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Improving sales turnover in fashion retailing by means of an RFID-based replenishment policy

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Abstract.

In this paper, we aim to provide evidence of the capability to generate an increase in sales turnover by implementing an RFID-based system able to improve the shelf replenishment operations, reducing stock-out situations in fashion retailing.

To assess the increase in sales turnover, we developed a pilot project involving a store of a major fashion firm located in northern Italy. RFID technology was used to generate daily a list of models that turned out to be available in the backroom, but not on the shelves (referred to as “scandals”), to drive employees in the replenishment process. By subsequently monitoring the consumer’s purchase, we estimated the contribution of RFID technology to the store turnover.

We found that increasing the availability of products (and of scandals in particular) on the shelves leads to a significant increase in the sales volume. Moreover, the availability of those products on the shelves stimulates the customers to ask for different sizes or colours of the items exposed, generating further potential for sales increase.

The results of this study may encourage fashion retailers to invest in RFID technology, whose cost often appears as high, since the increase in turnover can significantly contribute to recover the initial investment required. Also, since we carried out an in-field implementation, targeting a real scenario of the fashion industry, our results are realistic, solid and reliable. Fashion retailers can look at them as a concrete possibility to improve their business by adopting RFID technology.

Keywords: RFID, fashion industry, turnover increase, pilot study, shelf replenishment

1. Introduction

Radio Frequency Identification (RFID) is a wireless technology, used to tag, recognize, track and trace automatically the movement of an item, by using transmitted radio signal (Jones et al., 2005).

RFID is increasingly deployed for product tagging throughout the supply chain, in the light of the numerous benefits it can bring to the supply chain players. For

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29 instance, by applying RFID tags at item-level, each product can be easily tracked
30 and information about its state and location can be shared real time within the whole
31 supply chain (Prater et al., 2005). This brings significant improvements to the logistics
32 processes, in terms, for instance, of better inventory control, stock-out reduction,
33 labour savings, reduced shrinkage and transaction errors (De Marco et al., 2011).

34 In fashion retailing, the value of RFID technology is particularly relevant, because
35 its implementation has the potential to solve some problems that are unique to that
36 industry (IDTechEx, 2005a). Specific features of the fashion supply chain, which
37 make this business environment particularly challenging, are short product lifecycle,
38 high volatility and low predictability of the demand, often coupled with a high pur-
39 chasing impulse of customers (Christopher et al., 2004). In such a context, delivering
40 new products to the customer quickly in response to market changes is crucial. Sim-
41 ilarly, identifying the customer's needs quickly and correctly is a main leverage to
42 gain competitive advantage. Moreover, fashion retailers experience significant eco-
43 nomic losses in the case of out-of-stock (Garrido Azevedo & Carvalho, 2012). To
44 this extent, the deployment of RFID technology can bring significant benefits to the
45 fashion retailers, by enhancing process automation and labour efficiency, as well as
46 by improving the accuracy of logistics activities (Agarwal, 2001; Prater et al., 2005).
47 Moreover, the availability of RFID data can open new business opportunities and
48 strategies (Krotov, 2008; Bertolini et al., 2009). For example, at the point of sale
49 (POS) level, RFID technology can help identify the demand trends and build a prob-
50 abilistic demand pattern, thus counteracting the high degree of demand uncertainty
51 (Zhu et al., 2012). Furthermore, sales transactions can take place instantly, avoiding
52 long payment queues. The unpredictable behaviour of fashion shoppers could also be
53 studied in greater detail, exploiting, for example, RFID-based customer cards able to
54 record the behaviour of each customer (Moon et al., 2008).

55 A study conducted by Bertolini et al. (2012) at an Italian fashion brand showed
56 that the implementation of RFID technology at a distribution centre and at a retail
57 store served by that distribution centre could improve the shipping process, the inven-
58 tory and shelf replenishment activities, at the same time reducing the time required
59 for receiving and sell-in operations. In addition, some RFID readers with a near
60 field antenna positioned in every fitting room allowed collecting try-ons data, whose
61 availability, in the case coupled with complementary data, opens new possibilities
62 for stylists and marketing managers. According to the same authors, RFID has also
63 the potential to increase the sales volume of fashion items. Indeed, by means of
64 RFID item-level tagging at the retail store and of a tailored software application, an
65 employee could immediately inform the interested customer about the availability
66 of the garments he/she is looking for and that do not seem to be available at the
67 store shelves. This led to an increase in the number of items sold of about 0.52%.
68 Moreover, replenishment operations could be improved, since RFID reads allow to
69 identify those items which are stored in the backroom but are not available on the
70 shop floor. The RFID-enabled replenishment process led to a further 4.91% increase
71 in the sales volume, taking into account the fashion items whose dwell time on the

72 shelf, before the sale, was lower than a week. Similar results are proposed by Gaukler
73 (2010). This author found, in particular, that more than 80% of the benefits generated
74 by RFID deployment are directly linked to preventing avoidable out-of-stocks *via*
75 improvements to the backroom-to-shelf replenishment process.

76 The examples above suggest that fashion retailers can reach a considerable increase
77 in the sales volume by exploiting RFID technology to optimally manage their inventory,
78 thus reducing the occurrence of stock-out situations. In the fashion industry, the
79 increase in the sales volume obtained by reducing stock-out occurrence can be particularly
80 relevant: estimates by American Apparel indicate that sales volume typically
81 increases by 15% to 25% when Stock Keeping Units (SKUs) are available on the shop
82 floor (Zhu et al., 2012). An increase in the sales volume, and therefore in the store
83 turnover, could be an important incentive to the deployment of technologies, such
84 as RFID, whose implementation cost is often regarded as difficult to recover. Please
85 note that, in this work, by SKUs we mean a specific combination of model, colour
86 and size that can (or cannot) be available on the shop floor in different quantities
87 of items (or garments). Also, by model we mean the style or design of a particular
88 product, and models can be grouped in classes due to the similarities of their styles or
89 designs.

