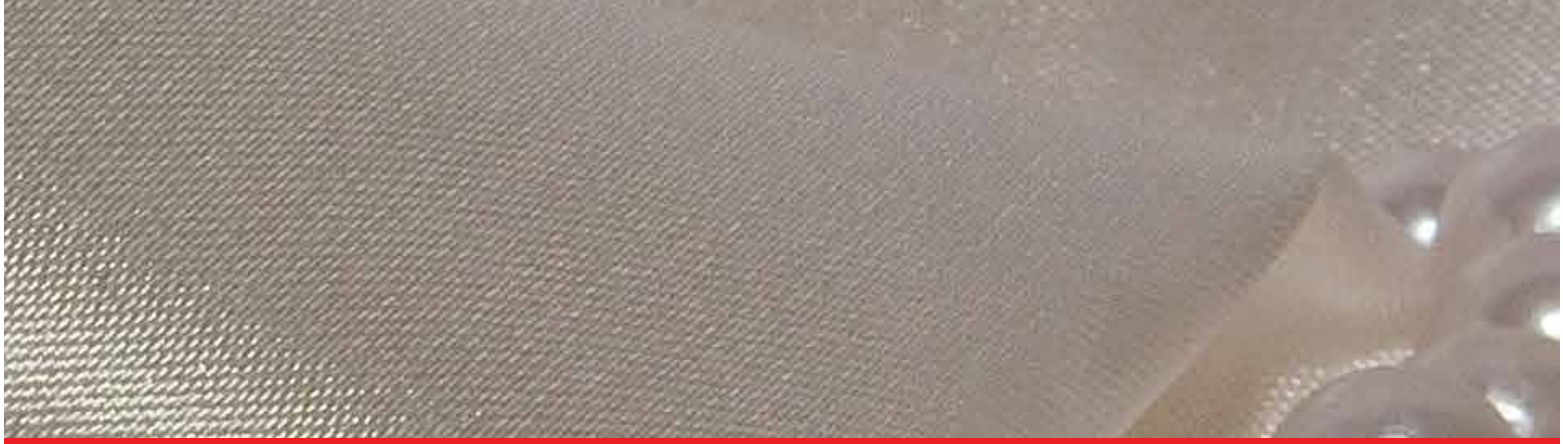

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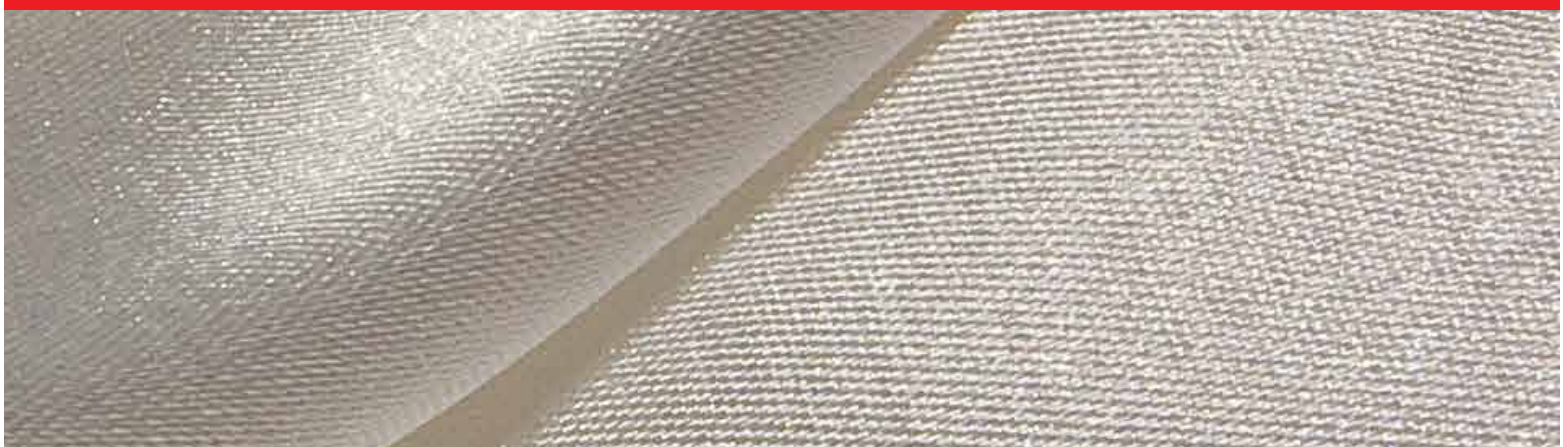
Fashion Industry

