11599	11255	12273	10004	10483	13215	12474
900000	11975	13779	14372	10830	13970	13424	14007	14941	11326	11905	13646	11902
1000000	11764	12578	13457	11050	13920	14165	14428	14521	12182	14278	12738	12379

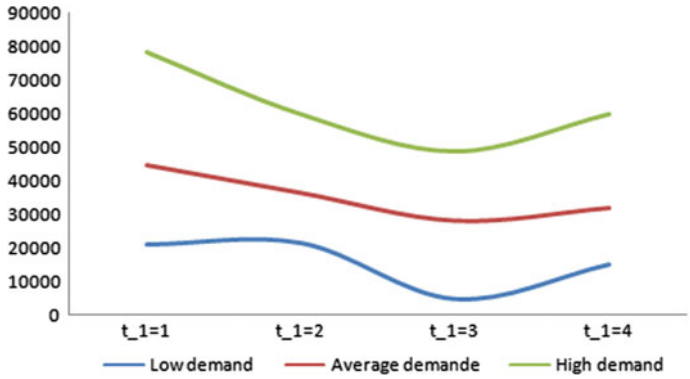


Fig. 9.2 Extract of result: replenishment quantity for macro category 1 in country1

The results are consistent according to the entry data, which demonstrates the model validation. The model was run in few seconds. The test data is going to be relevant for brand applications, according to their forecast calculations, costs and distances between stores and warehouses.

It was suggested that the strategic model covers 3 months as per the season length. The period covered might be changed according to the retailer policies. For instance, some retailers are working with a horizon of 6 months, namely: spring-summer and autumn-winter periods. The time range may also refer to a particular period of event, which impact directly on the sales (back to school, holidays, special festivals…).

Furthermore, the model is not imperatively run once 3 months. It is likely that several fluctuations occur within the season, which might affect the model parameters. Running the model for 3 months lengths within the season, will allow the retailer to model the transition period; in terms of inventory level and sales. Furthermore, it will support in mentoring markdowns and sales strategies mechanism.

9.5 Conclusion and Perspectives

In this paper, we proposed a set of integer linear programs, to optimize dynamically the replenishment problem of fast fashion retail. The model allows even for the just in time trend, enabling the retailer to change the set of the products in the study on the basis of the time range defined, on which the loop might be at a weekly basis or even daily basis if needed.

In work environments where fast fashion brands might have a huge number of models, the model execution delay can be longer.

Future eventual perspectives of the work might focus on a heuristic development of the model, to assure its responsiveness on a big data size in a short delay.

References

Abbott, H., & Palekar, U. S. (2008). Retail replenishment models with display-space elastic demand. *European Journal of Operational Research, 186,* 586–607.

Al-Zubaidi, H., & Tyler, D. (2004). A simulation model of quick response replenishment of seasonal clothing. *International Journal of Retail & Distribution Management, 32*(6), 320–327.

Bijvank, M., Bhulai, S., & Huh, W. T. (2015). Parametric replenishment policies for inventory systems with lost sales and fixed order cost. *European Journal of Operational Research, 241,* 381–390.

Caro, F., & Martinez-de-Albéniz, V. (2014). Fast fashion: Business model overview and research opportunities. *Retail supply chain management: Quantitative models and empirical studies* (2nd Edn.). New York, NY: Springer.

Caro, F., Martínez-de-Albéniz, V., & Rusmevichientong, P. (2014). The assortment packing problem: Multiperiod assortment planning for short-lived products. *Management Science*, *60*(11), 2701–2721.

Chaudhry, H., & Hodge, G. (2012). Postponement and supply chain structure: Cases from the textile and apparel industry. *Journal of Fashion Marketing and Management: An International Journal, 16*(1), 64–80.

Choi, T. M., Hui, C. L., Liu, N., Ng, S. F., & Yu, Y. (2014). Fast fashion sales forecasting with limited data and time. *Decision Support Systems, 59,* 84–92.

Cinar, E., & Martinez-de-Albieniz, V. (2013). *A closed-loop approach to dynamic assortment planning*. Working paper, IESE Business School.

Coelho, L. C., & Laporte, G. (2014). Optimal joint replenishment, delivery and inventory management policies for perishable products. *Computers & Operations Research, 47,* 42–52.

Cook, S. C., & Yurchisin, J. (2017). Fast fashion environments: Consumer's heaven or retailer's nightmare? *International Journal of Retail & Distribution Management, 45*(2), 143–157.

Dandeo, L. M., Fiorito, S. S., Giunipero, L., & Pearcy, D. H. (2004). Determining retail buyers' negotiation willingness for automatic replenishment programs. *Journal of Fashion Marketing and Management: An International Journal, 8*(1), 27–40.

D'Avolio, E., Bandinelli, R., Pero, M., & Rinaldi, R. (2015). Exploring replenishment in the luxury fashion Italian firms: Evidence from case studies. *International Journal of Retail and Distribution Management*, *43*(10/11), 967–987.

Grewal, C. S., Enns, S., & Rogers, P. (2015). Dynamic reorder point replenishment strategies for a capacitated supply chain with seasonal demand. *Computers & Industrial Engineering, 80,* 97–110.

Heikki, M., Russell, K., & Nina, O. (2002). Retail performance measures for seasonal fashion. *Journal of Fashion Marketing and Management, 6,* 340–351.

Iannone, R., Ingenito, A., Martino, G., Miranda, S., Pepe, C., & Riemma, S. (2013). Merchandise and replenishment planning optimization for fashion retail. *International Journal of Engineering Business Management*, 33–46. Special Issue Innovations in Fashion Industry.

Martino, G., Iannnone, R., Fera, M., Miranda, S., & Riemma, S. (2017). Fashion retailing: A framework for supply chain optimization. *Uncertain Supply Chain Management, 5*(3), 243–272.

Martino, G., Yuce, B., Iannone, R., & Packianather, M. S. (2016). Optimization of the replenishment problem in the fashion retail industry using Tabu-Bees algorithm. *IFAC-PapersOnLine, 49*(12), 1685–1690.

Mattila, H., King, R., & Ojala, N. (2002). Retail performance measures for seasonal fashion. *Journal of Fashion Marketing and Management: An International Journal, 6*(4), 340–351.

Novotna, V., & Varysova, T. (2015). The Application of functions of several variables analysis in an optimal replenishment policy for deteriorating items. *Procedia Economics and Finance, 23,* 1217–1226.

Pan, A., Leung, S., Moon, K., & Yeung, K. (2009). Optimal reorder decision-making in the agent-based apparel supply chain. *Expert System with Applications, 36,* 8571–8581.

Safra, I. (2013). Vers une approche intégrée de gestion de planification de la production et de la distribution: Cas de l'industrie textile. Ph.D. thesis, Ecole Centrale Des Arts Et Manufactures « Ecole Centrale Paris », Ecole Nationale D'ingénieurs De Tunis « ENIT ».

Spragg, J. E. (2017). Articulating the fashion product life-cycle. *Journal of Fashion Marketing and Management: An International Journal, 21*(4), 499–511.

Yu, U. J., & Kunz, G. I. (2010). Financial productivity issues related to assortment diversity and supply chain merchandise replenishment strategies. *Journal of Fashion Marketing and Management: An International Journal, 14*(3), 486–500.

Zhu, S. X. (2013). Dynamic replenishment, production, and pricing decisions, in the face of supply disruption and random price-sensitive demand. *International Journal of Production Economics, 146,* 612–619.

Chapter 10
Digital Fashion Competences: Market Practices and Needs

Nadzeya Kalbaska and Lorenzo Cantoni

Abstract Digital practices in fashion are gaining more attention, starting from digital communication, online reputation, up to eCommerce. Such highly moving dynamics—related both to the fashion market as well as to new available technologies and communication tools—require well-prepared and skilled employees, able to navigate in this constantly changing environment with needed competences, updated knowledge, and creativity. Within this study, current market needs in the field of digital fashion are investigated through the analysis of the open job positions published on LinkedIn. In particular, needed skills and competences to join digital departments of fashion companies are examined.

Keywords Digital fashion · Fashion education · Skills and competences
Training needs

10.1 Introduction

Information and Communication Technologies (ICTs) are having a major impact onto everyday life and most businesses. Similar to other industries, fashion is undergoing the process of adaptation to the digital world on different levels (Business of Fashion 2016): garments production cycles, management and sales, as well as communication with the help of digital tools.

In order to respond to ever-increasing needs and expectations of the customers, as well as to adapt to the changing management structures new professional roles within fashion appeared in recent years. Indeed, as technology and fashion are among the fastest growing sectors in the world economy, there is an important demand of the

N. Kalbaska (✉) · L. Cantoni
Institute of Communication Technologies, Faculty of Communication Sciences, USI - Università della Svizzera italiana, via Buffi 13, 6900 Lugano, Switzerland
e-mail: nadzeya.kalbaska@usi.ch

L. Cantoni
e-mail: lorenzo.cantoni@usi.ch

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_10

employees with combined fashion, business background, analytical and ICT skills, making them very desirable additional elements in the companies. Fashion businesses are struggling to find the right employees with appropriate mixture of technical, IT, and analytical skills. According to the Fashion Retail Academy, in 2016 there has been a shortage of skills in the fashion domain: with fashion retailers lacking 57% in technical and IT skills, 46% in analytical skills, and 35% struggling to find staff with appropriate eCommerce business skills (Fashion United 2016).

Due to the constantly changing needs on the new skills and competences, updated curricula that can help to fill such skills gaps in the industry are needed at both fashion schools at the vocational level as well as in the academia at the (post)-graduate level. This has called in recent years for an adequate inclusion of digital fashion related topics and skills within academic curricula. Caring for the future of digital fashion is equal to caring for balanced and adequate training practices for future professionals in the fashion domain. To do so, continuous improvements and updates of the training curricula are needed.

Neglecting the fast growth and importance of the digital fashion industry, few academic studies are available that provide reliable maps of what are the market needs in terms of the new professional roles, but also needed skills and competences in the domain, so to discern educational and needed training trends and to support managerial decisions.

While the main goal of this research is to assess market practices and needs when it comes to digital fashion related skills and competences, it will answer the following research questions:

What are the specific job roles within digital fashion domain?
What are the skills and competences needed today in the digital fashion domain?

Determining relevant competencies and skill sets on one hand can help human resource managers to improve hiring and selection practices, to develop strategies in order to retain managers, and in supporting career planning initiatives. On the other hand, the understanding of current market practices and needs in the digital fashion domain, and the determined competences and skills sets can point to needed changes in the curriculum reform in fashion studies. It will eventually guide the definition of higher and/or continuous education curricula in digital fashion and on-the-job training within fashion companies.

10.2 Background

10.2.1 Digital Fashion

Digital fashion is the interaction between information and communication technologies (ICTs) and the fashion domain. The global fashion market has been valued 3 trillion dollars in 2017, and accounts for 2% of the global GDP (Fashion United

2017). According to the eCommerce Foundation Report (2016), 15% of all global sales from fashion companies in 2016 were generated by eCommerce.

Digital fashion is the interplay between digital technology and couture. ICTs have been deeply integrated both into the fashion industry as well as within the experience of clients and prospects. Such interplay has happened at three main levels:

- ICTs used in the production cycle: to design and produce fashion products, while also the industry organization leverages onto digital technologies;
- ICTs impact marketing, distribution and sales;
- ICTs are extensively used in communication activities with all relevant stakeholders, and contribute to the co-creation of the fashion online environment.

In the production cycle, digital technologies are being used in the fabrics manufacturing. Digital tools support creativity of the fashion designers, as well as make it easier for them to develop a large variety of prints. Recently 3D Printing started to be used both by the companies in their production of the garment, and by the end users, while giving them a possibility to design and/or print their fashion products at home (Hoskins 2013; Vanderploeg et al. 2016).

At the same time, digital fashion includes also digital practices in the physical shops (Bethan et al. 2017) as well as eCommerce or the online sales of the fashion items. eCommerce in the fashion domain (Escobar-Rodríguez and Bonsón-Fernández 2016; Taylor 2016) provides the following opportunities:

(i) offering a wider variety of products to the customers compared to the ones sold in store;
(ii) exploiting new geographical distribution;
(iii) exploiting the relationship with traditional customers in new ways (e.g. customers can experience the brand not only in a physical store but also when they are at home);
(iv) offering a customized shopping experience to the clients.

Currently fashion companies are also using extensively digital tools to communicate with potential and current publics in the addition to the traditional media channels used for fashion communication, which include television, cinema, magazines and newspapers, advertising outdoor, and transport (Rocamora 2017).

Digital fashion communication includes communicating brands, designers, and clothes online (Sadaba 2015), while reaching potential customers through official media channels: own websites and mobile applications. Meanwhile in recent years, also User Generated Contents have started to play a major role in the fashion communication domain (Dennison and Montecchi 2017; Montecchi and Nobbs 2017; Wolny and Mueller 2013).

