Building **R**adio frequency **ID**entification for the **G**lobal **E**nvironment

Supply Chain Management in the European Textile industry

Problem analysis and expected EPC/RFID benefits

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About the BRIDGE Project:

BRIDGE (**B**uilding **R**adio frequency **ID**entification for the **G**lobal **E**nvironment) is a 13 million Euro RFID project running over 3 years and partly funded (€7.5 million) by the European Union. The objective of the BRIDGE project is to research, develop and implement tools to enable the deployment of EPCglobal applications in Europe. Thirty interdisciplinary partners from 12 countries (Europe and Asia) are working together on : Hardware development, Serial Look-up Service, Serial-Level Supply Chain Control, Security; Anti-counterfeiting, Drug Pedigree, Supply Chain Management, Manufacturing Process, Reusable Asset Management, Products in Service, Item Level Tagging for non-food items as well as Dissemination tools, Education material and Policy recommendations.

For more information on the BRIDGE project: www.bridge-project.eu

This document:
Supply Chain Management in the European Textile Industry is one of the areas addressed as a dedicated work package within the BRIDGE project. The objective is to compile a comprehensive overview of challenges in the supply chain which can be solved through EPC/RFID. To this end, the supply chain is analysed to identify potential benefits, define requirements for EPC/RFID applications and carry out a business case calculation. These analytical studies will also be based on the results of an empirical study (pilot), underpinning the research as part of this work package.

This document comprises the first of a total of five tasks addressed by the work package. It analyses the challenges and problems in logistic supply chain processes in the European clothing sector, which could be solved or improved by implementing radio frequency identification (RFID) on the basis of the Electronic Product Code (EPC).

Disclaimer:

This document results from work being done in the framework of the BRIDGE project. It does not represent an official deliverable formally approved by the European Commission.

Index

Abbreviations:

DSD   Direct store delivery

EAS   Electronic article surveillance

EPC   Electronic product code

NOS   Never out of stock

OOS   Out of stock

OSA   On shelf availability

POS   Point of Sale

RFID   Radio frequency identification

ROI   Return of investment

WP   Work package

List of figures:

List of tables:

1. Introduction

Over the last 15 – 20 years, the clothing sector has been in a state of continuous restructuring. A combination of technological and socio-economic changes, production costs, liberalization, and the emergence of important international competitors from Asia and the Mediterranean region are influencing the European clothing manufacturing.[1] Clothing companies are facing increasing competition and cost pressures. Hence efficient supply chain logistics seem to be an important key factor for retailers to survive in this high competitive market.

The clothing sector is especially confronted with challenges and problems in logistic processes and needs to find solutions for improvements. Radio frequency identification (RFID) may play an important role in the future to reform and optimise logistic processes in the supply chain. In addition RFID and the Electronic Product Code (EPC) may be the technology to generate an even broader range of applications than identified today.

In this analysis, weaknesses in the logistic supply chain of the clothing industry are outlined. Besides focusing on well-known challenges in logistics, such as "out of stock" (OOS) situations, shrinkage, counterfeiting, parallel trade and management of the flow of physical goods as well as information, this report also describes innovative possibilities and application areas for EPC/RFID.

The key findings of this document will be further studied in task 7.2: Requirements analysis. An evaluation with a return on investment (ROI) analysis will be executed in task 7.3: Business case. In parallel an empirical study will be conducted in task 7.4 at a Kaufhof department store to research various RFID applications.

1.1   Scope

This document focuses on clothing supply chain processes, which were analysed in collaboration with the companies participating in the BRIDGE project. Due to the complexity of the clothing supply chain the following assumptions were made to restrict the view regarding our objectives and focuses:

- Textile sectors such as home textiles, technical textiles as well as the fibre manufacturing and their logistics are excluded.

- The supply chain processes were analysed from the manufacturer's sourcing logistics at the clothing manufacturer to the sales floor including intermediate logistics operators and point of sale (POS).

- The processes described are generic and based on selected distribution channels. Distribution channels such as e-commerce and mail order are excluded.

- Unfinished goods, work wear, accessories, and shoes were not considered.

- Different sourcing countries and procurement channels may affect processes along the supply chain, which are not explicitly outlined.

1.2   Objective of the Problem Analysis

This study was undertaken to analyse the clothing supply chain and identify challenges and problems. The study attempts to:

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[1] European Commission (2006)

- Describe the market of clothing in Europe.

- Identify processes along the supply chain and highlight potential weaknesses and problems.

- Evaluate the consequences and effects of the identified process related weak points.

- Identify the expected EPC/RFID opportunities in process steps along the supply chain, which can be achieved through item level tagging.

- Estimate the consequences and research potential additional EPC/RFID applications and customer benefits, which can be achieved through EPC/RFID.

- Provide a supply chain process model based on the participating WP end users, that identifies single process steps and in this connection potential weak points and expected EPC/RFID opportunities for relevant processes.

1.3   Working Approach

For the identification of weaknesses and challenges in the clothing supply chain, the following approach was taken:
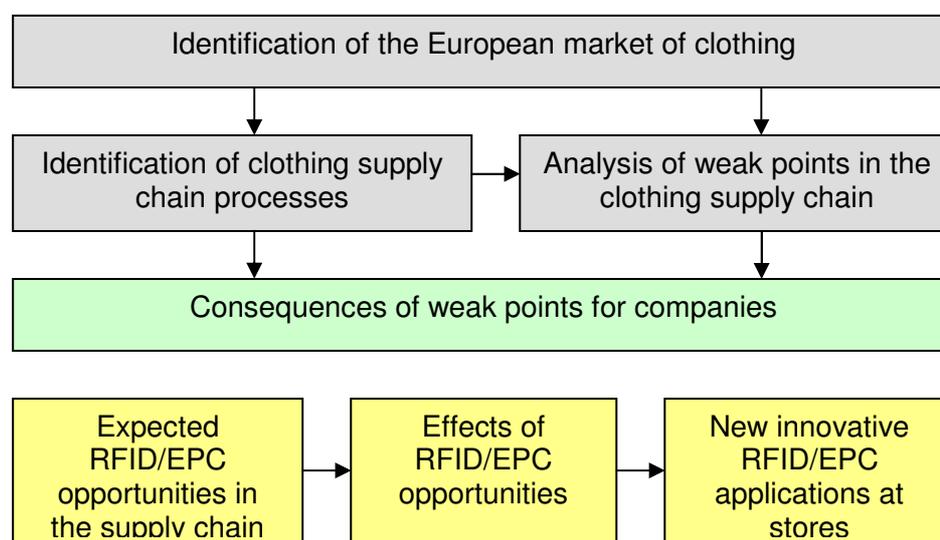
Figure 1: Working approach

First the European clothing market is analysed in Chapter 2 to identify the market situation and their challenges. In Chapter 3 the logistic supply chain was identified and arising weaknesses and problems in different process steps were outlined. The consequences of these weak points were studied at a next step.

In Chapter 4 the expected EPC/RFID opportunities and the related effects were analysed and innovative EPC/RFID applications at stores were discussed. In Chapter 5 a process model will illustrate individual process steps, weak points, and expected EPC/RFID opportunities, which are based on experiences and knowledge of three textile companies and a hyper- and supermarket participating in the BRIDGE project. Chapter 6 concludes the findings achieved in the report.

2. The European Market of Clothing

In this section, the market for clothing in Europe will be defined. Trends in this industry such as clothing consumption, procurement channels, and different types of business models will be outlined to provide a general overview of the current market situation.

Excursus: Market structure in the European clothing sector

The European textile and clothing sector accounts for approximately 4% of the total EU manufacturing production and accomplished a turnover of about 200 Billion Euros in 2005.[2] The clothing sector accounts for 42% of this turnover.[3] The increase of 15% in clothing imports from 46.53 Billion Euros in 2002 to 53.53 Billion Euros in 2005 underlines a trend of sourcing abroad. In comparison, European exports decreased by 0.6% to 14.72 Billion Euros. China is by far the biggest supplier and has nearly doubled the imports of clothing to Europe since 2002. Second place is taken by Turkey. Clothing is mainly sourced in Asia, Eastern Europe and the Mediterranean region (see figure 1)[4].