An Itinerary Between Feelings and Technology

Edited by Riccardo Beltramo, Annalisa Romani and Paolo Cantore



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Meet the editors

Riccardo Beltramo is Full Professor at the University of Turin, Department of Management. He works as the Coordinator of the Commodity Sciences area. Since 1986 he has worked in the field of industrial ecology and carries out research on integrated management systems applied to manufacturing, service activities, and industrial areas. He currently teaches environmental management systems, tourism eco-management, and industrial ecology. He is President of the Bachelor Degree in Business Administration. Maker soul, in the field of Internet of Things has invented the Scatol8® System, a remote sensing system to monitor, show, and process environmental and management variables, giving life to the innovative startup "Lo Scatol8 per la Sostenibilità srl," an academic spinoff of the University of Turin.

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Paolo Cantore is a computer science engineer and graduated at the Polytechnic of Turin. His work experiences mainly concern wireless sensor networks for environmental monitoring and management systems. He has participated at many research projects working for the universities of Turin and Prato, and he took a PhD in business and management. He is currently doing a research grant at the University of Turin.

Contents

Preface

We approached the editing of this book on the fashion industry with a clear vision, formalized in the invitation to contribute.

Fashion is a lot more than providing an answer to primary needs. It is a way of distinction, of proclaiming a unique taste, and/or expressing the belonging to a group. Sometimes to an exclusive group. Currently, the fashion industry is moving towards hyperspace, to a multidimensional world that is springing from the integration of smart textiles and wearable technologies.

It is far beyond aesthetics, though new properties of smart textiles have allowed designers to experiment with astonishing forms and expressions. There are new functionalities made possible by the interactions between wearable technologies, fabrics, and the wearer.

There are also surprising contrasts and challenges: a new life for natural fibers, fabrics, and dyeing techniques, environmental friendliness, rediscovered by eco-fashion, and "artificial apparel," made of microprocessors, sensors, and actuators. A movement begun by makers, startups, and microcompanies that today solicits the interest of famous fashion makers. Is the fashion industry taking profit from this revolution? How is this revolution affecting the strategies of the fashion industry?

With this spirit, we have selected scientific works capable of composing the multi-faceted world of fashion in a single design.

Now, the outcome of the process is in your hands.

The theme of sustainability takes to the stage and becomes the protagonist of the first part of the book. Very complex issues, involving economic, social, and environmental aspects, are dealt with in two phases: initially, through three contributions on tools that allow companies to collect and provide evidence of their environmental motivation; therefore, through effective examples of the application of technologies and methodologies aimed at improving communication with consumers and eco-compatible solutions.

Chapter 1 discusses "Sustainability initiatives in the fashion industry," by Li Li, and proposes an itinerary in four steps: an overview of the most concerning environmental impacts caused by the fashion industry; current leading collective sustainability campaigns mobilizing the fashion industry; current available benchmarks and tools for measuring environmental impact of the textile lifecycle; and examples of how companies in the fashion industry are executing sustainability initiatives in their products or processes.

The goal of the second chapter, written by D.G.K. Dissanayake, is to provide a detailed and robust answer to the question that stands also as the title of the chapter: "Does mass customization enable sustainability in the fashion industry?" The starting point is the consideration of the dimension, in environmental form, of the

evolution of the fashion industry, in particular due to the diffusion on fast fashion. The search for new business models seems to be the only way out. A promising consideration is the mass customization strategy and the author discusses the potential of this alternative, considering seven key elements that could possibly enhance sustainability. Innovation drives industry to ever cleaner and more efficient technologies. It's a matter of ethical management and of being able to provide evidence to clients and stakeholders.