90 The availability of SKUs on the shop floor, as mentioned, could be ensured only
91 by means of adequate replenishment operations. To this extent, De Horatius & Ton
92 (2009) pointed out that non-optimal product availability on the store shelves is due
93 to three main factors, i.e. poor assortment, inadequate inventory planning and poor
94 execution of the replenishment process. Similarly, Gruen et al. (2002) estimated that
95 25% of all stock-out situations observed in retailing are caused by inefficiencies in
96 shelf replenishment operations, which lead to a lack of products on the shop floor
97 even though the same product is available in the store backroom. This brings back to
98 the importance of the replenishment process and its correct management, in order to
99 reduce the occurrence of stock-out situations and stimulate the customers to purchase.
100 RFID technology can be used to detect discrepancies between the inventory available
101 on the shelf to satisfy the customer's demand and the backroom inventory. Related to
102 this latter point, one of the biggest problems that retailers face concerns the inaccuracy
103 of inventory records; inaccuracy can lead to wrong decisions in managing inventories,
104 thus generating either excessive costs or stock-out situations (Hardgrave et al., 2009a).
105 During a study conducted in the fresh food supply chain, Bertolini et al. (2013)
106 observed that, thanks to the improved inventory accuracy and shelf management and
107 to the reduction of stock-out situations, RFID technology could bring an increase in
108 the sales turnover of about 1.75%. Although this implementation is specific to the food
109 industry, it can be argued that RFID technology has potentials to improve inventory
110 accuracy in different contexts. Looking at the fashion industry, a study by Hardgrave
111 et al. (2009b) demonstrated that the implementation of RFID technology improved
112 inventory accuracy at Bloomingdale's by more than 27%. Fashion retailers obviously
113 take advantage of the higher accuracy of their inventory records, by improving the
114 efficiency of stock control and shop floor management; those activities are particularly

115 critical to that industry, because of the short life cycle of products and the complex
116 assortment requirements (Moon et al., 2008).

117 A further relevant problem for fashion retailers is the need to display numerous
118 products, of different styles, colours and sizes, in a limited space, such as the store
119 shelves. Some studies in literature suggest that RFID could be useful to deal also with
120 this problem. For example, using a simulation model, Condea et al. (2011) demon-
121 strated that significant benefits can be achieved combining RFID technology with
122 the most suitable shelf space allocation decisions and with a flexible replenishment
123 process, which should be adapted continuously by the inventory management system
124 to meet the customer's demand. Moreover, with respect to the replenishment issues,
125 Hardgrave et al. (2005) carried out a study in 12 retail stores of the Wal Mart distribu-
126 tion channel. Although their work did not target the fashion industry, they showed that
127 RFID can bring significant benefits in the replenishment operations, by generating
128 automatic picking lists for shelf replenishment, on the basis of the items sold. The
129 implementation resulted in an increased accuracy of the picking process and in signif-
130 icant time savings, by reducing manual scanning of empty shelves to detect possible
131 missed products. Overall, the authors observed a decrease in stock-out situations of
132 about 16%. A similar process could be implemented also in the fashion industry, to
133 improve the accuracy of replenishment operations.

134 As already mentioned, a decrease in stock-out situations can significantly affect
135 the sales volume of the fashion retailers. IDTechEx (2005b) explained that GAP, the
136 US apparel company, increased its sales by 2% by reducing stock-out, using RFID
137 technology. Similarly, a pilot project, involving 280 American Apparel fashion stores,
138 ascribed to the implementation of RFID technology an increase in sales volume of the
139 retail stores up to 15% (RFID Journal, December 12th, 2008). De Marco et al. (2011),
140 through a simulation model, observed that the introduction of RFID technology in the
141 Miroglio Fashion retail channel increased the personnel's time available for customer
142 care significantly, up to 2.5%, thanks to the corresponding decrease in the time spent
143 by the employees in backroom operations. Although the authors did not carry out a
144 pilot implementation, their results suggest that retail stores adopting a sales-person-
145 assisted strategy could benefit from an increased turnover as a result of the increased
146 time available for customer care.

147 Overall, the studies reviewed indicate that RFID technology has the potential to
148 increase the turnover of the fashion industry, thanks to improvements in the replen-
149 ishment operations and the increase in product availability on the store shelves. In
150 line with this premise, this study aims to provide a quantitative assessment of the
151 RFID impact on the turnover of the fashion industry, with a particular attention to the
152 sales volume generated by optimizing the shelf replenishment process. The quantita-
153 tive evaluation is obtained starting from real data, collected in-field as the result of a
154 pilot implementation, involving a store of a famous fashion firm located in northern
155 Italy. To be more precise, this study presents a quasi-experimental design – namely
156 a pre-test/post-test design without a control group, as illustrated in Shadish et al.
157 (2002). This approach was chosen because our field experiment failed the true test

158 of an experimental manipulation, i.e. random assignment to groups, due to practical
159 reasons.

160 The remainder of the paper is organized as follows. In the next section, we describe
161 the pilot implementation, the research methodology, the data collected from the in-
162 field measurements and their subsequent elaborations. In Section 3, we present the
163 detailed results of this study. Finally, in Section 4, we discuss the main findings and
164 highlight research limitations and future research directions.

165 2. Experimental design and methodology

166 2.1. Background and objectives

167 The research proposed in this paper is the last step of an experimental campaign
168 started by the RFID Lab of the University of Parma (Italy) in 2012, in collaboration
169 with an important Italian company operating in the fashion industry (we will refer to
170 it as “fashion retail store” hereinafter, due to secrecy reasons). The campaign began
171 with the implementation of RFID technology in the fashion retail store.

172 A preliminary analysis, carried out in late 2012, focused on the benefits that RFID
173 could bring to the different logistics operations and store activities, and compared
174 the original (manual) processes with the new (RFID-enabled) ones. This analysis
175 highlighted that RFID technology could bring significant improvements in receiv-
176 ing, replenishment, inventory, check-out and return flows management, thanks to
177 the capability to reduce the time required for manual operations, and to ensure a
178 quick and accurate acquisition of information about the status and location of each
179 item. During that step of the research, a software application, called *RSA dashboard*,
180 was also developed, to help calculate and monitor some specific key performance
181 indicators of the retail store processes. The dashboard also allowed monitoring the
182 stock availability and the trend of the sales in time. Furthermore, the dashboard
183 highlighted the SKUs that were out-of-stock; by knowing the sales rate of those
184 items, the loss of sales due to the occurrence of stock-out situations could be esti-
185 mated.

186 In the second step of the research, which is described in this paper, the focus was on
187 assessing how RFID technology can improve the replenishment operations, by means
188 of accurate data about the fashion items and their location in the store. Specifically,
189 the objective of the analysis was to exploit this technology to facilitate and speed up
190 the identification of those SKUs that were unavailable on the store shelf, but were
191 stocked in the backroom, and, therefore, could be replenished. The implementation
192 of the RFID-enabled replenishment process targeted a specific set of SKUs referred
193 to as “scandals”. By scandal, we mean a SKU with a significant sales volume, and
194 whose stock level, at a given time, is found to be very low (i.e., null or equal to one
195 item) on the shop floor and greater than zero in the backroom. If detected, such SKUs
196 should be prioritized during replenishment operations.