Beside the dynamics of single users/laypeople co-creating the image (and reputation) of brands, and shaping the very concept of what is fashionable (and what is not), Social Media Systems are also used by famous bloggers, celebrities, and social media influencers, who are helping companies to communicate in new ways (Halvorsen et al. 2013; Hong and Kim 2014; Park et al. 2016; San Miguel and Sadaba 2015). Moreover, companies have received the opportunity to better "listen" to their

clients and prospects, by following them during their daily activities through social networks (Facebook, Pinterest, Twitter, Instagram, Weibo, Vkontakte, and others). There is a crucial change not just *where the brands communicate*, but especially *how they communicate* (Business of Fashion 2016; Rocamora 2017), thus the connection with consumers is more challenging.

Late technological developments have increased the number of channels through which customers interact, made faster the pace of customer demands, expanded the amount of data available, as well as enhanced the intensity of the competitive environment. Thus, the understanding of the new customer, also through all available data that the customer leaves, as well as the development of analytical skills and competences might become crucial in the domain.

While digital fashion is a major emerging trend, and there is a strong industry interest in the domain of digital fashion communication, the academic research and the educational offer in the related field are on their initial stages.

Based on the changes happening in the fashion industry, the specific skills that are required by the employees of the industry are also changing. Currently employers in the fashion industry tend to choose new employees that are skillful in information technology, being innovative and creative (Chida and Brown 2011). Unfortunately, the exact set of skills and competences that are on demand today in the digital fashion domain is still unclear and under-researched, thus, this became a main mission of the current research.

10.2.2 Methodology

While assessing which ICT-related skills are crucial to work in the digital fashion domain, it is important to solicit efforts from principal stakeholders such as future employers, educators, and alumni themselves. In this research the industry perspective will be taken into consideration while examining available job offers.

Digital fashion related jobs were analyzed through LinkedIN, a business- and employment-oriented social networking service. LinkedIn is being extensively used for professional networking, including employers posting jobs and job seekers posting their CVs (Rapanta and Cantoni 2016). The crawling of available job positions was done in 29 countries, including 28 European Union countries and Switzerland. Two analyse of the publicly available job positions were undertaken: the first one in the period from 09.01.2017 to 19.01.2017, and the second one from 06.02.2017 to 16.02.2017.

The search on LinkedIN was done using the following keywords: Digital Fashion, Digital Media, Digital Marketing, eCommerce, Social Media, eFashion. While then job listings only from the following industries were taken into consideration: Apparel and Fashion, Internet, Luxury Goods and Jewelry, Marketing and Advertising, Retail, and Textiles.

In the data cleaning phase, automatic separation of English job postings from other languages was undergone, followed by the automatic removal of duplicates based on the available published Job ID. The positions offered twice, or more times, for

instance by the fashion brand itself and an HR company were taken into consideration only once.

The following job posting attributes were considered: job title, job link, company name, location, publication date, job description, industry the job belongs to.

10.2.3 Research Results

Through the analysis of digital fashion related positions on LinkedIn in 28 countries of the European Union and in Switzerland 1427 job listings were found. Quantitative content analysis of job titles and job descriptions was then performed using Word Smith Tools 6. This tool allows to create concordances within a textual corpus, and to study frequently co-located couples of words.

The results are presented below, starting from the introduction to the number of available positions in every country, followed by the analysis of available job titles in the digital fashion domain, and concluded with the analysis of the digital fashion skills extracted from job descriptions.

a. **Available jobs in the digital fashion domain**

Through the search of digital fashion related positions on LinkedIn, 1427 job listings were found in the European Union and Switzerland. No positions were found in the following countries: Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Latvia, Lithuania, Luxembourg, Malta, Romania, Slovakia, and Slovenia.

In Table 10.1. we can see the list of countries were digital fashion positions were advertised on LinkedIn in the first two months of 2017, with the respective number of available job positions.

These results should be carefully evaluated due to the fact that the analysis was undertaken only on the dataset in English. This might have had an impact on the number of available positions for instance in France, Italy, Spain, or Switzerland, where the jobs might be advertised in national languages.

From this analysis we can conclude that the hubs of the digital fashion domain today in Europe are the United Kingdom, Germany, and The Netherlands, followed by Sweden, France, and Switzerland.

Two searches of the job positions were undertaken: on 09.01.2017–19.01.2017; and on 06.02.2017–16.02.2017. This repetition was done in order to evaluate the number of positions that remained open in the chosen period. Indeed 71 positions available at the first analysis were still open at the second one exactly one month later. This number suggests that the job market in the digital fashion domain is very fast, where the positions are quickly filled in.

b. **Digital fashion related skills in job titles**

In order to understand and evaluate specific skills as expressed in job titles that are on request today within the digital fashion domain, quantitative content analysis was then performed, using Word Smith Tools 6.

Table 10.1 Number of digital fashion jobs

Countries	Frequencies
Austria	4
Belgium	24
Denmark	10
Finland	1
France	34
Germany	144
Greece	7
Hungary	1
Ireland	19
Italy	18
Netherlands	96
Poland	2
Portugal	11
Spain	15
Sweden	40
Switzerland	25
United Kingdom	976

In the Table 10.2. the combinations of the most frequent keywords among the job titles in the digital fashion domain are introduced.

We might see the following most frequent combinations: "digital marketing", followed by "social media"—representing two most desired areas of jobs (be it at the level of assistant, manager, director, ...). The keywords that represent professions, such as "digital designer", "graphic designer", "eCommerce manager", "media manager", "project manager", and "account manager" follow.

c. **Digital fashion skills in job descriptions**

In Table 10.3. the combinations of the most frequent keywords among the job descriptions in the digital fashion domain are introduced along with the number of times these combinations have appeared in the database. These combinations of keywords help us to recognize what are the main skills and competences on demand today on the market.

By far, the first required competence today in the domain deals with "social media". The ability to manage social media accounts (4866 repetition), profiles, and strategies has appeared on the first position in terms of the repetition of the keywords combination in the database. This result is not surprising given the importance of social media not only for the fashion brands, but also for fashion individual designers, due to its use during catwalks, and fashion shows. The knowledge of digital marketing (2324), and previous experience to managing eCommerce projects (1867) do also frequently appear in the job descriptions.

Table 10.2 Digital fashion skills in job titles

Keywords combinations	#
Digital marketing	297
Social media	263
Digital designer	106
Graphic designer	102
eCommerce manager	82
Media manager	71
Project manager	58
Account manager	55
Fashion brand	50
Customer care	48
Account executive	48
Customer service	47
PR manager	42
Luxury fashion	40
Digital analyst	40
Email marketing	39
Online marketing	35
Brand marketing	33
Sales manager	32
Product manager	31

Communication abilities and skills are playing a curial role (1438) today among current employers looking for the new entrants in their digital departments. The mention of "communication skills", whether as a category or more specifically as oral and written communications is common in the requests. The ability to speak to the customers for instance on social media, with other employees, or managers is a skill needed and used on a daily basis. Furthermore, being able to communicate ideas through digital channels often involves writing skills. Experts in content creation, who are able to drive more engagement with the brand, and as a result commercialization of social media, are on high demand today. Thus, communication skills are crucial in the fashion and apparel industry, which is considered to be one of the most globalized industries.

Communication skills were followed by a request of the new employees with strong customer focused service and user centric attitude (631). The skill sets, as the ability to resolve customer problems or manage guest problems with understanding and sensitivity were cited. Other soft skills, such as project management skills (430) and being able to work well in a team (360) are also required.

The employees in the sector need to have general operational skills in managing marketing campaigns (597), as well as to be able to run email marketing campaigns

Table 10.3 Digital fashion skills in job descriptions

Keywords combinations	#
Social media	4,866
Digital marketing	2,324
eCommerce	1,867
Communication skills	1,438
Customer service/care	759
Customer/user experience	631
Marketing campaigns	597
Web analytics (including Google analytics)	532
Email marketing	509
Project management	430
Online fashion	381
Team player	360
Digital content (Creation)	313
Digital media	274
Luxury fashion	249
Analytical skills	245
Marketing channels	214
Paid search	213
Multi channel	210

(509), be the experts in the paid search/search engine marketing (203), as well as able to manage digital campaigns across different media channels (210).

Understanding of the online fashion domain (381) and luxury fashion (249) are also requested today. The experts in the digital fashion fields, need also to have an overview of the domain they are working, and be up-to-date on the latest in terms of developments, luxury domain, garments, and textiles.

Current employees in the digital fashion sector are expected to be competent not just in understanding technology, they need to be able to analyze and interpret big data, for instance through web analytics tools (532), so to improve business strategy and competency, as well as to be able to do trend prediction and forecasting. This might require certain previous preparation in research, analysis, problem solving, as well as critical reflection abilities.

Surprisingly, no important mentioning of digital technologies to be used in the production cycle or in eCommerce were found in our research. We have expected to see bigger presence of the available request of the new employees working with 3D printing, augmented reality, safe payment systems or logistics for the eCommerce. Thus, we can assume that such skills are still not highly requested by the industry, but we believe, the number of such jobs will increase in the nearest future following fast developments in the industry. In case the companies wouldn't be able to hire the employees in such fields, they will need to outsource the skills from specialized agencies.

10.3 Conclusion

Due to the fast developments in both sub-domains, fashion and ICTs, the digital fashion domain is a very competitive field. In order to become successful here the employees must have not only talent and creativity, but also needed skills and competences.

Thanks to this research, we can conclude that fashion industry is a very dynamic one, where the number of job positions is very high and the speed with which they are being taken is impressive. Digital fashion roles require both analytical and creative skills, but also the knowledge of some tools at the operational level, for instance social media or paid search. Successful candidates should have a strong attitude as well as passion for the digital world. Central to such roles is not only the need of having IT, technology, and analytical skills, not only to keep up, but also to stay ahead of other, so to be able to push both involved industries forward. At the same time the employees in the digital fashion domain should have an understanding and the sensibility about the industry they are going to enter.

Since this topic has never been explored before the results of this research and its findings will have an implication on the research community interested in the digital communication as it helps to map and evaluate knowledge acquisition and needed competences within online communication and eCommerce in the fashion domain. They also have practical impact for those in charge of the curriculum design and development within higher educational institutions, as well as those developing life-long learning training activities within fashion brands.

Given that digital fashion domain might see further significant growth and advances, which will be affecting all the fashion industry, fashion educators need to make sure that the ICTs-related skills needed by the job market are duly covered by the overall curriculum and courses' syllabus. Thus, digital fashion education and training must aim to enhance the ability of their students to use a wide range of tools to increase their efficiency and responsiveness to a very dynamic market's needs.

10.3.1 Limitations and Future Research

The following limitation of this study should be mentioned: as this research is based on a single platform, LinkedIN professional social network, the results of the study cannot be generalized without extreme caution, while its methodology, on the contrary, can be fully—and, as we hope, fruitfully—replicated in similar cases.

Furthermore, only job positions in English were taken into consideration within this study. We do acknowledge that further search in other European languages might have brought different results. For instance, the number of available jobs in the digital fashion domain in France, Italy, Spain, Switzerland, or Portugal, might have had been different.

Being a very dynamic domain by nature, it is likely that the competences and skills desired by digital fashion professionals will be evolving in the following years, due to the changes in the available technologies, online communication tools, and in the structure of the fashion industry. Thus, a longitudinal study would be advisable, so to evaluate the changes happening in the searches for the employees in the digital fashion domain.

There is also the need to further research perspectives from the fashion industry sectors, fashion alumni themselves and the educators in the field regarding the skills and competences in ICTs they see as important for the employees to have.

References

Bethan, A., & Olivares Alvarado, D. (2017). Convergence of physical and virtual retail spaces: The influence of technology on consumer in-store experience. In A. Vecchi (Ed.), *Advanced fashion technology and operations management* (pp. 191–219). IGI Global.

Business of Fashion. (2016). The digital Iceberg. Retrieved September 2017, from https://www.businessoffashion.com/articles/fashion-tech/the-digital-iceberg-luxury-fashion-marketing.

Chida, M., & Brown, G. (2011). Evaluating the gap between industry assessment of job readiness and graduation standards in higher education institutions: The case of fashion studies. *International Journal of Fashion Design Technology and Education Technology and Education* (2), 71–82.

Dennison, J. A., & Montecchi, M. (2017). The effects of online consumer reviews on fashion clothing purchase intention: Peripheral cues and the moderating role of involvement. In A. Vecchi (Ed.), *Advanced fashion technology and operations management* (pp. 318–347). IGI Global.

Ecommerce foundation. (2016). *Global B2C eCommerce report*. Retrieved April 2017, from http://www.ecommercefoundation.org/reports.

Escobar-Rodríguez, T., & Bonsón-Fernández, R. (2016). Analysing online purchase intention in spain: Fashion e-commerce. *Information Systems and e-Business Management* (pp. 1–24).

Fashion United. (2016). *As Fashion Goes Digital, Skills Must Adapt*. Retrieved April 2017, from https://fashionunited.uk/news/retail/as-fashion-goes-digital-skills-must-adapt/2016091921820.

Fashion United. (2017). *Global fashion industry statistics—International apparel.* Retrieved March 2017, from http://fashionunited.com/global-fashion-industry-statistics.

Halvorsen, K., Hoffmann, J., Coste-Manière, I., & Stankeviciute, R. (2013). Can fashion blogs function as a marketing tool to influence consumer behavior? Evidence from norway. *Journal of Global Fashion Marketing, 4*(3), 211–224.

Hong, H. R., & Kim, Y. I. (2014). Communication characteristics of fashion shows using digital images. *Journal of the Korean Society of Costume, 64*(6), 1–15.