Chapter 3, "Exploration of bamboo fabric with natural dyes for sustainability," by Kavita Chaudhary, shows the opportunity of bamboo viscose, a regenerated cellulosic fiber. The competitive advantages of bamboo as a provider of fiber, compared to other natural fibers, are described in terms of physical and chemical properties that contribute to the performance characteristics of fabrics. The chapter makes a comparative study of natural-dyed, printed bamboo, and cotton fabrics; it shows through a sequence of duly illustrated experiments the developing process of garments and natural-dyed bamboo fabric, thus providing an environmentally friendly and aesthetically challenging proposal.

The second part includes three chapters: two of them are focused on counterfeit. Pernicious behaviors, which are recorded with increasing concern, cause damage to consumers and to companies producing goods, in the parcel of luxury goods. Counterfeits are harmful both to the manufacturers of authentic products and to the buyers. The economic damage suffered by the company is direct, but it is only a small percentage of the reputational damage. The damage suffered by buyers is direct, when they believe they are buying a genuine product, and indirect for the problems that may be caused to their health when dangerous (and forbidden) substances have been used in the making process.

"The counterfeit market and the luxury goods," the fourth chapter, by Amélia Brandão, focuses on the counterfeit market, its influence on luxury consumption, and consumers' drivers for the counterfeit. The chapter also discusses innovative ways by which authenticity of luxury goods can be verified.

Erica Varese and Anna Claudia Pellicelli explore "The RFId technology for monitoring the supply chain and for fighting against counterfeiting. A fashion company case study" in Chapter 5. Their study involves an Italian company, Oscalito, which has adopted RFId technology as a valid support not only to monitor the supply chain, especially with reference to inventory management, waste disposal, logistics, and transport, but also to protect the Italian origin of production.

Chapter 6 contains a proposal sprung from our research team, joined by the academic spinoff company of the University of Torino, "Lo Scatol8 per la Sostenibilità srl." It describes the integration among devices inspired by the Internet of Things technologies and garments. The lifecycle thinking approach is applied to the evaluation of alternative fabric upcycling scenarios. In addition, wearable technologies make up a new dimension in the field of awareness raising. People, through the application of Scatol8's system, are allowed to witness their environmental consciousness, wearing interactive garments that extend the life of used products, even improving them. In the meantime, they contribute to the construction of maps of environmental quality, depending on the sensors that are hand stitched on the new garments.

We trust that you will be able to find interesting topics and ideas to further explore what you are most passionate about. We express our gratitude to all the authors with

whom we have opened a collaborative and fruitful dialog, which we hope will meet with the favorable opinion of the readers.

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Section 1

Fashion and Sustainability

Chapter 5

The RFId Technology for Monitoring the Supply Chain and for Fighting against Counterfeiting: A Fashion Company Case Study

Erica Varese and Anna Claudia Pellicelli

Abstract

The purpose of this chapter, after a brief literature review, is to analyse how the RFId technologies applied by an Italian fashion firm, Oscalito, contribute to monitoring the supply chain and are a useful tool to fight against counterfeiting, enhancing the Made in Italy. In the textile sector, characterised by a short and constantly evolving production cycle, the RFId technology has enormous potential. According to Regulation (EU) No 1007/2011 on textile fibre names and related labelling and marking of the fibre composition of textile products, consumer protection requires transparent and consistent trade rules, including as regards, indications of origin. When such indications are used, they should enable consumers to be fully aware of the origin of the products they purchase, so as to protect them against fraudulent, inaccurate or misleading claims of origin. In this context, RFId technology has emerged as a valid support for the company not only to monitor the supply chain, especially with reference to inventory management, waste disposal, logistics and transport, but also to protect the Italian origin of production. This study also has some limitations, typical of the applied methodology.

Keywords: RFId, supply chain, counterfeiting, fashion company, label, case study

1. Introduction

The Textile Regulation (EU) No 1007/2011 on textile fibre names and related labelling and marking of the fibre composition of textile products (hereafter, Regulation) was adopted in September 2011 and became applicable on 8 May 2012. It repealed and replaced the previous Textile Directives.

By it, the EU legislator intended to eliminate potential obstacles to a good functioning of the internal market, caused by divergent rules in the member states.

The enforcement of this Regulation thus aims at standardising textile fibre names as well as terms appearing on labels, markings and documents accompanying textile products in the various production, transformation and distribution cycles.