	China	Turkey	Romania	Bangladesh	India	Tunisia	Morocco	Hong Kong	Indonesia	Bulgaria
2002	9'333	6'925	3'757	2'744	2'322	2'908	2'612	2'345	1'476	897
2005	16'855	7'993	3'602	3'530	3'233	2'455	2'252	1'703	1'196	1'091

Country

Source: Eurostat
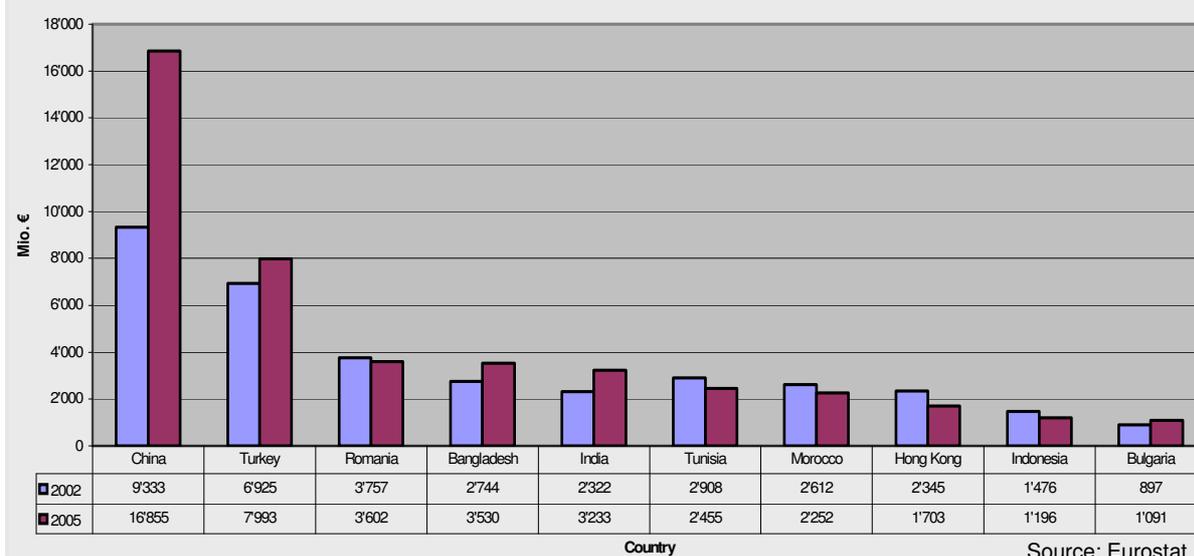
Figure 2: Development of the EU 25 imports of the Top 10 supplying countries in clothing

However this European view only shows accumulated import figures, which may represent the market situation of most countries. The significant differences in import levels of the single European Member States also have to be considered. For instance, Italy and Portugal have still relatively low import rates coming from outside the Union. In these countries clothing manufacturing is considerably high. In comparison, the Netherlands, Sweden and Denmark have an import rate of around 90%.[5]

Due to the increase of global sourcing in the clothing sector, production outputs, turnovers, and employment are decreasing in the Union. In 2005, the number of manufacturing companies declined by 5% to 102.421 companies, which produced 8.4% less output.[6] At the same time the turnover of European clothing companies declined from 73.2 Billion Euros (2004) to 71.5 Billion Euros in 2005, though only about 2.3%.[7] Considering the last five years, the manufacturing output decreased by more than 33% in the European Union. Only Estonia (+6.8%), Lithuania (+3%), and Slovakia (+20.9%) increased their output.[8] As a

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[2] Marchi, F. Euratex (2006)
[3] Marchi, F., Euratex (2006)
[4] Eurostat (2006)
[5] Bedeschi, A. (2005): AEDT
[6] Marchi, F. Euratex (2006):
[7] Euratex (2006)
[8] Adinolfi, R., Euratex on Eurostat data (2006)

consequence, the decrease of 6.7% to a total number of 1.03 Mio. jobs in the clothing employment sector in 2005 is not surprising.[9]

The poor market situation of the clothing industry does not affect each country in the same way, as the importance in the Union varies significantly. Around 80% of the turnover is generated by the five leading clothing manufacturing countries Italy, France, Germany, Spain, and UK.[10] Italy is by far the largest manufacturer of clothing with a production of 24.7 Billion Euros amounting about 34% of the European clothing turnover.[11]

The market situation in the European retail industry can account for a 3% increase (in volume) in retail sales in 2005.[12] Thus the sector has to handle emerging new distribution channels, decreasing consumer prices[13], and socio-economic developments, which affect consumer behaviour and forces companies to adapt their business models. Such changes are likely to continue in the near future. Especially for the retail industry the following three main developments have a strong impact on the supply chain processes and business strategies and will therefore be described further.

     2.1 Clothing Consumption in Europe

     2.2 Procurement channels in the clothing sector

     2.3 Retail structure in the clothing sector

2.1   Clothing consumption in Europe

European consumption is considered to be a key factor for the development in the retail industry. The decrease of private household expenditures for clothing and shoes from 9.7% in 1970 to 6.0% in 2004 and the associated decline in the price level has led to a higher price pressure and competition on the market.[14] Socio-economic changes and shifting demographic structures are also influencing the clothing consumption in Europe. Some important aspects are:

− Increasing rate of women in full employment, smaller families, and later parenthood.

− Different purchasing behaviour across the countries, which can be attributed to the peculiarities of culture, nationalities, demographic changes, and age.

− Different tastes and preferences for clothing in relationship to fashion and price in the European market.

As a result, the clothing distribution is still mainly covered by national or regional actors. Very few clothing companies generate a turnover of more than 30% outside their national borders. Altogether these companies only represent one fifth to one fourth of EU turnover, though the share is increasing.[15]

Besides these socio-economic changes the consumer behaviour is also changing. Consumers are better informed through internet and travels. They are more critical and expect more and better service and shopping experiences. An increasing number of consumers tend to trade off quality and exclusivity to the benefit of "value for money" and "hot" fashion.[16] For Europeans it is a pleasure to get dressed.

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[9] Adinolfi, R., Euratex on Eurostat data (2006)
[10] Bedeschi, A., AEDT (2005)
[11] Adinolfi, R., Euratex (2006)
[12] Marchi, F., Euratex (2006)
[13] In 2005 the consumer price index for clothing declined 1.1% (see Marchi, F, Euratex, 2006)
[14] European Commission & Eurostat (2002); The data capture considered changes in the EU partnership during that time.
[15] Bedeschi, A., AEDT (2005)
[16] Bedeschi, A., AEDT (2005)

2.1.1. Procurement channels in the clothing retail sector

The search for lower prices

Globalisation and increasing trade flows have influenced the procurement channels in the European clothing industry. On the one hand, more and more clothing is produced outside Europe at a low price due to lower manpower costs. On the other hand, emerging e-commerce and hyper- and supermarkets on the demand side are pushing down the prices through more competition. Retailers are forced to push down the entry-price point through a reduction in transaction costs and shorter and more efficient lead times along the value chain. The increase of direct procurement instead of having many offices and agents in different countries is one of the most important solutions to reduce these costs and permit an improved transparency of the supply chain.[17]

Retailers make use of three different supply methods, which play varying importance in regard to different distribution channels:

- Manufacturing their own products: The clothing is produced in factories owned by the retailers themselves.

- Sub-contracting: Retailers forward designs and cuts to contracting manufacturers to produce the clothing on the retailers´ behalf.

- Finished product purchase: Finished products designed and produced by manufacturers will be purchased directly at the manufacturer or through wholesalers or buying syndicates.[18]

Furthermore the supply strategy can be distinguished in "push" and "pull" logistics. When applying the pull strategy, clothing is ordered by retail stores to replenish garments or order new collections based on the individual demand of the store. The "push" strategy applies mostly to vertical integrated companies that have the overall management and responsibility of the supply chain. These companies usually "push" collections from the distribution center (or manufacturer) directly to the stores without an existing order. Which strategy is used by a company is mainly dependent on the business models (see Chapter 2.1.2) and the kind of fashion such as basic fashion or fast fashion.

More flexibility in buying

Another trend can be seen in the increase in frequency and flexibility in buying. In general, retailers have moved away from two traditional collections/buying seasons to as many as twelve or more collections per year, resulting in an increasing number of purchase orders. The 'non-replenishment' approach (in which a garment is not re-replenished when out of stock) and introduction of mid-season orders of some retailers illustrate a trend towards more frequent, smaller batches, and more flexible orders.

Specialised chains like Zara, Esprit, and Mango successfully apply these approaches in their business models and are rapidly gaining market share.[19] Their company strategies consist of short lead times, avoiding warehousing costs, and continuously renewing their collections rather than replenishing stock. A combination of local procurement as well as imports has enabled them to reduce delivery times to 48 hours. (In comparison, the delivery from Asia takes up to 90 days).[20] This strategy enables them to offer very fashionable clothing.

In response to this changing procurement habits, European manufacturing companies have also undergone a process of restructuring. They have built up competitive advantages such as higher flexibility, shorter lead times, quality and design, higher productivity, and

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[17] KPMG (2005), page 26
[18] Bedeschi, A., AEDT (2005)
[19] Baden (2002), page 63
[20] Baden (2002), page 78

innovation.[21] As a consequence, production often remains in Europe for upper-end market products and very fashionable clothing. It is anticipated that the European procurement continues for:

- Products requiring high technology or labour skills.

- Replenishment orders requiring a very rapid turnover of merchandise.

- Selected fashion items of very high quality.

- Products with a high focus on national identity due to consumer preferences or branding.

2.1.2. Business models in the clothing sector

More competition, changing procurement channels, and consumer behaviour have affected the business models of companies. In Europe there are six main types of business models[22]:

- Independent multi-brand stores,
- Specialised (vertical integrated) chains,
- Department stores,
- Hyper- and supermarkets,
- Traditional manufacturers and
- Other distribution channels.

The main characteristics of these models are described below. A more accumulated table outlining the main features of selected company models is attached in the appendix.

1. Independent multi-brand stores

Independent multi-brand stores can be described as "stand alone" retailers who may have very diverse assortment strategies because they cover the whole range of quality and price and vary in the degree of specialisation in clothing.

These stores predominantly purchase from favoured suppliers such as agents, buying syndicates, and agencies on the wholesale market. Hence clothing is "pulled" by the retailer to the store.

Typical for this business model is that it is impossible to influence the design, cut, and branding. Compared to other business models, the lead times are comparatively long and may account for about 6 month or sometimes even longer. Multi-brand stores do not have private labels since they do neither own production facilities nor cooperate with subcontract-manufacturers. This distribution channel is dominated by SME´s, which will not have very extensive supply chain processes.

