PROJECT FINAL REPORT

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1 Final publishable summary report

1.1 Executive summary

The growing interest in RFID technology in recent years has sparked an intensive debate on the benefits to be expected. With its recent growth in size and scope, RFID technology has shifted away from infrastructural aspects to the question of how to draw value from the large amounts of collected data. However, the necessary procedures for the handling of massive RFID data sets are still an under-researched issue. Against this background, the objective of the SERAMIS project is to push the boundaries of current RFID implementations, thus turning them into powerful tools for intelligent information management.

SERAMIS has produced several outcomes that can be useful for the European Union in general. The outcomes include the development of novel use cases for the RFID-enabled fashion industry like smart fitting rooms (special fitting rooms that are able to detect garments within the cabins and offer users additional personalized services such as product recommendations), and a real time locating system (RTLS) for apparel within a retail store environment. SERAMIS also developed software solutions for the industry including RFID data based dashboards and decision support tools, recommendation services and data classification procedures. Additionally, for the new EU General Data Protection Regulation, a machine-readable model has been developed along with a software tool to assist with the compliance checking process. Both of these are relevant and useful for any organisation involved with data processing in the EU.

Furthermore, SERAMIS also produced conceptual frameworks and guidelines which can help the European companies in implementing RFID based applications. The project furthermore had a special focus on the privacy related issues that come with the usage of RFID, leading to special guidelines and an open source tool that helps firms to comply with the novel EU regulations about privacy.

1.2 Summary description of project context and objectives

Seven partner organisations form the project consortium, brought together the expertise in research and development that was required to achieve the project objectives. Table 1 gives an overview of the partners, their short names which will be used in the following and their countries of origin.

The SERAMIS consortium consisted out of partners from four nations, namely Germany, Austria, Italy and Greece.

Table 1 Partners, short names and country of origin

No	Name	Short name	Country
1	JULIUS-MAXIMILIANS UNIVERSITAET	UNIWUE	Germany
2	ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS - RESEARCH CENTER	AUEB-RC	Greece
3	UNIVERSITA DEGLI STUDI DI PARMA	UNIPR	Italy
4	WIRTSCHAFTSUNIVERSITAT WIEN	WUV	Austria
6	DIFFUSIONE TESSILE SRL	DITE	Italy
7	ID-SOLUTIONS SRL	IDS	Italy
8	ADLER MODEMAERKTE AG	ADLER	Germany

The scientific partners comprised the University of Würzburg (Germany), the University of Parma (Italy), the University of Vienna (Austria) and Athens University of Economics and Business (Greece).

Figure 1 Geographical distribution of the SERAMIS partners

Furthermore, three industry partners were part of the project. The two fashion retailers Adler Modemärkte AG (Germany) and Diffusione Tessile Srl (Italy) as well as the Italian system integrator ID-Solutions Srl. Figure 1 shows the geographical distribution of all partners. The partners will in the following be named with their abbreviations.

The objective of the SERAMIS project was to push the boundaries of current RFID implementations, thus turning them into powerful **tools for intelligent information management**. For this purpose, SERAMIS developed **models, procedures, and tools for the handling of massive RFID data sets**. The project aimed at covering the entire causal chain from the initial investment in an RFID data collection infrastructure to the impact of data processing on firm performance and customer satisfaction. Not least, SERAMIS put special emphasis on the analysis of **privacy issues** arising from RFID data. The project results are put into practice by two leading European fashion retailers and innovators in RFID usage. Our ultimate aim was to **create benefits for individual business processes, strategic and industry-level impacts** as well as **guidelines** for handling the trade-off between the interests of technology users and the privacy rights of their customers. The project outcomes were developed for the largest reuse possible and address the needs of players in the retail industry and beyond.

More specifically, the project had the following objectives:

(1) Coping with the noisy nature of RFID data streams

Although the automatic detection of goods using RFID seems trivial at first glance, technical constraints limit the quality of the collected data. As a consequence, powerful techniques for filtering and aggregating sequences of RFID reads were an outcome of the SERAMIS project.

(2) Searching for information that matters in the RFID haystack

Our second objective was to develop novel performance indicators and other forms of management-relevant reports based on RFID data.

(3) Understanding the impact on workflows and decision-making

After achieving objective 2 we answered the following question: How can we make use of the obtained information in the best possible way on an operational or managerial level? Our findings help managers to make better decisions and support sales staff with offering better advisory services to their customers. Furthermore RFID is used to feed novel decision models that substitute human decision-making. A well-known but nevertheless only poorly understood example is the issue of RFID-based shelf replenishment processes in retail stores.

(4) Putting it all together on the IS level

RFID data in themselves provide little value if they are not integrated with other operational systems to link tag IDs to product information and business events. It requires enrichment with information from further data repositories before any interpretation makes sense. Thus our goal was to investigate the different options and necessities for integration on the level of information systems.

(5) Managing the social and political context

The risks associated with RFID that are discussed in the public include both the direct impact of electromagnetic radiation on health, as well as indirect economic consequences such as the elimination of jobs through increasing automation. However, the most frequently voiced fear around RFID is the technology's potential to breach personal privacy. Before SERAMIS, it has not been investigated how RFID could be deployed on the shop floor and for innovative customer service purposes without compromising customer privacy. Thus our fifth goal was to get insights into privacy mitigation techniques that preserve the service potential of the rich set of RFID data while still respecting customer privacy.

1.3 Overview of main outcomes of SERAMIS

SERAMIS was a very practice oriented project and has produced several research results which can be categorized into

1. ***RFID-related frameworks and guidelines,***
2. ***RFID-enabled infrastructure components and***
3. ***RFID-enabled software applications.***

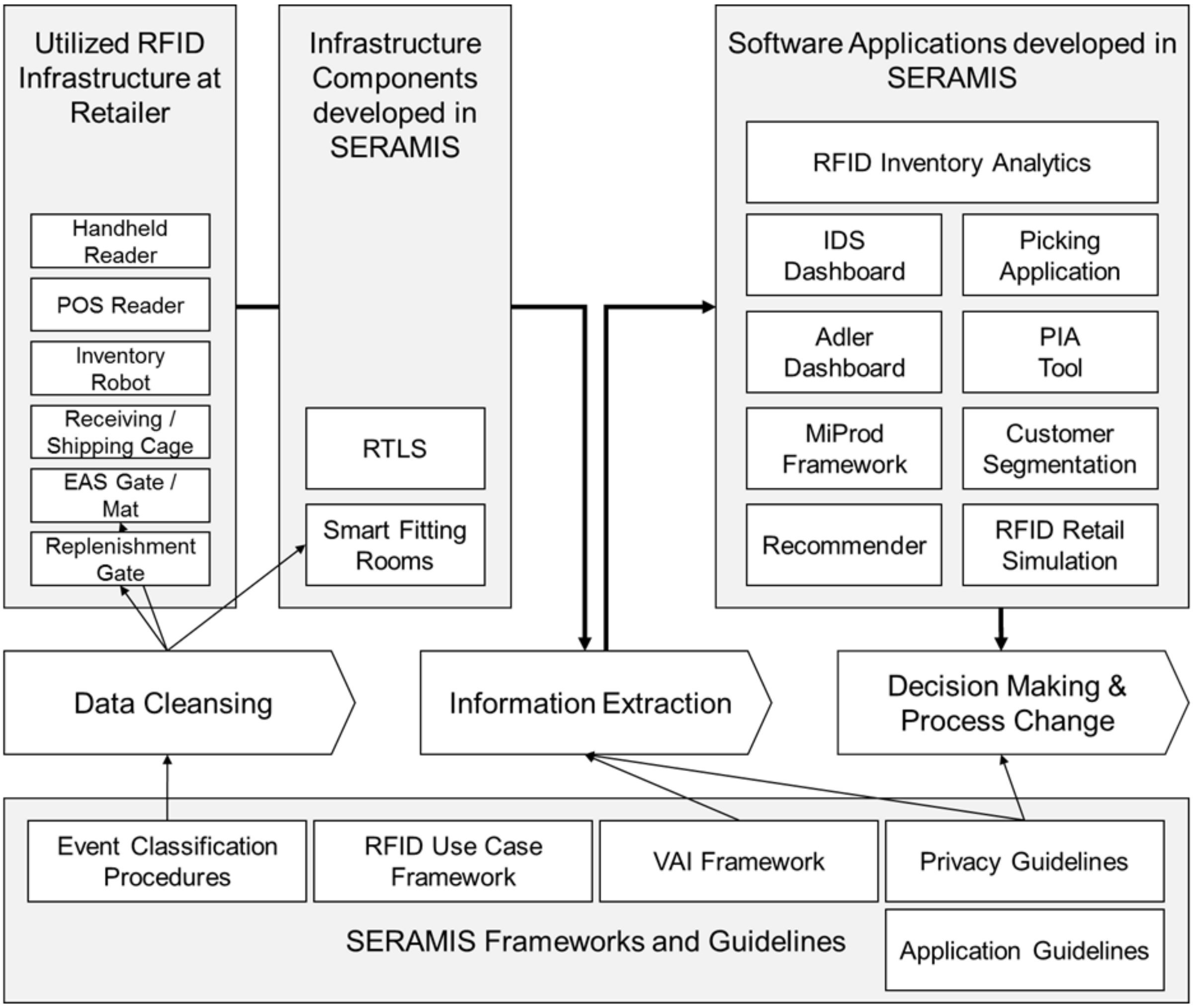


Figure 2 Overview of SERAMIS results

Figure 2 gives an overview over the outcomes of the project and the utilized RFID infrastructure components, (i.e. hard- and software systems that integrate with the existing RFID infrastructure of both SERAMIS industry partners) at both partner companies. The utilized RFID infrastructure components comprise handheld readers, POS readers, an inventory robot, receiving gates and cages, electronic article surveillance and replenishment gates.

SERAMIS also produced two RFID-enabled infrastructure components during the project, beginning from concepts up to productive real-world prototypes. The developed components comprise a real time locating system for the location of products within a retail store in Italy and a smart fitting room that was rolled out to several Adler stores in Germany.

During SERAMIS we also developed several software solutions that utilize the generated RFID data. The solutions comprise dashboard systems, RFID-based inventory analytics, simulation software and a customer segmentation system to support management and marketing decisions. Furthermore, SERAMIS produced applications that help to support in-store processes. First, we developed a picking application which helps employees and customers to faster find garments they are looking for, and second we developed and tested a framework for the detection of misplaced products based on RFID and positioning data at both our industry partners. To extend the capabilities of the smart fitting room we developed a recommender system which shall support customers during their shopping trips. Finally, we developed a privacy impact assessment (PIA) tool and made it open source in order to help companies to comply with novel legislation.

Several frameworks and guidelines were created during the project, to support future studies to build upon our current work and results: namely a framework for event classification procedures, an RFID use case framework, a framework for RFID relevant performance indicators, privacy guidelines for the industry and application guidelines on how to perform an RFID implementation project.

1.4 Conceptual Contributions of SERAMIS

In this section, we describe the conceptual contributions of SERAMIS which cover classification procedures, frameworks and guidelines.

1.4.1 Event Classification Procedures

While RFID solutions are commonly used in retail supply chains for the automatic detection of logistical units (i.e., pallets and containers) in upstream and backroom processes, front store applications have not progressed beyond pilot trials. The application of RFID for these applications is especially error-prone and challenging (see e.g. Bottani et al.). This is because in contrast to controlled processes in other parts of the supply chain, the sheer number and variety of simultaneously moving objects is very high. Complexity is further increased by the manner in which objects are transported (stacked, in bags, etc.), unpredictable customer walking paths, and suboptimal store layouts (e.g., shelves near the exits).

RFID-based Electronic Article Surveillance gates at the exits of retail stores are a good example to illustrate these challenges. Here, the objective is to distinguish between tagged products that are currently leaving the store and others. Due to the lack of process control, accurate product detection is a complex and error-prone task. Misclassification events may occur, for example, if customers with items walk in close proximity to but not through the gate or products are displayed in close proximity to the antennas. The presence of products with metal applications or any other metallic object within range of the antennas may also influence the readability of RFID tags.

To address such misclassification problems, we apply data analytics techniques to differentiate between real-world events (e.g., tagged products that are carried through an RFID gate and others) based on low-level RFID data. Table 2 provides an exemplary data excerpt from such low-level data. Each row reflects a single tag read event triggered by one RFID antenna. Here, EPC is the unique identifier of the RFID tag, RSSI is the radio signal's power measured in dBm and Antenna is the unique ID of the antenna that read the tag. To distinguish between different events, we extract so-called "features" from the low-level data, which contain information regarding observed real-world events. One example is the mean RSSI value measured in a series of detections of a particular tag within a certain time interval. Not all features we use are such aggregations of signal strength. In addition, individual reads are put into temporal relation to one another and are augmented with antenna information.

Table 2. Exemplary data excerpt

EPC	*Timestamp*	*RSSI*	*Frequency*	*Power*	*Antenna*
E28011606…	1465992659	-66.0	867.5	30.0	1
E28011606…	1465992660	-66.5	867.5	30.0	3

We approach the classification problems by considering classification models based on white-box and black-box methods. White-box models are comprehensible to humans, while it is very difficult or even impossible for humans to understand the knowledge black-box models use to classify instances. White-box models we consider are for example decision trees and logistic regression. On the other hand, black-box classification models we use are random forests, gradient tree boosting, neural networks and support vector machines.

Figure 3 provides an overview of the developed event classification procedures. We considered two types of RFID systems. These are (a) readers with moveable antennas (i.e., the arrangement of the antennas is not fixed) and (b) systems with array antennas (i.e., the arrangement of the antennas is fixed). In our tests, we used the Impinj Speedway Revolution R420 reader with four Laird far-field antennas and the Impinj xArray Gateway with a 2D array with 52 dual-polarized antenna beams. First, we developed (a) procedures to detect transitions of RFID tags between two areas (e.g., front- and backstore) for systems with moveable antennas (procedure 1) and (b) procedures to detect transitions of RFID tags between multiple areas (e.g., different fitting rooms) for systems with array antennas (procedure 3). Second, we developed procedures to distinguish between static and non-static tags in the antennas' reading field for both systems (procedures 2 & 4). These procedures allow for instance to distinguish between RFID-tagged objects lying on a shelf or hanging on a rack and objects carried around by people.

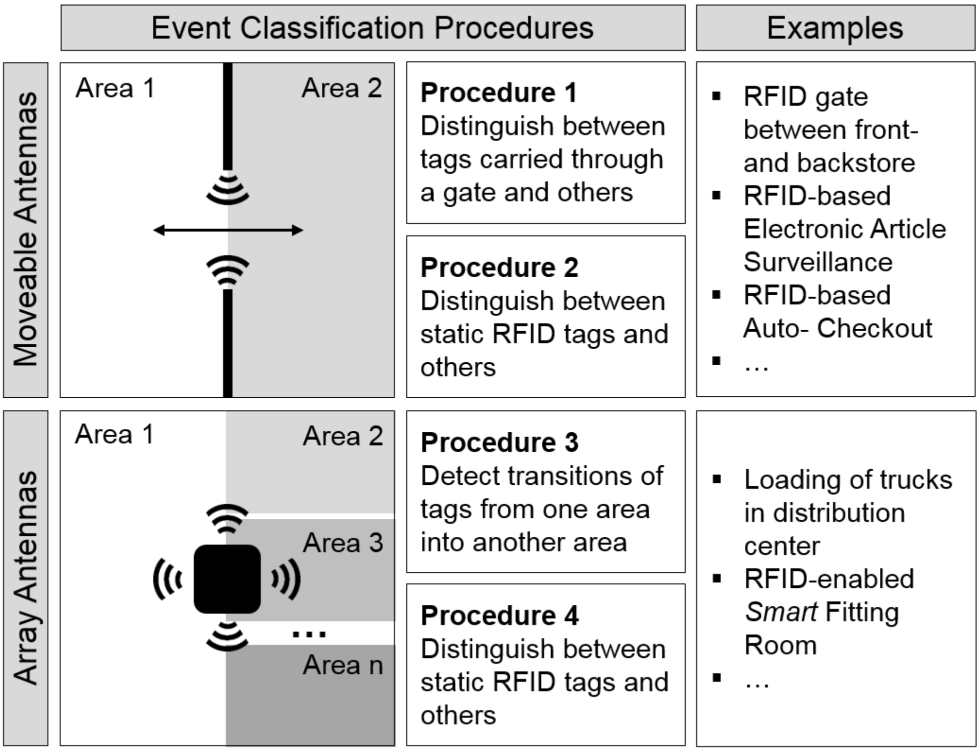


Figure 3. Event Classification Procedures

1.4.2 Use Case Framework

One of the first activities of the project was that of defining and organising the use cases of RFID in the fashion and apparel retail sector. As Cockburn reports (Cockburn, 2000), a use case can be defined as a contract made between all the stakeholders of a system (i.e. 'someone or something with a vested interest in the behaviour of the system under discussion') about the behaviour of the system itself. Although the term use case (UC) was firstly used in software engineering, its use has quickly spread to other areas, such as business process management. We have seen during the first deliverables of the project that no other sector has as many uses cases for RFID technology as the apparel and fashion industry (Rizzi, Romagnoli, & Thiesse, 2016). RFID applications in this sector can range from shop floor management, to logistics, from customer relationship management to brand protection, and from marketing and promotions to inventory and supply chain management.

To organise this matter, we proposed a framework for classifying RFID implementations in this sector: starting from a comprehensive review of the literature, we analysed 86 different RFID projects carried out by 63 different organisations. Our framework comprehends several different use cases (UCs) pursued by fashion and apparel retailers in the last 15 years, and it updates what had already been presented in the literature.