With the double objective of offering consumers accurate information and of improving the internal market, it also sets rules on labelling or marking of textile

products containing non-textile parts of animal origin, and regulates modalities for determining the fibre composition of textile products.

A textile product is defined as "*any raw, semi-worked, worked, semi-manufactured, manufactured, semi-made-up or made-up product which is exclusively composed of textile fibres, regardless of the mixing or assembly process employed*" (Regulation, art. 3).

The burden of labelling lies on all producers, importers or distributors of textile products, from raw materials to the finished product.

At the time of introducing a product into the market, the producer ensures the presence of the label or marking and the accuracy of the information therein displayed. If the producer is not established in the Union, the importer guarantees the above. A distributor is considered producer to the scopes of the Regulation in case he introduces a product into the market with his name or factory mark, labels it or modifies its contents. When making a textile product available on the market, the distributor guarantees that it is provided with the appropriate label or marking (Regulation, art. 15).

The Regulation does not apply to textile products contracted out to persons working in their own homes or to independent firms that carry out work from materials supplied without the property therein being transferred for consideration or to textile products tailor-made by self-employed tailors.

Furthermore, the following do not require a label: (i) textile products not intended for final consumers; (ii) textile products which, under customs control, are in transit because they are intended for non-EU markets; (iii) textile products temporarily imported for processing; (iv) textile products intended for sale in non-EU countries, for which the rules of the destination country need to be respected.

On top of mandatory indications, the legislator allows operators to characterise their production by voluntary information to be applied on labels or markings. In recent years, smart labels [1] are spreading out more and more in the textile sector also.

The objective of this chapter is to present, among indications which can voluntarily be added to labels, the application by Oscalito of RFId tags on finished items of clothing, in order to guarantee control on supply chain, on Made in Italy and, in general, on the high-quality characteristics of production.

This research fills a gap in literature: to the authors' knowledge, this is the first paper to present a case study on an Italian company applying RFId technologies to control the supply chain and to protect the Italian origin of production.

This chapter is divided into five sections: Section 2 presents a brief literature review on RFId technologies in the textile sector for monitoring the supply chain and for fighting against counterfeiting; Section 3 shows the research methodology; Section 4 offers considerations regarding the case study, Oscalito; in Section 5, the final conclusions are summarized.

2. Literature review

RFId technology uses a radio frequency to identify, detect and locate objects [2]. In a nutshell, these systems are based on remote reading of the information displayed by a specific label (the RFId tag), activated by a special reader. Thus, it is possible, through magnetic impulses, to codify the data contained in the tag accompanying the product throughout the entire production process [3]. Passive RFId tags do not have own power supply; therefore, the chips are activated by the power received from the antenna of the reader.

Literature analysis primarily brought up two main uses of RFId tags in the textile industry: (i) for monitoring supply chains in general and (ii) as tools for fighting against counterfeiting.

2.1 RFId technologies for monitoring the supply chain

Numerous publications describe potential benefits of the use of RFId tags in the supply chain. For example, see [4–11]. Few authors succeed in quantifying the benefits deriving from the application of this technology, because of the relatively scarce concrete applications [12].

In recent years, RFId tags have risen great interest, and some authors [12] believe that they will substitute bar codes, an automatic identification technology that has been characterising retail sales for decades [13].

They are used for monitoring supply chains especially with reference to inventory management, waste disposal, logistics and transport [14].

In the textile industry, characterised by a short and continuously evolving production cycle, RFId technology enjoys enormous potential. Brands such as Prada, Tesco, Wal-Mart, Benetton and, recently, Zara [15] are studying possibilities for its implementation [16]. The positive impact of these tags has been analysed by [17], who presented the highly satisfactory results obtained along the supply chain by applying RFId tags to clothing items of a US company. In Ref. [18], on the other hand, in a Hong Kong company, it has been noted that a resource allocation system based on RFId tags can ensure more efficient processes than those obtainable by traditional techniques.

The Italian textile and clothing industry has for years been struck by strong competition from emerging economies: this situation led some authors [19] to verify the existence of traceability initiatives in order to obtain competitive advantages. The study analysed the 'Traccia' project for dissemination of the 'traceability of textile products', carried out also by using RFId tags. It was brought into evidence that various traceability models might have come up, supported by public or private certification systems. Even though the textile industry is considered one of the most indicated for the application of this technology [20], the authors lament that operators do not yet fully perceive its advantages.