2. Specialised Chains

Specialised chains sell their own branded production, which is produced by contracted manufacturers or their own manufacturing sites. Clothing is offered under private or brand labels.

Time is a key component of these vertically integrated companies. The elimination of wholesalers and agents reduces the time from design to shop to about three months, enables an improved transparency of the supply chain, and lowers costs. The understanding of clothing trends and fast creation of collections are essential advantages of this business model. The limited availability of clothing through the non-replenishment approach also

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[21] European Commission (2005)
[22] The business model descriptions are based on interviews and questionnaires with European companies.

affects buying behaviours: customer visits increase because of continuously changing collections and their limited availability in the stores.[23]

These vertically integrated chains can be split in the following three categories depending on their business strategies:

a) Private Label

European players like **H&M, C&A**, and **Zara** are common private label chains, which may also be called "fast fashion companies". Their focus is to reduce lead times to a minimum, avoid warehousing costs, and continuously renew their collections rather than replenish stock. These strategies enable them to offer very fashionable clothing at low to average prices and quality. They have the responsibility of design and cut, which are forwarded and then produced at their own production facilities or by subcontractors. The distribution of garments to the stores will be carried out daily or every two days through distribution centres. Their marketing approach is predominantly focused on the company as a "brand" rather than the "brand of clothing".

b) Mono Brand fashion

Mono brand fashion companies like **Benetton, Esprit,** and **Lacoste** have established brand labels from average to very high quality and price level in the market. Similarities with the private label approaches in their supply chain processes can be found. Especially the average priced brand fashion companies are also considerably flexible regarding the number of collections, lead times, and replenishment strategies. They may differ due to a higher percentage of basic clothing and depth and breadth of a product line.

The complete responsibility of design, cut and, marketing activities for their brands is also characteristic. For very high-level fashion, which requires high technology and continuous quality on a very high level, sourcing may be done mainly in Europe.[24] In addition fewer collections and high costumer service characterize their business models.

c) Category killers

Another differentiation can be found in stores, which have specialised in selected product categories like the lingerie retailer **Palmers**. Characteristic for them is a considerably narrow but deep assortment. Their supply chain processes and approaches are similar to the other two specialized chains in most cases.

3. Department Stores

Department stores usually sell clothing as part of their assortment and have private branded collections as well as brand manufactured clothing in their range of clothing. Department stores like **Kaufhof** and **Galeries Lafayette** mainly work with contracted manufacturers and sub-contractors.[25] Exceptions include companies that may also have their own production companies such as **El Corte Inglés**.

Characteristic for them is a considerably wide range of assortments across all clothing categories for basic and fashionable clothing at different price and quality levels. Their lead times and logistic processes often will not be as efficient as vertically integrated chains due to the wide extent of assortments. However, fast fashion product categories may have similar processes compared to the vertically integrated companies.

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[23] KPMG (2005), page 18
[24] Baden, S. (2002)
[25] Department stores also offer "shops-in-shops". This model allows medium to high quality and price manufacturers to offer their apparel in a special area of the department store.

4. Hyper and supermarkets

Hyper and supermarkets like **Carrefour** and **Metro** usually offer specific product ranges such as kids wear or lingerie. They tend to offer more basic garments and "weekly promotional clothing". The supply method is mainly finished-product-purchasing for promotional clothing and sub-contracting for private label clothing. The fashion factor is relatively low and store deliveries are fewer compared to the specialised chain models.

Discounters like **Aldi** and **Lidl** only offer promotional clothing, which is not replenished. A trend to increase their assortments can be detected.[26]

5. Traditional manufacturers

Traditional manufacturers such as **Gardeur AG** usually stay competitive through specialization in a comparatively narrow product range, competitive prices, and high quality. Distribution is often carried out through department stores or independent multi-brand stores. But also a trend to enter the retail market is recognised. Examples for a successful penetration of the retail market are the specialised chains, which have their origin in clothing manufacturing.

6. Other distribution channels

Other distribution channels are factory outlets and mail order companies including sub-channels like catalogue, e-commerce (internet), and TV sales. A trend to develop "multi-channel companies" in these distribution channels can be recognised. Already specialised mail-order companies like **Otto** and **Quelle** tend to emerge also in the e-commerce market, which will gain more and more market share in future.[27]

2.1.3. Competition between different distribution channels

The selection of distribution channels varies with respect to the differences in consumer behaviour in European countries and were analysed by the "Institut français de la mode" in 2004 for the five leading clothing countries in Europe (Germany, UK, France, Spain and Italy). Table 2 lists the available figures.[28]

Excursus: The retail market in selected European countries

Italy

In Italy, the biggest clothing producer in Europe, the main distribution channels are independent multi-brand stores with more than 50% share of sales. This huge network of stores is facing high competition from specialised chains and hyper and supermarkets.

	Germany	France	Italy	Spain	UK
Independent multi-brand stores	24 %	14%	50%,	40%	n. a.
Specialised chains	27%	23%	n. a.	23%	30%
Department Stores	11%	5%	n. a.	15% *	26%
Hyper and supermarkets	17%	15%	n. a.	7%	n. a.
Others	13%	8%	n. a.	n. a.	n. a.

*El Corte Inglés   Source: La Mode

Table 1: Distribution channels in selected European countries

Spain

Also a high share of independent stores (40%) can be found in Spain with a tendency to decline for the advantage of specialised stores, which account for 23% of sales. The department store El Corte Inglés takes 15% of sales, followed by less important hyper- and supermarkets with 7%.

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[26] KPMG (2005), page 35
[27] Intersélection (2005)
[28] Institut français de la mode (2005)

France
In France, specialised chains account for 23% with an increasing tendency, whereas department stores (5%), hyper- and supermarkets (16%), independent stores (14%), and mail order (8%) tend to decrease (figures from 2005).[29]

UK
The UK clothing retail market is dominated with 30% by specialised chains followed by department stores with 26% (among them Marks & Spencer´s with 12% of market share). Discounters, however, (e.g., Matalan, Primark) as well as hyper- and supermarkets (e.g., Asda, Tesco) profit from an increasing market share.

Germany
Germany has a more diverse market structure. Specialised chains are leading the market with 27% with the tendency to increase, whereas the share of independent stores (24%) is declining. With 17% in sales for hyper- and supermarkets (including discounters such as Aldi and Lidl) and 13% in sales for mail order (e.g., Otto, Quelle), these two distribution channels are playing a considerable role in Germany. Department stores only account for about 11% in sales.

A different development in the share and importance of distribution channels in Europe can be noticed. Nevertheless, an acceleration of retail concentration can be recognised lately everywhere in Europe. The foreseeable consequence of this trend is the increasing difficulty for independent retailers to compete with large retail chains. An overall decrease of independent stores in most European countries is therefore not surprising. Less efficient sourcing logistics and multi-brand strategies may not be profitable enough in future.[30] Hyper- and supermarkets as well as discounters maintain their market position and are even able to increase their share in some countries.[31] The overall market structure will be increasingly polarized by fast- and high-level fashion, basic clothing and low-priced/discount clothing.

2.2 Conclusion

The retail market is confronted with a changing environment:

- More and more retailers adopt or expand the emerging non-replenishment approach.
- More competition exists through emerging distribution channels like e-commerce, factory outlets, and discounters.
- Cost pressure is caused by declining prices and emerging distribution channels.
- Costumers are better informed and expect more service.
- The diverse buying behaviours in the Union require different business models.

In view of these changes, retailers have to adapt their business models. They have to

- increase imports from low cost countries, especially global procurement for basic and low cost fashion.
- offer more collections in a year to satisfy customer demands and expectations.
- decrease the product life cycle of clothing and increase the number of collections.

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[29] TnS Word panel (2006)
[30] KPMG (2005)
[31] Bedeschi, A., AEDT (2002)

  − improve logistic processes to be more flexible as these collections are usually produced in smaller batch sizes.

Companies have the constant necessity to build new applications and strategies to generate value to their clients and differentiate from their competitors. The high-priority objectives are the reduction of costs, increase of sales, and the improvement of customer service. An efficient use of new technologies, and especially EPC/RFID, should allow the textile sector to reach these three main objectives. Thus logistics are playing a key role in this sector.

3. The clothing supply chain and its weak points

The supply chain of the clothing sector has very distinctive processes. As described in Chapter 2, different supply methods, push and pull logistics as well as the non replenishment approaches especially for the fast fashion sector are affecting processes in the supply chain. In addition, the depth and range of assortments such as different sizes, colours, and cuts of a collection requires very efficient and optimised logistics. Furthermore time efficiency is one of the key factors for this industry to provide a competitive advantage.

For a better understanding, the forward and return process flows will first described and then analysed regarding weak points along the supply chain. The objective of this analysis is to detect potential weaknesses.