Hoskins, S. (2013). *3D printing for artists, designers and makers.* Bloomsbury.

Montecchi, M., & Nobbs, K. (2017). Let it go: Consumer empowerment and user-generated content—An exploratory study of contemporary fashion marketing practices in the digital age. In A. Vecchi (Ed.), *Advanced fashion technology and operations management* (pp. 294–317). IGI Global.

Park, J., Ciampaglia, G. L., & Ferrara, E. (2016). Style in the age of instagram: Predicting success within the fashion industry using social media. In *Proceedings of the 19th ACM Conference on Computer-Supported Cooperative Work & Social Computing* (pp. 64–73). ACM.

Rapanta, C., & Cantoni, L. (2016). The linkedin endorsement game: Why and how professionals attribute skills to others. *Business and Professional Communication Quarterly,* 1–17.

Rocamora, A. (2017). Mediatization and digital media in the field of fashion. *Fashion Theory, 21*(5), 505–522.

SanMiguel, P., & Sadaba, T. (2015). Fashion influentials: Prescripcion y liderazgo en moda. In T. Sadaba (Ed.), *Moda e nil entorno digital* (pp. 111–122). Navarra, Spain: Ediciones Universidad de Navarra.

Sadaba, T. (2015). *Moda e nil entorno digital* (p. 187). Navarra, Spain: Ediciones Universidad de Navarra.

Taylor, E. (2016). Mobile payment technologies in retail: A review of potential benefits and risks. *International Journal of Retail & Distribution Management, 44*(2), 159–177.

Vanderploeg, A., Lee, S. E., & Mamp, M. (2016). The application of 3D printing technology in the fashion industry. *International Journal of Fashion Design, Technology and Education*, 1–10.

Wolny, J., & Mueller, C. (2013). Analysis of fashion consumers' motives to engage in electronic word-of-mouth communication through social media platforms. *Journal of Marketing Management, 29*(5–6), 562–583.

Part III
Standards and IOT Technologies for the Fashion Industry

Chapter 11
eBusiness Standards and IoT Technologies Adoption in the Fashion Industry: Preliminary Results of an Empirical Research

Bianca Bindi, Virginia Fani, Romeo Bandinelli, Arianna Brutti, Gessica Ciaccio and Piero De Sabbata

Abstract The present paper aims to analyse the main barriers and drivers that obstacle and push the adoption of an eBusiness standard, such as eBIZ, and IoT technology, such as RFId, within the fashion industry. This purpose represents the first step of the European project "eBIZ 4.0—Enhancing textile/clothing sector by eBIZ and RFIds technologies adoption", aiming to promote the integration between RFId technology and eBIZ standard for improving data interoperability among companies operating along the fashion supply chain. The tool used for this kind of analysis has been an online survey dispatched to the mailing list of all the project partners belong to different European Community countries and involving both software houses and fashion companies. The survey results have been crossed with the external variables that characterize the analysed companies, in order to classify the evidences related to one or another cluster of companies similar in terms of external variables such as dimension, headquarter location, industry segment.

Keywords Fashion · Supply chain · eBIZ · RFId · Standards · Interoperability

B. Bindi · V. Fani · R. Bandinelli (✉)
Department of Industrial Engineering, University of Florence,
Viale Morgagni, 40, 50134 Florence, Italy
e-mail: romeo.bandinelli@unifi.it

B. Bindi
e-mail: bianca.bindi@unifi.it

V. Fani
e-mail: virginia.fani@unifi.it

A. Brutti · G. Ciaccio · P. De Sabbata
DTE-SEN-CROSS Laboratory, ENEA, Via Martiri di Monte Sole 4, 40129 Bologna, Italy
e-mail: gilda.massa@enea.it; gessica.ciaccio@enea.it

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_11

11.1 Introduction

European Textile/Clothing and Footwear (TFC) industry is the second product exporter in the world and the global leader in top and luxury fashion products.

A key factor for this success has been the special symbiosis in the product value chain between internationally acknowledged brands and networks of SMEs; the strong cooperation allows continuous new design proposals, high flexibility and reactivity, top quality of products and services to the customer.

Nevertheless, the fashion industry is currently subject to new trends so, even if the supply chain cooperation model has been successful until now, it needs a new configuration to answers new market requirements and expectations.

On the supply chain side it deals with:

- the fragmentation of the supply chain, composed of small and medium enterprises in a long and large configuration with a lot of interconnection (Eurostat[1]);
- the difficulty of manufacturing SMEs to keep up with demands of brands in terms of traceability (e.g. business data, data on raw materials, chemicals, etc.).

On the market side it is required to manage:

- the fast increasing demand for small series and customized products;
- the increasing consumer attention to product sustainability and traceability;
- the new strategies to follow the less and less predictable consumer demands (the traditional two-seasons-based business model is obsolete);
- the reduction of production lots, with a more complex logistic and warehouse management.

The achievement of a strong integrated supply chain through the complete digitalization of the manufacturing processes is a crucial factor to face these new challenges.

In this context, an important role is played by data exchange standardised specifications, like eBIZ, and Internet of Things technologies, like RFID. Whilst the first ones are interoperability enablers that can favour the integration across the supply chain, increase the quality and extend the collaboration between brands and SMEs, avoiding these last ones are cutted off, the other ones aim to create new services (e.g. about traceability) and improve the supply chain performance (e.g. RFId technologies support the logistics management).

According to this evidence, the main purpose of the present work is to analyse what is the adoption level of these technologies, considering both software houses in developing their tools and fashion companies that use them and what are the main drivers and barriers to their adoption.

The present work is structured as follows: in the first section, an overview of the analysed sector has been conducted and the main evidences in terms of challenges that companies have to face with are highlighted; Sect. 11.2 shows the status of the art on the analysed technologies, in Sect. 11.3, a brief introduction to the European

[1]Eurostat data: Decrease in the percentage of small and medium enterprises from 35% in 2005 to 24% in 2014.

project that push the realization of this paper has been reported, while is Sect. 11.4 the methodology used to analyse their adoption level and the related drivers and barriers is reported; in the Sect. 11.5 the results collected have been shown and resume in the final section.

11.2 State of the Art

11.2.1 eBIZ Initiative

The TFC industry represents traditional manufacturing in some of the European Union (EU) member countries. Recently, however, this industry is facing important challenges that may have strong impact on its own ability to survive and perform at an efficient level particularly in its operational function.

The crisis in these industries is due to the need to adapt to the changes introduced by the internationalization of markets and technological change. In addition, these industries have two important identifying characteristics.

First, the TFC industry tends to locate production in territorial industrial districts (Callejón and Costa 1996). Second, the various production tasks that integrate the TFC value chain have a heterogeneous and interrelated character (Bindi et al. 2016).

According to this, system interoperability is the prerequisite to create a strong integrated and collaborative supply chain, including companies of all sizes, making all of them, especially SMEs, able to quickly and efficiently share information and manage data exchange issues (De Vries et al. 2009). Previous studies demonstrated the crucial role that eBusiness standards for data exchange play at this purpose, especially in contexts with high number of SMEs, like the TFC one (De Sabbata et al. 2010; Gessa et al. 2005).

In this perspective, in the last 10–15 years, the topic of fostering the standard adoption and the interoperability in TCF supply chain has been tackled from different points of view and by different projects and initiatives (Asuman et al. 2008; De Sabbata et al. 2008, 2009; Duque et al. 2009; Rishad Rayyaan et al. 2014).

Nevertheless, the use of standards is still too low related to potential benefits coming from the adoption. A past analysis (De Vries et al. 2009), aiming to detect the factors hampering the standard diffusion in SMEs, reports problems like: lack of information as to which standards have to be met; lack of awareness about the importance of the standardization process; difficulty in interpreting specifications and problems with their implementation; costs to sustain initial adoption effort and not enough financial and human resources. Furthermore, it has been observed that even where standard are adopted, because of the "complexity" of the specifications, they could not be correctly applied or there could be different allowed implementations of the same specification; this causes lack of interoperability (Brutti et al. 2010). In order to prevent this scenario and speed up the adoption of standard, possible approaches have been identified: first of all, the customization of the stan-

dard specification through the definition of Use Profiles (Brutti et al. 2011) in order to simplify and to reduce the degree of ambiguity in the specifications; then, the adoption of methodologies and tools to perform conformance and interoperability Test (Brutti et al. 2014). The crucial role of Use Profile and Testing activity in the standard adoption has been detected also studying criticalities of the life cycle of B2B standards (Brutti et al. 2012a, b).

Finally, a more recent analysis (Gessa et al. 2016), focused on eBusiness standards for data exchange, highlights the criticalities from the user perspective, confirming some of the aspects discussed before: specifications are in some cases too abstract and complex and they are not accompanied by examples; missing of tools and methodology for testing the solutions; customization is a necessity but enterprises often do not have resources and skills to do it; lack of awareness of the advantages in using standards.

From a normative point of view, a significant step toward the harmonization of information flows in the TFC industry has been done in 2008 by the European Commission (DG Enterprise and Industry), that launched a first standard based interoperability initiative to "harmonise eBusiness in the European Textile Clothing and Footwear industry", named the eBIZ-TCF project.

This project gave the possibility to collect all the outcomes of previous initiatives, identifying a common Reference Architecture (RA) and deploying it with a large-scale experimentation involving more than 150 organizations within 20 European countries and whose results and cost-benefits analyses were collected and published. This activity evidenced the largest benefits can be achieved when a critical mass of adopters is in place.

11.2.2 RFId Technology

Tracking systems are generally developed using different types of barcodes or based on RFId-technologies. According to IDTechEx, the fashion and apparel industry has been the most active in integrating RFId tracking as part of its SCM operations, with RFId penetrated about 7% of the total apparel market 2014 (Harrop and Das 2013).

RFId solutions aim to reduce errors in handling operations and shipments, bringing better inventory accuracy to stores and DCs, reduces the probability of out-of-stock, improve the customers experience, etc. RFId technology can also assists in collecting data on store inventory and consumers' shopping and buying behaviours (Azevedo and Carvalho 2012; Sarac et al. 2010). However, implementing RFId technologies cannot be easy due to the limited knowledge of the technology and its possibilities (Visich et al. 2009), and to develop an actual business case might turn out to be difficult for many retailers constrained by a diverse supplier base and network of LSPs and retail channels.

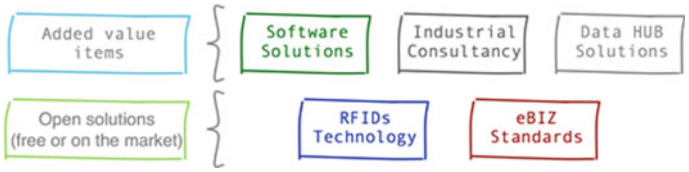


Fig. 11.1 RFIds and eBIZ relationship

11.3 The European Project eBIZ 4.0

Within this context, the work here presented, developed in the first phase of eBIZ 4.0 European project, aims to provide a further contribution to the identification of barriers that hamper the adoption of eBusiness standards.

The general objective of eBIZ 4.0 is to take-up the well-known RFId technology in two key sectors of fashion industry (Textile/Clothing and Footwear) jointly with eBIZ common standards, in order to allow the flow of digital information along smart and flexible supply chains that reinforce the collaboration between SMEs and large industry and retail, with a deeper quality of the collaboration that turns the paradigm from just supplying a quantity of SKUs (Stock Keeping Units) into sharing design, production and distribution of products with a digital identity; it enables companies in managing logistic processes, have in no time information about stocks orders and location of the goods.

These objectives can be reached by the commercialisation of new smart services based on the use of eBIZ standard of communication among industries of the textile/clothing sector, allowing interoperability among different production systems (ERP, SCM), logistic management systems through the use of RFId tags, using business models similar to those used in the Open source software development. The eBIZ 4.0 solution will support textile/clothing producers, through the parallel use of RFId and communication standards, in increasing the traceability of products, improving the time to market and warehouse management and, at the same time, reducing data exchange barriers with external providers shortening the distances along the supply chain. The adoption of eBIZ 4.0 solution will enable the industries in creating and managing large networks of relationships inside and outside the supply chain, implementing new business models in traditional production chains and boosting the fast response process for EU enterprises (Fig. 11.1).

Starting from this point, in the first phase of the eBIZ 4.0 European project the identification of market barriers and benefits perceived by software houses and their customers (i.e. fashion companies) have been achieved with the development of a specific work packages, which results are reported within this paper.

11.4 Objective and Methodology

In the following paragraphs we will resume the main purpose and the tool used to conduct the market analysis (i.e. "Objective and methodology" paragraph), the sections included in the survey (i.e. "Survey description" paragraph) and, finally, the companies to which we have sent the survey (i.e. "Sample description" paragraph).

As written in the previous section, a survey has been developed within the European project "eBIZ 4.0—Enhancing textile/clothing sector by eBIZ and RFIds technologies adoption", aiming to promote the integration between RFId technology and eBIZ standard for improving data interoperability among companies operating along the fashion supply chain. More in detail, the main goal of the questionnaire is to analyse the adoption level of RFId and eBIZ standard and the reasons why a company decides to implement or not these technologies.

This analysis has been conducted developing and distributing an online survey to both software houses and fashion companies.

