Abstract

Most Radio Frequency Identification (RFID) tracking researchers agree that it would be ideal to track the products all the way from the manufacturers to the retailing store and perhaps even further. However, the biggest existing item-level RFID tracking solutions in logistics are designed for retailers’ purposes and in these systems RFID tags are usually attached in the retailer’s facilities or just before sending the products to the retailer. Therefore tracking in these systems covers only a small part of the supply chain and these systems do not fully exploit RFID technology. Attaching RFID tags in the earlier phases of the supply chain is also usually more cost-efficient. However, the place where tracking is started can be different than the place where the RFID tag is attached, if the benefits of the tracking remain small in some supply chain partner’s operations.

The viewpoint for this paper is supply chain wide, and it includes a literature review of over 30 RFID cases and two in-depth supply chain case studies from two industries: fashion and book. The literature review revealed that there are many RFID tracking pilots, where RFID technology is used also in the manufacturing facilities and in the distribution centres. The found cases are classified by the place where the RFID tag is attached and by the place where tracking starts. As a result of the literature case classification and in-depth case studies, the framework for analyzing different RFID tracking solutions is created and road-maps to build supply chain wide tracking systems are presented.

Keywords: Item-level tracking, RFID, supply chain management.

1. Introduction

The number of successful Radio Frequency Identification (RFID) tracking solutions is increasing all the time. Wal-Mart and Metro have the best-known RFID implementations [1, 2], but there are also other more industry specific applications. In the book industry, the best-known item-level RFID tracking applications are Dutch bookstore chain Selexyz and Portuguese bookstore Byblos. In the fashion industry, the best-known and the biggest item-level RFID application is used by 120 fashion stores of Mark & Spencer (M&S) [3, 4]. However, these well known solutions are each designed for retailers’ purposes. The supplier or the store itself attaches RFID tags, and the tags are mainly exploited for the retail stores’ purposes, even though the same tag could be used upstream in the supply chain. If the tag is attached early, also other supply chain members can exploit these tags, which increases supply chain visibility and potentially reduces handling errors and confusion.

This paper presents the results from a research project spanning two different supply chains: Book and fashion retailing. The focus of the research is item-level RFID tracking systems that cover the whole supply chain. In such solutions, the tags are attached already in the manufacturing phase, and the information of these tags is exploited by as many supply chain members as economically feasible.

Even if this kind of supply chain wide tracking system is likely to be the most economical way to use RFID technology, there are many issues to consider when planning a system to be used on a large scale. First, there has to be a threshold share of RFID technology users...
especially among the end users. Second, the system requires a business model that prevents the manufacturer paying the tagging costs and the retailer getting the biggest benefits. Third, trade-offs concerning the coverage of tracking in the supply chain may require that some products are tagged in the later phase of the supply chain.

2. Literature review

A supply chain can be defined as all the activities involved in delivering a product from raw material through to the customer [5]. The logistics network is explained to have the following basic parts: suppliers, manufacturing centers, warehouses, distribution centers (DCs) and retail outlets [6, 7]. The purpose of supply chain management is to improve the long-term performance of the individual companies and the supply chain as a whole by doing strategic coordination of the traditional business functions and the tactics across these functions within a particular company and across businesses within the supply chain [8].

Tracking systems are based on check-points that register the movements of tracked items [9]. The benefits of tracking are: real-time coordination of material flows and individual tracked items, such as merge-in-transit; providing an effective link between physical reality and information systems, for example, improved inventory count and goods receipt transactions; improved logistics management metrics and analyses [10-13]. RFID is the most efficient technology used for tracking and tracing purposes in the supply chain. Most RFID tracking researchers agree that it would be ideal to track the products all the way from manufacturers to the retailing store or even use the tracking in after sales and return logistics applications [14-16]. However, literature mentions several obstacles, why supply chain wide tracking solutions are difficult to implement.

An RFID-tracking system consists of three primary components – tags, readers, and tracking databases [17]. RFID technology is under development all the time, and the technology is not yet mature. As the technology suppliers can not e.g. guarantee 100% reading rate in any circumstances, potential user companies hesitate to invest in the technology [18, 19].