The main responsibility for the delay in implementing these tags, on the Italian as well as the international level, seems to be upon difficulties in aligning objectives and strategies along the supply chain: if this were not to happen, RFId might hinder instead of favouring integration of the various processes [21]. In Ref. [22], finally, a possible application of RFId to the shopping context is suggested: by guiding consumers in their purchases, added value could be created for firms.

Furthermore, numerous other interesting studies concern applications of RFId tags to the textile industry (e.g., see [22–26]).

2.2 RFId technologies for fighting against counterfeiting

In the twenty-first 'Whereas' of the Regulation, the EU legislator states that the textile industry is hit by the phenomenon of counterfeiting and that this raises problems in terms of consumer protection and information. The legislator encourages member states to devote particular attention to the enforcement of EU horizontal legislation and of measures concerning counterfeited products in the textile industry, such as Regulation (EU) No 608/2013 concerning customs enforcement of intellectual property rights and repealing Council Regulation (EC) No 1383/2003.

Technologies enabling contrast counterfeiting can be classified into four groups [27–29]: (i) holograms and filigrees (manifest technologies), (ii) safety inks and invisible printing (hidden technologies), (iii) chemical tags and (iv) bar codes and RFId ('track-and-trace' technologies).

On the international scale, the proposal and analysis of RFId tags in order to fight against counterfeiting have been studied by many authors (e.g., see [30–40]).

In Ref. [41], it is suggested that consumers should use personal mobile devices (with RFId reader) in order to obtain information on products they are about to purchase and verify, in particular, their authenticity, while in Ref. [42], it is proposed to integrate RFId tags through the innovative anti-counterfeiting 'TagPrint' system, using COTS RFID tags and readers. This system is characterised by low-cost and offline genuineness validation utilizing passive tags. These three purposes are achieved "*by leveraging a few of federated tags' fingerprints and geometric relationships*". In TagPrint, a new kind of fingerprint is utilised, called phase fingerprint, "*extracted from the phase value of the backscattered signal, provided by the COTS RFID readers*". To further solve the separation challenge, a geometric solution is developed to validate the genuineness. TagPrint, using COTS RFID devices, may increase the inviolability of RFId tags.

Concerning the textile industry, Ref. [43] presents a practical application of the RFId technology to the fashion sector of an Italian firm: it is argued that the implementation of this technology as to the two most imitated lines of production has enabled to limit the counterfeiting phenomenon and to improve logistics.

Still with a view to the textile industry, thanks to using RFId technology, Refs. [44, 45] propose a system called 'electronic-pedigree' (e-pedigree), which enables to verify single elements, identify missing objects and foresee the status of the products wherever they are located within the supply chain. In 2015, an algorithm named 'tag data processing and synchronization—TDPS' was presented, which makes it possible to develop an e-pedigree [29]. To date, the studies of these authors however still miss practical applications.

On top of eliminating sales of counterfeited goods, the application of RFId tags on items of clothing enables to hamper organised crime, by rapidly identifying and reacting to its illicit strategies, which are constantly evolving [46].

Further interesting cases are mentioned in Refs [47, 44].

3. Methodology

With the purpose to achieve the aim of this research, the following hypothesis has been developed:

H1. *In the fashion industry there is an increasing need to monitor the textile supply chain; in Italy, furthermore, it is necessary to protect the textile production against counterfeiting. Since RFId technologies are considered a strategic tool in many sectors (for example, in traceability of food, animals, and people thanks to electronic passports), the Italian textile industry may be very interested in approaching them*.

The research methodology was structured as follows: the first stage consisted in a review of existing literature, focused on RFId technologies in the textile sector for monitoring the supply chain and for fighting against counterfeiting; the second stage consisted in applying a qualitative case study methodology helping to explore this phenomenon within its context [48, 49].

According to Ref. [50], the choice of this methodology is justified by the need to answer 'how' and 'why', as well as by the fact that authors cannot manipulate the behaviour of those involved in the study, and by the fact that the research focuses on a contemporary phenomenon [51].

We feel that it would be impossible to gain a true picture of the chances for adopting an RFId technology in the fashion industry without considering the context in which it may be developed and used.