The reason why we have decided to reach both of them is related to this twofold purpose: on the one hand, the feedback from the software houses will show the reasons why and the reasons why not they are developing IT solutions that include standardized flows and/or interfaces to RFId technology; on the other hand, the analysis on the fashion companies will show if these technologies are perceived as enablers to competitiveness or not.

Another purpose, common for software houses and fashion companies, is to understand how much companies operating along the fashion supply chains know about these two technologies.

Finally, information related to the main characteristics of involved companies that operates in the fashion industry have been included in the questionnaire in order to highlight trends coming from the survey results and related to the different context variables that characterize the answering companies.

11.4.1 Survey Description

The survey has been developed using the Google Forms platform, in order to be easy-to-use for all the receivers and to reach most of them rapidly even if they belong to different countries and have different technical skills.

Two versions of the survey have been developed, in order to reach both software houses and fashion companies. Despite this, the macro-sections of the survey are the same: "Respondent's and Company's anagraphical data", "Market analysis on RFId technology", "Market analysis on eBIZ standard".

The first section (i.e. "Respondent's and Company's anagraphical data") aims to collect the information about the respondent in terms of his/her role within the company he/she belongs but also several information about the company that operates in the fashion industry (i.e. the company itself in case of survey sent to fashion

companies or the customers in case of survey sent to software houses). Examples of the required company-related information are its dimension (in terms of turnover and number of employees), the localization of its headquarter, the sector in which it operates and its positioning along the supply chain.

The second section (i.e. "Market analysis on RFId technology") analyses what are the respondents' knowledge level about RFId technology, the adoption level of this technology, distinguishing between different areas (e.g. inbound and outbound logistics, inventory management, production advances monitoring), the drivers in terms of expected benefits and the barriers to the adoption of RFId technology. Examples of drivers are improving performances, competitiveness and/or integration with other supply chain partners, while possible barriers are increasing efforts, low technical competences. Moreover, benefits in terms of improving performances are deeply analysed asking respondents to list the impacts (expected or reached) on company's performances following the RFId adoption, considering different areas and a set of commonly used KPIs (Key Performance Indicators), such as ROI or inventory accuracy.

Finally, the third section (i.e. "Market analysis on eBIZ standard") is structured like the previous one but refers to the eBIZ standard instead of the RFId technology. In this case, examples of areas considered for the standard adoption are ecommerce platform feeding, production forecast and sales reporting and inventory, while examples of listed drivers and barriers are easier integration between software and complexity of available technical documentation related to the standard adoption respectively.

11.4.2 Sample Description

The sample for the first round of survey dispatch includes both software houses and fashion companies belonging to the following countries: Bulgaria, Croatia, France, Germany, Italy, Romania, Spain, and Tunisia. The listed countries have been chosen considering the pool of customers of the partner of the European project.

The aggregate mailing list (i.e. considering that ones from each partners and excluding duplicates) include 2800 people, 35% from software houses and 57% from fashion companies. Among the 900 software houses, 80% have their headquarter in Italy, 10% in Europe, the remaining in other countries. For fashion companies, the 80% of them have their headquarter in Italy, 15% in Europe, 5% in other countries. Different channels were adopted to contact the potential respondents: direct mailing, LinkedIn messages and Posts.

11.5 Results

Considering the first round of survey dispatch, the number of filled questionnaires is 48, resulting in a response rate of 1%. Among them, the fashion companies represent the main respondents, covering 78%.

The respondents are geographically distributed as follows: 17 from Italy (42.50%), 13 from Romania (32.50%), 3 from Bulgaria (7.5%), 2 from France (5.00%), 2 from Spain (5.00%), 1 from Croatia (2.50%), 1 from Germany (2.50%) and 1 from Tunisia (2.50%). Among them, the segment of fashion industry mainly analysed is the clothing one (i.e. 63% of the respondents are dealing with), followed by Textile (i.e. 49%), Sportswear (i.e. 34%) and Footwear (i.e. 12%).

Analysing the answering companies' dimension, most of them are small and medium sized enterprises (SMEs) with 20 filled questionnaires, followed by big companies (i.e. 11 filled questionnaire). For the enterprises classification, we follow the one proposed by the Eurostat: micro enterprises (with less than 10 persons employed); small enterprises (with 10–49 persons employed); medium-sized enterprises (with 50–249 persons employed); small and medium sized enterprises (with 1–249 persons employed); large enterprises (with 250 or more persons employed).

Considering the previous evidences about context variables that characterize the answering companies, we deeply analyse them crossing them to the survey results of the market analysis sections.

The first evidence of the questionnaires regards the knowledge level of RFId and eBIZ, clustered per software houses and fashion companies.

Referring to Tables 11.1 and 11.2, it is possible to observe a major knowledge level of both RFId and eBIZ for the Software House respondents, in comparison with the Fashion companies. This is partially justified by the fact that solution providers are more expert in new technologies than manufacturer companies. At the same time, it is important to remark that, even if RFId and eBIZ are not recent innovations, there is still the 13% of solution providers that declare to don't know anything about eBIZ, and the 15% of Fashion Companies that still are not informed about RFId.

Table 11.1 RFId knowledge level

Knowledge level	FC (%)	SH (%)
I am an expert	12	20
I use it	15	20
I know how to use it	3	30
I know its applicative domain	31	30
I know just the acronym	15	0
I don't know anything about it	9	0
I am finding out about how to use it	15	0
Not considering	0	0

Table 11.2 eBIZ knowledge level

Knowledge level	FC (%)	SH (%)
I am an expert	6	10
I use it	9	10
I know how to use it	0	20
I know its applicative domain	37	40
I know just the acronym	14	10
I don't know anything about it	31	10
I am finding out about how to use it	3	0
Not considering	0	0

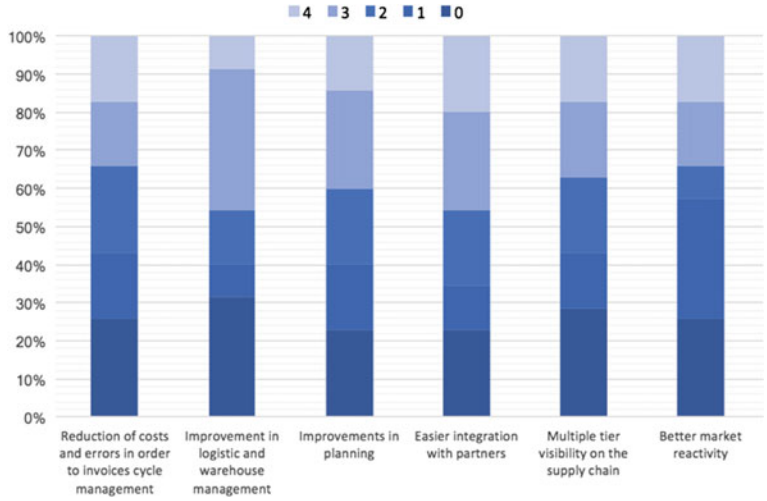


Fig. 11.2 eBIZ adoption drivers in fashion companies

Regarding both RFId and eBIZ, most of the responders of the Fashion Company have a middle level of knowledge (they know their application domain), whilst most Software Houses' responders declare to know how to use them. Comparing RFId and eBIZ, the first one is, for all respondents, most known than the second one.

Going to analyse the drivers that companies recognize important to adopt one technology or the other, the major results are reported in the Figs. 11.2 and 11.3.

Due to space limit, only the drivers regarding the adoption of the eBIZ standard have been reported, both for Software Houses than Fashion companies, in order to compare their vision on such standard.

Drivers for Fashion companies have been classified into reduction of costs and errors, improvement in logistic and warehouse management, improvements in planning, easier integration with partners, multiple tier visibility on the supply chain, better market reactivity. Drivers for Software Houses have been classified into better performances, better company's image, to be more competitive on the market

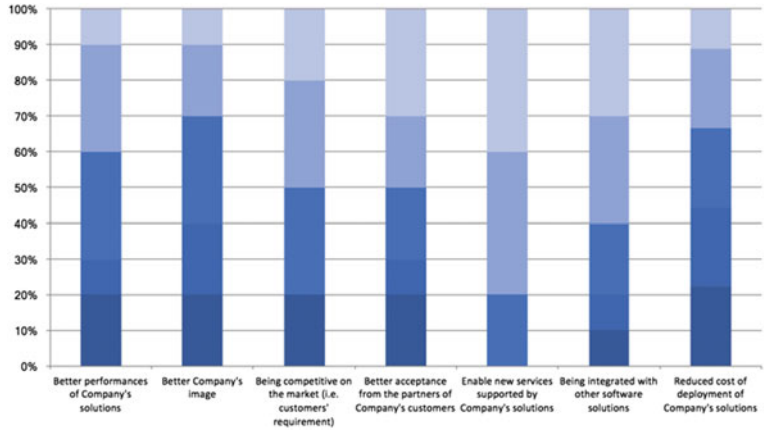


Fig. 11.3 eBIZ adoption drivers in SH companies

(i.e. customers' requirement), better acceptance from the partners of Company's customers, to enable new services, to be integrated with other software solutions and finally to reduce cost of deployment. Both drivers have been classified with a 4-level Likert scale, from 0 (Not relevant) to 4 (Highly relevant).

As it is possible to observe, drivers considered by these two types of companies are different: this means that the vision on why eBIZ should be adopted is different. While brands are more focused on the improvements of process performances, software houses deal with the integration of data with other solutions and to be more competitive on the market. Moreover, both from fashion companies than software houses, there isn't a huge difference from one driver to the others, in terms of importance, and no one of the drivers is considered very important for most the respondents. This result demonstrates that still today there is not a clear vision on the benefits that this standard can introduce in the companies.

11.6 Conclusion

The present paper presented the preliminary results of an ongoing research on the identification of drivers and barriers in the adoption of eBIZ standard and RFId technology in the TCF industry. In the paper the results coming from 48 questionnaires, developed together with the partners of the European Project eBIZ 4.0, have been partially described. Two evidences have been reported. The first one regards the level of knowledge of both RFId and eBIZ, that needs to be increased both in Fashion companies than Software Houses. The second result deals with the identification of eBIZ adoption drivers. Again, these results demonstrate that all the companies still do not

have clear the advantages that it can introduce and which are the drivers that have to be highlighted in order to facilitate its adoption.

Acknowledge This word has been carried out within the EU project eBIZ 4.0, started in December 2016 and co-founded COSME program of the European Commission and supported by the partner Kyklos s.r.l.

References

Azevedo, S. G., & Carvalho, H. (2012). Contribution of RFID technology to better management of fashion supply chains. *International Journal of Retail & Distribution Management, 40*(2), 128–156.

Bindi, B., Bandinelli, R., & Rinaldi, R. (2016). RFID and eBIZ implementation in the textile and clothing industry: Evidence of a pilot project. In *Proceedings of the Summer School Francesco Turco*, pp. 156–160.

Brutti, A., Cerminara, V., D'Agosta, G., De Sabbata, P., & Gessa, N. (2010). Use profile management for standard conformant customization. In *Enterprise interoperability IV, Making the Internet of the Future of Enterprise*. ISBN 978-1-84996-256-8, e-ISBN 978-1-84996-257-5.

Brutti, A., De Sabbata, P., Frascella, A., Novelli, C., & Gessa, N. (2011). Standard for eBusiness in SMEs networks: The increasing role of customization rules and conformance testing tools to achieve interoperability. In *Enterprise Interoperability,* ISBN 978-1-84821-317-3.

Brutti, A., De Sabbata, P., Scalia, M., Krzystek, K., Aguado, J. I., Ricchetti, M., & Baker, M. (2012a). eBusiness in fashion industry: Interoperability standardisation meets industry supply chain. In *Proceedings of eChallenges e-2012 Conference*, ISBN 978-1-905824-35-9.

Brutti, A., De Sabbata, P., Ciaccio, G., Frascella, A., & Novelli, C. (2012b). A model to analyse critical factors in B2B interoperability standards life cycle. In *Enterprise interoperability, I-ESA 2012 Proceedings*, Valencia 2012, ISBN 978-1-84821-426-2.

Brutti, A., De Sabbata, P., & Gessa, N. (2014). An approach to interoperability testing to speed up the adoption of standards. In *Proceedings of the Workshops "Standardisation Developments for Enterprise Interoperability and the Manufacturing Service Domain"* (pp. 295–300), ISBN 978-1-84821-799-7.

Callejon, M., & Costa, T. (1996). External economics and the location of an industry. In *36th European Congress of European Regional Science Assocation*, Zurich, Switzerland.

De Sabbata, P., Scalia, M., Baker, M., Somers, J., Stefanova, M., Brutti, A., & Frascella, A. (2008). eBIZ-TCF: An initiative to improve eAdoption in European Textile/Clothing and Footwear industry. In *Proceedings of e-Challenges 2008 Conference* (pp. 1169–1180), Stockholm, ISBN 978-1-58603-924-0.

De Sabbata, P., Brutti, A., Gessa, N., Frascella, A., Novelli, C., D'Agosta, G., Stefanova, M., Cerminara, V., & Cristiani, S. (2009). Promoting Interoperability through Research, Standardisation and Demonstration. In *Proceedings of 6th Conference of the Italian chapter of AIS (itAIS 2009)*, Olbia, October 2–3 2009, ISBN: 978-88-6105-060-0 (CD).