The framework is structured in two levels: at the first level, 6 categories were identified. These categories group specific UCs according to some common characteristic, such as: (i) the main objective of the RFID implementation, (ii) the physical space where it takes place and (iii) the kind of business processes managed through RFID. Each category was then circumstantiated with the specific UCs it contains, resulting in a total of 18 UCs, corresponding to a specific objective pursued by an RFID implementation, as reported in Figure 4. For the detail of the specific use cases, we refer to (Esposito, Romagnoli, Sandri, & Villani, 2015); and (Rizzi et al., 2016).

The framework can be used with profit by both practitioners and researchers. From a practitioner point of view, experienced professional can find in our framework a tool to support and validate their business purposes, while novices could use it to appraise the aspects, benefits and criticalities of RFID deployments. From the researchers' point of view, this framework could help them to understand new branches of research. One of the most promising perspective research topics we are currently working on is to publish an open access data base of RFID projects, with great regard to privacy aspects and security of the data base, so that literature on this topic can gain access to a comprehensive data set.

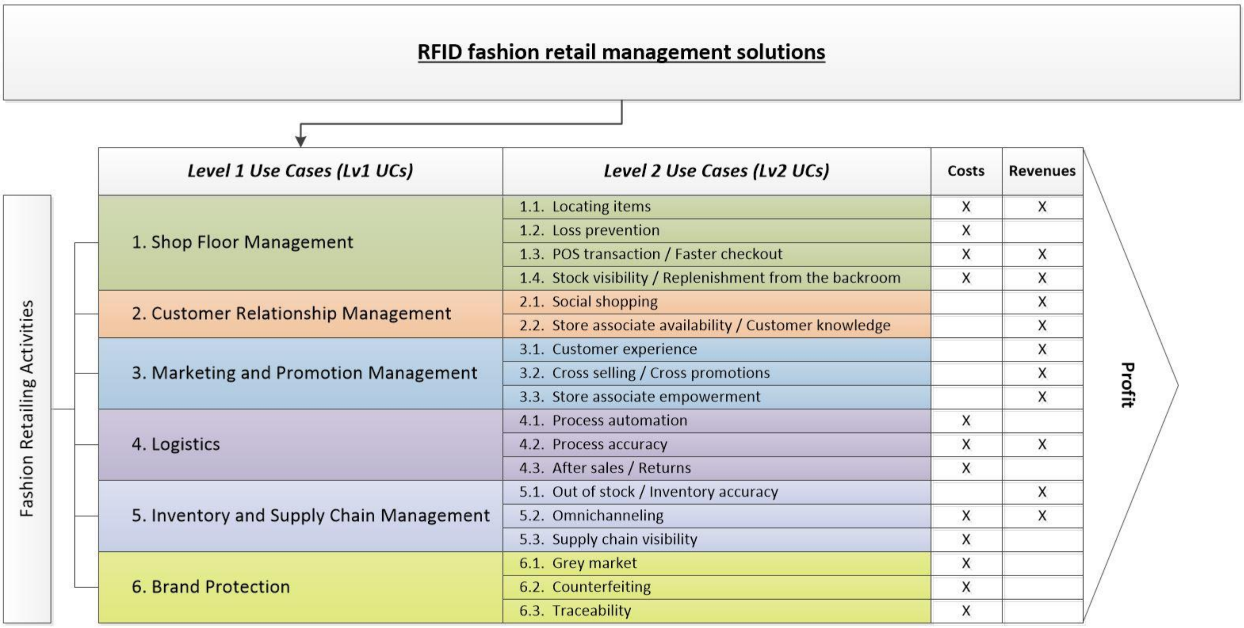


Figure 4: The framework for RFID UCs in fashion and apparel retailing[2]

1.4.3 Value Added Indicators Framework

Another important activity has closely followed the creation of the use cases framework proposed in section 2.2, and this is the proposal of a similar and related framework for value added indicators. Both scientific literature and industrial practice, in fact, agree on the fundamental importance of measuring and evaluating performance in any kind of organisation. As it is suggested by a famous way of saying: 'you get what you inspect, not what you expect' (Melnyk, Stewart, & Swink, 2004). The fashion and apparel retail, clearly, does not play by different rules; also in this sector, metrics can assess how work is performed, direct future activities and educate people, because they explain how a company wants to deliver value to its customers (Beamon, 1999).

The number of works on performance measures has greatly increased in the last decade, but still several issues dispute recent works of researchers, because technologies, organisations, and, ultimately, the whole surrounding environment change at an ever-growing speed (Maestrini, Luzzini, Maccarrone, & Caniato, 2017). The SERAMIS project focussed on a crucial technology for the Internet of Things (IoT), such as RFID. Thus, the project studied how large RFID-enabled data sets can generate new performance indicators and management reports for fashion and apparel supply chains. The use of the term Value-Added Indicators (VAIs), instead of the more common Key Performance Indicators (KPI), is, in our opinion, justified. Our indicators, in fact, starting from the point of sale and extending to all the business processes of the supply chain, focus on increasing the value delivered to customers.

Starting from a review of relevant literature on business metrics, and adding existing metrics used by the industry partners of SERAMIS, we produced a first set of VAIs. This first list was validated and organised in a framework, according to section 2.2: VAIs are linked to RFID use cases with different cardinalities, ranging from 2 to 12. To better describe the framework for VAIs, we introduced three different directions or characteristics of our indicators, such as:

- **Category:**
    - Sales / turnover (i.e. measuring an economic performance);
    - Customer satisfaction / involvement (i.e. customer-related indicators measuring the degree of customer interaction with the process);

[2] Reprinted from Rizzi A, Romagnoli G, Thiesse F. A new framework for RFID use cases in fashion and apparel retailing. Int J RF Technol Res Appl.; 7(2-3):105-129, Copyright (2016), with permission from IOS Press. The publication is available at IOS Press through http://dx.doi.org/10.3233/RFT-150075

    - Process efficiency / cost (i.e. measuring the effectiveness of a process achievable with a given cost);
    - Process improvement / innovation (i.e. assessing the improvements related to the implementation of RFID technology).
- **Nature:**
    - RFID-based indicators (i.e. their only viable measure is through RFID);
    - RFID-influenced (i.e. they can, or cannot use RFID technology).
- **Dimension:**
    - Vertical (i.e. they focus on only one primary activity of the value chain);
    - Horizontal (i.e. they focus on more than one primary activity of the value chain, or on one or more secondary activities).

The descriptive statistics of the VAI framework are reported in Table 3, and for the complete list of VAIs reported in the framework, provided also with their source (e.g. industry or academic literature), units of measurement, category, nature and dimension, we refer to (Bertolini, Romagnoli, & Weinhard, 2016).

Table 3: Number and percentage of VAIs per category, nature and dimension

Category	**#**	**%**	**Nature**	**#**	**%**	**Dimension**	**#**	**%**
Sales/turnover	24	40%	RFID-**B**ased	39	65%	**V**ertical	52	87%
Process **E**fficiency/cost	17	28%	RFID-i**n**fluenced	21	35%	**H**orizontal	8	13%
Process **I**mprovement	11	18%						
Customer satisfaction/involvement	8	14%						
Total	**60**	**100%**	**Total**	**60**	**100%**	**Total**	**60**	**100%**

1.5 Privacy Guidelines

During the project, privacy aspects were considered for all the different stages. Also, we conducted an extensive privacy impact assessment. The assessment gives a good idea of the privacy guidelines associated with similar customer related use cases. For the assessment, we have considered the loyalty card application and smart fitting room application for Adler and, fidelity card application and real-time location system for DITE. At a high level, during the early months, substantial efforts were put in for modelling the different customer related use cases to prepare the data flow models for the processing. Then based on the data flows, privacy threats were analysed. In the end, privacy controls were proposed to minimise the privacy risks.

Additionally, the new General Data Protection Regulation has been analysed and a detailed comparison has been made with the current data protection directive, shown in Table 4, along with a short summary of the new requirements defined in the GDPR.

Table 4: An example of a table comparing the GDPR with the directive

Article. # (New)	**Article. Name (GDPR)**	**Article. # (Old)**	**Old title (Directive)**	**Changes**
5	*Principles relating to personal data processing*	6	Principles relating to data quality	Addition of transparency as a basic principle with lawfulness and fair.
9	*Processing of special categories of personal data*	8	The processing of special categories of data	Addition of genetic data and biometric data as sensitive data
13	*Information to be provided where personal data are collected from the data subject*	10	Information in cases of collection of data from the data subject	Elaborating on the list of information that should be provided and adding time constraints to share the information
14	*Information to be provided where personal data have not been obtained from the data subject*	11	Information where the data have not been obtained from the data subject	

Further, we also analysed different criteria under which RFID data becomes personally identifiable. A total of 12 scenarios (4 cases with 3 possible data sources) were considered for the analysis, shown in Table 5. We found that, even in cases where RFID data is well separated from customer systems, there exists potential privacy risks. In this separated scenario, RFID database (related to the inventory) and Point of Sale (POS) database (related to customers) keep a log of timestamps. Though, RFID data is maintained separately, the timestamps can be correlated with the POS database to potentially identify the customers. Thus, in the guidelines we recommend adjusting the granularity of timestamps in either database to reduce the possibility of RFID data becoming personally identifiable.

Table 5: Different scenarios considered for analysing the identifiablity of customers

Possible data sources	**In isolation**	**with POS data** *all features on the left plus:*	**with POS data + SL** *all features on the left plus:*
RFID data	**Potentially identifiable**[3] + time of visit + frequency of visit	**Identifiable** + fitting room usage + after purchase lingering probability	**Identifiable** + min. walking speed
RFID RTLS data	**Potentially identifiable**[3] + fitting room usage + items of interest + walking speed[4]	**Identifiable** + linkage to customer profile	**Identifiable** + detailed path information + walking speed + distance covered
Wi-Fi positioning data	**Identifiable** + detailed path information +shopping partners	**Identifiable** + linkage to customer profile + shopping partner identities	**Identifiable** + min. walking speed + distance covered
RFID RTLS data + WiFi	**Identifiable** + detailed item interactions *+all features in this column*	**Identifiable** *all features in this column and to the left of it*	**Identifiable** *all features in this matrix*

[3] Sewn-in RFID tags from the retailer (or other organisations) that are carried allow for identifiability of persons. With DeviceFree data, the obtained information can be used to extract activities. These activities and their features might allow us to single out individuals who have certain traits (e.g., a person suffering from Parkinson's disease would emit a shaking pattern when holding RFID tags).

[4] Walking speed can be extracted when devices support the extraction of Doppler-shifts that hint at the speed of tags.

1.6 Developed Infrastructure Components

In this section, we report the infrastructure components that were developed during the project. With the term *infrastructure*, we denote the solutions that, comprise hardware and software components and provide a fundamental service to the retail stores (e.g. real-time locating items or RFID-enabled smart fitting rooms).

1.6.1 Real Time Locating System

One of the major infrastructure developed during the project is the first industrial application into a retail store of a real-time locating system (RTLS) based on passive-RFID tags (Rizzi & Romagnoli, 2017; Uckelmann & Romagnoli, 2016). In 2014, DITE planned to deploy an RTLS in its store located near Rome (Pomezia). The main use cases of the implementation of such an infrastructure were (see Figure 4): (i) 1.1 Locating items; (ii) 4.1 Process automation. The Pomezia store was selected due to its size, as it was the largest DITE store, both in terms of surface (over 1,800 m^2) and of number of garments exposed in the sales floor area (between 15 and 20,000 items). For these reason, the management of DITE believed that a significant percentage of sales could be lost because customers could not locate their garments of choice, albeit those items were available on the sales floor. Moreover, the large surface of the sales floor area made it difficult to perform regular inventory counts, cause this process was time consuming (1-2 hours of a skilled worker). To address these issues, and due to the fact that other proprietary solutions were not available back then (e.g. Impinj xArray), the cooperation of IDS and DITE during SERAMIS developed a real-time locating infrastructure composed of off-the-shelf antennas, multiplexers and readers. The RTLS developed by IDS for the DITE store in Pomezia counts 254 antennas that are linked through 13 multiplexers to just as many readers, as reported in Figure 5. After a warm-up period, during which the system was improved to solve some issues, the RTLS was tested and it is fully operative since the second half of 2015, locating around 15-20,000 items in a retail store that can host a few hundreds of customers and staff.

The system has reported up to 98.2% of inventory accuracy, which is the percentage of items identified by a complete handheld inventory count that were also located by the RTLS (note that the test was performed off-peak during the opening time of the store). The location accuracy of the system is 90.0%, if we only consider location of items in the precise area where the items were located via handheld scan, and it increases to 99.4%, if we also consider neighbouring location (with respect to the location of items via handheld readers).

From an economic point of view, we considered sales performance to evaluate the business impact of the RTLS system. Specifically, we assessed the sales performance of garments located in different areas of the store, to support the decision making on the store’s assortment of different models and/or classes. We analysed RTLS data and we examined the correlation between the locations of items in particular areas of the store and the sales performances. According to DITE requests, the areas of the store we analysed are small cabinets where items may be displayed according to the season and the fashion trends. These areas are identified by letter "S" in Figure 5.

The analysis showed that S areas display on average 5-10% of the all the models displayed in the store. However, product items exposed in S areas reported much higher sales volumes; indeed, almost three-times higher than average values of the whole store (12.03% against 4.07% product items sold per day). This effect is also visible if we consider the classes of products on display in S areas (see Figure 6): classes that are present in the S areas account for sales between 10% and almost 700% higher than the corresponding whole-store average.

Figure 6 could be of great assistance for the store managers to decide which product classes should display in S areas in every period of the year to maximise sales volumes.

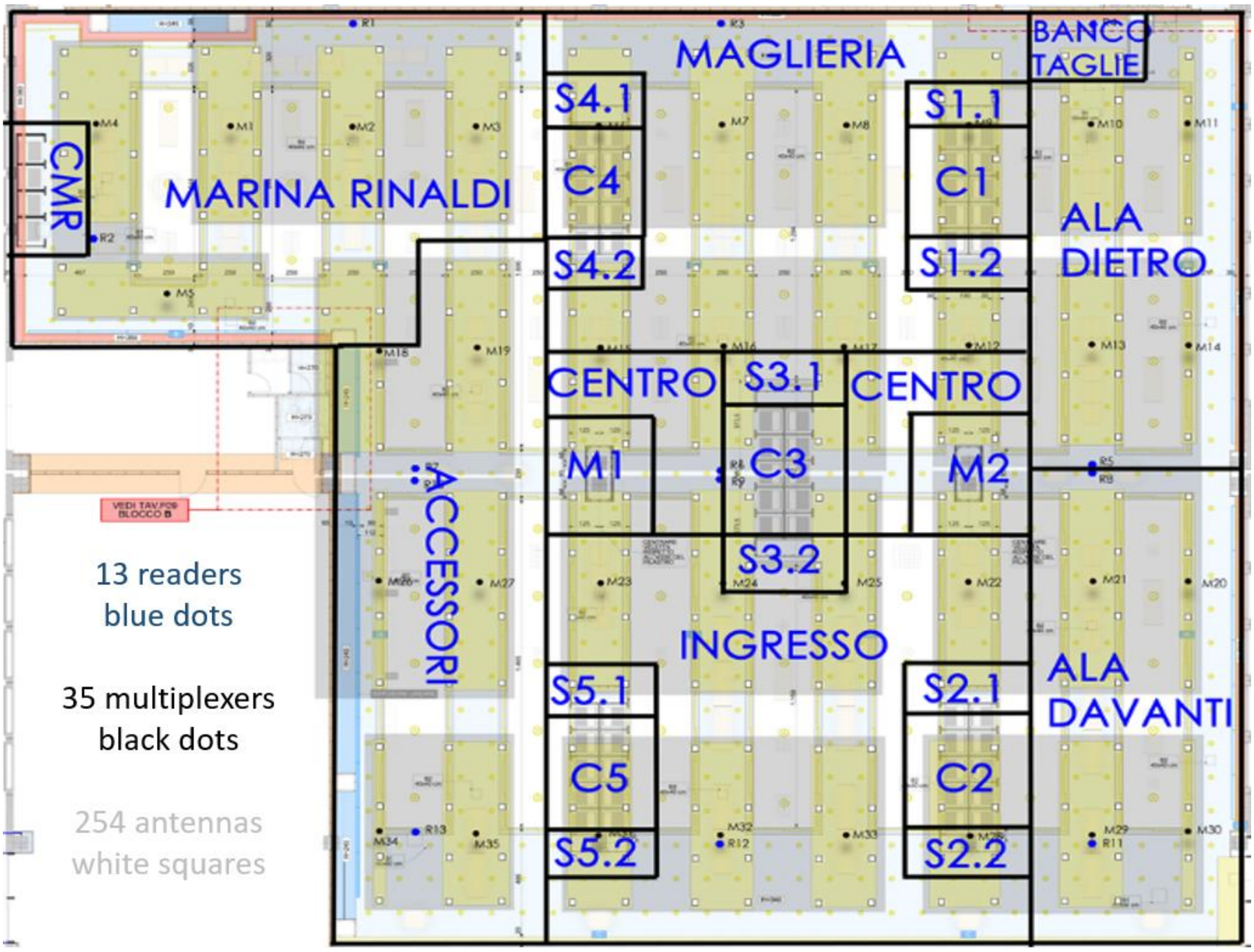


Figure 5: The elements of the RTLS (lower left corner) and the areas where garments are located.