197 *2.2. Analysis of the replenishment processes*

198 The implementation of RFID technology in the fashion retail store brought with
199 it a whole re-engineering of the replenishment processes. Before implementing the
200 technology, in fact, the replenishment activities were based on: (i) number and models
201 of items sold every day; and (ii) the identification of an out-of-stock (OOS) event of
202 a model of products (in fact, we considered a model to be OOS if it is available on
203 the shop floor in less than two items). At a greater detail, the pre-RFID replenishment
204 process was as follows:

- 205 i. in the morning of every working day, before the store opening time, the store
206 employees performed replenishment operations on the basis of the sales of the
207 previous working day and of the amount of garments available in stock. The
208 store information system (named POSWEB) recorded every combination of
209 model/colour/size sold on the previous working day, and this list of SKUs sold
210 was used for replenishment purposes on a daily basis;
- 211 ii. in addition to the previous point, whenever a store associate identified an OOS
212 event (again, a model available in less than two items) in the shop floor for
213 one or more models, he/she was responsible for looking in the backroom for
214 some items belonging to that model and, if possible, replenish them in “real
215 time”. The choice of which SKU replenish of a given model was made by, or
216 in accordance with, the store manager.

217 These processes, however, presented some major weaknesses. Due to internal
218 guidelines of the company, in fact, only two different sizes for each combination
219 of model/colour could be exposed on the shop floor at the same time, so as to maxi-
220 mize the number of different models shown to the customers and available for sale.
221 That is to say that, if a specific model (e.g., model 1) is available in 3 different colours,
222 a maximum of 6 different SKUs, i.e. combinations of model, colour and size, could
223 be exposed in the shop floor simultaneously. Therefore, the list of items sold every
224 day was just a draft for replenishment operations that needed to be compared with
225 the sales floor and the backroom availabilities. Unfortunately, however, the pre-RFID
226 system could not monitor the stock positions in the sales floor and in the backroom
227 separately, but it rather measured the overall inventory of the store.

228 Therefore, as the size of the shop floor is not so large, every sales assistant is respon-
229 sible for replenishing certain models during off-peak periods. This activity took, on
230 average, 10 man-hours every working day (i.e. approx. 5 people working from 8 to
231 10 a.m.), and was therefore very time consuming. Indeed, due to requirements of the
232 human resource department, 10 man-hours per opening day was the maximum time
233 allocated to replenishment processes. One of the main goals of reengineering this
234 process was to automate it and, potentially, reduce OOS. As it was commonly per-
235 ceived by store associates, in fact, the replenishment processes was often interrupted
236 by opening times at the shop and, therefore, not completed correctly.

237 For this reason, this practice often resulted in the lack of some products on the shelf,
238 because of the high number of models and variants composing a fashion collection and
239 of the limited space available on the shelf. This kind of mistake was only detected and
240 corrected by the identification of an OOS event (see point ii), but some OOS events
241 happened anyway, especially during rush periods. As an example, a model available
242 in the backroom and not available on the store shelves would not be replenished,
243 because of its null sales, unless some store associate would notice its OOS position
244 and ask the store manager to replace it.

245 For all these reasons, the pre-RFID replenishment policy did not allow managing
246 scandals adequately. The first option considered was to reengineer this process without
247 eliminating barcode technology. However, analysing the problem with managers from
248 the fashion retail store, we realised that the need to scan the barcodes of every item
249 moved from the backroom to the shop floor, or *vice versa*, was simply not feasible,
250 due to the increased amount of labour requested.

251 Therefore, we decided to implement RFID to reengineer the replenishment activi-
252 ties. In fact, combining sales data with RFID data related to the stock available allows
253 identifying and replenishing scandals more easily. The final goal of the implementa-
254 tion of RFID was to demonstrate that the RFID-enabled replenishment generates an
255 increase in the sales turnover, by reducing the occurrence of stock-out situations and
256 stimulating the consumer to purchase.

257 2.3. Hardware and software apparatus

258 The fashion retail store analysed consists of two main areas: the shop floor, where
259 items are located on the shelves, and the backroom, where products are kept in stock.

260 Given the aim of the analysis carried out in this paper, the accuracy of the inventory
261 data is particularly relevant. Indeed, to design an effective replenishment process, it is
262 essential to precisely identify which items are available either on the shop floor or in
263 the backroom, and which items are moved from the backroom to the shop floor (and
264 *vice versa*). Similarly, the availability of accurate POS data is crucial to determine
265 which products are sold and should be prioritized in replenishment activities because
266 of their high sales volume. Also, accurate POS data allow identifying those purchases
267 that can right be ascribed to an effective replenishment strategy, resulting in a turnover
268 increase compared to the original situation.

269 With the purpose of ensuring a high level of data accuracy, RFID technology was
270 implemented in several processes of the retail store. More precisely, to facilitate
271 data acquisition during receiving operation and return flow management, an RFID
272 cage was installed in the store backroom, equipped with an antenna on each side.
273 The antennas were able to automatically, and real-time, update the inventory data by
274 identifying the products that were put in the cage for inbound and outbound activities.
275 A replenishment gate, installed between the shop floor and the warehouse, recorded
276 any change in the product location (i.e., from the shop floor to the backroom and *vice*
277 *versa*). The gate was equipped with two antennas, able to read the tag of the items

278 moved, and a monitor, where the information associated to the crossing items was
279 displayed. In Fig. 1 we propose a representation of the store areas considered in the
280 study and of the corresponding reading equipment.

281 To identify possible errors in inventory data and items position, periodical inventory
282 counts were conducted separately in the store and in the backroom, using two RFID
283 handheld readers. Errors detected were realigned to the actual situation.

284 A particular metal bin, equipped with two RFID antennas, was placed near the cash
285 counter to track sales and update the stock data. Specifically, when a product is sold,
286 the shop assistant should put the corresponding tag in the bin. By this operation, the
287 tag will be excluded from any subsequent process and, although it is still in the store,
288 it will no longer be read (for example, during inventory counts operations).

289 Finally, the aggregation and processing of the RFID reads was carried out by
290 means of the *RSA dashboard*, which was made available to the store employees. The
291 dashboard included five modules, such as Traceability, Historical EPC, Availability,
292 Inventory and Replenishment. Those modules track any event occurring at the
293 store. Moreover, the dashboard included five specific shortcuts for the analysis of the
294 scandals, which were used during the implementation.

295 2.4. Preliminary activities

296 We spent the first part of the project in testing the reliability of the experimental
297 apparatus, so as to ensure that the data collected during the experimental campaigns
298 would have been correct and accurate.