De Sabbata, P., Gessa, N., Brutti, A., Novelli, C., Frascella, A., & D'Agosta, G. (2010). Standard creation and adoption for SME networks. In *Interoperability for Enterprise Software and Applications* (pp. 41–51), ISTE/Wiley, June 2010, ISBN 9781848212701.

De Vries, H., Blind, K., Mangelsdorf, A., Verheul, H., & Der Zwan, J. (2009). *SME access to European Standardization. Enabling small and medium—sized enterprises to achieve greater benefit from standards and from involvement in standardization,* August 2009. Rotterdam School of Management: Erasmus University.

Dogac, A., Erturkmen, G. B. L., Olduz, M., Kabak, Y., & Okcan, A. (2008). An Interoperability service utility for collaborative supply chain planning across multiple domains supported by RFID Devices, ISURF Project, Proceeding in eChallenges Conference, Stockholm 2008.

Duque, A., Campos, C., Jiménez-Ruiz, E., & Chalmeta, R. (2009). An ontological solution to support interoperability in the textile Industry. In Poler, R., van Sinderen, M., & Sanchis, R. (Eds.), *Enterprise interoperability. IWEI 2009*. Lecture Notes in Business Information Processing, Vol. 38. Springer, Berlin.

Gessa N., Cucchiara G., De Sabbata P., & Brutti A. (2005). A bottom-up approach to build a B2B sectorial standard: The case of Moda-ML/TexSpin. In *Interoperability of Enterprise Software Applications* (pp 249–260), ISBN-1-905209-45-5.

Gessa N., De Sabbata P., & Brutti A. (2016). Analysing difficulties in the adoption of e-business standards, a look from the user perspective. In *21st Euras Annual Standardisation Conference Proceedings 2016*, ISBN 978-3-95886-103-9.

Harrop, P. & Das, R. (2013). Fashion and retail apparel manufacture, sorting, delivery and stock control, rented apparel, laundry. *Apparel RFID* 2013–2023, IDTechEX.

Rayyaan, R., Wang, Y., & Kennon, R. (2014). Ontology-based interoperability solutions for textile supply chain. *Advanced Manufacturing*, *2*, 97–105. https://doi.org/10.1007/s40436-014-0073-2, edited by Springer.

Sarac, A., Absi, N., & Dauzère-Pérès, S. (2010). A literature review on the impact of RFID technologies on supply chain management. *International Journal of Production Economics, 128*(1), 77–95.

Visich, J., Li, S., Khumawala, B., & Reyes, P. (2009). Empirical evidence of RFID impacts on supply chain performance. *International Journal of Operations & Production Management, 29*(12), 1290–1315.

Chapter 12
Dual Frequency Tag Performances in the Fashion Industry

Andrea Volpi, Antonio Rizzi and Rinaldo Rinaldi

Abstract The paper strives at benchmarking performances of dual frequency inlays, operating in UHF and HF bands, when deployed in the apparel logistics and end-user retail processes. The developed testing protocol makes it possible to evaluate performances of RFID devices in simulated supply chain and end-user-oriented processes. It has been designed according to the needs for identification both of the supply chain and of the end-users, who can take advantage of the adoption of NFC technology. We applied the testing procedure to RFID inlays equipped with an innovative IC and two antennas, capable of managing both EPC communication in UHF band and NFC communication in HF band with smart devices. The performances of the inlays have been compared to standard tags commonly used in EPC and NFC fields. We measured and compared read rate, accuracy, and read time when testing EPC capabilities, and read/write throughput, time and distance when measuring NFC functionalities. By simulating a real-world environment, test results give a direct insight of performances to be expected from different dual frequency RFID inlays. Therefore, IT and logistics managers can find answers to how these innovative tags perform and which would be the best choice for new RFID applications.

Keywords RFID · Apparel · Performance benchmarking · NFC · Dual frequency

A. Volpi (✉) · A. Rizzi
RFID Lab, Department of Engineering and Architecture, University of Parma,
Viale G.P. Usberti, 181/A, 43124 Parma, Italy
e-mail: andrea.volpi@unipr.it

A. Rizzi
e-mail: antonio.rizzi@unipr.it

R. Rinaldi
Department of Industrial Engineering, University of Florence,
Viale Morgagni, 40, 50134 Florence, Italy
e-mail: rinaldo.rinaldi@unifi.it

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_12

12.1 Introduction

The implementation of the Radio Frequency Identification (RFID) in the apparel industry had a steady increase over the past several years and this trend is projected to continue for the immediate foreseeable future. As suggested by several studies, fashion and apparel retail is a leading sector for RFID technology, because RFID implementation in this sector can count a wide diversity of use cases, and it has the potential to solve unique problems (Bottani et al. 2016; Rizzi et al. 2016). Harrop and Das (2013) forecast the annual demand for RFID tags from the apparel industry to reach 20 billion within the next decade; this is due to the fact that about 100 apparel and related firms are currently at the RFID tag trial and rollout stage, and that the combined annual demand from just two of these firms is about 500 million tags. Moreover, during the next decade, they expect the systems and tag business in the apparel industry to grow at double the rate of the overall RFID market. Given these premises, the apparel industry appears to be a significant player in RFID adoption and use scenarios, thus there is a need to give a direct insight of performances to be expected from different dual frequency RFID inlays.

The benefits of item-level RFID tags in the apparel industry span a wide spectrum, depending on the application context. For example, a report from Motorola (2010) identifies several benefits of item-level RFID tags in a retail store setting that include improved inventory accuracy, fewer inventory check personnel, lower out-of-stock situations, just-in-time inventory replenishments, improved stock flow between stockroom and sales floor, reduced inventory carrying cost, improved customer service, faster checkout, improved information-rich customer shopping experience, efficient returns management and enhanced loss prevention. Several benefits of item-level RFID tags are also found in distribution and logistics that include better inventory visibility, lean inventory management, electronic proof of delivery, shorter invoice and payment cycle times and improved shipment accuracy.

From the above discussion, it is clear that there should no longer be any doubt with respect to the decision to adopt RFID in the apparel retail industry. The auto-identification needs at different points in the apparel retail supply chain (e.g., warehouse, during transit, supplier, retailer, end-user) are not necessarily the same. The auto-identification needs could be different even between two retail settings. For example, a retailer of relatively inexpensive fast moving consumer goods, whose requirements are mainly related to stock management as in Bertolini et al. (2013), may require simple passive RFID tags with minimal memory and processing power compared to that which is required by an exclusive high-end retailer whose needs may be aligned more with counterfeit prevention. To add to the complexity, the availability in a wide variety of specifications of each RFID system component (e.g., tags, readers) necessitates a careful analysis of the application needs and the assembly of the most appropriate RFID system that comprises selected individual components. Given this, the natural next step is to develop guidelines on the RFID adoption process. The RFID technologies commonly adopted in current scenarios are based on Electronic Product Code (EPC) standards, for logistics and supply chain processes,

and on Near Field Communication (NFC) standards, for use cases involving item's identification by an end-user. A couple of tag, one for each standard, is required in order to merge the benefits of the two technologies, but a synchronisation issue arises between the memories of the two ICs. Innovative chips available on the market can implement EPC and NFC standards, sharing the same data stored on the tag. Logistics, supply chain, anti-counterfeit, after sales processes can profitably relay on the same data stored in tag's memory and accessible via both interfaces.

12.2 Literature Review

The performance of the supply chain can be easily improved adopting Information and Communication Technologies (ICT), as repeatedly reported in literature. There is an extensive set of published literature that considers the use of RFID, an ICT example, in the apparel industry; for this reason, RFID systems have been gaining popularity in supply chain applications due to their beneficial properties.

Bertolini et al. (2012a) consider the supply and demand side of RFID systems. Specifically, they evaluate available RFID solutions in the fashion industry in terms of their performance and attempt to match these with end-users of such technology. Performances of RFID and production systems can be monitored by means of business intelligence modules described in Bertolini et al. (2009).

Bertolini et al. (2012b) quantify the business benefit of RFID in apparel and fashion supply chains related to logistics and store processes at both operational and strategic levels. With results obtained from about 20,000 tags on garments tracked from a distribution centre to a retail store of a major Italian fashion brand, they observe that sales and customer satisfaction increase with the use of data generated through RFID tags.

GS1 has recently defined the Tagged Item Performance Protocol (TIPP) guidelines (2015), aimed to provide standard procedures to express performance requirements of UHF tags in retail, and a standard test protocol to verify the performance of a tagged item. GS1 workgroup defined performance levels for tagged items (rather than tags, inlays, labels), that can be verified independently by retailers, suppliers or any 3rd party by means of a standardized test procedure. TIPP introduces the concept of grade for UHF tags, defined as a group of performance specifications for a tagged item; it is easily measurable for tags in an anechoic chamber using dedicated hardware and software. A tag matches a specific grade if it satisfies all the performance requirements of the considered grade; different tags with same performances (sensitivity and backscattered power) has the same grade. For RFID end-users, it is more difficult to establish the required grade for their processes, since in-field tests are needed because it is not possible to get this information from a laboratory test. In this paper the GS1 TIPP is not applied for two reasons: (1) the two fashion companies interested in the dual frequency tags needed results in a short time, not allowing us to equip the lab with an anechoic chamber; (2) they were interested

in measuring the performance of the tags in their logistics processes, whose grade is still undetermined.

Dahl et al. (2015) pointed out that currently, there is not sufficient published data about the performance and energy efficiency of NFC as experienced by NFC applications and there does not exist proper tools for NFC application developers to efficiently benchmark and test tags. Thus, the authors developed an open source Android based toolset for NFC tag testing and performance evaluation. Moreover, as a confirmation that the application fulfils its purpose, extensive testing has been performed to compare five tags based on NFC standard.

These are just some samples of literature related to RFID and its use in the apparel industry. In order to validate the capability of RFID devices to reach and support the above-mentioned expected benefits, it is necessary to test new equipment (tags, readers) in the considered use cases, i.e. processes involving logistics and end-users. In the remaining part of the present work a test methodology is presented in order to assess and compare the performances of tags operating according to EPC, NFC or both standards.

12.3 Materials and Methods

The presented testing procedure is aimed at assessing the performance of innovative RFID dual frequencies inlays, operating according to EPC and NFC standards. To this extent, specific testing procedures have been designed in order to compare the performances of the inlays with standard, commonly used RFID tags operating in the first or the second scenario. The dual frequency inlays are composed of a chip capable of connecting and managing two antennas, one dipole antenna operating in the UHF band according to EPC standards, and a loop antenna tuned in the HF band according to NFC standards. The chip shares the same memory blocks across the two standards, thus the information contained in the IC's memory can be read or written by means of UHF readers (commonly adopted in logistics processes) or HF readers (typically smartphones). These functionalities are very important in the fashion retail sector, where the tag can be profitably adopted in both logistics/supply chain processes and in customer-oriented processes.

12.3.1 EPC Tests

Six families of different tags have been tested, according to Table 12.1. Tag 1, 2 and 3 are three tags commonly used in retail, thanks to their good performances and the suitable form-factor, while Tag 4, 5, and 6 are equipped with the innovative dual frequency IC.

A logistic process involving reads of multiple tags has been replicated to test the performances of the tags. In particular, a handheld RFID reader (*manual test*) and

Table 12.1 Tags tested in EPC scenario

Tag	Frequency	Standard	IC
1	UHF	EPC	NXP G2iL
2	UHF	EPC	NXP UCODE 7
3	UHF	EPC	NXP G2iL
4	UHF/HF	EPC/NFC	EM4423
5	UHF/HF	EPC/NFC	EM4423
6	UHF/HF	EPC/NFC	EM4423

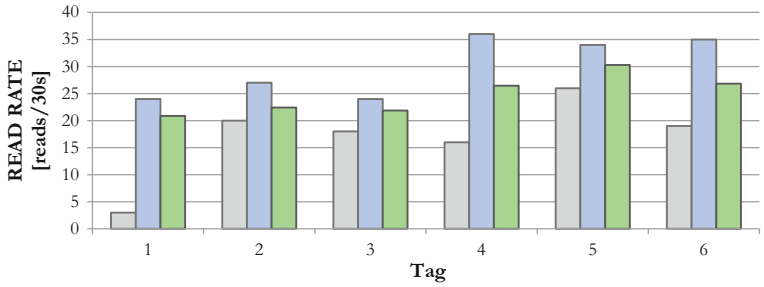


Fig. 12.1 Minimum (grey), maximum (blue), average (green) read rate (reads/30 s), mobile reader

a fixed RFID reader (*automated test*) have been used to inventory tags in a bulk shipping/receiving test.

Manual shipping/receiving test is aimed at reading the maximum number of tagged garments placed inside a cardboard box and read with a Zebra RFD8500 handheld device at maximum power (32 dBm ERP). The device is waved for 30 s around the box containing 90 tagged garments, 15 for each family of tags. The number of tagged items contained in the box has been chosen in order to be representative of the real logistics processes taken in retail; the reading time is set to 30 s because of two reasons: it is compatible with the operation considered (manual shipping or receiving process) and, according to the experimental results, the highest accuracy for each read is achieved within the first 10 s, and just sporadic reads occur during the remaining time. Test procedure is repeated 10 times.