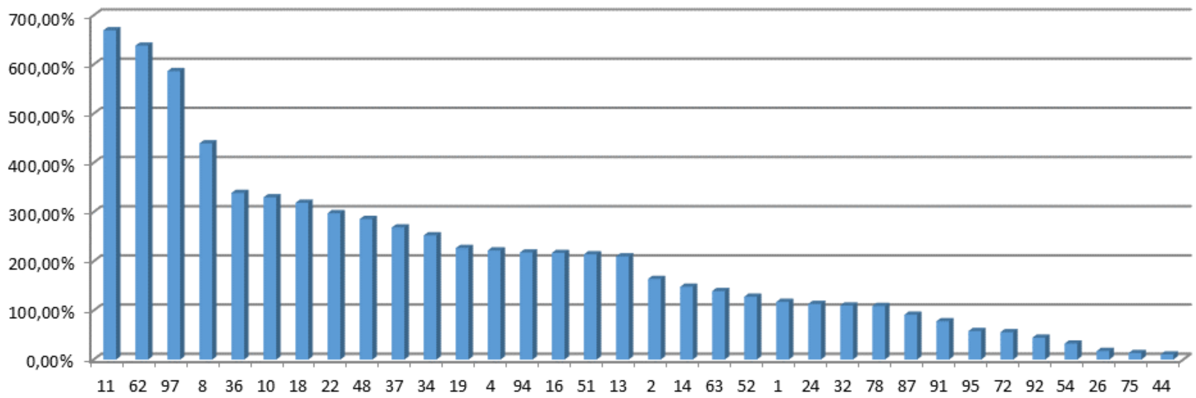


Figure 6: Percentage of sales increase of classes displayed in the S areas, with respect to the corresponding whole-store average values.

1.6.2 Smart Fitting Room

During SERAMIS we developed a so called smart fitting room (see Figure 7). The smart fitting room is an application which is able to detect the garments a customer brings into the fitting room cabin with the help of RFID tags which are attached to all garments in a retail store. As soon as a customer enters the fitting room the touch screen within the fitting room displays a button that allows a customer to enter the menu.

Figure 7 Smart fitting room

Figure 8 Monitor within the cabin

In order to cope with the privacy rights of the customers, we chose this unobtrusive approach. This means a customer has to actively push the button on the screen in order to use the functionality of the fitting room (see Figure 8).

A customer can then use the touch screen inside the fitting room (see Figure 8) in order to,

- get additional information about the products (s)he has brought into the cabin,
- receive garment recommendations that fit to the garments brought into the fitting room (see Figure 9),
- receive complete outfit recommendations (see Figure 10),
- browse the articles within the store and the e-shop (see Figure 11) and
- call an employee via the touch screen (s)he needs further assistance (see Figure 12).

Furthermore, employees can see via a display outside the fitting rooms (see Figure 7), which cabins are currently occupied, how many garments are within the cabin and if there is a cabin in which a customer has left some garments. Consequently, the smart fitting room provides customers with a completely new shopping experience and helps employees to perform a better service.

By recommending suitable garments to customers our industry partner strives to leverage cross-selling and up selling potential as well as to improve its omni-channel strategy. Furthermore, the smart fitting room supports the store’s workforce because the employees do not have to look for the fitting room cabins all the time. So far our evaluations with customers were quite positive. Especially the middle aged target group of Adler likes the possibility to get in touch with computer systems. Older people love the functionality to call an employee without having to leave the fitting room. Consequently, the smart fitting room is making their shopping trips easier. Adler is continuously improving its system based on the feedback from the customers and has done so during the course of the project. The smart fitting room use case shows the potential of RFID not only as a tracking technology, but also as a technology that enables better customer service.

Figure 9 Garment recommendations

Figure 10 Outfit recommendations

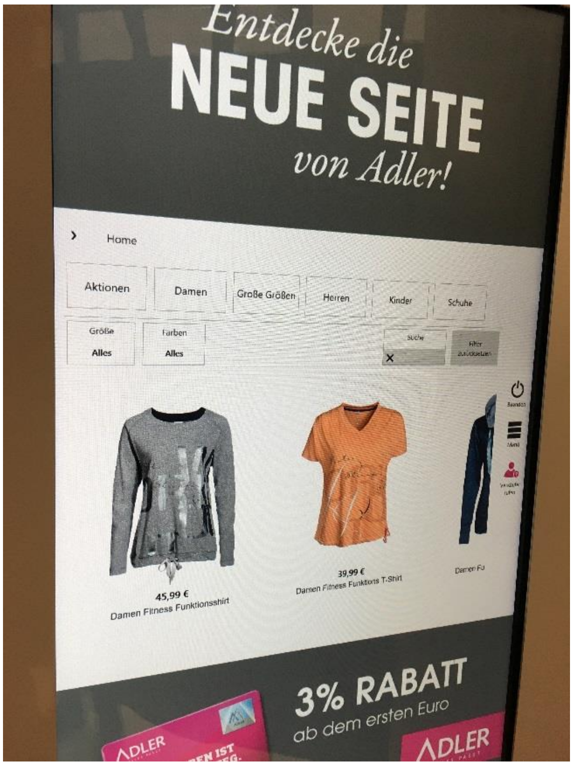


Figure 11 Browse articles

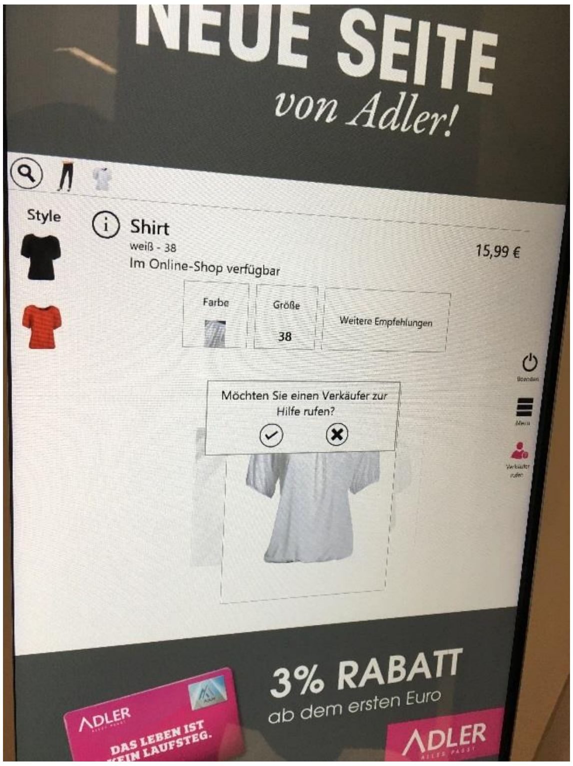


Figure 12 Call an employee

1.7 Developed Software

In this section, we report the software solutions that were specifically developed during SERAMIS, to answer the needs of one or more beneficiaries of the project.

1.7.1 IDS Dashboard

The first software that we describe in this subsection is IDS “RFID Dashboard for Fashion”. One of the tasks of the project, in fact, had the goal of developing a business intelligence software tools able to interpret RFID data and provide consistent VAI (Value-Added Indicators) values. The RFID Dashboard for fashion is a business intelligence and parametric software tool. It can be fully configured in several different ways: (i) in terms of products to be monitored, e.g. at different granularity levels; (ii) by actors of the supply chain, e.g. manufacturer, retailer, 3PL; (iii) in terms of processes, e.g. shipping, receiving, inventory count, replenishment; and (iv) it makes use of several Value-Added Indicators, as we will report below.

The software was developed following the usual process: (i) requirements specification; (ii) software design; (iii) implementation and integration; (iv) testing. The business intelligence dashboard was firstly validated on simulated EPCIS data, and then refined accordingly, in order to ensure its proper working conditions and that it strictly meets design requirements.

The software was delivered and tested in DITE, and it is used by the company since 2015. However, it is important to remind the reader that the RFID Dashboard for Fashion is not only tailored for DITE’s needs. On the contrary, the solution was developed for a wide range of companies, that is apparel, textile and fashion supply chains. Nonetheless, the approach to the software was intentionally kept general enough to be easily transferred to other sectors.

Although a thorough description of the software is outside the scope of this document, we will report below its main features (see Table 6-Table 8).

Table 6: Granularity levels considered by the dashboard

Granularity level	**Description**
Store area	Sales floor or backroom
Category	Group of classes that can be clustered together (e.g. jackets, dresses)
Class	Set of models with similar characteristics (e.g. style or fabric)
Model	Group of SKUs, only differentiated in colour and size
SKU (Stock Keeping Unit)	Set of identical items, i.e. same model, colour and size

EPC (Electronic Product Code)	RFID tag associated to each and every item, it identifies the specific piece of garment

Table 7: List of modules in the RFID Dashboard for Fashion

Module	**Functionality**	**Developed in SERAMIS**
Traceability	Indicates all previous processes and locations of any given SKU value	No
Product history record	Displays information regarding a selected EPC and all processes it has gone under	No
Availability	Displays the number of items belonging to any given class, size, colour etc. both in the sales floor and in the backroom	**Yes**
Inventory	Displays all information about availabilities of selected SKUs and the availability history records too	No
Assortment	Allows the store associates to retrieve all information concerning the assortment of the sales floor area by different SKUs	**Yes**

Table 8: List of shortcuts in the RFID Dashboard for Fashion

Shortcut	**Functionality**	**Developed in SERAMIS**
Composizione Classe/Taglia	Displays Availability module organised by class and size	**Yes**
Scandali da ripristinare (Classi 01-02-03-08-48-49)	Links to the Assortment module and indicates jackets and coats to be replenished straight away	**Yes**
Scandali da ripristinare (Classi 13-18-78)	Links to the Assortment module and indicates trousers to be replenished straight away	**Yes**
Scandali da ripristinare	Links to the Assortment module and indicates items to be replenished straight away (all classes)	**Yes**
Scandali da sostituire	Links to the Assortment module and indicates the low-selling items to be taken to the backroom (all classes)	**Yes**
Scandali da rendere	Links to the Assortment module and indicates the low-selling items to be shipped back to the DC (all classes)	**Yes**

The software collects single RFID read events on single EPCs, and then groups them together according to some logic (see Table 6). Different **modules** of the software are then available to report and display Value-Added Indicators. Some of these modules were already available before SERAMIS, but two of them were developed during the project (see Table 7). Also, from software's home page it is possible to generate pre-defined reports, also called **shortcuts**, which have all been developed for the fashion and apparel sector (i.e. within SERAMIS) and are reported in Table 8. The RFID Dashboard for Fashion is currently deployed in every RFID-enabled DITE store, with a full deployment (all products, all stores) by the end of 2018. A screenshot of the RFID Dashboard for Fashion is reported in Figure 13.

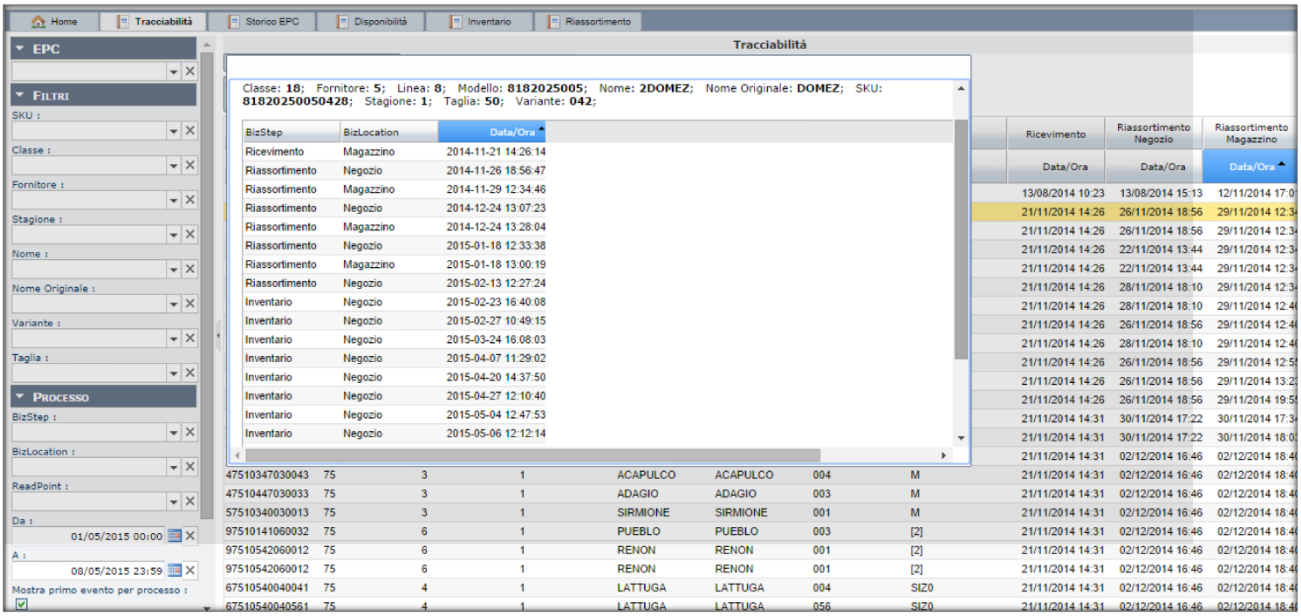


Figure 13: Screenshot of the RFID Dashboard for fashion – product history module

1.7.2 Adler Dashboard

The various data sources at the SERAMIS partner Adler enabled us to create several novel data mining reports based on the RFID log data. The data sources comprise, hand held readers, RFID gates, RFID cash desks, the previously presented smart fitting rooms and an RFID-enabled inventory robot. We were able to show that the combination of these data sources enables novel insights into fashion retail stores from a management perspective.

The analyses and metrics we developed for our industry partner comprise:

- Key metrics for the smart fitting room, including try-ons vs sales ratios and fitting room utilization (see Figure 14)
- Key metrics for the RFID-enabled POS, namely the average number of customers in queue and the average waiting time during busy periods
- Visual analyses of the sales floor area using positioning data from Adler's inventory robot.
- Key metrics in order to control for RFID-data quality

In the following we give some examples in order to illustrate the possibilities which the combination of different RFID data sources offers. Figure 14 shows the utilization of two different smart fitting room clusters in comparison to their respective sales (i.e. we track which of the items that were tried on in the cabins were finally bought by a customer). The red bars show for each time of the day the number of tried on articles in the women's department while the red line shows the percentage of sold articles that could be connected with the try-on. The blue bars and the blue line show the same for the men's department.

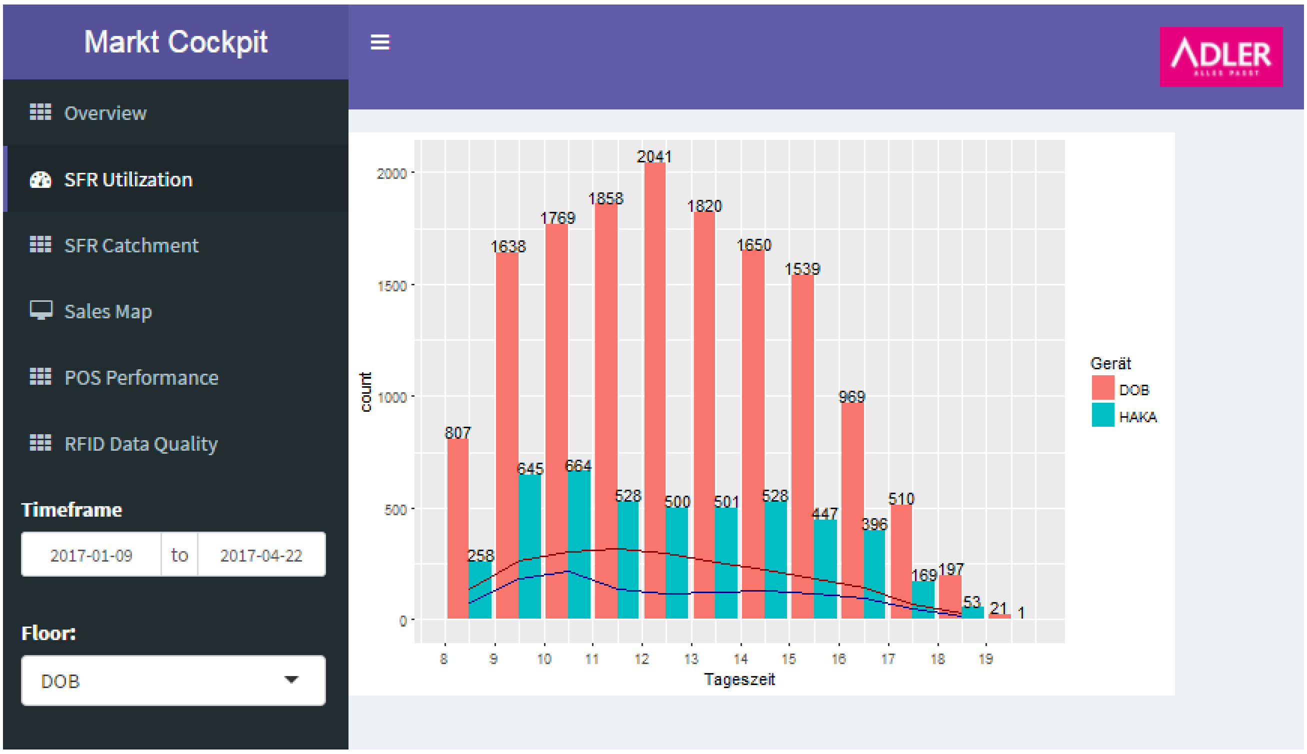


Figure 14 Dashboard Example - Fitting Room Utilization

Another example is shown in Figure 15 where we use position information, collected by Adler's inventory robot and use it in order to visualize the catchment area of the smart fitting rooms with a heatmap. The figure illustrates from where customers bring garments into the fitting room cabins. In the example dark read areas are very relevant for the fitting room cluster under consideration. This information can for example help store managers to decide where to strategically position articles on the sales floor. We also perform a similar analysis by combining the data from the inventory robot with the data from the RFID-enabled cash desk. This allows us to spot areas on the sales floor with a high sales volume which is a useful information that can also be utilized by managers.