299 In the pilot implementation, the fashion items arrived at the retail stores equipped
300 with the RFID tags. Indeed, the tags, that are associated to a unique EPC code (in turn,
301 linked to a specific item and to the corresponding SKU), were printed and encoded
302 at the distribution centre. This latter also took care of applying them to the finished
303 goods monitored during this study (see section 2.5) before shipping them to the retail
304 store. Thanks to this tagging process, the receiving activities of the store can be fully
305 automated, by simply placing the products received inside the RFID cage. This latter,
306 by reading the RFID tags, verifies the correctness of the delivery, by comparing the
307 items received with those expected, and updates the corresponding inventory data.
308 After some modifications to the antennas' position and of some preliminary tests,
309 aimed at identifying the optimal products arrangement in order to facilitate reads, the
310 accuracy of the RFID cage reached 100%. This means that the cage, in its optimal
311 setting, was able to read the whole sample of items placed inside it. The accuracy
312 level was verified by means of some manual controls, where an employee compared
313 the tags read by the cage with the number of items actually placed inside the RFID
314 cage.

315 Conversely, some more difficulties were encountered when testing the replenish-
316 ment gate, which took about one month and a half to be optimized. More precisely, to
317 evaluate the reliability of the RFID gate, reading data of the crossing items were com-
318 pared with the data resulting from periodical RFID inventory counts, carried out on

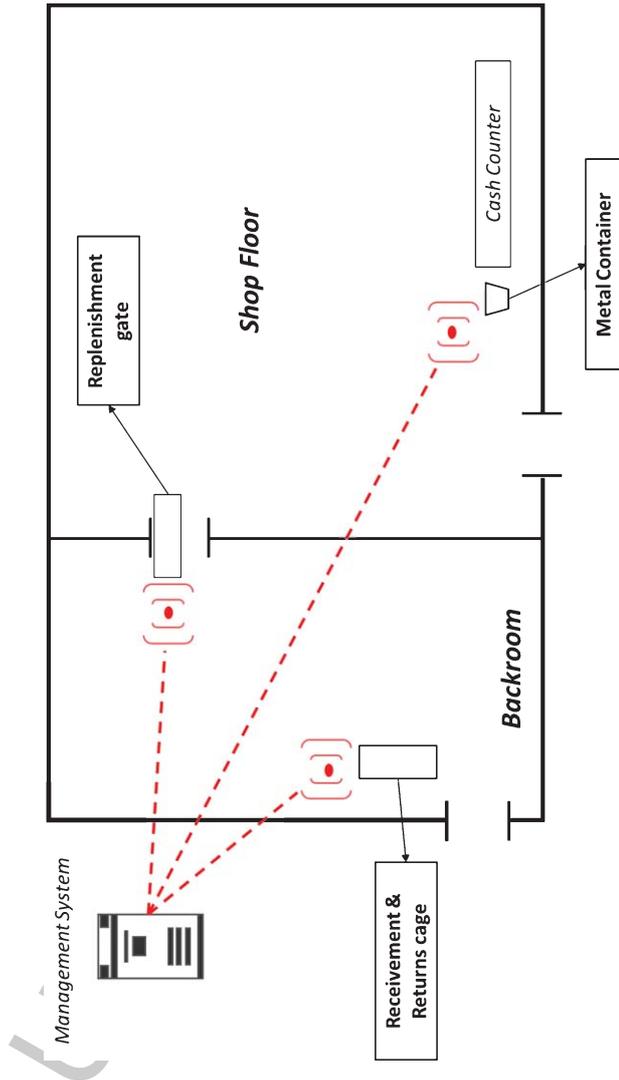


Fig. 1. Scheme of the store areas and reading points.

Proof

319 the whole collection available at the retail store. If the stock position of an item (i.e.,
320 either the shop floor or the backroom) was found to be different in two subsequent
321 inventory counts, we verified whether the gate had detected the item movement from
322 the backroom to the shop floor or *vice versa*. In the case this observation was missed,
323 and therefore the item position recorded on the information system was incorrect,
324 we used the information resulting from the inventory counts to update the inventory
325 data. During the test, we observed that weekly inventory counts, coupled with the
326 attention of the shop assistants while crossing the gate with replenished items, led to
327 a significant accuracy in data updating. The detailed outcomes are reported in Section
328 3.1.

329 The choice of using a metal bin equipped with RFID antennas (that will be referred
330 to as “RFID bin”, for simplicity) to record the sales data is the result of different
331 solutions that have been tested during the implementation. Compared to other equip-
332 ment that was tested during the project (i.e. an antenna with a tag-holder cage and
333 an antenna equipped with a buzzer beeping whenever a tag was read), the RFID bin
334 immediately showed a significantly higher reading accuracy. Moreover, its higher
335 capacity could be very important during sales and festivity periods, when the sales
336 volume increases and numerous tags are put in the RFID bin when items are sold.
337 The detailed results of the tests carried out on the check-out process are proposed in
338 Section 3.2.

339 At the end of these preliminary activities, we were almost sure that subsequent
340 analyses would have been based on solid RFID data, collected using a reliable system.

341 2.5. Data collection

342 The experimental phase began with the identification of the product classes to
343 be monitored during the analysis. Indeed, analysing the whole set of items sold at
344 the retail store could have been either unfeasible from a practical perspective or
345 meaningless in terms of the number of scandals. Therefore, the application of the new
346 replenishment policy was limited to the SKUs belonging to the most sold product
347 classes of the store. By analysing the historical sales data of the Autumn/Winter
348 collections, we identified five clothing classes, labelled 01, 02, 08 (coats) and 34, 36
349 (knitting items, i.e. the class of knitwear products).

350 The data collection started in September 2013. For the first two weeks, SKUs of
351 the Autumn/Winter collection were exposed on the store shelf in rotation, in order
352 to identify the most sold models, which should be managed with priority in the
353 replenishment activities.

354 From September 23rd (Week 39) until November 17th (Week 46), excluding the
355 weekends, the store employees carried out replenishment activities according to the
356 new procedure of scandals management, on the basis of the observations available
357 on the RSA dashboard. The reason why weekends were excluded from the anal-
358 ysis is that, although the store is opened during the weekends, store activities are
359 particularly intense; therefore, the store’s managers preferred not to introduce an

360 experimental replenishment procedure in those days. Indeed, during the weekends,
361 the store is visited by numerous customers (as it is expected); hence, during the day,
362 store employees should, primarily, assist consumers, and, despite the high sales, can-
363 not carry out replenishment operations regularly. Accurate replenishment operations
364 are actually performed on Monday morning. In this moment, it is likely that there
365 will be very numerous items to replenish, because of the high sales of the weekend.
366 According to this explanation, the sales observed on Monday were primarily ascribed
367 to the replenishment operations carried out in the same day, early in the morning.