Measured KPIs include: Accuracy, percentage of tags correctly read out of the overall number of tested tags (90); Read rate, number of time a tag has been read in 30 s timeout. Average accuracy is 100% for all considered tags, while Fig. 12.1 shows the achieved read rate. The better the performance, the higher the achieved read rate; closer values of minimum, maximum, average read rate mean higher control of tag production process (and thus constant tag performances) and/or favourable orientation of the tag towards the reader's transmitting antenna.

During the execution of the automated shipping/receiving dock door test, the box is moved and rotated through an RFID gate composed of a Impinj Threshold antenna connected to a Impinj Speedway R420 reader, without any added shielding

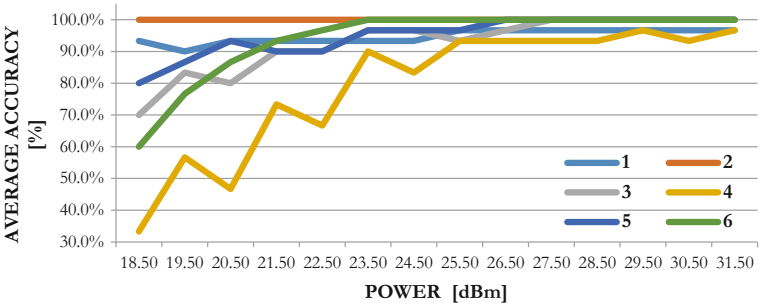


Fig. 12.2 Average accuracy (%), fixed reader

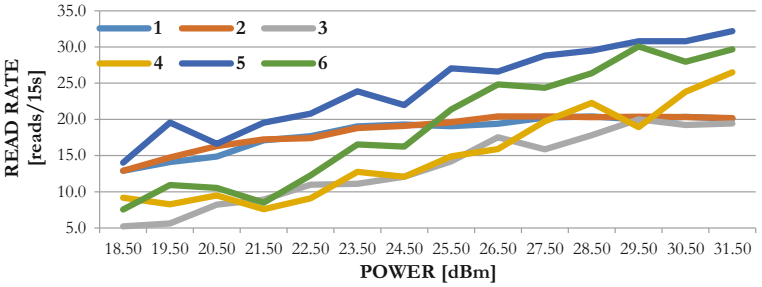


Fig. 12.3 Average read rate (reads/15 s), fixed reader

structure. During each test run, the reader is activated using the software provided by the manufacturer (Multireader), the power is swept from 18.5 to 31.5 dBm, and for each power level a 15 s read is performed. The reading time is set to 15 s because of two reasons: is compatible with the operation considered (automated shipping or receiving process) and, according to the experimental results, the highest accuracy for each read is achieved in the first 4–5 s, and no significant reads occur during the remaining time. Test is repeated 10 times.

Measured KPIs include: Accuracy, percentage of tags correctly read out of the overall number of tags tested (90); Read rate, number of time a tag has been read in 15 s timeout; TTFR (Time to First Read): time required to read all the readable tags belonging to the same family. Figures 12.2, 12.3 and 12.4 plot the measured performances.

12.3.2 NFC Tests

Seven different families of tags have been tested, as reported in Table 12.2.

Tag 1, 2, 3 and 7 are four commonly used tags in NFC applications for their performances and the form-factor; while Tag 4, 5, and 6 are equipped with the

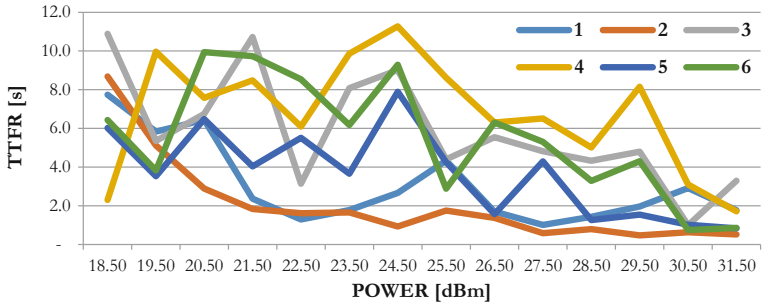


Fig. 12.4 Average TTFR (s), fixed reader

Table 12.2 Tags tested in NFC scenario

Tag	Frequency	Standard	IC
1	HF	NFC type 2	NXP MIFARE ULTRALIGHT
2	HF	NFC type 2	NXP NTAG203
3	HF	NFC classic	NXP MIFARE CLASSIC
4	UHF/HF	EPC/NFC	EM4423
5	UHF/HF	EPC/NFC	EM4423
6	UHF/HF	EPC/NFC	EM4423
7	HF	NFC type 5	NXP ICODE SLIX

innovative dual frequency IC. Tags have been tested according to a typical use case of NFC tag: short range read by means of a mobile phone, following two different test procedures.

Procedure #1: simulation of a typical use case involving a single tag read by the end-user.
The tag under test is placed on a wooden table, then a stack of 8 cardboard spacers, 6 mm thickness each, is placed over the tag. A mobile phone equipped with a NFC reader is set in continuous reading mode and placed over the stack, aligning the transmitting antenna of the phone with the tag, and kept in this position for 10 s or until the complete read of the tag's memory is over. If no read is possible, after 10 s the phone is removed anyway. Tag Info application, developed by NXP, is used on the mobile phone to activate and control the NFC reader; the whole tag memory (UID and user memory) is scanned and read, measuring the required time. One cardboard spacer is removed from the stack and the test is repeated as described above. The whole test procedure is repeated 10 times; while three different mobile phones have been used.

Measured KPIs include: Average read time required to read the tags of the specific family using three different mobile phones; Maximum distance required to obtain 90% accuracy. Figure 12.5 shows the achieved performances.

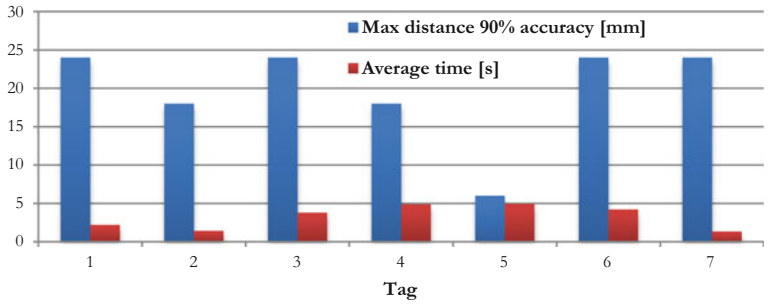


Fig. 12.5 Maximum distance (mm) and Average reading time (s)

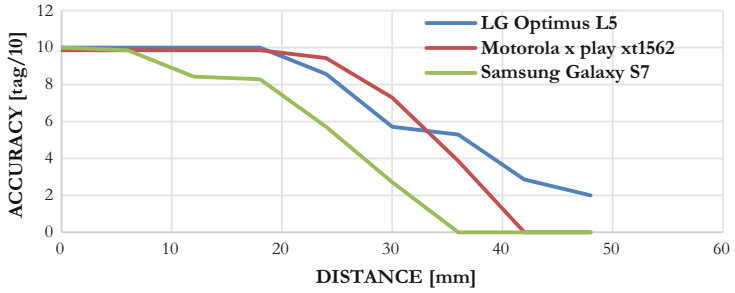


Fig. 12.6 Average accuracy (read tags/10)

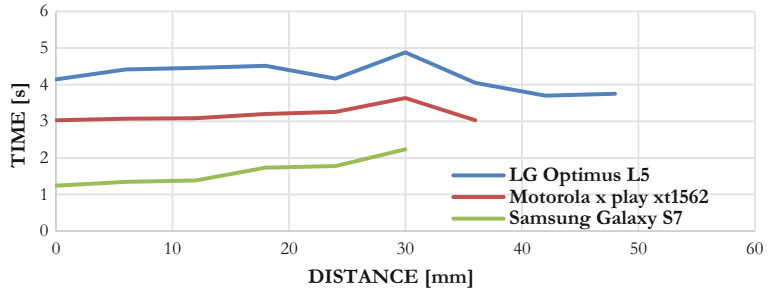


Fig. 12.7 Average read time (s)

As far as it concerns the mobile phones under test, measured KPIs include: Accuracy, number successful tag reads out of the overall number of read attempts for each family (10); Average read time required to read the tags of all the families. Figures 12.6 and 12.7 chart the achieved performances.

Procedure #2: replication of the tests described by Dahl et al.
The authors simulated typical use cases involving a single tag read by the end-user, in particular the tag under test is placed on a plastic card connected to a sliding rail,

Table 12.3 Tags tested in NFC scenario by Dahl et al.

Tag	Frequency	Standard	IC
1	HF	NFC type 1	Topaz 512
2	HF	NFC type 2	NXP NTAG203
3	HF	NFC type 3	FeliCa Lite-S
4	HF	NFC type 5	Mifare Desfire
5	HF	NFC classic	MF1S50

which is used to control and set the tag/reader distance. A mobile phone, equipped with a NFC reader and running an ad hoc developed application, is fixed to the rail by means of a clamp and kept in this position until the complete read of the tag's memory is done by the software. If no read is possible, after 10 s the read is stopped anyway. NFC Benchmarker application, developed by the authors of the paper, is used on the mobile phone to activate and control the NFC reader; tag memory (UID and user memory) is read and scanned, and the required time is measured for different sizes of memory blocks. After the test is done, the clamp with the tag is placed closer to the phone and the test is repeated as described above. Five different tags have been tested, as shown in Table 12.3.

It must be noticed that above listed Tag 2 has the same IC of Tag 2 tested in the present work (NFC type2, NTAG 203), thus it can be taken as a benchmark for performance comparison. Due to some technical issues arisen during the execution of the test, some restrictions had to be applied; in particular:

- a compatibility issue between the App and the mobile phone used (a Samsung Galaxy S2) and/or its Android release made impossible the exact replication of all the tests described by Dahl et al., more precisely only *Read/write throughput* test could be performed;
- tags listed in Table 12.2 could not be all tested, in fact Tag 3 and Tag 7 were not compatible with the App and/or NFC stack.

Measured KPIs include: Average speed and Std Dev for reading/writing tag's memory with packets size ranging from one byte up to maximum memory size. Tables 12.4 and 12.5 show the achieved performances.

12.4 Conclusions

The tests show that the performances of the dual frequency inlays are appropriate in the considered processes, and comparable to the performance of specific tags designed and optimized for only one standard.

In EPC scenario, the accuracy of all the tested tags is 100% when read by a mobile reader, showing a read rate which guarantees a good capability of detection for almost

Table 12.4 Average speed and Std Dev (BPS) for tag's memory reading operations, and comparison with Tag 2 tested by Dahl et al. (2*) with 64 bytes packets

Tag	Speed 0 mm	Std Dev 0 mm	Speed 5 mm	Std Dev 5 mm	Speed 10 mm	Std Dev 10 mm	Speed 20 mm	Std Dev 20 mm	Speed 30 mm	Std Dev 30 mm
1	60	198	59	192	71	230	63	204	65	213
2	911	470	974	480	970	496	946	549	–	–
4	1.160	350	1.127	331	1.064	376	1.151	311	–	–
5	1.252	325	1.112	339	1.076	397	–	–	–	–
6	1.114	342	1.120	343	1.132	328	1.185	335	–	–
2*	1.520	106	1.430	151	1.450	144	–	–	–	–

Table 12.5 Average speed and Std Dev (BPS) for tag's memory writing operations, and comparison with Tag 2 tested by Dahl et al. (2*) with 64 bytes packets

Tag	Speed 0 mm	Std Dev 0 mm	Speed 5 mm	Std Dev 5 mm	Speed 10 mm	Std Dev 10 mm	Speed 20 mm	Std Dev 20 mm	Speed 30 mm	Std Dev 30 mm
1	24	78	24	78	23	76	19	70	23	75
2	290	146	311	142	294	147	310	144	–	–
4	384	63	376	68	376	60	379	69	–	–
5	385	74	377	67	383	60	–	–	–	–
6	385	65	377	66	374	56	380	55	–	–
2*	303	22	287	34	301	21	–	–	–	–

all families. In fact, for Tag 2, 3, 4, 5, 6 every tag has been read at least 15 times in 30 s, so the shipping/receiving process appears reliable.

When a fixed reader is used and transmitting power is set higher than 27.5 dBm, 100% accuracy and good read rate are obtained for all the tags except for Tags 1 and 4. TTFR shows high oscillations, being in any case lower than 12 s; this result appears absolutely compatible with the manual logistic process considered which takes usually longer.

In NFC scenario, Tag 4 and 5 show worse performances than other specific NFC tags, while Tag 6 has better reading distance and faster reading time, being comparable to standard dedicated NFC tags.

The performances of NFC reading devices show that older phones have better accuracy compared to new models, but they are slower in reading tag's memory. The longer reading time can be explained considering that old phones have low performing CPUs (affecting time to scan and process data) but probably better radio interface (affecting reading distance). Their HF transmitter uses chips that are designed for HF readers commonly adopted in industry and not specifically optimized for smartphones, the latter having lower energy consumption and lower reading distance.