Our proposed analyses can serve as a blueprint for other RFID equipped retailers in order to build RFID-based decision support tools and serve as a basis for developing novel RFID-based reports.

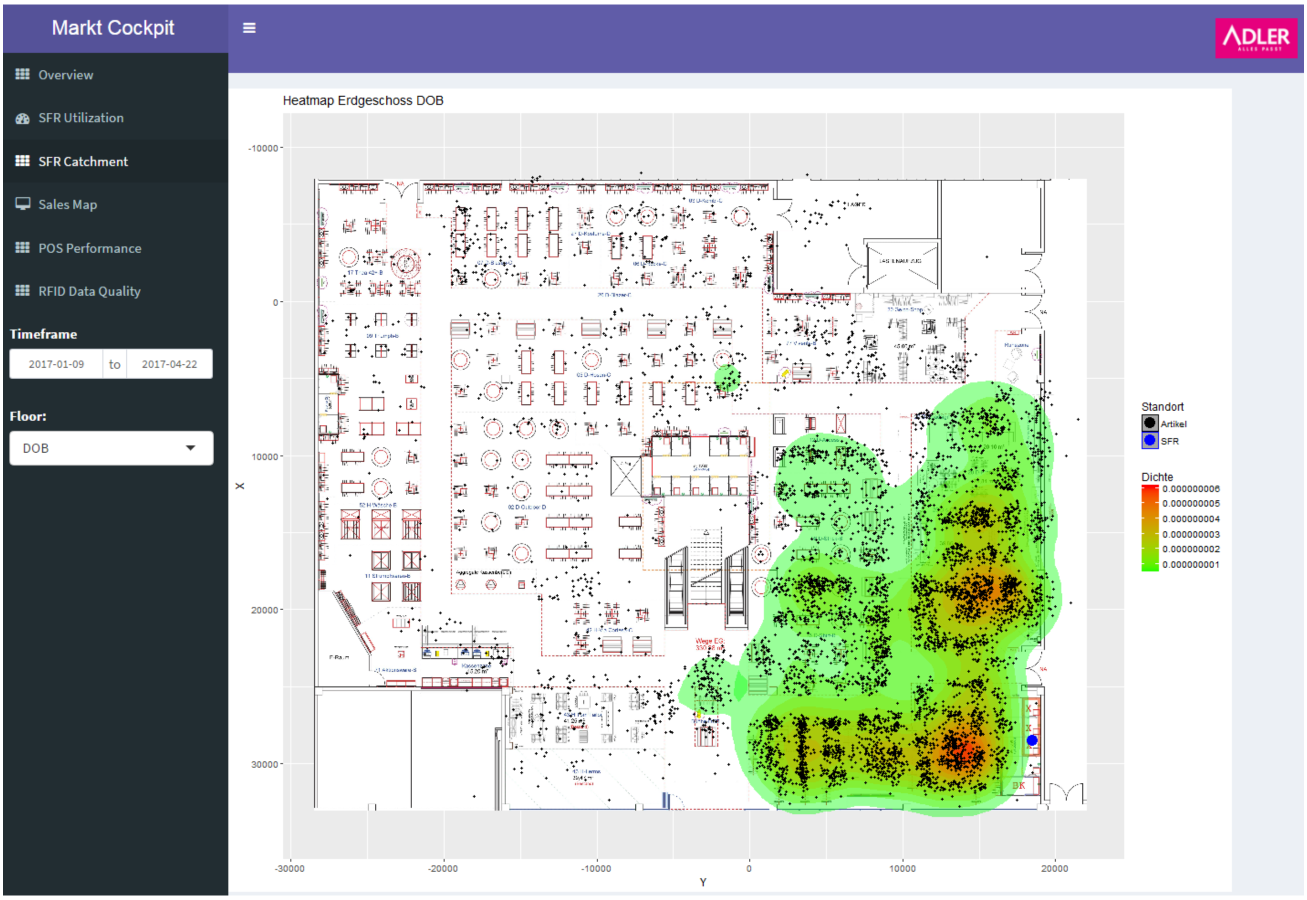


Figure 15 Dashboard Example - Catchment area of smart fitting rooms

1.7.3 MiProD Framework

In the domain of brick-and-mortar retail the orderly positioning of products is important. Customers trying to find products that are misplaced somewhere will assume that the desired product is out of stock. Consequently, the customers might leave the shop without buying a product resulting in missed sales opportunities. Reports estimate an average of 8.3 percent (Gruen & Corsten, 2007) of out-of-stock situations, out of which 10 percent (Gruen & Corsten, 2007) to 16 percent (Raman, DeHoratius, & Ton, 2001).

In the course of SERAMIS project, we developed a misplaced product detection method (MiProD) that detects and distinguishes misplaced products from ordered products. MiProD is essentially an algorithm that takes the raw RFID readings of RTLS systems (or also inventory robot based locations of tags) as input to determine a ranking of candidate products that seem to have been misplaced. The detection approach builds on complex event processing to transform raw sensor reads to position and movement data and on anomaly detection. It scores the garments based on their moved distance and on their outlier factor. This way, we can automatically detect when an item has been moved away from its original position in noisy sensor reading settings. The resulting list of misplaced product candidates can be integrated into a smart device application for employees to locate misplaced items that might otherwise be difficult to spot.

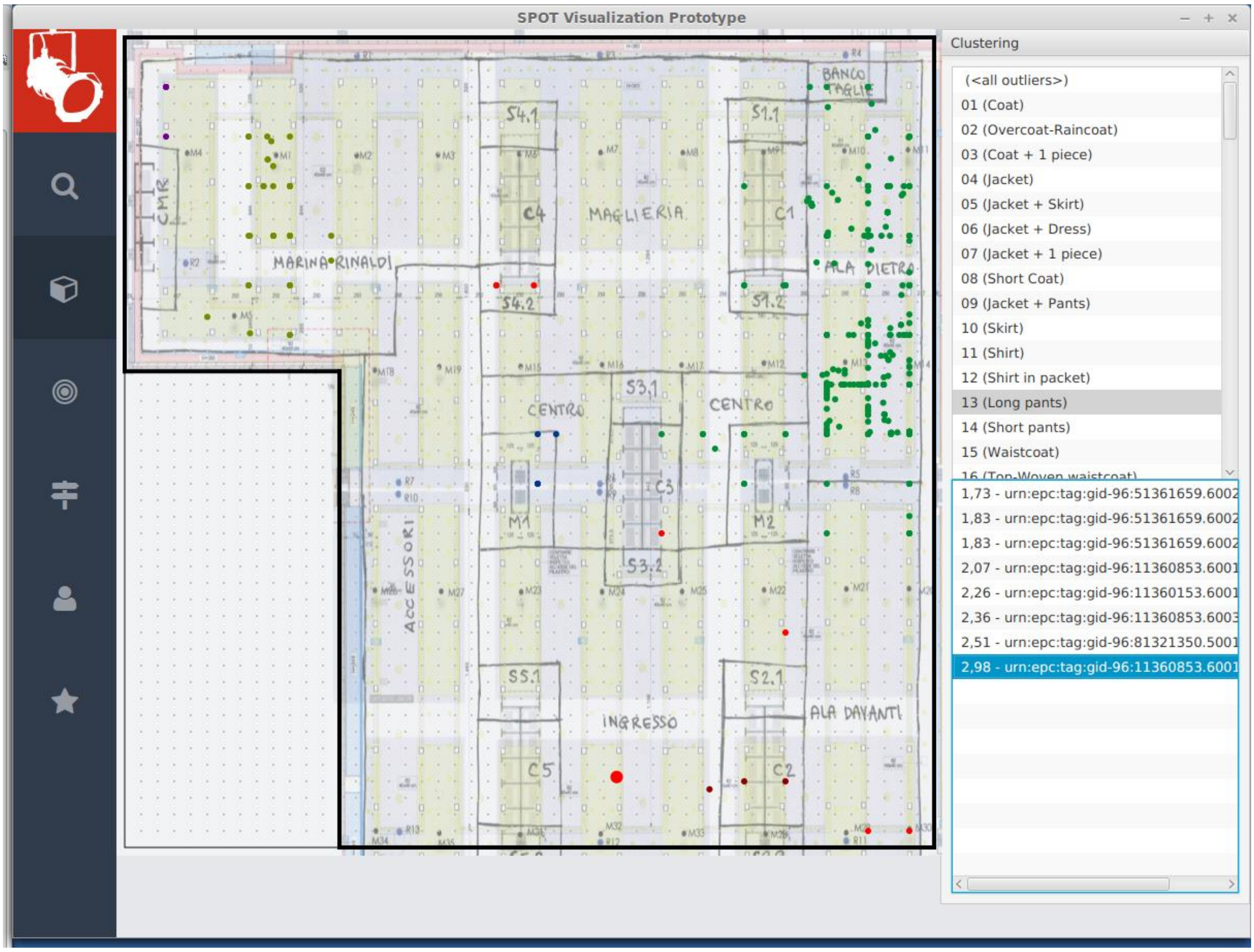


Figure 16: Misplaced Product detection prototype with visualization of outliers on the map.

The screenshot shown in Figure 16 illustrates a conceptual user interface that assigns clusters to products of one class (in this case long pants) and shows individual outliers that are potentially misplaced products. The EPC code is returned along with the estimated position on the map for easier picking up by sales employees.

1.7.4 Recommender System

A Recommender System (RS) is a software agent that predicts and suggests specific, useful and interesting "items" (e.g. music, products) to users; and its design, user interface, and core recommendation technique are customized based on the context needs (Resnic et al., 1997).

We developed a recommender system that can be integrated with the ‘smart fitting room’ application. It proposes to consumers in the fitting room garments that are similar to the ones they have brought with them in the fitting room. The recommendation logic is based only on products/ garments similarities, because we do not have customer identification information (e.g. customer loyalty identity); and, thus, the recommendation does not consider the consumer/ user profile. In other words, we apply content-based recommendation (Amatriain et al., 2011; Lops et al., 2011), which is a popular, widely used technique because it is easy to implement and, also, each new item (garment/ product) can be recommended without waiting of customers to buy or rate it.

Specifically, we have implemented the recommender system as web service (see Figure 17) that receives as input the product/ garment identity and returns as output a list of similar garments. The similarities between garments are the cornerstone of the recommendation logic and we calculate them utilizing available product / garment characteristics, such as colour, size and product category. Essentially, the recommender system service initiates when a customer enters a fitting room and the tagged products he holds are read. Then, the products’ identities are the input of the web-service and the web service returns a set (an array) of similar recommended garment identities.

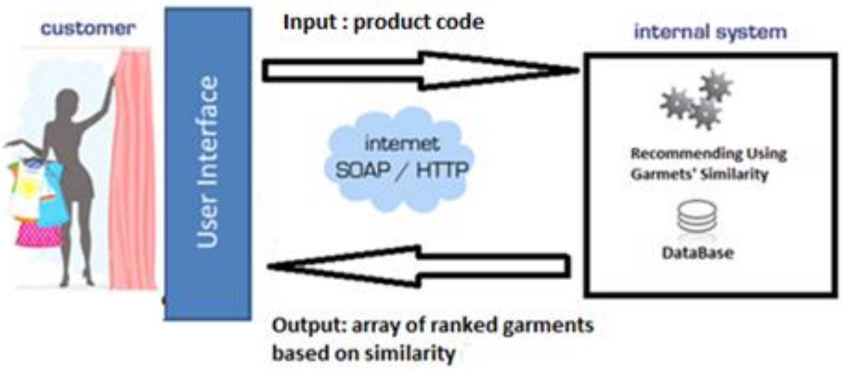


Figure 17: Recommender system web-service

We utilize the Jaccard similarity index (or Jaccard similarity coefficient) to calculate the similarity for each possible pair of products/ garments. The Jaccard index is a measure of similarity for two sets of data, with a range from 0% to 100%. The higher the percentage, the more similar the sets of data.

We have chosen to implement the recommender system as a web service, because this way is portable and can be customized easily to each future adopter of such a system.

1.7.5 Picking Application

During SERAMIS we developed a specific picking application (picking app) that is integrated with the RFID Dashboard for Fashion. The app deals with requests issued by the size request desk (the place where customers go when they look for items they cannot find on the sales floor) to pick up items from the backroom (see Figure 18). SKUs that are looked for can be read or searched for on the dashboard and the request is sent to the picking app by simply pressing a button: this action generates a picking request for the SKU. A set of mobile devices, where the app is installed, receives the request; if necessary, pickers can ask for details of the SKUs (see Figure 19). The store staff using the mobile devices in the backroom can accept the picking requests and, eventually, complete it, either positively (item found) or negatively (item not found). When picking requests are completed, customers are notified whether the item(s) they are looking for has been found or not.

The picking app is used in Pomezia store since mid-2016, and it has increased pickers' productivity by almost 50%, if compared with a non-RFID store. For this reason, DITE is now deploying the picking app in all its stores (by the end of 2018).

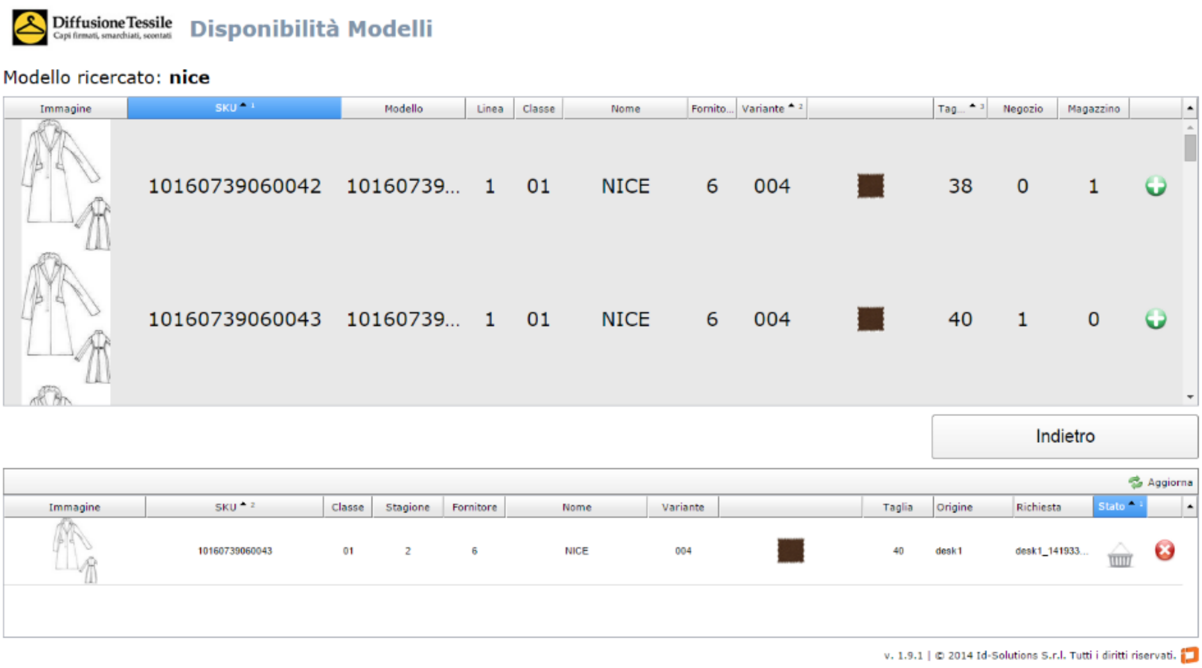


Figure 18: The screenshot of the RFID Dashboard for Fashion where it is possible to send a picking request to the app

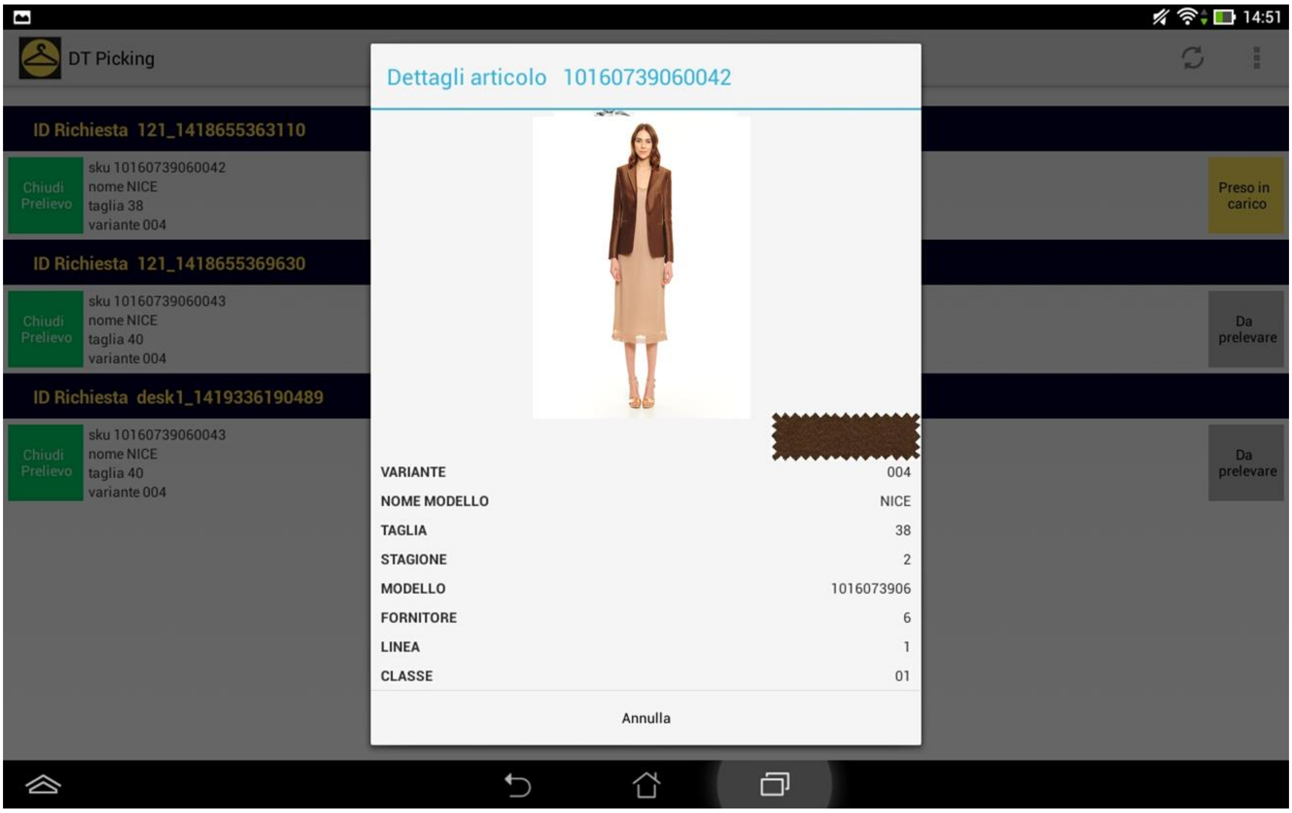


Figure 19: Picking request received and details of the garment displayed

1.7.6 The GDPR Compliance Tool

During the project, a GDPR compliance-checking tool was developed. There were two major contributions – 1) A machine-readable model for obligations applicable to the companies involved in data processing based on the GDPR, 2) A software tool that uses the model and interacts with the user to interactively check compliance with the GDPR.