In fact, the relationship between RFId technology on the one side, and its implementation for monitoring the supply chain and avoiding counterfeiting on the other side, seems crucial to us.

We chose this case, Oscalito, because it is quite unique [52, 50, 53].

Oscalito undoubtedly shows the above-mentioned characteristics, because it has been one of the first Italian firms to implement voluntary RFId labels.

According to Ref. [54], this essay uses a wide range of sources of information in order to develop and analyse the case study. In the interest of data triangulation, we observed directly, analysed company documents and made interviews.

Direct observation was conducted at the company premises in 2018, so as to catch the reality and analyse events in real time: we enjoyed the opportunity to observe several meetings. We are conscious of the weaknesses of such observation: time-consuming; selectivity (might miss facts), reflexivity (observer's presence might cause change) and costs (observers need time)—[55, 51].

On these occasions, we asked to be granted access to company documents in order to better understand the firm and to increase our knowledge about the enterprise, especially concerning the RFId label.

We had the opportunity to analyse memoranda, study reports, etc. The validity of these documents was carefully reviewed so as to avoid incorrect data being analysed. We spent almost a week collecting data emerging from this documentation. Further information was collected from the Oscalito website.

In order to capture different dimensions of the same phenomenon, we interviewed the managing director and other people in the company (semi-structured interview) so as to clarify some important topics [54, 56, 57]. Each interview lasted for approximately 1 hour and was conducted by both of us. With a view to reducing the subjectivity of data interpretation, on permission by the interviewee [51], the interviews were recorded and later transcribed.

We autonomously analysed all data obtained by direct observation, company documentation and interviews, and we finally compared our individual interpretation of the results.

We did a triangulation of data sources (data triangulation) [58].

According to the Ying categorisation of case studies, this is a 'descriptive' one: this type of case study is used to describe a 'phenomenon and the real-life context in which it occurred' [50, 49].

4. Case study: Oscalito

In order to better understand the practical applications smart labels can have in the textile industry, the CEO of Oscalito, Dr. Dario Casalini, was contacted and interviewed.

The Oscalito brand (acronym for Osvaldo Casalini Lino Torino) is produced by Maglificio Po, a textile company founded in Turin in 1936 by two brothers, Osvaldo and Lino Casalini. Initially, clothing lines of underwear and fashion knitwear for men, women and children were created, using high-quality natural fibres. Basically, tubular fabric (without stitching) was produced, using circular machines. Lino's sons, Arrigo and Andrea, later joined the firm, extending the product range to fashion clothes and gaining success even on foreign markets. Export became fundamental for the business (so fundamental that nowadays 70% of the production is exported), and over the years, the women's fashion line acquired a central role in Oscalito's offer. In 2014, Dario Casalini joined the firm; as third generation of the family, he gradually took the lead of the company, renewing the brand and making it grow on the international scale, but always in the sign of continuity. In fact, Oscalito has always kept the entire production chain in Turin: from yarn production to finished garment. It has been among the first firms in the textile industry to introduce RFId labels on individual items of clothing in order to ensure production chain traceability.

Since 2012, Oscalito has been using RFId tags, which allow to trace the entire chain: fabric weaving, finishing and cutting, tailoring, quality control and logistics. This makes absolute control on quality flaws possible and guarantees Made in Italy. Such instrument enables to enact the intent of the EU Legislator, who, at the twentieth "whereas" of the Regulation, with the aim to protect consumers, requests transparent and coherent commercial rules, also concerning indications of origin.

These indications, when available, should enable consumers to be fully informed on the origin of the products they purchase, so as to protect them from indications of origin which are fraudulent, inaccurate or misleading.

Oscalito's production chain is managed through an ERP which uses bar code technology in the first two processing phases [(i) fabric weaving and finishing; (ii) fabric and lace cutting], while during the further four phases [(iii) tailoring the completed garments; (iv) finishing the completed garments; (v) ironing and packaging; (vi) logistics and warehousing], the information contained in the bar code is poured out into the RFId tag and therefore individualised for every single piece of clothing.

The implementation of RFId technology in the above production phases took place, as mentioned, starting from May 2012; it foresees continuous printing of the cards with RFId tags even in case part of the production cycle is carried out by third parties (**Figure 1**).