3.1 Weak points in forward supply chain logistics

The general forward logistics of a clothing supply chain was analysed in terms of weaknesses starting at the manufacturers outgoing/preparation area to the end consumer. Figure 2 shows the main flows of the clothing supply chain. Individual process steps are visualized in table 2 of Chapter 5 based on the input provided by three textile companies and a hyper and supermarket, which are working in the BRIDGE project. Below the process flow with its weak points is described in detail:
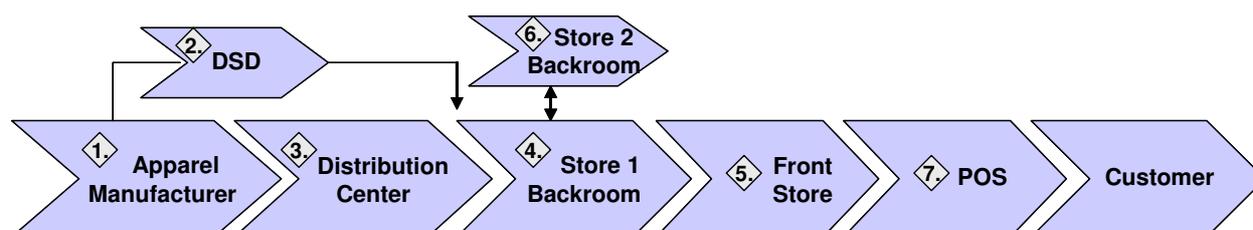
Figure 3: Forward logistics in the clothing supply chain

1. From the clothing manufacturer to the distribution center

At the outgoing and preparation area of a clothing manufacturer the delivery will be prepared to meet the purchase order of a retailer. Mixed transport units will be picked and compiled according to the supply order. At the next step the transport unit will be labelled and after the printing of the delivery note the truck will be loaded at the dock doors for the dispatch to the distribution center. Processes such as reconditioning and storage may apply, but will be considered at the distribution center, as the processes will be similar.

2. Direct store delivery (DSD)

At the outgoing and preparation area of a clothing manufacturer the delivery will be prepared to meet the purchase order of a retail shop. Garments will be picked from storage, compiled to a transport unit, labelled and finally shipped with the printed shipping documents.

The weak points at the manufacturer:

In the manufacturers' storage area processes usually are very efficient. The challenge is to ensure the accurate configuration of transport units for either retail stores or distribution centers in time.

- The manufacturer usually gets little information regarding sales and store availabilities of the garments. Hence the forecast quality is often not very reliable. In many cases electronic data interchange (EDI) is used between manufacturer and retailer/distribution center to guarantee the information flow. Nevertheless the time delayed transmission of sales and inventory reports typically cause problems to the manufacturer to identify the exact store inventory. Especially for never out of stock (NOS) items this will cause problems.

- For direct store deliveries (DSD) the picking processes require a lot of time. It is usually labour intensive work as the mixed transport units have to be collected from the storage area. In addition, errors may occur during picking processes and the updating of inventory management systems. The depth and range of a product line also have to be considered. For instance a high number of different sizes and colours does require higher process optimisation than a limited product line.

- Further reasons for inaccurate inventory can be shrinkage, theft, and wrong pickings.

3. Distribution Center

Distribution centers are the foundation of a retailing network. They could be run by manufacturers, retailers or service providers. Each center usually supplies a number of stores. The principal task of a distribution center is the reception of large quantities of garments and to ship small quantities to individual stores. This avoids the time-consuming processes of garment receptions from multiple suppliers at individual stores. A second point is the storage of garments to guarantee the timely replenishment of the retail shops. The process flow may vary after the reception of the transport units and the quantity control. Further functions such as reconditioning processes, cross docking, and storage can apply.

a)   Receiving area
At the receiving area all incoming goods are unloaded and the quantity will be checked and verified before the goods will be transported to further processing areas.

The weak points:

- The manual verification of deliveries requires time and may cause errors.

b)   Reconditioning processes:

At the reconditioning area, goods will be unpackaged and prepared for the store. Such processes are ironing, hanging up of items, and attaching price labels as well as security tags. They may also apply at the manufacturer site. Depending on the flow, the garments will be shipped to the storage area or to the cross docking area.

The weak points:

- The tracking and tracing of garments through the reconditioning processes is difficult to organise. Often a "black box" in data and physical process flows may exist, which makes it difficult to provide accurate information regarding the current location of garments.

- Due to the difficulties to locate garments, items may get lost. Also theft and shrinkage may occur. This will significantly slow down the lead times.

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c)   Cross Docking processes

Cross docking is a practice of unloading products from an incoming truck and loading these products in outbound trucks, with nearly no storage in between. In the clothing supply chain this may be done to sort clothing intended for multiple different stores, or to combine clothing from different origins for stores. A transport unit will be picked and compiled to meet a purchase order from a store. Finally the transport unit will be labelled and shipped to the outgoing area of the distribution center.

The weak points:

- As already described above, the verification as well as the picking and packaging processes for the consolidation of transport units may cause delays and errors.

- The high degree of labour-intensive and time-critical processes may cause bottlenecks in the whole operations.

- Unpredictable events such as late receptions may cause delays, which will affect the whole cross docking processes.

- Inaccurate data through misplaced items, shrinkage, and theft will lead to differences between data and physical process flows.

=> These problems can lead to wrong, late, inaccurate, and incomplete deliveries to retail stores.

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d)   Warehousing of clothing

One of the main functions of distribution centers is the storage of products until needed by the retail location. They ensure the replenishment of stores and may require unpackaging processes.

Regularly inventory controls shall ensure the availability of products. The picking of items and the consolidation of transport units is be done to meet the purchase orders of the destined shops and dispatched to the outgoing area.

The weak points:

- Regular inventory captures require time and labour and will increase storage costs. Still the inventory data will not be updated continuously. This forces companies to have higher storage amounts and costs to compensate discrepancies caused by theft, shrinkage, data errors, wrong storage, etc.

- Yet replenishment cannot be guaranteed when the demand of stores fluctuates significantly.

- Another important issue is the obsolescence of garments which may be detected too late. Through an increasing number of collections and higher stock turnovers, the non detection of obsolescent garments may cause depreciations.

- Further already mentioned weak points are: picking errors, delays, etc.

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e)   Outgoing area
At the outgoing area, transport units will be shipped to the multiple retail shops. The goods will either come from the cross docking area or the storage area. Usually the transport units are already compiled for dispatch and only the shipping documents will be printed before the truck is loaded.

The weak points:

- At the outgoing area, already aggregated transport units could be loaded in the wrong truck and shipped to a wrong destination.

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4. Retail store – back store

The back store of a retail shop has two main functions. The reception of clothing from distribution centers or manufacturers is the first function. Along with the unloading of the truck, the verification of delivered items is done. At a next step items will be selected for storage in the back store or for the display in the front store. The second function is the replenishment of the sales floor.

The weak points:

- − The verification of incoming deliveries requires time and labour.

- − If those deliveries are not accurate, additional time consuming processes such as identifying missing garments, placing additional purchase orders, or even returning wrong deliveries may occur. If delivery errors are not detected, there will be discrepancies between data and physical inventory.

- − Delays during previous processes at the manufacturer or distribution center will lead to out of stock (OOS) situations at the retail store. This will affect sales, when garments are not available.

- − Because of the continuous replenishment of the front store, the inventory of the back store cannot be exactly identified. Garments may be placed at the front store or the back store. Therefore the tracking and tracing of garments is not guaranteed.

- − High labour costs may apply for locating items in front and back stores. Additional regularly inventory controls have to be executed to achieve an overview of the items in the store.

5. Sales floor

At the sales floor the garments will be placed on shelves or rails. The main responsibility of sales staff is to provide customer service. The second duty is the already mentioned replenishment of items from the back store. Inventory checks on the sales floor and the replacement of misplaced garments to the original shelf or hanger are also part of the processes.

The weak points:

- − The searching and replenishment of items will bind service staff and therefore lead to less time for customer service because of additional handlings.

- − Due to the time consuming processes on the sales floor, more staff is needed to provide service, accurate item availability and correct inventory.

- − Theft and shrinkage on the sales floor will lead to inaccurate inventory data. Regular inventory controls are also essential on the sales floor.

- − The retailer does not get any information about item movements on the sales floor. Helpful information, why a customer does not buy selected items are not detected (e.g., tracking items from fitting room to shelf).

- − Customers are not able to check the availability of items by themselves. If the sales staff is busy with store operations, potential sales might be lost.

6. Store-to-store transfers

Store-to-store transfers occur when single shops have an oversupply which cannot be sold. Stores might also offer item transfers between shops according to the customers´ requests. After checking the availability, for example, by checking the computer system or calling a store, the garment will be picked in the back store or the front store, verified, packaged, and then dispatched to the outgoing area and finally to the shop.

The weak points:

- A multitude of additional manual processes such as locating, verifying, packaging and shipping processes are added to the already time-consuming store operation processes.

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7. Point of sale (POS)

At the point of sale, each garment has to be identified, for example, by scanning the barcode. The security tag is detached. After the paying process all items are put in a bag and handed over to the customer.

The weak points:

- Long queues at the point of sale often cause a great source of dissatisfaction for costumers. Although this usually happens only at the main shopping hours or before Christmas, this problem can be found in nearly all business models with shops.

- Furthermore, returns are usually not possible if the customer has lost or forgotten the receipt. In this case, the stores are not able to track, where the product was purchased.

3.2   Weak points in return logistics

Return logistics apply when

- customers return clothing because of complaints,

- companies start product recalls, or

- items could not be sold on the sales floor.

This clothing may be returned to the distribution center or to the manufacturer. Depending on quality and price the returned garments will either be pushed on the market through other distribution channels (such as factory outlets, low priced fashion retailers, or other stores) or destroyed. These processes are typically relatively time intensive, as they are labour-intensive processes, which usually do not provide much benefit and in many cases no benefit at all. The return flow will be described as well. The weaknesses may be similar compared to the forward processes and will therefore only be summarized. The following figure (3) shows a typical return process flow in the clothing sector.