1.7.6.1 Machine readable model for the obligations defined in the GDPR

To best of our knowledge, software tools for data protection compliance checking are based on a pre-defined and hard coded checklist. However, these tend to be a short term solution as the legislations are dynamic and are also based on the court decisions. Thus, for all major court decisions, it is necessary to adapt the changes in the checklist accordingly. The new data protection regulation (GDPR) was published in 2016 and will be effective from 2018. As the regulation is a new set of legislation, we believe that the interpretation would change substantially in the early years of its applicability. As a result, we focused on creating a dynamic model for the GDPR such that a hard-coded checklist would not be required.

To make this possible, we first analysed all the relationships between the 99 articles defined the GDPR. We found that there were 700+ cross-references defined in the text. As the aim was compliance checking for companies, we then short-listed the articles, which define obligations. After that, from a total of 30 selected articles with 135 paragraphs, we extracted 72 obligations, 105 sub-obligations and 25 scenarios defining exceptions. In addition, all the associations and relationships were also analysed. For instance, Obligation X is *defined in* Paragraph Y and *requires* Obligation Z. Figure 20 shows all such relations based on the coded associations and relationships.

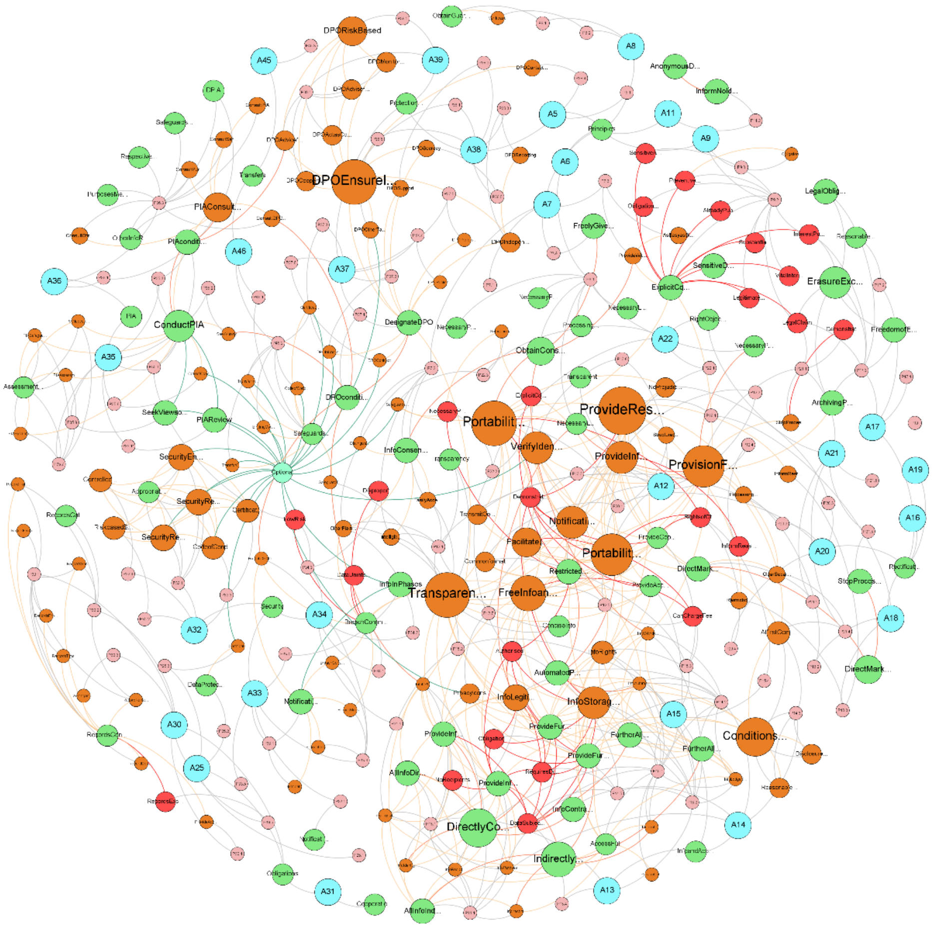


Figure 20: A graphical representation of Articles (in blue), Paragraphs (in pink), Obligations (in green), Sub-obligations (in orange) and Exceptions (in red) along with their relations

After the modelling, the next task was to translate it in a machine-readable format. The EU commission has also recommended in the past to model the regulations in a machine-readable form such that it becomes easy to retrieve them online. For this, they also put forward an ontology called ELI to help with the modelling of metadata associated with the legislations. For instance, modelling information like where is it applicable, when did it come into force, which legislation does it supersede etc. Though we did not use this ontology, made sure that the model we propose can easily integrate with ELI. Thus, we also used Resource Description Framework (RDF) technology, on which ELI is based, to translate the model illustrated in Figure 20 in a machine-readable format.

The developed model is currently used for the software tool described in the next sub-section. However, as it is in a machine-readable format, it can also be used for other applications. For instance, as the regulation is available in 20+ languages the model can potentially be used for showing information in different languages. For instance, consider a case where a user is reading a paragraph and wants an official translation of the paragraph. In the current scenario, the user has to simultaneously browse two different documents and search the paragraph manually. Through the model, as even the paragraphs are modelled in a machine-readable form, it would be easy to cross-reference the texts in different languages. Similarly, the model can also be used for information querying, for instance, query to show paragraphs related to processing of data related to minors. Thus, the model can be used for several applications.

1.7.6.2 The software tool for compliance checking

The developed model is utilised for an application related to compliance checking. A software tool reads the model, filters the applicable obligations and presents a list of questions to the user in order to analyse the compliance with the GDPR.

Technical aspects

The developed tool is a web application, which can be accessed via a web browser. This results in platform independence and high flexibility in terms of its usage as no installation is required at the user's end for using the application. The frontend is built upon "Bootstrap", one of the leading frameworks for building web applications. The framework is well supported on all the modern internet browsers including desktop based as well as mobile browsers. For user interaction, JavaScript has been used to provide information in a dynamic way. The backend consists of a parser, an assessment engine and a report engine. The parser dynamically reads the GDPR model, stores it a RDF store (database), and reflects changes whenever the model is modified. The assessment engine then executes SPARQL queries on the RDF store to first prepare the questions for the preliminary analysis and then based on the user input, the set of obligations that would be applicable. All the code for the processing and interaction with the databased is written in PHP 7.1 along with the framework called Laravel.

User Interface

When a user starts the assessment, a preliminary assessment screen is shown. The preliminary assessment analyses the type of data processing under consideration to generate the set of obligations, which would be applicable. Thus, through the answers provided for the preliminary assessment, the tool understands the type of data processing involved. Also, an information button is provided to display additional information relevant to the questions. Figure 21 shows a screenshot of the preliminary assessment screen.

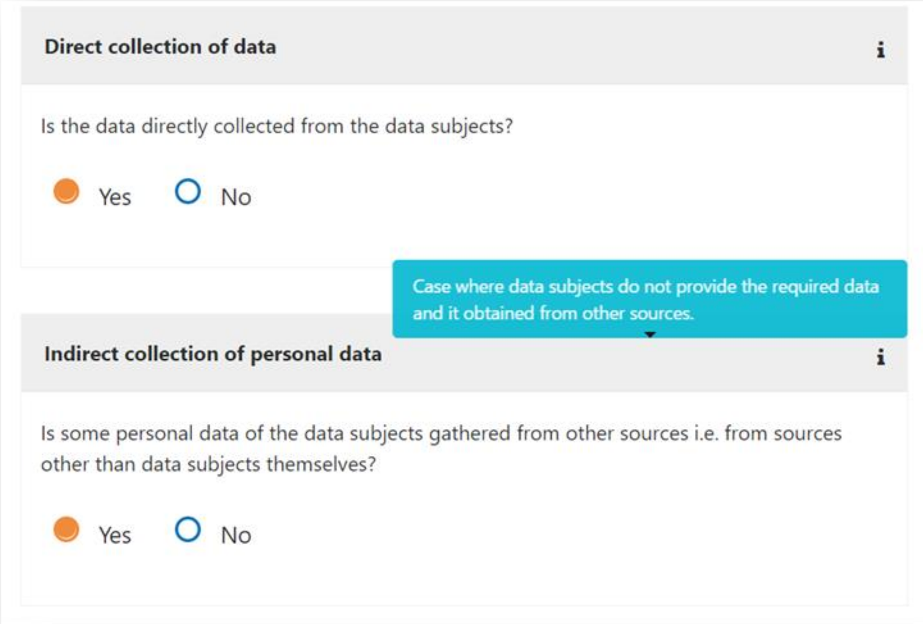


Figure 21: A screenshot from the preliminary assessment screen

After the preliminary assessment, the tool filters the applicable obligations and categorises them based on the topics (chapters) as defined in the GDPR. Figure 22 shows the dashboard that is shown after the preliminary assessment where the chapters are shown and user can select any chapter to start with the analysis.

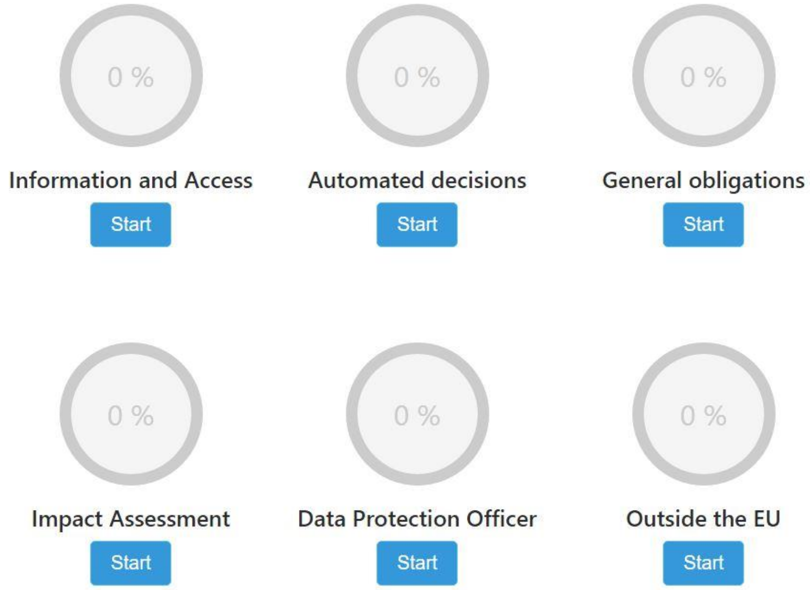


Figure 22: A screenshot of the dashboard

When the user selects a chapter, the tool shows a list of questions related to the fulfilment of the applicable obligations. Users are required to answer with a YES or a NO. Figure 23 shows a question where No is selected as the answer.

Figure 23: Screenshot showing the interface when user clicks No

In case "Yes" is selected, the tool then shows the applicable sub-obligations to investigate the obligation in detail. Figure 24 shows the list of sub-obligations generated in case the user clicked Yes for an obligation.

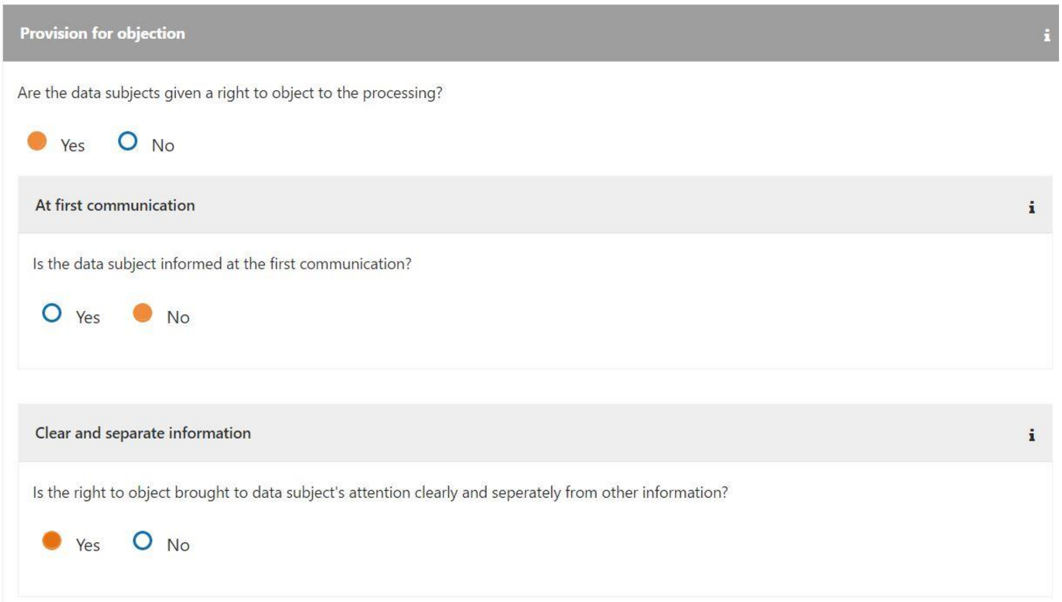


Figure 24: Screenshot showing the interface when user clicks Yes

In the end, based on all the answers, the tool creates a report showing a list of fulfilled obligations and obligations which are not fully fulfilled. Through the tool, companies can get an idea of how compliant they are with the data protection regulation by simply answering a list of Yes/No questions. Also, as the tool is based on the dynamic model, in case some interpretation changes for any part of the text, we just have to modify the model and the tool will dynamically reflect the changes.

1.7.7 Customer Segmentation

Understanding the reasons for which consumers enter stores has always been among retailers' greatest aspirations. The advent of affordable analytics and data processing capabilities has made this knowledge attainable (Bose, 2009). Retailers can instantaneously infer a wealth of consumer behavioural insights by extracting the knowledge hidden in point-of-sale (POS) data. Associations and complementarities between product categories in shopping baskets convey signals that, if properly analysed, can reveal the true meanings of consumers' shopping trips.

We have devised a business intelligence approach that utilizes POS basket data to mine the different customer segments that visit retail stores and, thus, understand the specific shopping needs and preferences per segment for offering suitable services to them. Specifically, we propose a clustering-based approach that conducts behavioural segmentation and characterization of shoppers' visits, by examining the product categories a customer has in her/ his basket during each visit in physical or web stores. The customer segmentation artefact utilizes the retailer's product assortment, product category tree and/or more data sources, such as consumer demographics, in order to interpret the customer segment behaviour in the most possibly accurate manner. The customer segmentation draws on CRISP-DM (Cross-Industry Standard Process for Data Mining) methodology (Chapman et al., 2000) and it includes four phases (Figure 25) : A) Business and Data Understanding (B) Modelling, i.e. creation of the data mining model, (C) Evaluation of the model and its results, and (D) Segmentation of customers' visits. We have validated the customer segmentation artefact and justify its applicability by producing the customer segments for five (5) different ADLER stores (2,3 billion records from one and a half year (2/1/2015 till 30/6/2016) point-of-sales data).