368 It should be noted, however, that the issue of collecting data only on weekdays
369 (excluding the weekends from the analysis) does not seem to be a threat from the
370 scientific perspective. The only reason why this could be a concern is if there was
371 the possibility that the results would be reversed or nullified if data from the week-
372 ends were included. However, both the authors and the staff from the fashion retail
373 store believe that it is more likely that the results would be strengthened, rather than
374 weakened, if the weekends were included in the study. The rationale behind this opin-
375 ion can be found in Hardgrave et al. (2011; 2013): as these studies report, in fact,
376 RFID-enabled visibility is more effective in reducing out-of-stocks occurrence and
377 inventory record inaccuracy, respectively, for SKUs with higher sales velocity and
378 higher sales volume. With the higher sales velocity and volume on weekends, it is
379 reasonable to expect the experimental intervention in the current research to be more
380 effective in improving the performance of replenishment activities.

381 In the new replenishment procedure, scandals were detected by combining sales
382 and inventory data, available thanks to the RFID technology. More precisely, by iden-
383 tifying those models (i.e. sets of SKUs with different sizes and colours but belonging
384 to the same model) whose inventory level in the backroom is higher than zero, while
385 the number of items on the shelves is almost null, the RFID system generated daily a
386 list of ten scandals to replenish. Models with the same stock level on the shelf were
387 prioritized in the list based on their sales volume.

388 As already mentioned, inventory data were derived by combining RFID reads made
389 by the cage used during receiving operations, the RFID bin and the replenishment
390 gate. To correct possible misalignments between RFID reads and physical inventory,
391 employees carried out weekly (or twice a week) manual inventory counts, to monitor
392 the stock level of the clothes examined on the shop floor, and to realign it in the case
393 of errors. Handheld RFID readers were used to this extent. The realignment rules
394 were as follows:

- 395 1. If the reader detects, on the shop floor, an EPC associated with an item whose
396 location should have been the backroom, the corresponding information is
397 updated in the store information system, allocating the EPC to the shop floor.
398 The rationale for this realignment is that the RFID gate could miss some items
399 while they cross it; therefore, this procedure is expected to solve possible reading
400 errors of the replenishment gate;

401 2. Conversely, in the case the reader does not detect an EPC on the shop floor,
402 and the EPC is expected to be in that area, the latest available information
403 about the item's position is maintained in the store information system. In this
404 case, the reading error could be either due to the replenishment gate (that did
405 not detect an item that moved from the shop floor to the backroom) or to a
406 missed read during an inventory count on the shop floor. This latter, however,
407 seems to be more probable, due to the wide number of items on the shop floor,
408 which probably generates hidden or overlapped tags. Consequently, the item
409 is assumed to be on the shelf, and this is why the latest available information
410 about the item's position is maintained in the store information system.

411 As mentioned, the RFID system generated a list of models to replenish daily on
412 the shop floor, while it does not indicate the specific SKU. The choice of indicating
413 the models (and not SKUs) in the list was made in accordance to the store manager,
414 with the purpose of keeping the replenishment procedure followed by the employees
415 almost unchanged. Indeed, before the RFID implementation, the identification of the
416 items to be replenished was carried out based on the sales volume of the different
417 models (and not on the single SKUs). Once the model to be replenished is detected,
418 thanks to the replenishment list, the choice of the specific SKU (i.e., size and colour of
419 the model), as well as of the number of items for each SKU, to be displayed on the store
420 shelves is left to the store manager, who is expected to have a sufficient experience
421 to identify the most appealing SKUs. Indeed, due to the limited shelf space, it mostly
422 happens that a model is not exposed on the shop floor in all its variants (i.e., colours
423 and sizes).

424 Similarly, the number of models (10) included in the list was defined together
425 with the store managers. Such number could seem limited, compared to the number
426 of items replenished daily in the store (more than 350 items/day, on average). As a
427 matter of fact, the replenishment list should be regarded as a support to the employees,
428 to help them in the replenishment operations, by indicating some selected models that
429 should be replenished with priority, because of the high sales and the limited stock
430 available in the store.

431 Store employees downloaded and printed this list daily, exploiting an application on
432 the RSA dashboard. This application automatically generates a query with predefined
433 parameters (i.e., for example, the classes monitored, the minimum number of items
434 available on the shelves, etc.). The scandals list was then used to drive employees in the
435 replenishment operations. It should be mentioned, however, that each list included
436 only the models to be replenished, while did not define the related variants (e.g.,
437 colour and size) nor the number of items to restore; these choices were left to the
438 store manager.

439 In Fig. 2, we propose an example of scandals list. The first two columns list the
440 names of the models to replenish and the correspondent classes (in the example, the
441 model names are omitted, for confidentiality). Then, the list indicates the stock level
442 available on the shop floor and in the backroom and the number of items sold. Looking

Query	Filter	Quantity		
Model	Classes	Shop floor	Backroom	Sales
Mod1	34	0	3	4
Mod2	36	0	4	0
Mod3	36	1	4	5
Mod4	34	1	3	5
Mod5	36	1	42	4
Mod6	34	1	5	4
Mod7	34	1	6	3
Mod8	34	1	5	3
Mod9	34	1	3	3
Mod10	36	1	9	2

Fig. 2. Example of a scandals list.

443 at Fig. 2, it can be seen that model “Mod1” (of class 34) should be replenished with
 444 priority, since it is unavailable on the shop floor (“Shop floor = 0”) while its stock in
 445 the backroom is three items. The second model to replenish is “Mod2” (of class 36):
 446 for that model, the stock level in the backroom is higher than that of “Mod1”, but the
 447 number of items sold from the beginning of the season is lower (0 vs. 4).

448 To compute the turnover increase due to the RFID-based replenishment procedure,
 449 we needed to identify those sales that could be associated with the new practice.
 450 To this extent, we assumed that a sale could be *directly linked* to the replenishment
 451 procedure if it occurred within one week from the item replenishment on the shelf.
 452 Moreover, additional sales could be *induced* by the new replenishment process. First
 453 of all, it should be specified that, although the replenishment list only includes models,
 454 during replenishment the store employees read the RFID tag of each item replenished,
 455 to record the fact that these specific SKUs have been displayed on the store shelves.
 456 Therefore, the full set of data (model/size/colour) is actually available in the store
 457 information system. Let us suppose that the replenishment list proposes Mod1 to be
 458 replenished (as per the example in Fig. 2). The store manager will indicate the size
 459 and colour of this model to be displayed on the store shelves (e.g., size = small and
 460 colour = pink). By reading the RFID tag of the item replenished, the store employee
 461 records the full set of data (i.e., model = Mod1, size = small and colour = pink). If
 462 the retail store sells this item within a given time interval since the replenishment,
 463 a *direct sale* is recorded. Implicitly, we assume that this sale can be directly linked
 464 to the RFID-based replenishment procedure, which led to display Mod1 on the store
 465 shelves. Obviously, in the case a model is replenished (in a given colour and size)
 466 thanks to the RFID-based procedure, some sales of a different colour or size of the
 467 same model could also be generated. Specifically, if the retail store sells a different
 468 item of the same model (e.g. model = Mod1, size = large or colour = green), within
 469 a given time interval since the replenishment, an *induced sale* is recorded. In this

470 case, it is assumed that the sale of this item was due to the fact that the customer saw
471 Mod1 (in a given size and colour) on the store shelves and was stimulated to ask for a
472 different variant and finally purchased it. A more precise definition of *induced* sales
473 is proposed in Section 3.3.