The use of a specific benchmark software enabled the measurements of reading and writing speed in different conditions for most of the tags under test; the obtained results are comparable with the results reported by other authors. Slight deviations can be explained considering the differences in smartphones used and tag's antenna design.

In conclusion, dual frequency tags, although quite innovative and still not available for mass production, have good performances comparable to standard RFID tags operating only in a specific band (HF or UHF). It must be considered that logistics processes are more critical in terms of performance requirements than NFC reads; in fact, a missed tag in a receiving process may lead to inventory inaccuracy while missing a NFC read can be quickly fixed repeating the read attempt by the end-user. As a consequence, Tags 5 and Tag 6 are the most suitable for companies operating in fashion and retail; Tag 6 has top performances in both EPC and NFC scenarios, Tag 5 works well in logistics and has acceptable performances in NFC applications.

References

Bertolini, M., Bottani, E., Montanari, R., & Volpi, A. (2009). RFID-enabled business intelligence modules for supply chain optimisation. *International Journal of RF Technologies: Research and Applications, 1*, 253–278. ISSN:1754-5730.

Bertolini, M., Bottani, E., Ferretti, G., Montanari, R., & Volpi, A. (2012a). Analysis of the requirements of RFID tags for efficient fashion supply chain management. *International Journal of RF Technologies: Research and Applications, 3*(1), 39–65.

Bertolini, M., Bottani, E., Ferretti, G., Rizzi, A., & Volpi, A. (2012b). Experimental evaluation of business impacts of RFID in apparel and retail supply chain. *International Journal of RF Technologies: Research and Applications, 3*(4), 257–282.

Bertolini, M., Ferretti, G., Vignali, G., Volpi, A. (2013). Reducing out of stock, shrinkage and overstock through RFID in the fresh food supply chain: Evidence from an Italian retail pilot. International *Journal of RF Technologies: Research and Applications, 4*(2), 107–125. ISSN:1754-5730.

Bottani, E., Montanari, R., & Romagnoli, G. (2016). Improving sales turnover in fashion retailing by means of an RFID-based replenishment policy. *International Journal of RF Technologies: Re-search and Applications, 7*(1), 65–86. https://doi.org/10.3233/RFT-150072.

Dahl, A., Zaher, A., & Plagemann, T.P. (2015). Android based toolset for NFC tag testing and performance evaluation. European Wireless (2015).

GS1. (2015). Tagged-Item Performance Protocol (TIPP) tagged-item grading overview R2.0. http://www.gs1us.org/DesktopModules/Bring2mind/DMX/Download.aspx?command=core_download&entryid=1487&language=en-US&PortalId=0&TabId=785.

Harrop, P., & Das, R. (2013). Apparel RFID 2013–2023 fashion and retail apparel manufacture, sorting, delivery and stock control, rented apparel, laundry. http://www.idtechex.com/research/reports/apparel-rfid-2013-2023-000323.asp.

Motorola. (2010). Item-level RFID tagging and the intelligent apparel supply chain. White Paper.

Rizzi, A., Romagnoli, G., & Thiesse, F. (2016). A new framework for RFID use cases in fashion and apparel retailing. *International Journal of RF Technologies: Research and Applications, 7*(2–3), 105–129.

Part IV
Sustainability in Fashion

Chapter 13
Sustainability Certifications and Labels for the Fashion Industry: Selection Guidelines

Alessandro Fontana, Donatella Corti, Andrea Barni and Fabio Moltoni

Abstract In recent years, bigger and bigger attention is addressed towards the sustainability concept at all levels of the fashion supply chain. One of the main triggers of this trend is the increased awareness of the final consumers whose needs and wishes are translated in new requirements for the supply chain actors, from downstream to upstream, in a life cycle perspective. At the same time, there is a flourishing of certifications and labels related to different sustainability aspects and, often, it could be difficult to perceive the peculiarities of each instrument. In order to adopt them as a strategic lever in the sustainability management, it would be useful to have some support to make informed decisions about which instruments meet at the best the needs of customers, whilst reflecting the actual performance of a company. This paper develops a set of guidelines that could support companies belonging to the fashion supply chain in identifying which tool, certification or label, is the most appropriate considering the specific context. Available tools have been first identified and, then, classified mapping and assessing them against a set of criteria that resulted to be relevant in the fashion environment. Though the research takes advantage of the authors' experience in the field, the paper is mainly of a conceptual nature. Empirical validation of the guidelines is the necessary next step to refine and complete the proposed guidelines.

13.1 Sustainability and Fashion

In recent years, the attention towards sustainability issues has hugely increased in the fashion industry from both environmental and social perspectives. The industrial attention is aligned with the growth of the related scientific fields on the sustainable practices and approaches adopted in the fashion supply chain. Focuses of research contributions are several, to name a few of the most covered topics: analysis of

A. Fontana · D. Corti (✉) · A. Barni · F. Moltoni
SUPSI - University of Applied, Sciences and Arts of Southern, Via cantonale 2C, Manno, Switzerland
e-mail: donatella.corti@supsi.ch

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6_13

eco design and sustainable manufacturing practices (see for example Cimatti et al. 2017; Moon et al. 2013); reduction of specific type of impacts (see for example Grappi et al. 2017); deployment of corporate social responsibility (Li et al. 2014) or sustainable practices at the supply chain level (see for example Turker and Altuntas 2014; Winter and Lasch 2016; Caniato et al. 2012). The vast body of literature reflects the increasing need of supporting tools that could guide companies in making the most out of the attention paid towards sustainability issues.

At the same time, practitioners are more and more interested in implementing instruments that could support the structuring of the company's approach towards the sustainability management or the maximization of the communication efficacy to stakeholders, namely certifications and labels. Yet, it is often difficult for managers new to the topic to orient themselves in the plethora of existing certifications and labels, both general or sector specific. In fact, some tools can differ from each other for their scope: the focus could be on a single dimension of sustainability (i.e. environmental or social), or it is even more specific and looks at a single factor (i.e. water depletion or toxicity); in some cases the object of analysis is the product, in other cases the processes. Also the type of support provided by the tools varies: either they help companies to implement sustainability-related concepts, or the main aim is to guide the communication of the achieved results. Considering that the implementation of a certification or a label requires efforts in terms of both time and costs and that the selection of the right tool could not be trivial, it would be advisable to provide some support to companies to address directly the most proper instrument depending on the specific needs. Lo et al. (2012), for example, investigate the impact of environmental management systems, and in particular of the ISO 14000, on fashion companies' financial performance.

Aim of this paper is to present a first step of a research aimed at developing guidelines that could support fashion companies to identify the most proper certification-like tool that, one the one hand, fits at the best with the ongoing initiatives, thus making the most out of them; whilst, one the other hand, allows the company to meet the partner's and customers' expectations and requests. In order to achieve this aim, this paper is organized as follow: in the next section the research approach followed to develop the guidelines is presented before listing the main certifications and labels that can be used in the fashion industry. Then, a set of relevant criteria and contextual factors driving the selection of the right instrument is characterized and the identified fashion-related instruments are mapped against them. Some managerial implications for the use of the proposed classification are highlighted. Finally, some conclusions are drawn.

13.2 Research Approach

The piece of research presented in this paper is mainly of a conceptual nature and relies on an extensive search in the field of sustainability certifications and labels. Scientific papers have been analyzed as well as standard contents and specialized

literature on the topic. The main steps carried out to develop the guidelines can be summarized as follows:

- identification of the certifications and labels considering both fashion specific instruments and general ones that could be applied to the fashion industry;
- development of a set of criteria and contextual factors that can have an impact on the selection of the right instrument based on the expertise of authors and on the support of a company belonging to the industry;
- developing of the guidelines by mapping and assessing the certifications and labels on the criteria and contextual factors;
- drawing of considerations on the use of the guidelines from a managerial point of view.

It has to be noted that by fashion industry in this paper it is meant the entire supply chain since the implementation of sustainability concepts implies the adoption of a life cycle perspective and the contribution of each single actor has to be taken into consideration. Whenever an instrument is applicable to a specific phase of the supply chain, it will be pointed out, thus providing also hints on the certifications and labels to be adopted by partners.

13.3 Sustainability-Related Certifications for the Fashion Supply Chain

Sustainability certifications and labels have a twofold scope: on the one hand, they are meant to assist the introduction of the sustainability thinking in company practices, starting from planning and strategies definition, passing through the actual implementation and monitoring of the obtained results; on the other hand, they could support a company in communicating environmental and social performance related to operations and products.

The number of certifications and labels has rapidly grown in the last decade: more than hundred labels are currently addressing the textile sector (http://www.ecolabelindex.com). Out of them, a short list has been extracted in order to identify the ones that meet the most common requests in the field and that are suitable at the beginning of the sustainability journey. Also, it has been avoided to introduce too many labels replicating the same information and the same certification pattern (for instance only a couple of environmental labels compliant with Type I ISO 14024 have been considered, only one concerning Type III ISO 140025). Even if the following list of certifications and labels is not exhaustive, it could represent a good starting point including certifications addressing both products and production processes. In particular, the majority of product certifications that has been included in the list addresses environmental impacts since most often the supply chain partners requests are related to manufacturing operations, used substances used or consumed resources.

In what follows the selected certifications and labels are briefly introduced clustering them in two blocks relating, respectively, to product (10 items) and processes (9 items).

13.4 Certifications and Labels Addressing Products

- **Blue Angel (Der blaue Engel)**: it is a governmental certification issued by the German Environmental Ministry considering more than 100 categories of products and services. The certification is an Eco Label of type I and promotes products and services whose environmental and social LC impact is lower than the average product on the market.
- **Bluesign**: it was born from an independent industrial initiative launched in 2000 as an answer to the growing request of sustainable textiles. The certification takes into account five principles: resources productivity, consumers' safety, air emissions, water emissions and health and safety of workers.
- **Cradle to Cradle**: this certification evaluates product safety with respect to people and environment by considering the whole product lifecycle. Five criteria are taken into account to evaluate the processes: material health, material reuse, renewable energy, carbon and water management and social fairness. According to lifecycle performances five certification levels are provided.
- **Environmental Product Declaration (EPD)**: it is a document that provides registered, verified and comparable information about product lifecycle environmental impact according with ISO 14025 and calculated through LCA methodology. Its central objective is to provide a comparison mean for products belonging to the same category; this is the reason why the rules of assessment must be compliant with internationally accepted Product Category Rules.
- **EU Ecolabel**: it is a voluntary certification system intended to encourage companies at EU level to commercialize environmentally aware product and services. The evaluation criteria to obtain this certification rely on lifecycle analyses updated each three years.
- **Global Organic Textile Standard (GOTS)**: this is a standard that defines requirements useful to guarantee the organic state of textile products by assessing the whole product lifecycle under environmental and social indicators. To obtain the certification, at least 70% of fibres must be produced through organic cultivation.
- **Global Recycle Standard (GRS)**: this is a standard meant to monitor the quality of products manufactured with recycled materials by analysing the whole supply chain and introducing environmental and social evaluation criteria.
- **NATURTEXTIL iVN certified BEST**: this standard, developed by iVN (International Association of Natural Textile Industry), promotes the analysis of the whole supply chain of a textile product through the assessment of environmental and social indicators.
- **Nordic Swan**: known also under the name of 'Nordic Ecolabel', is a volunteer, Type I labelling system that evaluates the environmental impact of products within

their lifecycle, analysing the associated energy and water use, chemicals adopted, recycling and waste products generated.

- **OEKO-TEX Standard 100**: this is a Standard originally developed as a certification of environmental aspects related to the textile sector, with particular focus on safety of consumers and on possible negative reactions deriving by product use. This Standard is one of the three ones included in the whole tool: (i) OEJO-TEX Standard 100, certifying products safety from chemical point of view; (ii) STeP by OEKO-TEX, certifying sustainable textile production (also included in the following section being it focused on the process); (iii) Oeko-Tex Standard 100plus, a combination of the aforementioned standards.

13.5 Certifications and Labels Addressing Processes

- **ISO 14001:2015 and Environmental Management Systems**: it requires the development of an efficient and structured Environmental Management System (EMS). It has been first published by ISO organization in 1996 and is intended to enable a company to: (i) identify and control the main environmental aspects of their activities, products and services; (ii) comply with legal requirements related to the activity; (iii) continuously improve environmental performances; (iv) define a systematic approach towards the definition of environmental objectives.
- **STeP by OEKO-TEX**: STeP defines environmental requirements for the management of the whole production process by certifying an excellent production site management from environmental and social points of view. STeP applies to the whole textile sector and is provided through the assessment of six modules certifying chemicals management, environmental performances and management, social responsibility, quality management, health and safety. Within these modules, several levels of performance can be reached.
- **Corporate Accounting and Reporting Standard del Greenhouse Gas Protocol**: developed by the World Resources Institute (WRI) and by the World Business Council for Sustainable Development (WBCSD), it defines how to globally measure, manage and communicate the emission of greenhouse gases.
- **Detox by GreenPeace**: Greenpeace is active, from 2011, in reducing the introduction within water of hazardous chemicals by textile sector. The campaign defines eleven substances that should be deleted from processes.
- **Zero Discharge of Hazardous Chemicals (ZDHC)**: answering the Detox campaign, few relevant textile companies developed the ZDHC campaign in order to eliminate the discharge of hazardous chemicals by 2020.
- **Sustainable Apparel Coalition (SAC)**: the coalition was born as a desire of Walmart and Patagonia with the willing of making more sustainable the current clothing, footwear and home textile sectors. The main objective is the formalization of the Higg index, an instrument of standardization for the assessment of environmental and social impacts related to manufacturing and sale of product and services along the whole supply chain.