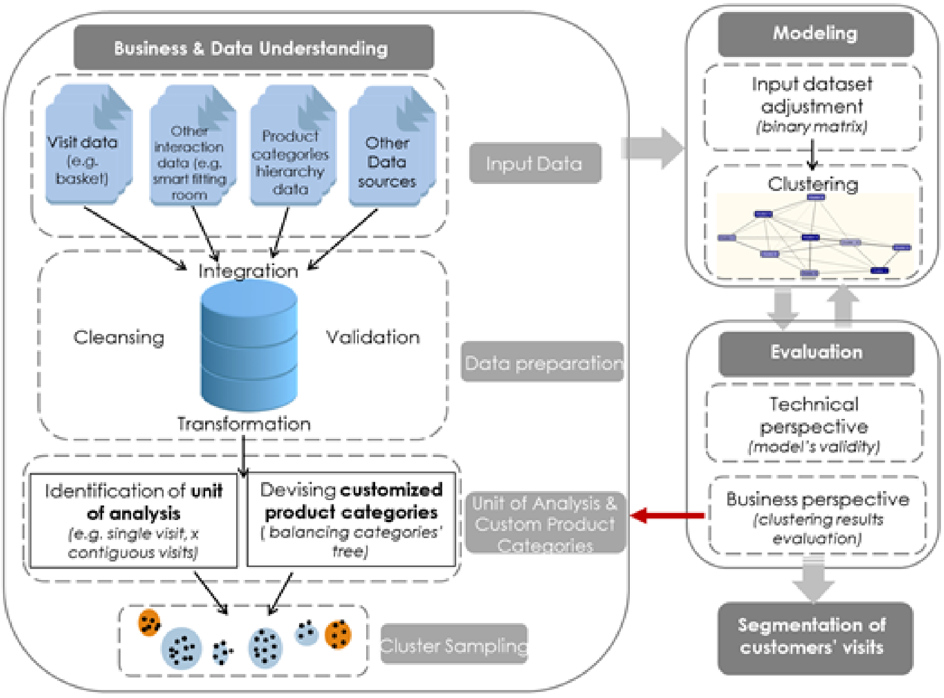


Figure 25: Clustering-based approach for visit segmentation

Further, we developed a module that visualizes the customer segment results in a way that they are more comprehensible and interpretable by the retailer executives. This visualization is built on HTML and D3.js JavaScript library that is used for producing dynamic, interactive data visualizations. The main user functionalities of the interface are:

- getting store overview information, such as shoppers gender, total revenue, top-selling product categories etc.,
- seeing all the customer segments (**Figure 26**),
- getting extra information per customer segment, e.g. size, percentage of baskets, number of visits, percentage of spending, percentage of male and female shoppers (**Figure 27**),
- user interaction with a customer segment to get more insights, such as the garment categories that are purchased more frequent in the specific customer segment and
- Comparative view of customer segments (Figure 28).

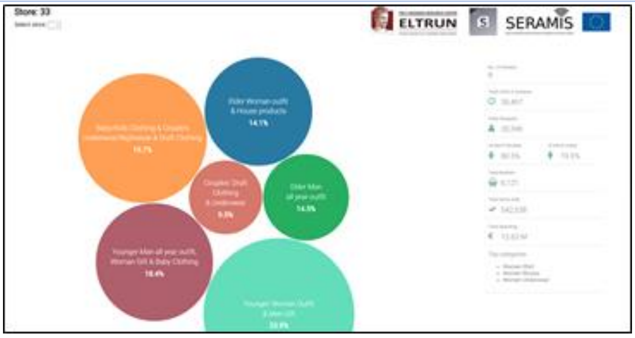


Figure 26: Customer segments for selected store

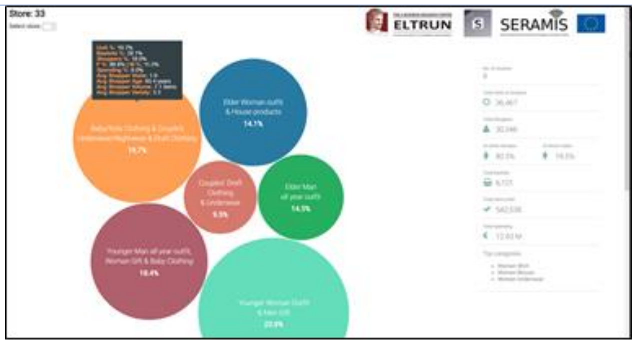
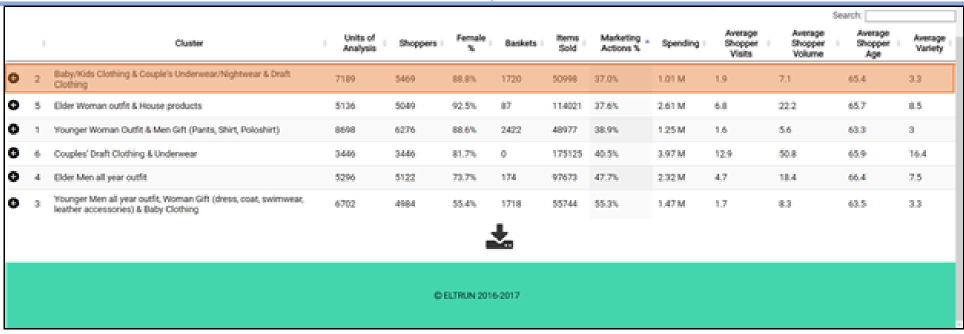


Figure 27: Customer segment's detailed info



		Cluster	Units of Analysis	Shoppers	Female %	Baskets	Items Sold	Marketing Actions %	Spending	Average Shopper Visits	Average Shopper Volume	Average Shopper Age	Average Variety
+	2	Baby/Kids Clothing & Couple's Underwear/Nightwear & Draft Clothing	7189	5469	88.8%	1720	50998	37.0%	1.01 M	1.9	7.1	65.4	3.3
+	5	Elder Woman outfit & House products	5136	5049	92.5%	87	114021	37.6%	2.61 M	6.8	22.2	65.7	8.5
+	1	Younger Woman Outfit & Men Gift (Pants, Shirt, Poloshirt)	8698	6276	88.6%	2422	48977	38.9%	1.25 M	1.6	5.6	63.3	3
+	6	Couples' Draft Clothing & Underwear	3446	3446	81.7%	0	175125	40.5%	3.97 M	12.9	50.8	65.9	16.4
+	4	Elder Men all year outfit	5296	5122	73.7%	174	97673	47.7%	2.32 M	4.7	18.4	66.4	7.5
+	3	Younger Men all year outfit, Woman Gift (dress, coat, swimwear, leather accessories) & Baby Clothing	6702	4984	55.4%	1718	55744	55.3%	1.47 M	1.7	8.3	63.5	3.3

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Figure 28: Customer segment's detailed info

The customer segmentation approach and the corresponding visualization interface module can support decision making, such as designing of marketing campaigns and promotions tailored to the customer segments, rearranging the store layout by placing product categories of the same customer visit segments at nearby store's aisles and shelves etc.

1.7.8 RFID Inventory Analytics

We have devised a data-driven approach that transforms RFID-captured data reflecting movements of inventory (products/ garments) between locations into a network of inventory flows between locations in the RFID-monitored business context. The inventory (product/ garment) flows reflect the sequence of actual RFID-tagged inventory movements between locations in the store, according to the business processes. This transformation of RFID inventory data into inventory flows supports the assessment of two extra inventory measures we propose:

- *Products flow volume*: represents the number of products that passed through a location at the same time moment and are directed to another location of the monitored business area.
- *Products flow mobility*: measures the time a product spends at a location before it moves to another (residence time), e.g. how much time an RFID-tagged product stays in a fitting room or in a sales floor shelf before it is purchased.

We have testified the credibility and effectiveness of this inventory analytics approach by applying it to real RFID data from a DITE store. Figure 29 depicts the mobility metric of the inventory flows in the DT store. For example, we see that the garments spent on average two months (60,49 days) in the whole store area until they are sold. Moreover, when a garment is delivered to the store, it takes about 43,12 days to be transferred in the store aisles in the sales floor.

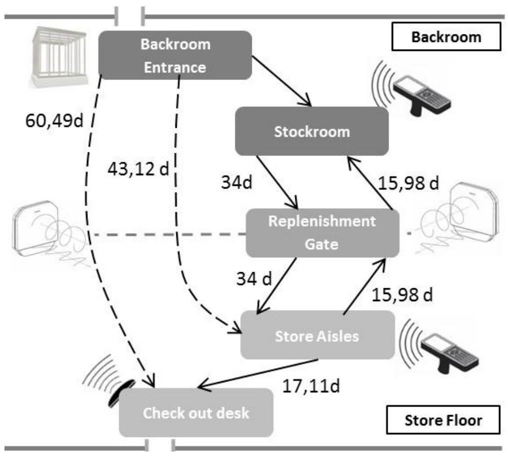


Figure 29: Mobility of inventory (garments) in the retail store

This extra knowledge of inventory flows provides improved inventory visibility and can facilitate managerial reports that support decision making. For example, utilizing the mobility of products flows, we can classify them into fast, medium, slow, and no moving-ones, based on the avg. time they spend in the sales floor before being sold (see the managerial report below in Figure 30). Such reports can help retail managers to reallocate the sales floor space in favour of the fast-moving products or design dynamic pricing strategies and promotions for slow-moving products. Further, the products flows volume can feed daily replenishment reports.

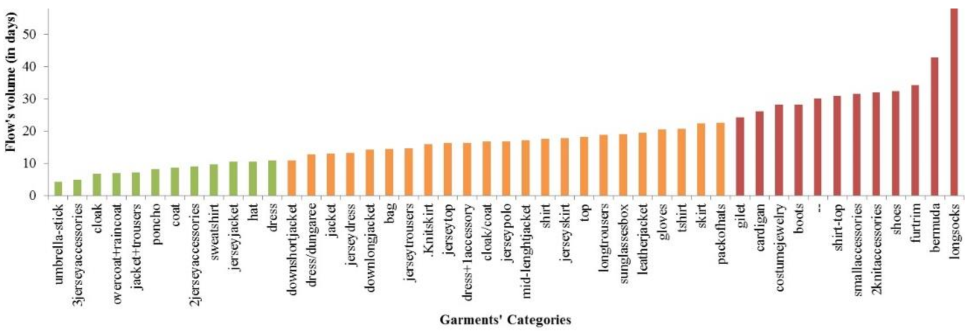


Figure 30: Classification of garments report

1.7.9 RFID Retail Simulation

In order to be able to better evaluate the impact of certain data quality measures like the implementation of our classification procedures, we developed a discrete event simulation model. Our model can help retailers to estimate the economic impact of the implementation of certain data quality measures on the quality of the data generated by their RFID infrastructures and the impact it has on the shelf replenishment process. As a result, we can estimate the influence these measures on inventory levels, stock out rates and services levels. We used the simulation framework SimPy for Python in order to create the model.

Our model is highly adaptable and able to simulate several RFID-based retail scenarios, like for example the introduction of an RFID-enabled inventory robot or the impact of improving the detection capabilities of different RFID gates or reading devices on the inventory accuracy of a retail store.

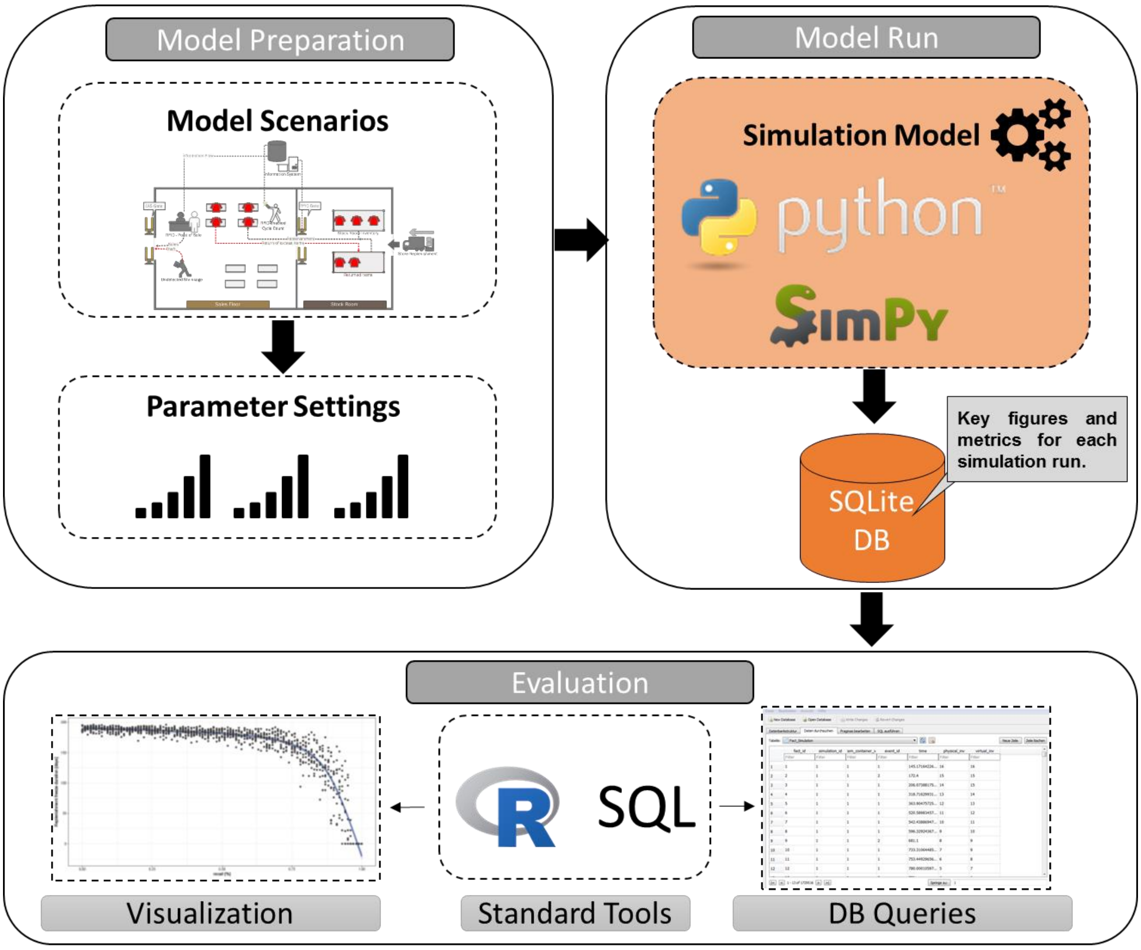


Figure 31 Simulation Workflow and elements

Figure 31 gives a rough overview of the elements of the simulation and our proposed workflow. Our developed model is able to simulate different scenarios for which parameter settings - i.e. assumptions about demand rates, as well as the detection capabilities of reading devices - have to be defined. Then the simulation is run based on the predefined parameter settings and saves the results to a database. We can then further analyze the results within the database with standard data analysis tools like SQL or R. This helps us to observe how a change in the model environment affects key performance indicators like the inventory accuracy or the stock out quota.

Figure 32 shows an excerpt from a simulation run and demonstrates a common problem of inventory management namely the growing discrepancy between on hand inventory (red line) and the inventory that is tracked within the system (blue line). This issue can lead to several problems, like bad replenishment orders from a retail store or in-store replenishment freezes on the shop floor (i.e. a shelf will not be replenished because the system “thinks” there is still enough inventory on the shop floor even though there is not).

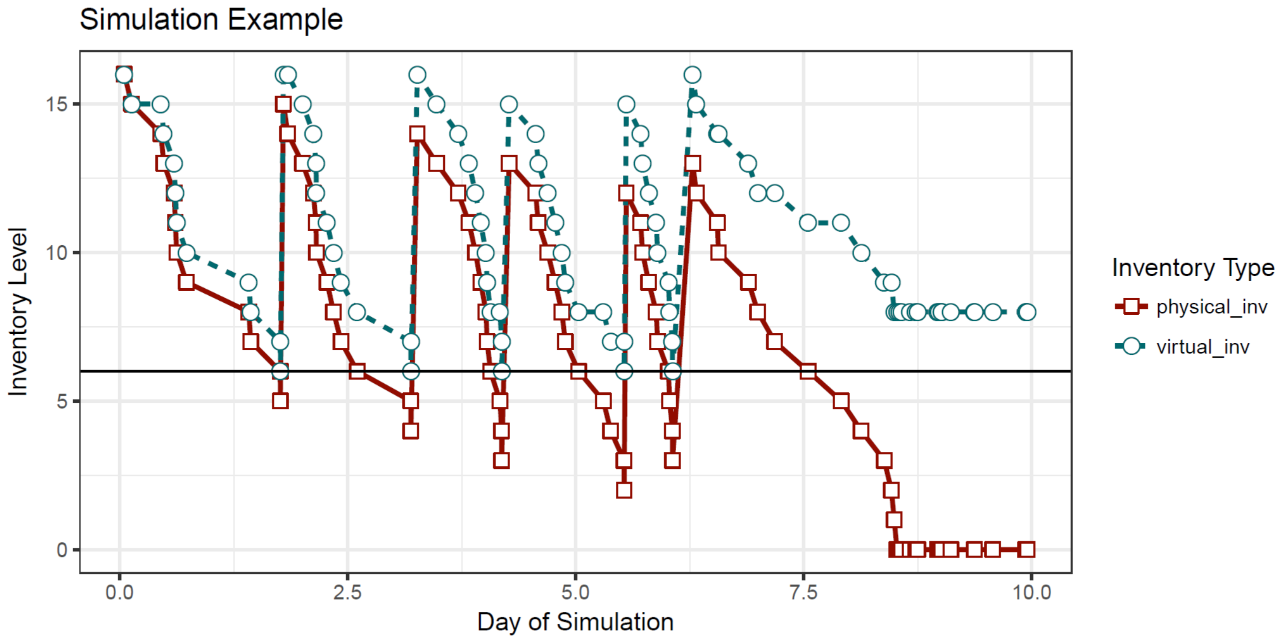


Figure 32 Example of a simulation run

We illustrate the utility of the simulation with the example of the RFID-enabled electronic article surveillance (EAS). Figure 33 illustrates the relation between detection capability of the EAS and the duration of replenishment freezes (a situation in which the stock level is zero and the RFID-system falsely does not trigger a replenishment of the sales floor inventory). Our figure shows that an improvement of a few percentage points in the detection capabilities of the EAS (e.g. with the help of our classification algorithms) can make a huge difference on the occurrence and duration of replenishment freezes.