The RFId tag is applied following quality control which is made on every garment, and it enables to manage the phases of repair of items which are faulty but can be recuperated. Applying RFId tags allows to trace all production phases and operators which came in the finished garment in case it was returned, bringing to evidence any shortcoming or organizational problem in one of the production phases.

The implementation of RFId tags automatized all logistic functions, such as entrance into the warehouse with production notes and inventory functions by

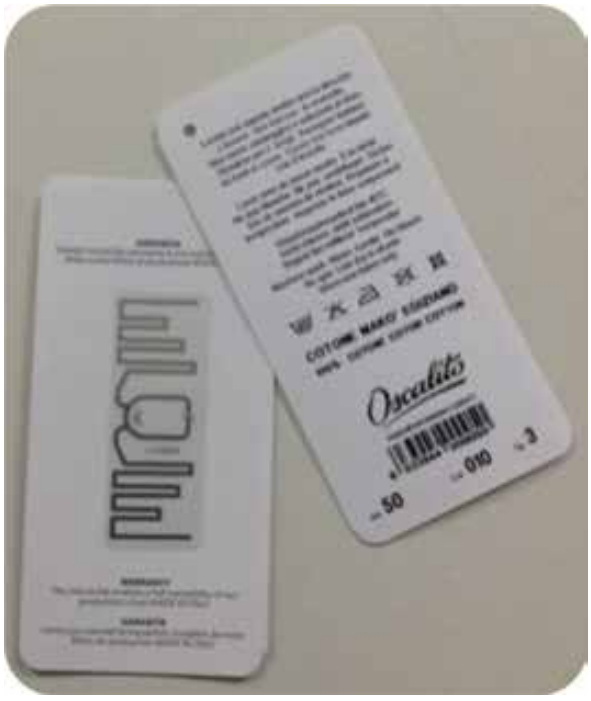

Figure 1.
RFId Oscalito. Particular of the 'maintenance' card with RFId tag associated to the guarantee of Made in Italy product. Source: Oscalito.

reader after passing through the tunnel (**Figure 2**) or by shelf reader scanner, as well as deliveries to customers.

Oscalito does not have an automatized warehouse; therefore, customer order preparation is done by manual shelf picking. RFId tags are fundamental in controlling picking accuracy: by printing the labels, first of all the true contents of every single box are brought into evidence, and then a further control of the complete order compared to the picking list (i.e., the customer's order) is carried out. Finally, packing lists for every single item and for the total delivery are printed (**Figure 3**), as well as the documents needed by the forwarder.

The results obtained by Oscalito may be summarized as follows:

- Complete traceability of the chain: from yarn to finished garment, in all production phases, with evidence of the operators who came in during the various processing steps
- Analysis of defects and errors in the various production phases
- Management of finished garments repair
- Warehouse and inventory management
- Delivery management: cancelling of human mistakes in picking up; automatic printing of labels on the boxes; note and packing list printing for every single item

With reference to countering counterfeiting, RFId system is ideal since each RFID tag generated has a 22-character alphanumeric code that is unique and not reproducible. It contains product production data that can be extracted via the ERP system that generated it and which is the only one that allows verification of the authenticity and originality of the product. The final consumer can verify the authenticity of the product by entering the 22-character alphanumeric code in a form made available by the manufacturer on its own mobile app or website.

The manufacturer can easily create his own mobile app or website where the final consumer can verify the authenticity of the product by entering the 22-character alphanumeric code of the RFID in a form made available by the manufacturer. By promoting this autonomous verification system by the final customer, a widespread control is carried out on the authenticity of the product without direct costs for the manufacturing company.

Figure 2.
RFId tunnel with exchanging direction motor conveyor for warehouse entry and delivery exit. Source: Oscalito.

Figure 3.
RFId reading post, Box label printing and application. Source: Oscalito.

As its future objective, Oscalito aims at extending RFId technology to all fabric weaving, finishing and cutting production phases and to warehouse management by customer, with pre-allocation of garments.

5. Conclusions

The implementation of a production chain traceability system by RFId tags and their readers (printers for initializing cards with RFId tags; tunnels to read warehouse entries and exits; printers for labelling boxes when dispatching) implied an investment of about 70,000.00 euros, increased by costs for the adaptation of the informatics management system and by current expenditure concerning periodical RFId tag purchase.