Figure 4: Return logistics in the clothing supply chain

The individual process steps based on input provided from three textile companies and a hyper- and supermarket, which are working in this work package.

8. Costumer Returns in Store

Customer returns will be received by the staff at the point of sale (POS). The items will be identified by receipt and label, if it is still attached. The returned garments might be displayed again in the store after a quality check. In this case new labels and security tags must be attached. Garments that cannot be sold in the store will be returned to either the distribution center or the manufacturer.

9. Backstore

Garments dispatched to the distribution center or the manufacturer will be stored temporarily at the back store. After quantities are verified, security tags and labels will be detached and then the garments are shipped to their destination.

10. Distribution Center

At the distribution center the returned garments are identified and the quantity will be checked. When garments are faulty, they might temporarily be stored and then either returned to the manufacturer or put on the market through other distribution channels.

11. Manufacturer

The manufacturer verifies the items.

The weak points of reverse logistics

Reverse logistics usually cause costs that cannot be put against a return on investment. Therefore the process-related efforts amount for additional costs, which may not provide any benefit at all. Looking at the different areas of the process chain, problems can be identified in the store, at the distribution center, and finally at the manufacturer. As these processes can be compared to the already identified processes in forward logistics, the individual weak points will not be explained separately. The main problems are

- picking errors

- increase in manual operations

- insufficient transparency and related tracking and tracing problems

- discrepancies between physical flow and inventory management system

As a consequence, additional labour and time is required, which will cause costs and decrease productivity.

3.3   Possible consequences of weak points

The identified process-related weak points apply to all business models outlined in chapter 2.3 on a larger or lower scale. On the one hand logistic processes will be inefficient, which will affect costs and on the other hand the sales will be affected. As shown in figure 5, time-consuming processes, errors, and insufficient process transparency will cause inaccurate inventory and forecast quality, and higher time-to-market processes to name a few consequences. As a result, the costs will increase by more labour and storage costs, shrinkage, theft, depreciations of overstock, and also illicit trade.

Process impact:
- Time consuming processes and high work load
- Errors
- Discrepancies between physical flow and data flow
- Insufficient supply chain visibility and low traceability
=> Inaccurate inventory
=> Inaccurate forecast quality
=> High Time-to-market processes
=> Less productivity
=> OOS

Costs factors:
- Labour costs
- Less/low productivity
- Illicit trade
- Shrinkage
- Theft
- Storage costs/high safety stock
- depreciations (overstock) and obsolescence

Less sales:
- OOS
- Misplaced items
- Late replenishment
- Less customer service
- Counterfeiting

Difficult to measure impacts:
Less customer loyalty
Decreasing costumer satisfaction

Figure 5: Consequences of weaknesses in the supply chain

The various dependencies and intersections of the weak points make it difficult to identify the correlation of the overlapping processes. For a better understanding the consequences of the individual weak points are summarized:

1. Transparency of the supply chain
The transparency of the supply chain is often insufficient. The EU Directive 1081/2003 for non food products forces companies involved in the supply chain to record ingoing and outgoing merchandise or parts. Due to a weak automation of multiple clothing companies a registry often cannot be generated automatically. In addition, the management of a withdrawn product requires a very deep traceability with a high degree of granularity. Depending on the automation process, this problem is more or less significant for all business models.

Inadequate transparency can result in a series of reactions of further challenges such as out of stock (OOS) situations, late replenishment, and further labour for locating stock and items in stores and warehouses. Inaccurate inventory will cause higher stocks to guarantee replenishment processes. Furthermore shrinkage, theft, and illicit trade might not be detected or noticed too late. Also obsolescence and overstock will be realised late, which may cause

depreciations. The whole productivity will be affected and the final result will be higher costs and fewer sales through OOS situations and less customer service.

2. Out of stock situation (OOS)

An out-of-stock situation may occur when a product demand from a customer cannot be satisfied immediately. OOS situations may apply to nearly all business models such as specialized chains, independent multi-brand stores, or even hyper- and supermarkets. Exceptions may occur in the case of promotional sales, which are pushed to the stores and not replenished. The out of stock situation can be explained by many reasons. The most common reasons are:

- – errors in the demand forecast,

- – delays and errors in the dispatch or reception of products,

- – unexpected demand,

- – discrepancies between physical and data related inventory.

- – Illicit trade and

- – lack of on shelf availability, even if it is available in the back room or in another place of the store (for example, wrong shelf or left items in a fitting room).

3. Operational efficiency

The exact verification of deliveries does require manual quantity controls, for instance by reading each barcode manually to update the inventory system. These are time-consuming and labour-intensive processes. Furthermore regular manual inventory controls are necessary because discrepancies always exist on a higher or lower scale. In the supply chain, manual verifications appear at multiple points: at the reception, during storing and picking processes in warehouses, when items are shipped, etc.

4. Shrinkage
Shrinkage is mainly due to external and internal theft, or shipments of products to an incorrect destination. It does apply to all business models on a varying degree of importance. The degree of shrinkage is influenced by factors such as the automation degree, process optimisation, and workforce culture.

5. Management of obsolescence and depreciations
In the clothing sector, most products have a limited commercial life cycle. Because of the high rotation of merchandise, obsolescent goods may not be detected due to a non-existing or inefficient inventory management in the retail store or warehouse. Necessary measures such as price reductions to prevent this obsolescence may not be conducted in time. The obsolescence can be found for instance at department stores, private label fashion, and also brand fashion.

6. Illicit trade

Illicit trade consists of merchandise sales – generally by third parties – at points of sales different than planned by the manufacturer. It could happen that products are turned aside towards markets with higher prices. This deviation reduces the product availability, the market quota and, in some cases, generates the impossibility to manage suitable post sale service, which results in a damaged image of the manufacturer. Illicit trade typically occurs in the high level brand fashion business model. The price margins are comparatively high in this area and therefore considerably profitable.

7. Counterfeiting

The counterfeiting of luxury goods and brand labels is widely spread nowadays. The consequences can vary from the simple loss of sales to greater risks regarding credibility and brand image.

8. Customer service

Time consuming store operations will affect customer service. The sales staff is often busy conducting store operations. On this account customers often have to wait and potential sales may get lost. Also OOS situations and insufficient product information will affect customer satisfaction. Customer loyalty may decrease and in the worst case may be completely lost.

In addition, most retail stores – regardless their business model – decline to manage a return or a change if the customer does not have the receipt of payment. The reason is that stores are not able to verify in which establishment and to what price the product has been acquired.

4. Expected EPC/RFID opportunities

Radio frequency identification is a technology that could provide more opportunities and application areas than other Auto-ID technologies. The main advantages are:

- The high reliability of the technology, also in extreme environmental conditions such as heat or cold.
- The non required line of sight between tag and reader.
- The possibility to read or write multiple tags at the same time (bulk readings).
- The increase of automation in data capture, which will lead to higher efficiency.[32]

RFID technology applied to the supply chain—at the manufacturer, at warehouses, and in stores—will reduce and in some cases eliminate a number of the problems frequently encountered in the clothing industry.

General statement

When considering EPC/RFID in supply chain processes, general aspects will impact the potential benefits for each supply chain player. Thus it is essential to account for the automation degree. A company can either have well automated processes with industry standards such as EDI and barcodes or a company is considerably low automated. In the first case, error rates may be comparatively low due to these automated processes. Also product ranges and push logistics should be considered, when evaluating EPC/RFID. In addition, the tagging level such as item or case level will affect the results of an EPC/RFID implementation.

Finally, important issues are possible changes in supply chain logistics, which may cause other processes. For instance the functionality of a tag may have to be checked before attaching it to items. This will cause additional time and labour costs. The emergence of new EPC/RFID related processes will depend on the company supply chain logistics. A universal assumption is therefore impossible to consider when talking about EPC/RFID opportunities.

4.1 The expected benefits: Less costs and more sales

The main objective of companies considering EPC/RFID is either to **reduce costs** along the supply chain or to **increase sales**. These two aspects are the main drivers for EPC/RFID. The objectives may be reached through optimising logistic processes along the value chain and gain a **higher-quality network of the supply chain**.

An increase of data and information accuracy will lead to better supply chain transparency and increased reliability. In shops this can lead to higher on shelf transparency through improved replenishment processes. An increase of an average purchase amount and the number of sales may be possible. "Soft benefits" such as higher customer satisfaction and customer loyalty obtained through better customer service may also cause higher sales.

On the cost side, the time saved for manual and further operational processes will increase the productivity and reduce labour. The increased transparency along the supply chain will reduce shrinkage, theft, and illicit trade. The better forecast quality will enable companies to reduce their safety stock and the related costs. Still they will maintain continuous replenishment.

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[32] GS1 Germany (2006)

In addition, EPC/RFID might provide further—not yet considered—benefits for the company and their partners along the supply chain.