474 With respect to the computation of the turnover increase, it should be mentioned
475 that our assessment takes into account only those scandals that were immediately
476 replenished. By “immediately”, we mean that items were replenished as soon as
477 they appeared on the scandals list, i.e. in the next replenishment operation. Typically,
478 replenishment operations are carried out early in the morning (before the store open-
479 ing); therefore, to be included in the analysis, items should be replenished in the same
480 day where the scandals list was generated.

481 In practical cases, it could happen that not all scandals are immediately replenished,
482 either because of a lack of space on the store shelves, or because the store employees
483 neglected or forgot them. Whenever, in the next replenishment, one SKU was, for
484 instance, omitted, the sales due to this SKU were not considered in the analysis.
485 Similarly, sales of items that were replenished later (e.g., the day after the generation
486 of the scandals list) were not considered in the analysis.

487 The new replenishment procedure was implemented for eight weeks at the retail
488 store. Sales data were elaborated weekly, to evaluate the turnover increase. In this
489 regard, it is worth mentioning that the turnover increase actually indicates an increase
490 in the number of items sold (i.e., it reflects a sales increase), while the economic
491 value is not assessed in this study. Numerical results related to the sales increase are
492 reported in Section 3.3.

493 3. Results

494 3.1. Reengineered replenishment process

495 Between May 17th, 2013, and June 30th, 2013, we collected the reading data of the
496 replenishment gate, to assess the performances of the replenishment process. More
497 precisely, we compared the inventory data stored in the store information system,
498 based on the item movements recorded from the backroom to the shop floor, with
499 the actual stock level, to detect possible reading errors or missing reads. By this
500 comparison we derived an estimate of the reading accuracy of the gate. We also eval-
501 uated possible improvements in the accuracy of the gate by adding periodic inventory
502 counts, to update the inventory data.

503 During the whole observation period, the gate recorded 22,084 crossing items, and
504 missed 326 items (1.45% of the total number of items crossing). The gate reading
505 accuracy, therefore, initially accounted for 98.55%. To increase this percentage, we
506 coupled RFID reads with periodic inventory counts to detect missing records of cross-
507 ing items and realign the inventory data. We observed that 140 of the 326 unread tags
508 (0.625% of the total number of items) remained undetected until the items were sold,
509 i.e. when they were finally read at the cash counter. These items, indeed, according to

510 the store information system, turned out to be still available in the backroom; however,
511 they were actually exposed on the shop floor, or, at least, they had crossed the replen-
512 ishment gate to be brought directly at the cash counter. Therefore, inventory counts
513 did not help identify the exact location of this percentage of items. Consequently, we
514 can affirm that the reliability of the replenishment gate can grow up to 99.375% by
515 associating periodical inventory counts to the replenishment gate reads.

516 Finally, during the eight weeks of data collection, we also recorded the average time
517 spent for replenishment processes, which resulted in an average value of less than 7
518 man-hours per working day, and a maximum value of around 9 man-hours recorded on
519 Friday the 27th of September. This testifies that the newly reengineered replenishment
520 process allows to maintain the labour below 10 man-hours and therefore to complete
521 the process according to the company requirements.

522 *3.2. Reengineered check-out process*

523 To assess the reliability of the RFID bin located near the cash counter, in Table 1
524 we show and compare the results of the reading accuracy test carried out on each
525 equipment originally proposed to record sales information (i.e., antenna with cage,
526 antenna with buzzer and RFID bin). The table reports the date of the check-out process,
527 the reader type, the total number of items sold in the day, the number of tags unread
528 and corresponding percentage. The tags unread were detected by means of manual
529 checks, comparing all the tags physically present in the reading device at the end
530 of the day with those that turned out to be read, and thus recorded as sold, in the
531 information system. Data related to the first two solutions (i.e., antenna with cage
532 and antenna with buzzer) are aggregated in Table 1 because those solutions have been
533 tested simultaneously. More precisely, the store employees put the tags of items sold
534 indifferently in one or other device, and both were checked at the end of the day. The
535 number of “unread tags” in Table 1 is obtained as the total amount of tags not read
536 by the cage-equipped antennas nor by the buzzer-equipped ones.

537 From the data in Table 1, it is evident that the reading accuracy is significantly
538 higher when using the RFID bin for check-out (percentage of tags unread=0.0%),
539 compared to the remaining solutions. Therefore, it can be right assumed that the RFID
540 bin was able to detect each tag put inside it during the check-out, so that, with this
541 solution, POS data were always accurate and updated.

542 *3.3. Turnover increase*

543 After this preliminary evaluation of the reading accuracy of the RFID apparatus,
544 we focused on the main objective of our analysis, i.e. the increase in sales turnover
545 as a result of the implementation of the scandals replenishment process. Results are
546 presented separately for the SKUs belonging to classes 01, 02, 08 (Table 2) and 34,
547 36 (Table 3), so as to assess the contribution of the new replenishment process for
548 each product category.

Table 1
Reading accuracy of check out device

Date	Reader	Total sold items (Tagged)	Unread tags	Percentage of unread tags
22/09/2013	Antenna with cage/buzzer	463	0	0,00%
23/09/2013	Antenna with cage/buzzer	193	2	1,03%
24/09/2013	Antenna with cage/buzzer	191	9	4,50%
25/09/2013	Antenna with cage/buzzer	173	2	1,14%
26/09/2013	Antenna with cage/buzzer	127	2	1,55%
27/09/2013	Antenna with cage/buzzer	301	3	0,99%
28/09/2013	Antenna with cage/buzzer	472	1	0,21%
29/09/2013	Antenna with cage/buzzer	350	4	1,13%
30/09/2013	Antenna with cage/buzzer	197	0	0,00%
01/10/2013	Antenna with cage/buzzer	131	0	0,00%
02/10/2013	Antenna with cage/buzzer	206	12	5,50%
03/10/2013	Antenna with cage/buzzer	211	2	0,94%
04/10/2013	Antenna with cage/buzzer	336	1	0,30%
05/10/2013	Antenna with cage/buzzer	472	0	0,00%
01/11/2013	Antenna with cage/buzzer	321	3	0,93%
01/11/2013	RFID bin	774	0	0,00%
02/11/2013	RFID bin	1003	0	0,00%
03/11/2013	RFID bin	795	0	0,00%