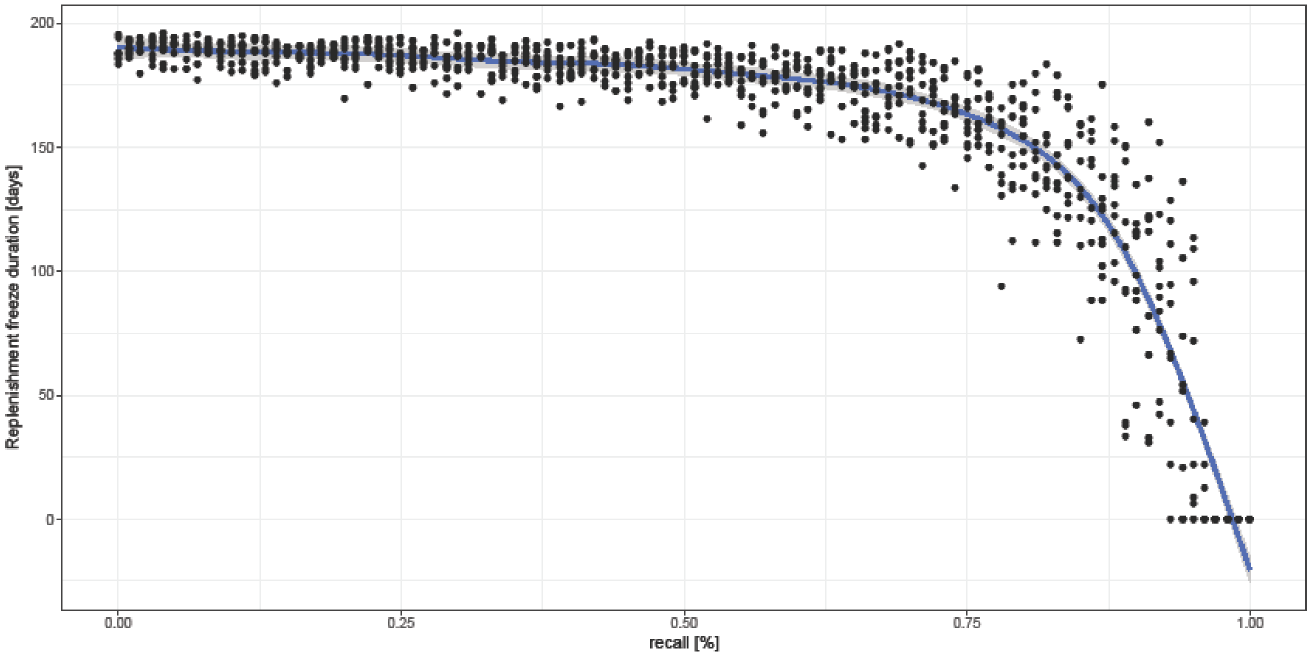


Figure 33 Reduction of the duration of replenishment freezes

Consequently, our simulation model can (i) serve as a decision support tool for management in order to help decide if to introduce certain data quality measures and (ii) serve scientists in order to try out different combinations of RFID devices and to observe the impact on the inventory data quality.

1.8 Potential Impact

SERAMIS contributes to the target outcome “Applications for the Sensing Enterprise” in two ways:

- On the one hand, the project considered the processing of massive RFID data sets generated along the logistical chain, both in real-time and offline. This includes data collected from logistics and store operations as well as data created by customers interacting in some way with the product on the sales floor. We made such data interpretable and ensured a high level of data quality by providing novel filtering and aggregation procedures.
- On the other hand, the project investigated the business value of the resulting data on different levels. First, information derived from RFID data streams was used in order to improve firm performance on an operational level by better informing and even transforming business processes. Second, decision-makers were enabled to make better decision based on RFID data that provides a more complete, fine-granular picture of the reality of operations, the physical flow of goods, and the actual behaviour of customers.

1.8.1 Business impact

SERAMIS impacts business decisions in multiple ways. Our frameworks and guidelines will help companies within the European Union to faster perform their item-level RFID projects. Clearly, the focus of SERAMIS research is in the fashion and apparel sector, but the frameworks and guidelines developed here can also be extended to other sectors and supply chains. Firstly, the use cases framework developed and validated during the project can be relevant for both practitioners and researchers: researchers can build upon this framework and understand new branches of research. Practitioners, on the other hand, can better understand the use cases and potential benefits of RFID deployments and use our framework as a support tool to validate their business purposes.

Moreover, our framework for RFID-enabled indicators will serve as a basis for companies who want to implement a performance measurement system that is based on RFID data. We used the term Value-Added Indicators (VAIs), instead of the common acronym KPIs (Key Performance Indicators), because the proposed metrics aim to add additional value to the existing management reporting with regard to the fashion and apparel supply chain. Practitioners from this sector, in fact, may benefit from our research by having available a validated framework with a set of 60 different indicators that can be readily implemented into their own management reporting. Thus, the framework may guide decision makers in choosing several topics of interest, and also can serve as the basis for the generation of novel ideas.

Another important goal of the project was to identify SERAMIS results that could be considered as subject for standardisation. Indeed, during the project, regular communication was established between project beneficiaries and relevant standardisation authorities (e.g. EPCglobal, DASH7) to provide timely input of SERAMIS' results into corresponding standardisation initiatives. At present, however, no SERAMIS' result has been considered by the consortium as subject for standardisation. The consortium, however, as well as single beneficiaries of the project are continuously monitoring the situation of SERAMIS-related results, to understand if and where they could be considered as subject for standardisation.

Social and legislative implications of RFID related data processing was a paramount concern for the project. For every step, privacy guidelines were prepared. These guidelines could be really beneficial for small and medium sized enterprises which would deploy smart use cases using RFID to interact with the customers. For instance, regarding development of a smart recommender system, the guidelines describe three different paths that a company can take, based on the efforts required to ensure data protection compliance. In other words, guidelines discuss various possible options and companies can do a cost-benefit analysis to choose a suitable option.

In addition, an extensive Privacy Impact Assessment was also conducted and documented, which companies can use as a reference. Based on the new GDPR, companies involved in data processing resulting in high risk to customers' privacy have to now compulsorily conduct a Privacy Impact Assessment. For such companies, the PIA conducted for SERAMIS would be a starting point.

Moreover, the machine-readable model of the GDPR obligations developed during the project could prove beneficial to multi-national firms operating in different EU countries. The model can be used for creating a referenced translation of the official documents as every Article and Paragraph of the GDPR has been given a unique identifier. Currently, on the official EurLex website, the translating of documents is not cross-referenced. Also, the GDPR compliance tool developed during SERAMIS would also be really beneficial for small companies which do not have a legal department to help them with the legal data protection compliance process.

1.8.2 Social acceptance

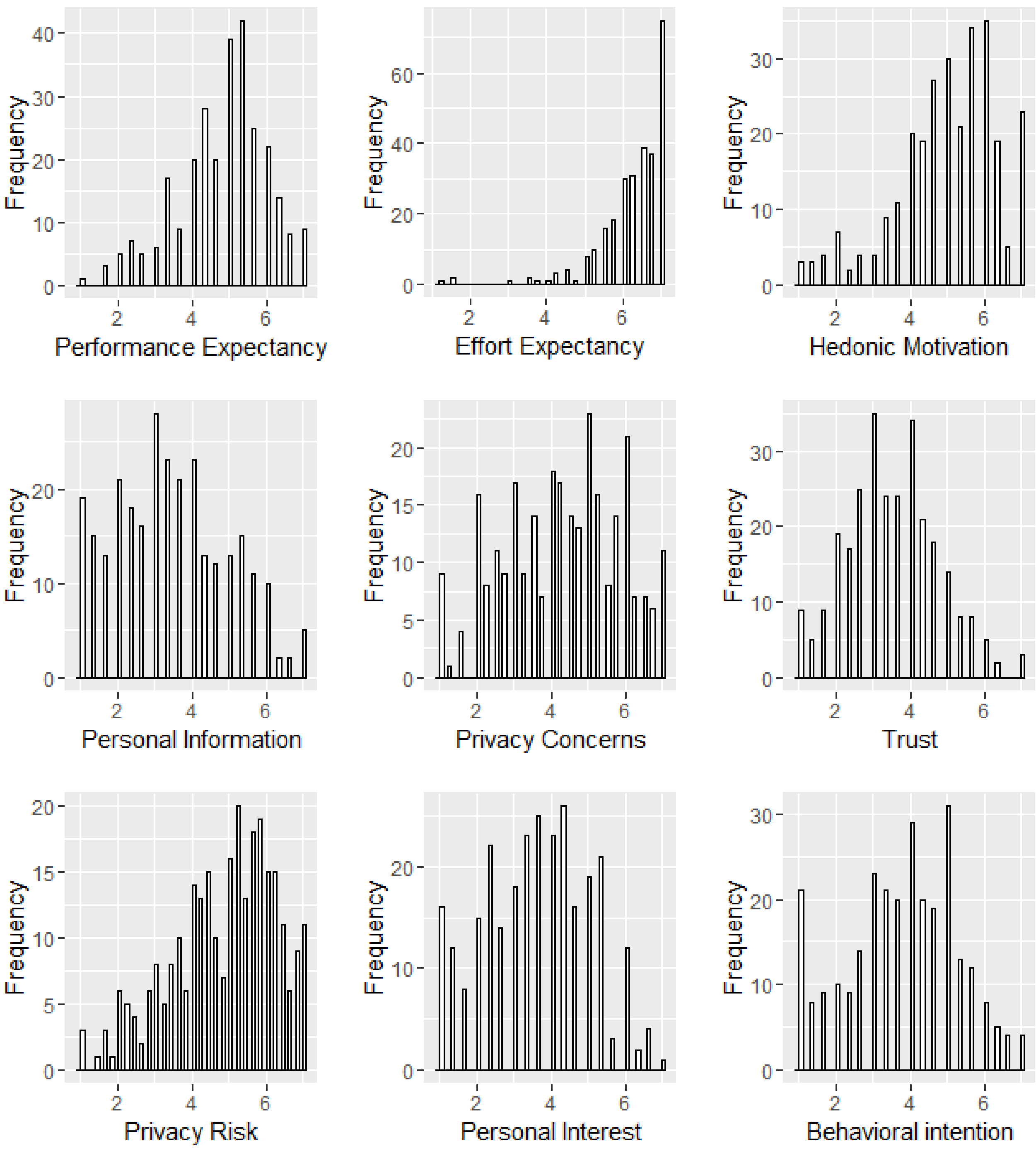
In order to socially evaluate the acceptance of the novel RFID-enabled applications we performed an online survey and several interviews in our test store with customers. The results of our online survey are depicted in Table 9.

The results of the survey show how people perceived the smart fitting room application. Most customers perceived the system as something useful and being able to streamline their shopping trips (Performance Expectancy). People perceived our prototype as easy to use (Effort Expectancy). Most people who participated in our survey were intrinsically motivated to try out novel technology (Hedonic Motivation).

However, most customers are rather reluctant to provide additional private information in order to use additional services. Also, other privacy related factors were important to the survey participants. The perceived risks, trust and privacy concerns towards using the smart fitting room were very important to them. According to our survey results, retailers which want to implement IoT-based applications have to emphasize on the security and reliability of the respective IoT system and the security of the handling of data. Clear communication with the customers is necessary in order to not accidentally harm the reputation of a company.

Besides the online survey, we conducted several interviews with customers of our industry partners Adler and DITE. Adler whose customer base is rather focused on an older target group showed great interest in using the smart fitting room. The interviews also showed us ways on how to improve the system for Adler's customers. Especially a clearer user interface and larger icons (so that older people can better see them) were an outcome of our interviews.

Table 9 Key attributes towards IoT-based applications answered on a Likert Scale



DITE has developed another questionnaire to evaluate the acceptance and use of RFID technology by its store associates. The choice of non-delivering the questionnaire to DITE end customers is due to the fact that RFID technology is, at present, not directly involved with users' experience in DITE stores. Thus, DITE staff evaluated the RFID Dashboard for Fashion and all its possible uses, namely: (i) replenishment, (ii) re-assortment, (iii) receiving and shipping, (iv) inventory count, (v) RTLS and (vi) picking app. The questionnaire was sent to all DITE staff that operates in RFID-enabled stores in

December 2016. We collected a total of 114 valid answers. The results are reported in Figure 34: in a Likert scale from 1 to 4, all groups of items have a positive or very positive response, with a strong average intention to use and perceived usefulness of RFID services.

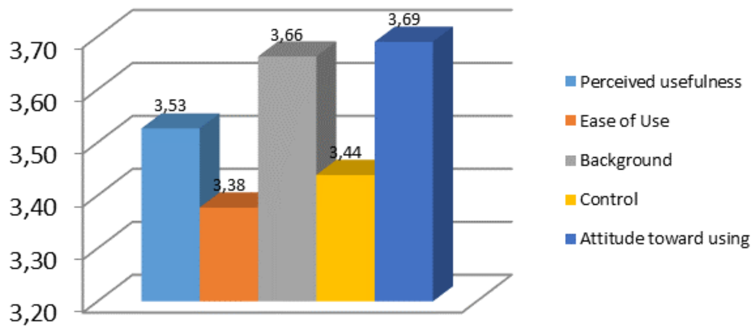


Figure 34: Aggregated results of the DITE survey of acceptance and use of RFID technology

1.8.3 Main dissemination activities

The main dissemination activities of the SERAMIS project are listed in the bullet points below:

- LinkedIn group (2014-present, currently 35 members);
- 5 newsletters issued (2014-present, currently 64 subscribers):
  - 2014: http://seramis-project.eu/?wysija-page=1&controller=email&action=view&email_id=5&wysijap=subscriptions
  - 2015: http://seramis-project.eu/?wysija-page=1&controller=email&action=view&email_id=8&wysijap=subscriptions
  - 2016_1: http://seramis-project.eu/?wysija-page=1&controller=email&action=view&email_id=10&wysijap=subscriptions
  - 2016_2: http://seramis-project.eu/?wysija-page=1&controller=email&action=view&email_id=11&wysijap=subscriptions
  - 2017: http://seramis-project.eu/?wysija-page=1&controller=email&action=view&email_id=14&wysijap=subscriptions
- **Special Issue of the International Journal of RF Technologies: Research and Applications** "Internet of Things and Big Data: How They Enable Effective Decision Making and New Innovative Services". The aim of this special issue is to understand how automatic

identification, tracking and sensing technologies, IoT and Big Data may be linked together to develop novel smart information systems. At present, 4 papers have been accepted (2 of which pending minor revisions) for the special issue, comprehending both research from within and outside SERAMIS. **The publication date of the special issue is planned in Autumn 2017**.

- A total of **42 research papers**, either published on international journals or presented at international conferences (the list is reported below in Table 10);
- Events & project presentations (does not include presentation of SERAMIS research results, but only presentation of the SERAMIS project as a whole):
    - **RFID 4 Fashion event**: On Thursday 12th November 2015, 100+ people gathered in Parma (Italy) for the RFID 4 fashion event. The workshop aimed at presenting the results of the latest research activities of the EU funded SERAMIS Project and detailing successful RFID deployments and benefits in companies like lmpinj, Diffusione Tessile, Adler, Liu Jo, Patrizia Pepe and Decathlon. The workshop was promoted by Id Solutions, and co-sponsored by Impinj, NXP, Smartrac, Zebra, TexTrace, Lab Id and Temera.
    - Frédéric Thiesse from the University of Würzburg and Andrea Volpi from the University of Parma presented the SERAMIS project at the GS1 Global Standards Event in Rome on the 8th of October. Frédéric Thiesse gave a speech titled “Handling massive RFID data sets”, Andrea Volpi presented "RFID Research activities".
    - Katerina Pramatari from the Athens University of Economics and Business and Antonio Rizzi from the University of Parma presented SERAMIS results at the International RFID congress taking place in Marseille from October 7th to October 8th. Katerina Pramatari gave a lecture about "Assessing the impact of RFID projects: European survey results", Antonio Rizzi about "Evolving Use Cases and Business Models for RFID in Retail".
    - SERAMIS project presentation at I-ESA 2016: http://193.136.11.52/programa/Conference_Booklet_i-ESA_%202016.pdf

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Maestrini, V., Luzzini, D., Maccarrone, P., & Caniato, F. (2017). Supply chain performance measurement systems: A systematic review and research agenda. International Journal of Production Economics, 183(November 2016), 299–315. https://doi.org/10.1016/j.ijpe.2016.11.005

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Rizzi, A., & Romagnoli, G. (2017). Testing and deploying an RFID-based Real-Time Locating System at a fashion retailer: A case study. In R. Rinaldi & R. Bandinelli (Eds.), Business Models and ICT Technologies for the Fashion Supply Chain (Vol. 413, pp. 201–214). Springer International Publishing. https://doi.org/10.1007/978-3-319-48511-9

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2 Use and dissemination of foreground

2.1 Section A (public)

Table 10: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES										
NO	Title	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers[5] (if available)	Is/Will open access[6] provided to this publication?
1	*Adoption of RFID Technology – The Case of Adler. A European Fashion Retail*	Leitz R., Rogge-Solti A., Weinhard A., Mendling, J.	*BPM Cases*	*N/A*	*Springer*		*2017*			no