All connected aspects are visualised in figure (4):
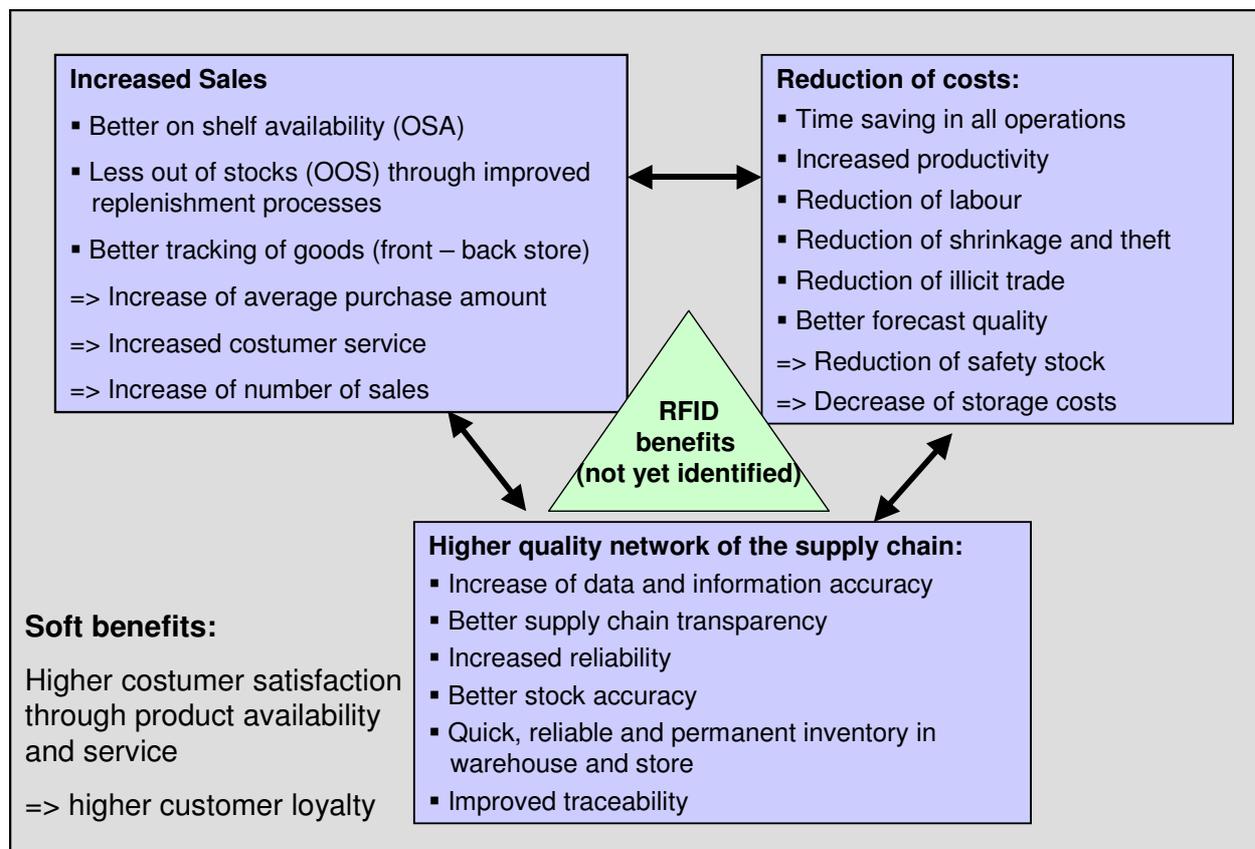
Figure 6: Expected RFD benefits

4.2   Taking advantage of the opportunities of using RFID

The expected opportunities deriving from EPC/RFID implementations will impact various processes in the supply chain. The individual process steps suitable for EPC/RFID applications were analysed by three textile companies and one hyper- and supermarket participating in the BRIDGE project and are listed in table 2 and 3 in Chapter 5. The focus at this stage will be the correlation of the overlapping effects in the supply chain due to EPC/RFID implementations and the related main opportunities, which are identified and described in more detail below:

1. Transparency of the supply chain

The transparency of the supply is one of the main evident opportunities of EPC/RFID. A better tracking and tracing of goods can be achieved when intersection points along the supply chain are equipped with readers such as storage areas or outgoing areas. The non necessity of line of sight and bulk readings of items will immediately detect errors in picking and packaging processes and lead to less discrepancies between physical inventory and data management. A quicker and much more reliable permanent inventory and the connected item localization will prevent unknown stock. This makes the management of information flow much more reliable and accurate.

Along with this wrong deliveries can be detected early while transport units pass read gates and directly detect errors before the truck is loaded. Furthermore the transparency of

contents in transport units guarantees the exact order fulfilment. For instance the lot numbers and production dates of single items along the whole supply chain can be tracked.

As a result the increased transparency will lead to a better forecasting, which will have a positive impact for all supply chain partners. Manufacturers could check the on-shelf availability at warehouses and stores and therefore better organize their productions. Automatic replenishment processes will benefit from the now reliable inventory data. The improved collaboration and information flow of partners will speed up time-to-market processes as the transparency of the supply chain detects bottlenecks quicker than today.

2. Lower out of stock situations (OOS)

OOS may occur along the whole process chain – at the manufacturer, the warehouse (third parties), and the store. EPC/RFID offers several alternatives to reduce these problems. One main part of the problem can be solved by the above described higher transparency of the whole supply chain such as delivery errors and better inventory accuracy. Lower safety stock is required, which will push down storage costs and still guarantees on-shelf availability (OSA) through punctual replenishment.

Especially at the store level, OOS seems to be one of the biggest challenges along the supply chain. Those EPC/RFID processes will be described in detail on page 29.

3. Operational efficiency improvement and manual task reduction

EPC/RFID can considerably reduce the manual operations by eliminating the necessity to read each single item. Bulk readings of EPC labels will save time and errors. Manual inventory controls and quantity verifications of deliveries are processes that will be redundant or decreased significantly in the future. This will lead to a reduction of labour while the work load decreases. Hence the less required time will achieve higher productivity and finally speed up time-to-market processes and save costs.

4. Management of obsolescence and depreciations

EPC/RFID will improve the management of obsolescence and depreciations by the improved inventory transparency. This can detect the necessity for tactical promotions to remove the product as quick as possible. Another possibility is the use of other distribution channels such as factory outlets to avoid obsolescence in time.

5. Shrinkage and Theft

The use of radio frequency labels for the prevention of theft is not new. Thus EPC/RFID can provide additional functionalities such as the detection of suspicious behaviours in a shop. Furthermore by using EPC/RFID the company has the opportunity to research at what time, where, and why shrinkage appears and will facilitate the identification of the weak points, where theft most frequently happens. This will lead to a reduction in shrinkage and also in a higher detection of employee theft.

6. Counterfeiting

The existence of an EPC label in the product is already a first barrier that makes counterfeiting difficult. Although counterfeiters might be able to equip an item with a label, the numeration scheme allows detecting false serial numbers, since there would be codes different from those generated by the original manufacturer. In addition, retailers will have a better control of the supply chain and could track individual items to the manufacturer.

7. Illicit trade

EPC/RFID provides increased real time transparency about the location of products in the distribution process, which allows identifying places and moments where the products are turned aside.

4.3 EPC/RFID applications at stores

Retail stores will benefit from optimised supply chain processes on the manufacturer's side and at the distribution center. The effects can be seen in correct store deliveries and connected with this also faster detection of wrong deliveries.

However the main EPC/RFID opportunities can be found in the retail store itself. At this point EPC/RFID especially provides potential benefits for internal store processes such as front and back store processes. On this account an empirical study on the sales floor will be conducted by Kaufhof and Gardeur. Various EPC/RFID applications will be researched and outlined in task 7.4 "Empirical study" of this BRIDGE project.

Improvement of store operations

OOS
Especially OOS caused by internal store operations seems to be a considerably big challenge in stores. With RFID readers at strategic points such as shelves, fitting rooms, POS, and at doors between back store and sales floor, garments can be located much faster and real time inventory will provide more transparency where and how much items are available in the front store. Misplaced items can be detected by shelf readers or handhelds. The increasing number of collections with variable product ranges such as sizes, cuts, and colours will be easier to handle as the available data represents real-time information. The typical "black box" of not knowing if an item is in front or back store can be solved.

Replenishment
Accurate inventory data will improve the replenishment processes and the management collection/assortment changes significantly. Readers may even be able to manage safety stocks by generating an alarm when the number of items on the shelf is below the safety stock. It is possible to grant the manufacturer real time access to stock level information and sales rates of a given product, thus being able to plan better the production and distribution activities. This can speed up time-to-market processes.

Shrinkage
With EPC/RFID emerging discrepancies in physical inventory and data management can be detected immediately. It is possible to identify, where items got lost at what time. For instance theft in front stores can be reduced by integrated anti-theft protections in the tags. Employee theft at back stores can also be decreased as each single item can be tracked through the whole front and back store. A reduction of shrinkage will be another effect.

EPC/RFID and costumer benefits

The changing consumer behaviour and socio-economic changes are influencing the expectations of consumers. A trend can be recognised that customers are basically looking for more product information. By adopting EPC/RFID, retailers could use additional information services at the POS. EPC/RFID-enabled information terminals on the sales floor could provide customers with detailed product information, prices, and additional information, for example, inventory information as well as cross- and up-selling information. This information could also include pictures, videos, downloads, and additional marketing

applications. The information could also be gathered with mobile devices like "near field communication" (NFC) cell phones. Information terminals could also be located at dressing room areas to enable customers to read tags and check if other sizes, colours, or styles are available in the store. Such applications could also include virtual catwalks, where customers could select items and test different combinations on virtual models.

Another opportunity is to install mobile devices that enables the user – sales staff or customer – to search for single items more quickly and easily. The EPC of the searched item must be fed into the mobile device and afterwards the whole store environment could be scanned to locate the item. An acoustic signal would indicate the searched item. An internal connection to the fileserver could provide additional storage and product information. Due to the more reliable database the service provided by sales staff will be more reliable and better.