549 For each week of observation, we evaluated:

- 550 - the number of *replenished scandals*, i.e. those scandals immediately replenished
- 551 following the list of scandals generated by the RSA dashboard;
- 552 - the *direct sales*, i.e. the number of items of the classes monitored that were sold
- 553 during the week, after a replenishment performed the week before;
- 554 - the *induced sales*, i.e. the number of items for which a variant (i.e., a different
- 555 colour or size) sold during the week was not on the shelves, although the model
- 556 was available on the shop floor, after a scandal replenishment performed the
- 557 week before;
- 558 - the *total sales due to RFID*, i.e. the sum of direct and induced sales;
- 559 - the *total sales of the week* for each class;
- 560 - the *turnover increase due to RFID for direct sales*, i.e. the ratio between the
- 561 direct sales and the difference among the total sales of the week and the total
- 562 sales due to RFID;
- 563 - the *turnover increase due to RFID for induced sales*, i.e. the ratio between the
- 564 induced sales and the difference among the total sales of the week and the total
- 565 sales due to RFID;
- 566 - the *total turnover increase due to RFID*, i.e. the sum of turnover increase due to
- 567 direct sales and that due to induced sales.

568 Other pieces of information collected during the study (such as, for instance, the
569 number of scandals reported, the number of items not restored for different problems,
570 etc.) are omitted in the tables, because they are not directly relevant to our analysis.

Table 2
Turnover increase for product classes 01, 02 and 08 (coats)

Week	39	40	41	42	43	44	45	46	Total
Classes	01,02,08	01,02,08	01,02,08	01,02,08	01,02,08	01,02,08	01,02,08	01,02,08	01,02,08
Replenished scandals	26	19	5	21	0	53	29	28	181
Direct sales	5	8	3	7	1	10	10	8	52
Induced sales	0	1	5	8	1	3	12	10	40
Total sales due to RFID	5	9	8	15	2	13	22	18	92
Total sales	112	160	181	152	134	127	107	123	1096
Turnover increase due to RFID - (direct sales)	4.67%	5.30%	1.73%	5.11%	0.76%	8.77%	11.76%	7.62%	5.18%
Turnover increase due to RFID – (induced sales)	0.00%	0.66%	2.89%	5.84%	0.76%	2.63%	14.12%	9.52%	3.98%
Total Turnover increase due to RFID	4.67%	5.96%	4.62%	10.95%	1.52%	11.40%	25.88%	17.14%	9.16%

Table 3
Turnover increase for product classes 34 and 36 (knitting items)

Week	39	40	41	42	43	44	45	46	Total
Classes	34,36	34,36	34,36	34,36	34,36	34,36	34,36	34,36	34,36
Replenished scandals	60	83	65	81	57	43	56	57	502
Direct sales	7	15	9	5	6	6	9	6	63
Induced sales	1	0	3	2	0	2	2	1	11
Total sales due to RFID	8	15	12	7	6	8	11	7	74
Total sales	187	240	252	221	181	236	163	163	1643
Turnover increase due to RFID - (direct sales)	3.91%	6.67%	3.75%	2.34%	3.43%	2.63%	5.92%	3.58%	4.02%
Turnover increase due to RFID – (induced sales)	0.56%	0.00%	1.25%	0.93%	0.00%	0.88%	1.32%	0.64%	0.70%
Total Turnover increase due to RFID	4.47%	6.67%	5.00%	3.27%	3.43%	3.51%	7.24%	4.49%	4.72%

571 Looking at Table 3, it can be seen that for knitting items (classes 34 and 36), RFID
572 technology could increase the sales turnover up to 4.72% overall, primarily as a result
573 of the increase in direct sales (63 direct sales vs. 11 induced sales). For those items,
574 indeed, the contribution of induced sales is limited, accounting for approx. 0.70% of
575 the turnover. A different result was observed for coats (classes 01, 02 and 08).

576 With respect to Table 2, which refers to coats (classes 01, 02 and 08), a first con-
577 sideration is that the sales (both direct and induced) of those items highlight more
578 variability compared to the knitting items. The contribution of direct sales ranges
579 from 0.76% in week 43 to 11.76% in week 45, while the contribution of indirect sales
580 ranges from 0% in week 39 (corresponding to the implementation of the new replen-
581 ishment procedure) to 14.12% in week 45. The variability of the results, in terms of
582 the direct and induced sales, could be due to different aspects. First, most SKUs are,
583 *per se*, subject to the month-to-month fluctuations in consumer's behaviour and pur-
584 chasing decisions (Starr-Mccluer, 2000). Moreover, the kind of products considered
585 introduces a further variability: for instance, poor weather conditions could increase
586 the sales (Starr-Mccluer, 2000). This is also the reason why sales are particularly
587 relevant in week 45, corresponding approx. to early November: probably, the wors-
588 ening of the weather conditions at the beginning of November pushed customers to
589 purchase coats. A further source of variability is represented by the fact that, once a
590 customer has purchased a new coat, it is very unlikely that the same customer will
591 purchase another coat in the same season, since this item is expected to be used for
592 the whole season, and also for future seasons, in the light of the relatively high cost of
593 that product. Those considerations probably do not hold for knitting items, for which
594 the cost is lower and it is, therefore, more likely that a customer will purchase more
595 than one item in the same season. Also, the purchasing impulse of customers can
596 be less sensitive to the weather conditions. Consequently, the trend of sales is more
597 stable and no peaks of request are observed (cf. Table 3).

598 Table 2 shows that, by means of the new scandals management procedure, the
599 increase in the sales volume of those items could reach 9.16%, on average, consid-
600 ering the contribution of both the direct and induced sales overall. Moreover, the
601 contribution of the induced sales was more relevant, compared to the knitting items.
602 Indeed, almost 4% of the sales increase was due to purchases of models whose vari-
603 ants were not available on the shop floor, but, since the model was replenished, it drew
604 the customers' attention, leading the customers to ask for different colours or sizes.
605 This result could be explained, in turn, considering that purchasing a coat is probably
606 a more thought-out decision, where the customers tend to control their purchasing
607 impulse and therefore can be interested in trying different models or colours.