[5] A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

[6] Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

	Company. Business Process Management Cases									
2	*Proposing a Value-Added Indicators framework for the apparel and fashion sector: Design and empirical evaluation*	Bertolini M., Romagnoli G., Weinhard A.	*Special Issue*	*N/A*			*2017*			no
3	Prediction of business process durations using non-Markovian stochastic Petri nets	Rogge-Solti A., Weske M.	*Information Systems*	*Eight volumes per year*	*Elsevier*		*2015*	*1-14*	https://doi.org/10.1016/j.is.2015.04.004	yes
4	A comparison of RFID-based shelf replenishment policies in retail	Frédéric Thiesse, Thomas Buckel	*International Journal of Production Economics*	N/A	Elsevier		2015		http://dx.doi.org/10.1016/j.ijpe.2014.09.002.	no

	stores under suboptimal read rates, International Journal of Production Economics									
5	Classification Models for RFID-Based Real-Time Detection of Process Events in the Supply Chain: An Empirical Study	Thorben Keller, Frédéric Thiesse, and Elgar Fleisch	ACM Trans. Manage. Inf. Syst.	Special Issue	ACM	New York	2014		doi>10.1145/2629449	no
6	A new framework for RFID use cases in fashion and apparel retailing	Rizzi, A., Romagnoli, G., Thiesse, F.	International Journal of RF Technologies: Research & Applications	7(2-3)	IOS Press	Netherland	2016	105-129	10.3233/RFT-150075	NO

7	Testing and deploying an RFID-based Real-Time Locating System at a fashion retailer: A case study	Rizzi, A., Romagnoli, G.	Business Models and ICT Technologies for the Fashion Supply Chain	Lecture Notes in Electrical Engineering, 413	Springer	Berlin (Germany)	2017	201-214	10.1007/978-3-319-48511-9_17	NO
8	The impact of RFID technologies on inventory accuracy in the apparel retailing: Evidence from the field	Bertolini, M., Bottani, E., Romagnoli, G., Vignali, G.	International Journal of RF Technologies: Research & Applications	6(1)	IOS Press	Netherland	2015	51-71	10.3233/RFT-150069	NO
9	A framework for efficiently mining the organisational perspective of business processes	Schönig S., Cabanillas C., Mendling J.	Decision Support Systems	89	Elsevier		2016	87-97	https://doi.org/10.1016/j.dss.2016.06.012	yes

10	Matching events and activities by integrating behavioral aspects and label analysis	Baier T., Di Ciccio C., Mendling J., Weske M.	*Software & Systems Modeling (SoSyM)*	2017	Springer		2017	1-26	10.1007/s10270-017-0603-z	yes
11	Improving sales turnover in fashion retailing by means of an RFID-based replenishment policy	Bottani, E., Montanari, R., Romagnoli, G.	International Journal of RF Technologies: Research & Applications	7(1)	IOS Press	Netherland	2016	65-86	10.3233/RFT-150072	NO
12	Benchmarking of RFID devices for apparel applications: An experimental approach	Piramuthu, S., Rizzi, A., Vignali, G., Volpi, A.	International Journal of RF Technologies: Research & Applications	6(2-3)	IOS Press	Netherland	2015	151-169	10.3233/RFT-140064	NO

13	Editorial - RFID for fashion: Advancements in research, technology and implementation	Bottani, E., Goyal, S., Volpi, A.	International Journal of RF Technologies: Research & Applications	6(2-3)	IOS Press	Netherland	2015	73-75	10.3233/RFT-140065	NO
14	Mining Resource Assignments and Teamwork Compositions from Process Logs	Schönig S., Cabanillas C., Di Ciccio C., Jablonski S., Mendling J.	Softwaretechnik Trends	36(4)	GI (Gesellschaft für Informatik)		2016		http://pi.informatik.uni-siegen.de/stt/36_4/03_Technische_Beitraege/Schoenig_et_al_2016.pdf	yes
15	*Explaining Adoption of Pervasive Retail Systems with a Model based on UTAUT2 and the Extended Privacy Calculus*	Weinhard A.; Hauser M.; Thiesse F.	*PACIS 2017 Proceedings*	*yearly*	*AIS*		*2017*			

16	*Customer Intentions towards Using IoT-based Shopping Applications*	Weinhard A.; Hauser M.; Thiesse F.	DIGIT 2016 Proceedings	*yearly*	*AIS*		2016		N/A	no
17	In Log and Model We Trust? A Generalized Conformance Checking Framework.	Rogge-Solti A., Senderovich A., Weidlich M., Mendling J., Gal A.	BPM 2016 Proceedings	yearly	Springer	Rio de Janeiro, Brazil	2016	179-196	https://doi.org/10.1007/978-3-319-45348-4_11	yes
18	The ROAD from Sensor Data to Process Instances via Interaction Mining	Senderovich A., Rogge-Solti A., Gal A., Mendling J., Mandelbaum A.	CAiSE 2016 Proceedings	yearly	Springer	Ljubljana, Slovenia	2016	257-273	https://doi.org/10.1007/978-3-319-39696-5_16	yes
19	Efficient and Customisable Declarative Process Mining with SQL	Schönig S., Rogge-Solti A., Cabanillas C., Jablonski S., Mendling J.	CAiSE 2016 Proceedings	yearly	Springer	Ljubljana, Slovenia	2016	290-305	https://doi.org/10.1007/978-3-319-39696-5_18	yes

20	Data-Driven Performance Analysis of Scheduled Processes	Senderovich A., Rogge-Solti A., Gal A., Mendling J., Mandelbaum A., Kadish S., Bunnell C. A.	BPM 2015 Proceedings	yearly	Springer	Innsbruck, Austria	2015	35-52	https://doi.org/10.1007/978-3-319-23063-4_3	yes
21	Time Series Petri Net Models - Enrichment and Prediction	Solti A., Vana L., Mendling J.	SIMPDA (Revised Selected Papers) 2015	yearly	Springer		2017	124-141	https://doi.org/10.1007/978-3-319-53435-0_6	yes
22	Deploying RFID in the fashion and apparel sector: an "in the field" analysis to understand where the technology is going to	Esposito, E., Romagnoli, G., Sandri, S., & Villani, L.,	Proceedings of the XXth Summer School Francesco Turco (Industrial Systems Engineering)	September 16-18	AIDI	Naples (Italy)	2015		not available	NO
23	Developing a new frame for categorising use	Esposito, E., Romagnoli, G.,	Proceedings of the XXth	September 16-18	AIDI	Naples (Italy)	2015		not available	NO

	cases of RFID in the fashion and apparel sector	Sandri, S., & Villani, L.,	Summer School Francesco Turco (Industrial Systems Engineering)							
24	Developing a new framework for Value Added Indicators enabled by RFID data in the fashion and apparel sector	Bertolini, M., Romagnoli, G., Weinhard, A.	Proceedings of the XXIst Summer School Francesco Turco (Industrial Systems Engineering)	September 13-15	AIDI	Naples (Italy)	2016		not available	NO
25	Benchmarking of RFID UHF and NFC tags for apparel applications	Bertolini, M., Cilloni, G., Romagnoli, G., Volpi, A.	Proceedings of the XXIst Summer School Francesco	September 13-15	AIDI	Naples (Italy)	2016		not available	NO

			Turco (Industrial Systems Engineering)							
26	Editorial - RFID for fashion: Advancements in research, technology and implementation	Bottani, E., Goyal, S., Volpi, A.	International Journal of RF Technologies: Research & Applications	6(2-3)	IOS Press	Netherland	2015	73-75	10.3233/RFT-140065	NO
27	Reconstructing the Giant: Automating the Categorization of Scientific Articles with Deep Learning Techniques	DANN, DAVID ; HAUSER, MATTHIAS ; HANKE, JANNIS	*Proceedings of the 13th International Conference on Wirtschaftsinformatik*	February 12-15, 2017		St. Gallen, Switzerland	2017	1538-1549		
28	A Hidden Markov Model	HAUSER, MATTHIAS ; GRIE	*11th Annual*	May 9-11, 2017		Phoenix, USA				

	for Distinguishing between RFID-tagged Objects in Adjacent Areas	BEL, MATTHIAS ; THIESSE, FRÉDÉRIC	*IEEE International Conference on RFID*							
29	Leveraging RFID Data Analytics for the Design of an Automated Checkout System	HAUSER, MATTHIAS ; GÜNTHER, SEBASTIAN ; FLATH, CHRISTOPH M. ; THIESSE, FRÉDÉRIC	*Proceedings of the 13th International Conference on Wirtschaftsinformatik*	February 12-15, 2017		St. Gallen, Switzerland		1201-1204		
30	Empowering Smarter Fitting Rooms with RFID Data Analytics	HAUSER, MATTHIAS ; GRIEBEL, MATTHIAS ; HANKE, JANNIS ; THIESSE, FRÉDÉRIC	*Proceedings of the 13th International Conference on Wirtschaftsinformatik*	February 12-15, 2017		St. Gallen, Switzerland		1299-1302		

31	Pushing the limits of RFID: Empowering RFID-based Electronic Article Surveillance with Data Analytics Techniques	HAUSER, MATTHIAS ; ZÜGNER, DANIEL ; FLATH, CHRISTOPH M. ; THIESSE, FRÉDÉRIC	*Proceedings of the Thirty Sixth International Conference on Information Systems*	December, 13-16, 2015		Fort Worth, USA				
32	Modelling the General Data Protection Regulation	AGARWAL, SUSHANT; KIRRANE SABRINA; SCHARF JOHANNES.	*Trends and Communities of Legal Informatics: Proceedings of the 20th International Legal Informatics Symposium IRIS 2017*	February, 23-25, 2017		Salzburg, Austria				

33	Developing a Structured Metric to Measure Privacy Risk in Privacy Impact Assessments	AGARWAL, SUSHANT	*10th IFIP WG 9.2, 9.5, 9.6/11.7, 11.4, 11.6/SIG 9.2.2 International Summer School, Edinburgh, UK, August 16-21, 2015, Revised Selected Papers*	August, 16-21, 2015		Edinburgh, UK				
34	Customer Visit Segmentation Using Market Basket Data	Griva, A., Bardaki, C., Pramatari K.	Proceedings of pre-ICIS 2016, Special Interest Group on Decision Support	11-14 December, 2016	AIS	Dublin, Ireland				

			and Analytics (SIGDSA)/ IFIP WG8.3 symposium: Innovations in Data Analytics								
35	Mapping moving object events into object network flows to support decisions	Griva, A., Bardaki, C., Pramatari K., Doukidis G.	Proceedings of 24th European Conference on Information Systems (ECIS 2016)	12-15 June 2016	AIS	Istanbul, Turkey					
36	Segmentation of Shopper Visits based on Shopper Interaction data	Griva, A., PramatariK., Bardaki, C., Doukidis G.	1st EURO Working Group on Retail Operations	3-5 June 2016		Munich, Germany					

	in Different Retail Contexts									
37	Garment Recommendations for Online and Offline Consumers	Skiada, M., Lekakos, G., Gkika, S., Bardaki, C.	MCIS 2016 Proceedings	September 2016	AIS	Paphos, Cyprus				
38	RFID-Enabled Visualization of Product Flows: A Data Analytics Approach	Griva, A., Bardaki, C.,Pramatari, K.	MCIS 2015 Proceedings	October 3-5, 2015	AIS	Samos, Greece.				
9	Location-Aware Path Alignment in Process Mining	Blank P., Maurer M., Siebenhofer M., Rogge-Solti A., Schönig S.	EDOC 2016 workshops	yearly	IEEE	Vienna, Austria	2016	1-8	https://doi.org/10.1109/EDOCW.2016.7584367	yes
40	Comparison of Visualization Concepts of Map Layouts	Pachinger F., Sheikh Z., Zajaczkowski P., Rogge-Solti A., Schonig S., Mendling, J.	EDOC 2016 workshops	yearly	IEEE	Vienna, Austria	2016	1-5	https://doi.org/10.1109/EDOCW.2016.7584356	yes

41	RF-based locating of mobile objects	Uckelmann, D., Romagnoli, G.	Proceedings of the 6th International Conference on the Internet of Things (IOT 2016)	November 07-09	ACM International Conference Proceeding Series	Stuttgart (Germany)	2016	147-154	10.1145/2991561.2991565	NO
42	Artifact-driven Process Monitoring: Dynamically Binding Real-world Objects to Running Processes	Meroni G., Di Ciccio C., Mendling J.	CAiSE Forum 2017	June 12-16, 2017	CEUR-ws	Essen, Germany	2017	105-112	http://ceur-ws.org/Vol-1848/CAiSE2017_Forum_Paper14.pdf	YES

LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities[7]	Partner	Name & Title	Date	Conference name & Location	Type of audience[8]		Countries addressed
1	Presentation	WUV	Jan Mendling, "So what are we really doing in BPM research?"	Oct. 6th 2016	TU/e Eindhoven, Netherlands	Scientific community		International
2	Presentation	WUV	Jan Mendling, "So what are we really doing in BPM research?"	Nov. 15th 2016	Uni Liechtenstein, Liechtenstein	Scientific community		International
3	*Video*	WUV	Jan Mendling, SERAMIS feature in the "researcher of the month" video	June 2016	https://player.vimeo.com /video/166389768	Public		International
4	Presentation	WUV	Andreas Solti "The ROAD from sensor data to process instances"	Feb.15th, 2016	Vreie Universiteit Amsterdam. Netherlands	Scientific community		International

[7] A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

[8] A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias ('multiple choices' is possible.

5	Presentation	WUV	Andreas Solti "The ROAD from sensor data to process instances"	Feb.25th, 2016	TU/e Eindhoven, Netherlands	Scientific community		International
6	Presentation	WUV	Stefan Schönig "Efficient and Customizable Process Mining with SQL"	June 16th, 2016	CAiSE 2016, Ljubljana, Slovenia	Scientific community		International
7	Presentation	WUV	Andreas Solti "Comparison of Visualization Concepts of Map Layouts"	Sept. 9th, 2016	EDOC workshops 2016, Vienna, Austria	Scientific community		International
8	Presentation	WUV	Andreas Solti "Location-Aware Path Alignment in Process Mining"	Sept. 9th, 2016	EDOC workshops 2016, Vienna, Austria	Scientific community		International
9	Presentation	WUV	Andreas Solti "In Log and Model We Trust? (extended abstract)"	Oct. 2nd-3rd, 2016	EMISA, Vienna, Austria	Scientific community		International
10	Presentation	WUV	Andreas Solti "Temporal Anomaly Detection in Business Processes"	Sept 7th -11th 2015	Business Process Management 2014, Eindhoven, The Netherlands	Scientific community		International
11	Presentation	WUV	Andreas Solti "RFID-Technologie und Innovation im Textileinzelhandel"	Nov. 23rd, 2016	GPM Process Management Summit	Industry, Civil Society		German speaking countries
12	Presentation	AUEB	Katerina Pramatari 'SERAMIS results'	7-8 October 2014	International RFID congress, France	Industry		International

13	Presentation	AUEB	Cleopatra Bardaki 'SERAMIS results'	Dec 2016	IoT Conference, Athens, Greece	Industry + Scientific community		International
14	Presentation	AUEB	Cleopatra Bardaki 'SERAMIS results'	March 31th 2015	RFID & INTERNET OF THINGS: CASE STUDIES AND EXPLOITATION	Industry + Scientific community		International
15	Presentation	UNIPR	Antonio Rizzi “Improving Sales Through RFID Empowered Visual Merchandising”	May 2017	RFID JOURNAL LIVE!	Industry + Scientific community		International
16	Presentation	UNIPR	Andrea Volpi “Dual frequency tag performances in the fashion industry”	Apr. 2017	IT 4 Fashion 2017, Florence	Industry + Scientific community		International
17	Presentation	UNIPR	Giovanni Romagnoli “Testing and deploying an RFID-based Real-Time Locating System at a fashion retailer: A case study”	22 Apr. 2016	IT 4 Fashion 2016, Florence	Industry + Scientific community		International
18	Presentation	UNIPR	Giovanni Romagnoli “RF-based locating of mobile objects”	09 Nov. 2016	IoT 2016, Stuttgart	Industry + Scientific community		International

19	Presentation	UNIPR	Giovanni Romagnoli “Developing a new framework for Value Added Indicators enabled by RFID data in the fashion and apparel sector”	13 Sep. 2016	XXIst Summer School F. Turco	Scientific community		International
20	Presentation	UNIPR	Giovanni Romagnoli “Benchmarking of RFID UHF and NFC tags for apparel applications”	13 Sep. 2016	XXIst Summer School F. Turco	Scientific community		International
21	Presentation	UNIPR	Giovanni Romagnoli “Deploying RFID in the fashion and apparel sector: an "in the field" analysis to understand where the technology is going to”	15 Sep. 2015	XXth Summer School F. Turco	Scientific community		International
22	Presentation	UNIPR	Giovanni Romagnoli “Developing a new frame for categorising use cases of RFID in the fashion and apparel sector”	15 Sep. 2015	XXth Summer School F. Turco	Scientific community		International
23	Presentation	UNIWUE	Alexander Weinhard	11 Dez. 2016	Digit 2016	Scientific community		International

			"Customer Intentions towards Using IoT-based Shopping Applications"					
24	Presentation	UNIWUE	Frédéric Thiesse "Presentation at Global Standards Event"	16 Okt 2014	GS1 Global Standards Event	Industry + Scientific community		International
25	Presentation	UNIWUE	Matthias Hauser "Empowering Smarter Fitting Rooms with RFID Data Analytics"	12. Feb 2017	WI 2017	Scientific community		International
26	Presentation	UNIWUE	Matthias Hauser "IoT-enabled Customer Experience in Retail Fashion Stores"	29 March 2016	I-ESA 2016	Scientific community		International
27	Presentation	UNIWUE	Matthias Hauser "Pushing the limits of RFID: Empowering RFID-based Electronic Article Surveillance with Data Analytics Techniques"	12 December 2015	ICIS 2015	Scientific community		International