All these applications will serve the customer to get faster additional information. It might increase the level of information and support the customers purchasing decision. The self-service opportunity to use these devices could affect the shopping experience as well. Customers could act more independently to get information.

1. Optimised product availability
Smart-shelf and intelligent rail systems will indicate which sizes are on shelf/rail. Item searching will be more convenient for the customer. An easy item searching application as described above will lead to better costumer satisfaction. Experiences that "desired items are always at the right place" will be reality.

The improved product availability could lead to more shopping convenience and costumer satisfaction.

2. Short wait times
The cashing process will be speeded up as not every single label has to be scanned separately. With EPC/RFID the desired items could be read in bulk and the EPC will be directly transmitted to the cash system. In combination with EAS, the time consuming detaching processes will be made obsolete.

3. Cashing processes at the point of sale
EPC labels can reduce the required time for cashing processes significantly. Thus long queues in front of the POS can be avoided. In addition, this technology enables self check outs in the future. In this case customer may have the opportunity to read the EPC label and pay the item at "cash terminals", which can already be found in supermarkets today – only with the barcode technology.

4. Comfortable after sales service
EPC/RFID will help to improve after sales services and make them much more comfortable for the customer. Customer returns, complaints, and warranty services can be done without the today's required paper receipt. EPC/RFID technology allows improving the management of returns. The complete item history can be recovered. This covers information when and where the item was sold, at what price, and which mode of payment was used. Therefore a customer return will be possible even without a receipt. A unique and quick identification of the returned items will reduce the waiting times and improve the customer service significantly.

This same functionality can be used to manage claims in guarantee, without the necessity for the customer to contribute a certificate.

5. Origin controls
The customer could independently check the product authentincy at RFID enabled information terminals. A reader scans the EPC label and via web services the customer will be able to check the supplier's product database. The opportunity to check product

authenticity could increase the customer's confidence in the product and the store. For the customer himself the check is quick and convenient.

With additional services such as track and trace functions the customer has access to a secure traceability function. This will provide customers with a new level of reliability, confidence and trust for products and retail stores.

5. A market view: A general process model with weak points and EPC/RFID opportunities

Three textile companies and a hyper- and supermarket working in the BRIDGE project, have verified the following process model as it applies to their own businesses. Their whole process chains were analysed to identify **their current weak points** at different supply chain levels and precisely individual process steps. Also **possible EPC/RFID applications** were taken into consideration. The detailed description of the process-related weak points, their consequences, and EPC/RFID opportunities are outlined in chapter 3 and 4.

The processes described are generic processes. Different processes for hanging and lying garments and different levels of transport units occur, but are not explicitly described.

Forward logistics

The following figure 5 shows the view of the forward process flow starting at the manufacturers outgoing area to the POS and the customer. The numbering outlines the areas, which will be analysed more closely in table 2.
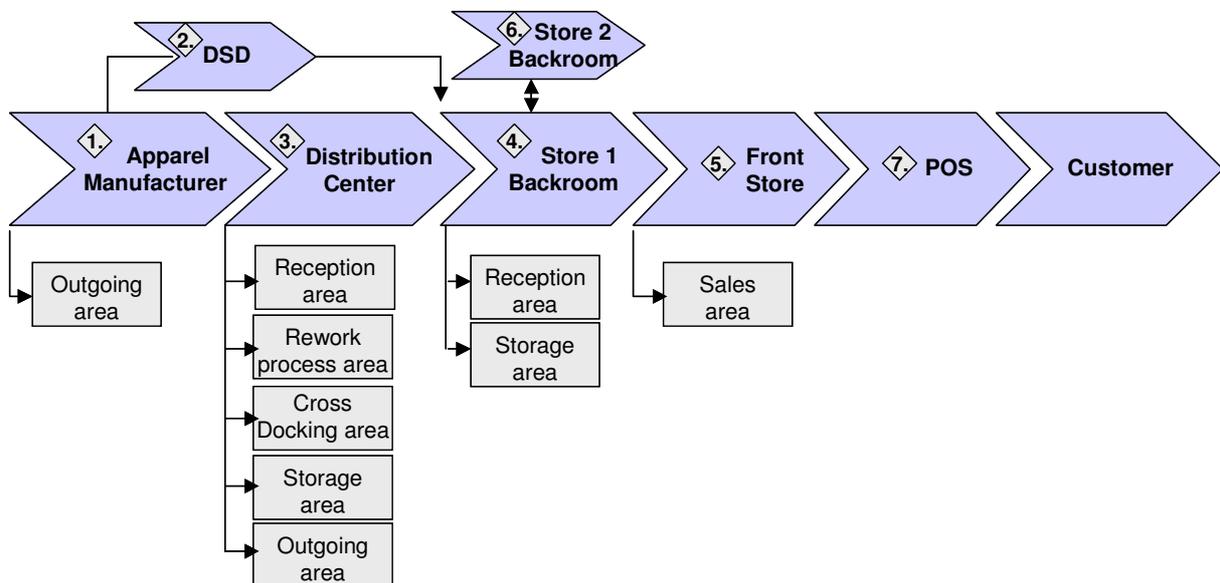
Figure 7: Forward process flow and main process areas

The following table 2 points out the weak points and the expected benefits at individual process steps along the supply chain. EPC/RFID benefits are expected to occur at the different areas along the supply chain. At this stage a quantitative analysis is not possible as impacts such as automation degrees, new RFID-related processes and implementation costs are not considered. A detailed analysis will be conducted in task 7.3 Business Case.

Forward logistics

	Step	Process	Pain points Description	RFID/EPC expected opportunities	possible new challenges
Manufacturing					
Preparation for DC	1.1	Labelling, attaching security tags* - finished items			functional check of tag
	1.2	Picking and packaging for transport	errors in picking, exception management searching items	Error detection in picking, better item tracking and localisation.	new error related processes
	1.3	Verification of transport unit	time consuming, labour intensive	visibility of content (of the transport unit)	
	1.4	Transport labelling (SSCC)			
	1.5	Print delivery note			
Outgoing area	1.6	Verification of the expedition			
	1.7	Loading truck and see 3.1	errors in loading and related longer lead	Errors detection in truck loading (warning systems).	new error related processes
or					
Direct Store Delivery	2.1	Labelling, attaching security tags* - finished items			
	2.2	Picking	lost time, picking errors	Labour, errors and time saving. Quality of raw data Error reduction in truck loading (warning systems). Better tracking and tracing (including employee theft) Automatic printing of delivery notes from the RFID massive tag reading.	
	2.3	Packaging for transport			
	2.4	Transport labelling			
	2.5	Print delivery note			
	2.6	Verification of the expedition.	errors		new processes
	2.7	Loading truck and see 4.1			
Warehousing					
Reception area	3.1	Unloading truck		Labour, errors and time saving. Quality of raw data Automatic goods registration and verification (earlier identification of wrong deliveries). Better tracking and tracing (including employee theft) stock.	
	3.2	partly quantity control	labour costs/ losing time	saving labour and time cost. 100% quantity check without additional costs.	
	3.3	Transport to finishing area of unfinished products or see 3.5			
Rework process area	3.4	Rework processes, e.g. ironing, dressmaking, washing			
	3.6	Transport stocking area (3.13) or Cross docking (3.7)	unit on wrong place	Errors and time saving. More control. Better internal tracking and tracing.	
	3.7	Quality control	no visibility	100% visibility	
	3.9	Storing preparation, e. g. repackaging (cases, hanging garments)	picking errors	Error detection in picking, better item tracking and localisation.	
Cross Docking area	3.10	Quality control			
	3.11	sorting the cartons to the destination area	wrong sorting	Labour, errors and time saving (earlier identification of wrong deliveries).	new error related processes
	3.12	Verification of the expedition (see 3.22)	wrong expedition contents	Labour, errors and time saving. Quality of raw data Error reduction in truck loading (warning systems). Better tracking and tracing (including employee theft) Automatic printing of delivery notes from the RFID massive tag reading.	
	3.13	Finalizing Transport unit	Sorting errors		
	3.14	Identification transport unit			
	3.15	Transport labelling			
Storage area	3.17	Transport to stock area			
	3.18	Inventory control	labour costs/ losing time	saving labour and time cost. 100% quantity check without additional costs	
	3.19	Picking	labour costs/ losing time	saving labour and time cost. 100% quantity check without additional costs earlier identification of wrong deliveries).	new error related processes

continues next page

Forward logistics (continued)