- **OHSAS 18001**: the Occupational Health and Safety Assessment Series is an international standard intended to support companies in the definition of formal procedures for the management of health and safety of workers.
- **SA 8000**: it identifies an international standard intended to certify aspects of the Corporate Social Responsibility. It maintains the formal structure of an ISO standard and covers the whole supply chain.
- **ISO 50001**: this certification promotes the sustainable use of energy through the introduction of an Energy Management System addressing the following aspects: (i) development of efficient energy use policy; (ii) define targets for the developed policy; (iii) use data to support decision making; (iv) measure results; (v) evaluate the results of policy implementation; (vi) continually improve the Environmental Management System.

13.6 Classification Dimensions

The sustainability dimensions presented hereinafter have been identified to characterize and classify the certifications and labels according the most relevant claims related to sustainability requested by the supply chain partners and customers. Mapping the certification and labels presented in the previous section against these criteria allows a company to identify the most suitable tool depending on the criteria that have to be fulfilled case by case. The set of criteria are presented in what follows.

- *Energy*: this dimension considers how a certification or label may support a company in managing the energy resources that are analyzed in terms of quantity (energy efficiency) and quality (renewable vs. not renewable). The energy use is evaluated along the whole product lifecycle and along the production steps that are directly or indirectly managed by the company. Since the direct link existing between the two aspects, energy management is usually associated to carbon management and carbon footprint issues that are meant to evaluate the greenhouse gasses emissions occurred during the company operations.
- *Water*: this dimension evaluates how the certification may address the efficient exploitation of the resource water considering the water withdrawal policies, the use and reuse of water and the quality assurance of the resource. It takes into account both the quantity and the typology of the emission occurred in this specific medium.
- *Chemicals and hazardous substances*: this dimension concerns the management policy of chemicals substances identified as acceptable, restricted, forbidden, considering, for the production point of view, their storage and manipulation, the risk management and the preparation to emergencies, and from the product point of view, the customer safety by controlling the substances content in the final product.
- *Emissions*: this dimension is meant to address how the certification may support the management of the pollutant emissions into the different environmental

compartments such as air, soil and water that could be harmful to the ecosystem and the human being.
- *Health and Safety of the workplace*: this dimension addresses the management of the health and safety of the workplace, concerning both the regulatory requirements and the voluntary ones. The certification has to support a proper management beyond the company boundaries, extending the scope also to the supply chain partners.
- *Social Responsibility*: under this umbrella concept various sustainability themes are included that have not been covered by the previous dimensions and that mainly focus on social issues. It considers how social themes such as child labor, forced labor, working hours, wages or freedom of associate are managed all along the supply chain.

In addition to the dimensions derived from the market requests, four further dimensions have been added for the selection scope meant to better characterize the certifications from the implementation point of view. The additional dimensions are:

- *Widespread adoption*: this dimension is meant to evaluate if the certification is accepted and accredited considering both the geographical dimension (is it widespread at national, continental or worldwide level?), and the sectorial one (is it extensively adopted by the fashion industry?)
- *Implementation support*: this dimension is meant to analyze the availability of instruments and guidelines that could support the certification deployment. These tools may be specifically developed for the certification or may be more general tools that can be applied also in the specific context.
- *Labelling availability*: this dimension evaluates if the certification is supported by the presence of a recognized label that could support the marketing and communication issues.
- *Implementation easiness*: this dimension is meant to qualitatively evaluate the implementation effort needed to integrate the tool into the company's managerial system. It considers, for example, the possible impacts on the corporate operations or the need to involve partners and stakeholders to get it.

13.7 Developing Selection Guidelines

In order to select the most appropriate certification to be implemented that may better support the sustainability activities of a company, easing, at the same time the compliance to the information claims coming both form partners and customers, a ranking system has been proposed. First, the selected certifications and labels have been qualitatively evaluated under the aforementioned relevant sustainability dimensions. The assigned rating is *Covered* (C), *Not Covered* (NC) or *Well Covered* (WC), except for Market acceptance that is rated under *Low*, *High* or *Medium* and the Implementation easiness that is rated under *Easy*, *Medium* or *Challenging*.

	Certification	Widespread adoption	Energy	Water	Chemicals & hazardous	Emissions	Health & Safety	Social Responsibility	Implementation tools availability	Labelling availability	Implementation easiness
Product	Blue Angel	Low	x	o	-	-	-	-	x	Existent	Challenging
	Bluesign	High	-	o	o	o	o	-	o	Existent	Medium
	Cradle to cradle	Medium	o	o	o	o	-	x	x	Existent	Medium
	EPD	High	-	-	-	-	x	x	-	Existent	Challenging
	EU Ecolabel	Medium	-	o	o	x	x	x	x	Existent	Challenging
	GOTS	High	-	-	o	-	-	-	o	Existent	Easy
	GRS	Medium	-	-	-	-	-	-	o	Existent	Easy
	Naturtextil IVN	Low	x	-	o	x	x	-	x	Not Existent	Medium
	Nordic Swan	Low	-	o	o	-	-	-	-	Not Existent	Challenging
	Oeko-Tex Standard 100	High	x	x	o	x	x	x	o	Existent	Easy
Process	ISO 14001:2015 & EMAS	High	-	-	-	-	x	x	o	Existent	Easy
	STeP	High	-	o	o	o	-	-	-	Existent	Medium
	Corporate Accounting GHG	High	x	x	x	o	x	x	x	Not Existent	Medium
	Detox	High	x	o	o	o	x	x	o	Not Existent	Challenging
	ZDHC	High	x	o	o	o	x	x	o	Not Existent	Challenging
	SAC	Medium	-	-	-	-	-	-	o	Not Existent	Challenging
	OHSAS 18001	High	x	x	x	x	o	x	o	Not Existent	Easy
	SA 8000	Medium	x	x	x	x	-	o	o	Not Existent	Easy
	ISO 50001	High	o	x	x	x	x	x	o	Not Existent	Easy

Legenda:		
	Covered	-
	Well Covered	o
	Not Covered	X

Fig. 13.1 Evaluation of product and process certifications through sustainability dimensions

Figure 13.1 shows the qualitative evaluation of the selected certifications and labels with reference to the classification dimensions.

To support the use of the table presented in Fig. 13.1 an assessment system has been defined in order to select the most proper certifications. Each classification is assigned a value depending on the relative importance of the different dimensions for a specific company. In this way a ranking of the existent certifications is derived pointing out which ones maximize the company's needs. The ranking system has been developed though the following classification function:

$$R = k \cdot [1/18 \cdot (a + b + c + d + e + f + g + h + i)]$$

where:

- R = certification value. The value is included between 0 and 1, with 1 as the higher possible rank, thus indicating a very supportive certification.
- k = *Widespread adoption*. This parameter can assume the following values: 1 if it is considered a certification with "*high*" widespread adoption, 0.5 if "*medium*" widespread adoption and 0.25 if "*low*" widespread adoption.
- $a, b, c, d, e, f, g, h, i$ = factors that are meant to measure in a quantitative way how much the analyzed certification is able to support a specific dimension. This

Table 13.1 Evaluation of the Bluesing certification against the relevant dimensions

Relevant dimension	Value
k Widespread adoption	1
a Energy	1
b Water	2
c Chemicals and hazardous substances	2
d Emissions	2
e Health and Safety of the workplace	2
f Social Responsibility	1
g Implementation tools availability	2
h Labeling availability	2
i Implementation easiness	1
Certification value	0.84

parameter can assume the following values: 2 if the dimension is "*Well covered*", 1 if it is "*covered*" and 0 if it is "*Not covered*". The parameters stay for: (a) *Energy*, (b) *Water*, (c) *Chemicals and hazardous substances*, (d) *Emissions*, (e) *Health and Safety of the workplace*, (f) *Social Responsibility*, (g) *Implementation tools availability*, (h) *Labeling availability*, (i) *Implementation Easiness*. In the case of factor (i), the three quantitative levels correspond to: 2 if the dimension is "*Easy*" meaning that it is easy to be implemented with low impacts both on company and suppliers, 1 if it is "Medium" meaning that it is easy *to be implemented by the company, more challenging for the suppliers* and 0 if it is "*Challenging*", meaning that it has a high impact both for the company and its suppliers.

- *1/18* = is a weighting factor that, in the present version of the formula, is equally attributed to all the parameters considered in the ranking.

As an example, let's try to assess the Bluesing certification assuming that the nine dimensions have the same weight. Table 13.1 shows the values of relevant dimensions assigned to this certification according to the classification of Fig. 13.1 and then the final value for the certification (0.84) is calculated. The process can be repeated for all the certifications to be evaluated, preparing a ranking that could address the specific company needs and vision by adjusting the weights.

To sum up, in order to assess the usefulness or appropriateness of a certain certification or label a company should:

- assign a quantitative value for the Widespread adoption dimension.
- assign weights to the other dimensions according to the specific needs;
- evaluate the certification value.

13.8 Managerial Implications

The increasing pressure towards the implementation of sustainable practices forces managers to identify proper tools to meet the supply chain partners' and market's requests, whilst paying attention to implement efficient solutions that could be seamlessly integrated into the operations.

The guidelines proposed in the previous sections can make easier for managers to identify the most proper certification or label. The use of the proposed procedure is multifold:

- the adequateness of an already implemented certification can be assessed in absolute terms or by comparing it with possible alternatives;
- the level of coverage of a tool with reference to a specific dimension can be assessed;
- if a new tool is needed, the guidelines allow to rank different tools so to identify the one the at the best match the company's needs;
- kind of a what if analysis can be carried out by changing the relative weight of dimensions so to select the certification that allows to be more flexible in case the relative importance of dimensions is expected to change in the future.

The guidelines here proposed can thus support the choice of certifications and labels by reducing the time needed to understand how the single tool works and what is the main focus. In fact, the number of certifications and labels is always increasing and it is difficult to keep the pace with the all the new tools. A quick look at the guidelines, kept properly update, could be very useful to keep an eye on innovation without losing too much time for searching and analysis activities.

13.9 Conclusions and Next Steps

In this paper a critical analysis in the shape of a set of guidelines of existent sustainability-related certifications and labels to be implemented in the fashion supply chain has been presented. These guidelines are meant as a support for practitioners who feel the need to implement certifications and labels, but get lost in the selection phase due to the vastness of the field that is evolving every day.

The used methodology to develop the classification and assessment is flexible enough to allow the addition of further certifications or other tools that have been neglected in this phase or that will be introduced later on. The list of criteria being the same, the assessment weights can be adapted depending on the interest of the specific company.

Some more research steps are advisable in the future to complete the guidelines and improve their quality. One the one hand, a more detailed analysis is advisable to better characterize the field of use of the process certifications, by introducing further criteria that reflect the different nature of those tools compared to the product-related

ones. Another necessary step is the empirical validation of the guidelines to test their actual value for a company and to make sure that all the relevant criteria have been included. The list of certifications and labels can be also extended to include more tools and, of course, need to be kept update with possible new entries that become relevant for the fashion industry. Ideally, it would be interesting to develop an online tool guiding the selection.

References

Caniato, F., Caridi, M., Crippa, L., & Moretto, A. (2012). Environmental sustainability in fashion supply chains: An exploratory case based research. *International Journal of Production Economics, 135,* 659–670.

Cimatti, B., Campana, G., & Carluccio, L. (2017). Eco design and sustainable manufacturing in fashion: A case study in the luxury personal accessories industry. *Procedia Manufacturing, 8,* 393–400.

Grappi, S., Romani, S., & Barbarossa, C. (2017). Fashion without pollution: How consumers evaluate brands after an NGO campaign aimed at reducing toxic chemicals in the fashion industry. *Journal of Cleaner Production, 149,* 1164–1173.

Li, Y., Zhao, X., Shi, D., & Li, X. (2014). Governance of sustainable supply chains in the fast fashion industry. *European Management Journal, 32,* 823–836.

Lo, C. K. Y., Yeung, A. C. I., & Cheng, T. C. E. (2012). The impact of environmental management systems in financial performance in fashion and textiles industries. *International Journal of Production Economics, 135,* 561–567.

Moon, K. K., Youn, C., Chang, J. M. T., & Yeung, A. W. (2013). Product design scenarios for energy savings: A case study of fashion apparel. *International Journal of Production Economics, 146,* 392–401.

Turker, D., & Altuntas, C. (2014). Sustainable supply chain in management in the fast fashion industry: An analysis of corporate reports. *European Management Journal, 32,* 837–849.

Winter, S., & Lasch, R. (2016). Environmental and social criteria in supplier evaluation—Lessons form the fashion and apparel industry. *Journal of Cleaner Production, 139,* 175–190.

Author Index

R. Rinaldi and R. Bandinelli (eds.), *Business Models and ICT Technologies for the Fashion Supply Chain*, Lecture Notes in Electrical Engineering 525,
https://doi.org/10.1007/978-3-319-98038-6