608 4. Conclusions

609 4.1. Discussion of findings

610 Potential benefits that RFID technology can bring to the supply chain processes
611 are particularly relevant for fashion retailing. The capability of RFID to improve

612 inventory accuracy and optimize shelf replenishment operations, in particular, is of
613 high relevance to the fashion industry. In this regard, this paper investigated the shelf
614 replenishment process in a fashion retail store. A new RFID-based replenishment sys-
615 tem was proposed, based on the identification of “scandals”, i.e. those models whose
616 sales volume is high but that are OOS (or available in less than 2 items) on the shop
617 floor (although available in the backroom). Those models should be replenished with
618 priority. The stock data of items were available thanks to the in-field implementation
619 of the RFID technology, while the sales volume was already recorded by the store
620 information system. Results of the in-field experimentation show that exploiting RFID
621 data to identify the scandals and thus to drive the replenishment process can lead to a
622 significant increase in the sales turnover of a fashion store. Obviously, improvements
623 can be achieved only if this replenishment system is grounded on solid data; in this
624 study, the experimental apparatus was previously tested to ensure reliability of the
625 RFID reads and of the data collected.

626 Although the data collection was limited to some selected product categories, the
627 results obtained allow concluding that the adoption of the new RFID-based replen-
628 ishment procedure has the potential to significantly increase the sales volume of the
629 fashion retail store considered. Obviously, the sales increase could be even more rel-
630 evant if the new replenishment process was extended to other product categories or
631 to other stores of the same fashion company. Specifically, the increase in the sales
632 volume, as it emerges from our study, ranges overall from 4.72% for knitting items up
633 to 9.16% for other clothing categories (e.g., coats). Such increase should be primar-
634 ily ascribed to the fact that reliable RFID reads allow to real-time update inventory
635 information both on the store shelf and in the backroom. As a second point, RFID
636 offers the opportunity to track the sales volume, thus supporting the identification of
637 the most profitable products.

638 Looking at the induced sales, it is easy to see that these latter are particularly relevant
639 for SKUs belonging to the coats category (3.98%), while their contribution is lower
640 for knitting items (0.47%). Such difference can be associated to the higher purchasing
641 impulse of customers against knitwear items, compared to more expensive items such
642 as coats. In other words, it is likely that a customer wishing to buy a coat will ask
643 whether different sizes or colours are available. The same behaviour is less likely to be
644 observed for customers that buy knitwear items: typically, those customers will make
645 their purchase more impulsively, without asking whether the same model might be
646 available in a different colour. Therefore, a more general conclusion from this study
647 is that turnover increase due to induced sales has potential to be more significant for
648 high value products, such as coats.

649 *4.2. Limitations*

650 We must remember that some limitations affected our experimental campaign.
651 First, the new replenishment policy was not applied during the weekends. As men-
652 tioned, this choice was driven by a decision of the store’s managers, motivated by the

653 fact that those days are particularly critical to the fashion store; hence, store's man-
654 agers preferred not to apply the new (experimental) procedures in such critical days.
655 Applying this policy also on Saturday and Sunday, when the sales volume is higher,
656 has potentials to generate a further increase in turnover. Evaluating this additional
657 contribution can be the starting point for future research activities. To our knowledge,
658 the encouraging results of this study led the store's managers to consider the appli-
659 cation of the new replenishment procedures also in the weekends, so that the process
660 is now implemented in all weekdays.

661 A similar consideration holds for the number of product classes examined in this
662 study. Since this was a pilot implementation, the analysis was limited to five clothing
663 classes, which could be RFID tagged at the distribution centre. Examining further
664 classes could bring additional insights about the potential of RFID to increase the
665 corresponding sales turnover.

666 Another issue was the improvement of the reading accuracy of the gate, which
667 took more than a month to reach its optimal setting, because of some difficulties in
668 detecting overlapping tags of items crossing the gate. Therefore, in future research,
669 alternative solutions could be studied to solve this problem.

670 Finally, although benefits brought by RFID technology are evident from our out-
671 comes, the cost of RFID implementation can be particularly high. In this regard, the
672 increase in sales turnover can help recover the initial investment more quickly, espe-
673 cially in fashion industry, where the product value is relevant. However, this point
674 was not investigated in detail in this study, since we limited the analysis to the number
675 of items sold thanks to RFID, neglecting their economic value.

676 4.3. Suggestions for future developments

677 An interesting opportunity for future research is to investigate in greater detail some
678 SKUs, for which we observed a strange situation during the implementation of the
679 new replenishment policy. More precisely, a particular SKU drew our attention during
680 the observation period. This was an overcoat model, never exposed on the shop floor
681 (probably because of a commercial strategy of the retail store, that privileged different
682 models), but available in the store backroom. The sales of that product, therefore,
683 scored zero. Despite the null sales, after some weeks from the implementation of the
684 RFID-based replenishment policy the product appeared in scandals list, because of
685 the very high stock level in the backroom. We have previously mentioned that the list
686 of scandals to be replenished prioritizes models with a limited number of items on the
687 shop floor and a high sales volume. However, when products whose shelf availability
688 was lower than two items had already been replenished, the RSA dashboard inserts
689 in the replenishment list (which always consists of ten models) those models that
690 are available in the backroom in large quantities but are not available on the shelves,
691 regardless of the amount of sales. This is the reason why, after some weeks, the
692 overcoat appeared in the scandals list. After replenishing it, and by analysing the POS
693 data and the RFID reads of the replenishment gate, we found that the model captured

694 the interest of customers. Indeed, several items were moved from the backroom to
 695 the shop floor, thus suggesting that customers appreciated the model and asked for
 696 different sizes and colours. Overall, six items of that model were sold within ten
 697 days from the replenishment. This particular case suggests that the potential benefits
 698 generated by the RFID-based replenishment management can be higher than those
 699 estimated in this study, involving also the opportunity to identify models whose sales
 700 potential is underestimated. In addition, the use of the new replenishment policy
 701 allowed also identifying a current limit of the commercial choice of the fashion
 702 company that never exposed the overcoat on the shop floor.

703 A second opportunity for future research is to compare, in greater detail, the per-
 704 formance of the RFID-based replenishment policy with the replenishment policy
 705 adopted by the retail store previously. As sketched earlier in the paper, before the
 706 implementation of the RFID technology, the store employees managed the replen-
 707 ishment activities on the basis of the data generated by the store information system
 708 (POSWEB). The next step of the experimental campaign could be to examine sep-
 709 arately the impact on the sales turnover generated by the RFID-driven replenished
 710 policy and that generated by a more conventional replenishment policy, driven by the
 711 POSWEB data and simply aimed at reducing stock-out situations on the store shelves.
 712 To evaluate this difference, it could be useful to manage the replenishment operations
 713 of the retail store examined with the conventional policy based on POSWEB data,
 714 and to compare the list of items replenished with those identified as scandals and
 715 generated by the RSA dashboard. Such a comparison would allow identifying those
 716 models missed in the first list, but detected by the RFID system and suggested for
 717 replenishment.

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