	Step	Process	Pain points Description	RFID/EPC expected opportunities	possible new challenges
	3.20	Packaging for transport.			
	3.21	Transport labelling (SSCC)			
	3.22	Print delivery note			
	3.23	transport outgoing area			
Outgoing area	3.24	Verification of the expedition.	wrong expedition contents	Labour, errors and time saving. Quality of raw data Reducing errors in truck loading (warning systems). Better tracking and tracing (including employee theft) Automatic printing of delivery notes from the RFID massive tag reading.	new error related processes
	3.25	Loading truck.			
Store					
Reception area backstore	4.1	Unloading truck	hidden picking mistakes, labour costs	Labour, errors and time savings.	
	4.2	Quantity control and verification	time, quantity errors	Automatic goods registration and verification (earlier identification of the wrong deliveries); 100% control.	
Storage area backstore	4.4	Item classification - front store or back store or other areas	no information about item location	more visibility of item location. Saving time by faster item finding (front or back store), tracking & tracing may detect theft by employees.	
	4.5	Transport to stock area or see 4.7			
	4.6	Inventory control	labour costs/ losing time, errors	saving labour and time cost. 100% quantity check without additional costs. Less OOS. More stock taking (with less errors).	
	4.7	selecting garments for sales floor	labour costs/ losing time, wrong selection	saving labour and time cost; accurate selection.	
	4.8	transport to sales floor			new related processes
Sales floor					
	5.1	placing garments and see 7.1	garment put onto wrong shelf	see 5.4	
	5.2	replenish garments (see 4.7, 4.8)			
	5.3	all kinds of Inventory control	labour costs/ losing time	saving labour and time cost. 100% quantity check without additional costs. Less OOS. More stock taking.	
	5.4	searching item (also backstore)	labour costs/ losing time	saving labour and time cost. More time for selling tasks.	
	5.5	replacing founded garments	searching for the right shelf	saving time and labour cost.	
Store to Store	6.1	Searching item	labour costs/ losing time	saving labour and time cost. More time for selling tasks.	
	6.2	Identification item	labour costs/ losing time	saving labour and time cost. More time for selling tasks.	
	6.3	Picking	labour costs/ losing time	saving labour and time cost. More time for selling tasks. 100% quantity check without additional costs. Less OOS. More stock taking.	new error related processes
	6.4	packaging garments			
	6.5	Transport to dock door			
	6.6	creating transport label			
	6.7	loading truck			
POS	7.1	reading label	Time to read label	saving time through reading labels simultaneously.	
	7.2	removing security tag	labour costs/ losing time	Labour and time savings (if EAS is integrated in RFID tag).	
	7.3	cashing process		Self check out (terminals).	
	7.4	putting items into bag			

* Labelling can be done at different areas

Table 2: Forward logistics – weak points and EPC/RFID opportunities

Return logistics

Figure 6 visualises the return process flow with the process areas, which are considered more closely. The numbering reflects the locations of processes outlined in table 3.
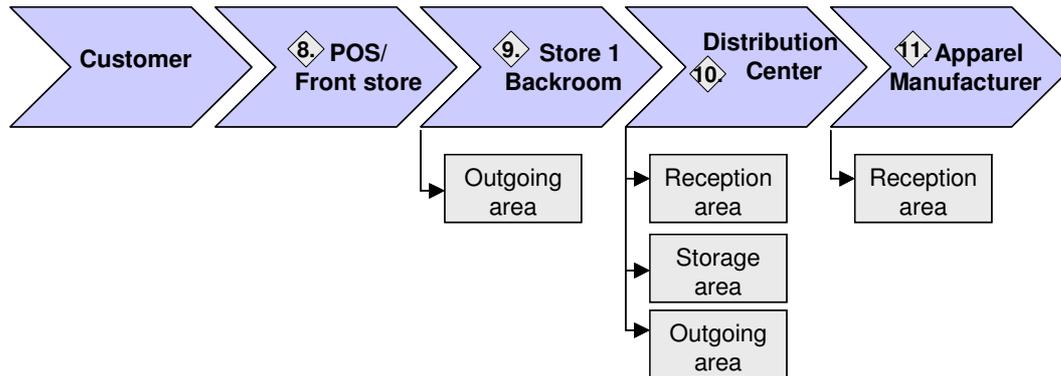

Figure 8: Return process flow and main process areas

Table 3 also illustrates the detailed return process flow with its main process steps and related weak points and EPC/RFID opportunities. A quantitative analysis is not conducted at this stage, but will be accomplished in task 7.3 Business Case.

Return logistics

	Step	Process	Pain points	RFID/EPC	possible new challenges
			Description	expected opportunities	
Store					
Sales floor	8.1	Customer returns: checking receipt and reading label	labour costs/ losing time, not return without a receipt	Custom comfort ability. Labour, errors and time savings.Serial item level identification enables return without receipt.	how to get the correct EPC, when tag is killed/removed?
	8.2	quality check			
	8.3	exchanging item or paying off			
		booking item into system			
	8.4	Attaching security tag and label, if for sale			
	8.5	placing in sales floor or backstore			register new stock
Backstore					
	9.1	Picking	Picking errors, losing time.	error saving. Less exception management Accurate stock. Faster item location.	
	9.2	Quantity verification of expedition			
	9.3	identification transport unit			
	9.4	transport to outgoing area			
	9.5	creating transport label/documents			
	9.6	loading truck			
Warehousing					
Reception area	10.1	Unloading truck			
	10.2	quantity and quality control	labour costs/ losing time/quantity errors	saving labour costs, saving time, better accuracy, 100% control without additional work.	
Storage area	10.3	Transport to storage area			
	10.4	Detaching security label and label			
	10.5	inventory check	labour costs/ losing time/quantity errors	saving labour costs, saving time, better accuracy, 100% control without additional work.	
	10.6	picking and packing	labour costs/ losing time	saving labour and time cost. More time for selling tasks. 100% quantity check without additional costs. Less OOS. More stock taking.	
	10.7	transport to outgoing area			
Outgoing area	10.8	labelling and print of transport documents			
	10.9	loading truck			
Manufacturing					
Reception area	11.1	unloading truck			
	11.2	quantity control	labour costs/ losing time/quantity errors	saving labour costs, saving time, better stock accuracy, 100% control without additional work.	
	11.3	quality check			
	11.4	transport to destination			

Table 3: Return Logistics – weak points and EPC/RFID opportunities

6. Conclusion

The European market situation of the clothing sector is in a state of continuous restructuring A combination of low production costs outside the European Union, the emergence of new distribution channels, and changing consumer behaviour have lead to high competition and cost pressures. Supply chain logistics can be a key factor to gain a competitive advantage for companies. Fast time-to-market processes at low costs will require new methods and technologies to handle the multitude of inefficient processes and weaknesses along the whole supply chain.

The main identified weak points in the supply chain are the high labour costs, low productivity, shrinkage, picking errors, inaccuracy of inventory, and low transparency, which may cause further challenges such as OOS and insufficient traceability. They may occur at different locations along the whole process chain and also at most of the business models – at a higher or lower degree of importance. Thus the degree of importance may vary regarding the company strategy, the automation degree, and individual supply chain logistics.

A major challenge seems to exist in the retail store. Here common Auto-ID technologies such as barcodes and also EDI do not provide enough transparency in the front and back store today. This will affect customer service and satisfaction.

The implementation of the EPC/RFID can mitigate these weak points on a higher or lower scale:

- More transparency along the whole supply chain in connection with better on shelf availability (OSA) and shorter time-to-market processes.

- A better inventory management will reduce costs through lower stock levels, less OOS, and shrinkage.

- Less time and labour will decrease the costs and lead to higher productivity as manual operations and errors will be reduced significantly.

- More customer service and satisfaction at the retail store will lead to higher customer loyalty and increased sales.

EPC/RFID certainly will not be the one and only solution for the clothing sector as various impacts always have to be considered. However, the multitude of possible applications with its connected potential cost savings and increasing sales certainly will make EPC/RFID a common state of the art technology in future.

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8. Appendix

The following table comprises selected company business models and their main features. This table is based on interviews with clothing companies and comments provided by AEDT (European Association of Fashion and Retailers) and illustrates only a broad description:

Criteria/main features	Independent multi-brand stores	Specialised Chains		Multi-brand Department Stores	Hyper and Supermarket
		Private label	Brand fashion		
	Boutiques	Zara, Mango, H&M, Sfera, C&A	Esprit, Lacoste, Hugo Boss, gardeur	El Corte Ingles, Kaufhof, P&C	Carrefour, Metro, Tesco
share of clothing in turnover*	100%	100%	100%	60%-100%	about 10%
Importance of design	medium to high	medium to high	high	medium	medium
Range of models	limited number of colours and cuts	high number of colours, average number of cuts	high number of colours and cuts	high number of colours and cuts	average number of diefferent cuts and colours
quality - price ratio	average to high, depending on fahion strategy	low to average	average to (very) high	average to high	low to average (depending on price)
share of basic clothing	depending on the fashion strategy	low	average to low	average	average to high
share of private label	None	100%	./.	15%-45 %	50% of volume, 40% of CA
Number of collections	average	flexible number of collections	2 main collection, also sub season collections	2 main collections, also sub-season collections	2 main collection, but also depending on number of sales promotions
Own production	None	medium (fashionable clothing is produced by own manufacturing	Low, often sourced in Asia	In exception it may apply, e. g. El Corte Ingles	None
Sub contracting	None (only finished product purchase)	medium	high	high	Mainly finished product purchase
Lead times	medium; about 6- month	very short, (most important variable, about 6 weeks)	Short to high (depending on sourcing country, 6 weeks to 3 month)	medium to high, depending on sourcing country (6 - 8 month)	medium to high
replenishment	basic average to high, for fashionable average	for basic clothing, for fashionable clothing usually push strategy with non-replenishment	for basic clothing, for fashionable clothing usually push strategy with non-replenishment	for basic clothing, for fashionable clothing usually push strategy with non-replenishment	none for "sales promotions", but for basic clothing
Store deliveries	weekly to bi-weekly	daily, bi-daily	bi-daily to weekly	weekly	bi-weekly or tri-weekly
Percentage of direct delivery	yes	low	for basic clothing	for basic clothing	for basic clothing
Customer Service	high	medium to high	High	high	low
price level	medium to high	low to average	medium to high	medium to high, depending on department store type	low (value for money)

*including assessories

Table 4: Selected company business models and their main features