Many benefits were obtained: from production chain management with traceability of garments being repaired, to automatic management of the general warehouse and of consignment accounts with some customers, to management of commercial or defectiveness returns by customers and final consumers who purchase through Oscalito's e-commerce portal, on top of annulment of mistakes in the dispatching phase, eliminating claims on contents of the dispatched pieces, which used to concern about 100 pieces a year.

Finally, the implementation of the production chain traceability system by RFId tags has enabled to obtain important supply chain certifications, especially the Italian Identity certification issued by Italcheck.

Even if, according to Refs. [59, 60], common criticisms of the case study method are that it lacks rigour and that the dependence on a single case exploration makes it difficult to reach a generalising conclusion, the authors believe that through the Oscalito case study, they have been able to describe their views on a relevant innovative reality.

We realise that this research has some limitations due to the applied methodology: we have adopted a qualitative method for a single case study; the findings of the study are based on the first results of prospected deeper research; and further interviews would be required in order to understand a general fashion industry perception of this kind of technology.

For this reason, we are planning to carry out further studies on the application of RFId in the fashion industry.

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Conflict of interest

The authors have no conflict of interest.

Other declarations

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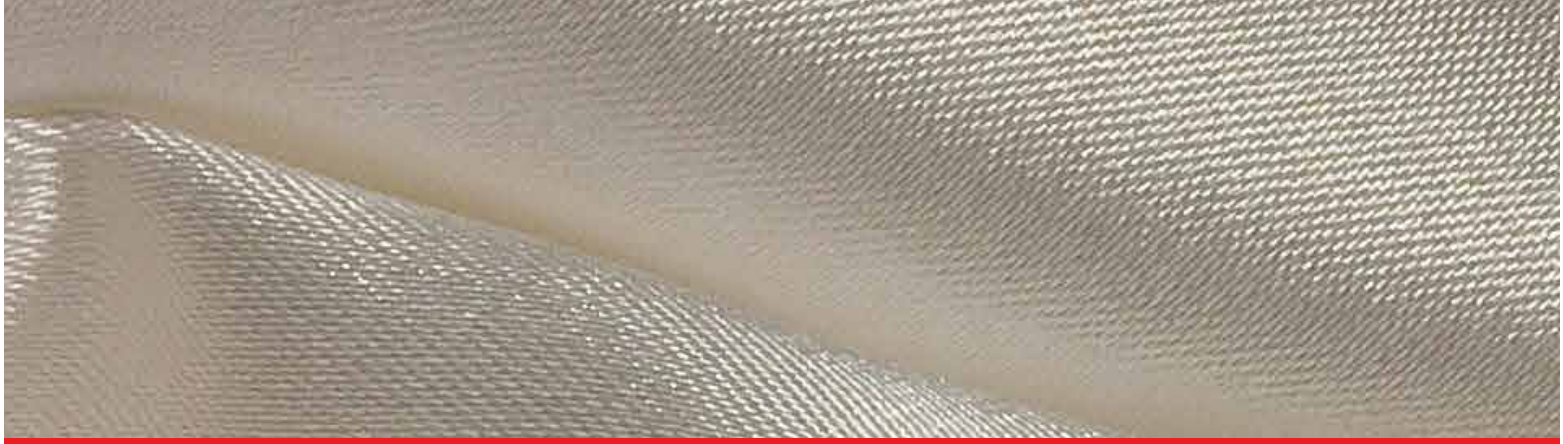

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Fashion is a lot more than providing an answer to primary needs. It is a way of communication, of distinction, of proclaiming a unique taste and expressing the belonging to a group. Sometimes to an exclusive group. Currently, the fashion industry is moving towards hyperspace, to a multidimensional world that is springing from the integration of smart textiles and wearable technologies. It is far beyond aesthetics. New properties of smart textiles let designers experiment with astonishing forms and expressions. There are also surprising contrasts and challenges: a new life for natural fibers, sustainable fabrics and dyeing techniques, rediscovered by eco-fashion, and "artificial apparel," made of wearable electronic components. How is this revolution affecting the strategies of the fashion industry?

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