Different standards are often mentioned to be an obstacle for supply chain wide RFID tracking. A few years ago, there were not any globally agreed standards for RFID technology. Dozens of different manufacturers produced RFID tags, which were not compatible with competitors’ tags. Also different reader manufacturers used to build equipment, which were compatible with only a single manufacturer’s tags. Another issue related slightly to the standards is the different frequencies, which are in use around the world [19]. Therefore it was difficult for companies to make a decision for an RFID investment, if they were not sure about the development of different RFID products. A supply chain wide RFID tracking system would have required a consensus of several companies. [14, 18, 20]

Cost of tagging is mentioned to be too high for many applications even if the costs of RFID tags have decreased for a long time. If item-level tracking is in use, the cost of an RFID tag is much higher than the cost of using bar code. That limits the companies’ willingness to invest in the increased supply chain visibility offered by RFID technology. If the tags are used in the whole supply chain, the quality requirements for the tags are also probably higher than if the tag is only used in one or two functions. That also increases the price of the tags. [14, 18, 20]

Privacy issues have limited the development of item-level RFID, because many consumer organizations are concerned about customers’ privacy, if the products they bought could be tracked around the world. Even if this concern can be seen as an overreaction towards new technology, it is one of the main reasons, why the development of RFID systems concentrates
on pallet and case level tracking in USA. [14, 18, 21-23]. One example is Benetton’s RFID trial in 2003. The company ordered 15 million RFID tags for item-level tracking of pullovers [24], but the company never executed the pilot, because the consumers started to boycott Benetton’s stores [25, 26].

Unbalanced division of costs and benefits of RFID system between different supply chain members is limiting the development of supply chain wide RFID systems. The retailers get the biggest benefits from RFID technology regardless of the industry [14, 27, 28]. However, in supply chain wide tracking systems, the tags are attached already in the manufacturing phase, which has been suspected to lead into a situation, where the manufacturers need to pay the biggest costs – the price of the tags – while getting hardly any benefits. In Wal-Mart’s RFID system, where the suppliers are forced to attach RFID tags to maintain Wal-Mart as their customer, the result has been that most of the suppliers do not exploit the tags in their own operations nor see any benefits of RFID technology for their company [28]. There is also concern of increased power of retailers in the supply chain relative to suppliers [21].

3. Research methods

The research concentrated on two different supply chains: fashion and book-selling. A literature survey of existing RFID applications in these industries classified the applications by the location where RFID tags are attached and by which parts of the supply chain tracking covers. Furthermore two in-depth case studies [29] conducted on the design of supply chain wide RFID tracking system.

For the book-selling industry, only few suitably detailed cases for the classification were found in literature. In the fashion industry, a list of potential cases was found in a report named “Apparel RFID 2009-2019” by IDTechEx [30]. The report listed 85 different company names under the headings “Case studies” in the table of contents of the report. That list was a starting point for surveying potential cases.

The first in-depth case study considered fashion supply chain. In this case, a large Finnish logistics service provider (LSP) company had expanded their current RFID trials with one fashion company to cover also some other fashion companies. The case focused on the fashion companies’ needs for RFID tracking solutions. The purpose of the study was to understand the different alternatives that the LSP company could offer to fashion companies using RFID technology and possible business models that could encourage the industry to introduce item-level RFID tagging and create added value for all supply chain members.

The second in-depth case study considered the book-selling supply chain. Several companies were involved in this case. There was one publisher, two printing houses, the biggest bookstore chain in Finland, and also the biggest book LSP in Finland. A book LSP handles the stocks of the other companies. To ensure the access to required technical expertise that the study needed, also an RFID tag provider company and a major information system provider were involved. The case study focused on available alternatives to build an RFID tracking system for the Finnish book industry and describing the costs and benefits of different scenarios for different types of supply chain participants.

The primary method for understanding the problem situation in these in-depth cases was interviews of the logistics and information system managers of the participating companies. A major data gathering method was also direct observation to understand the working processes of the companies and observing the current working practices. After conducting these interviews and process observations, the case report presenting the findings was sent to the
company representatives for comments. A meeting together with all studied parties was arranged to discuss and validate the case results. Based on the interviews, observing working procedures and examining the companies’ processes and feedback from studied parties, a supply chain wide model of the investment needs and operating costs was made for different RFID implementation options. The model describes what benefits RFID technology would bring to different parties of the supply chain under the alternative implementation approaches.

The findings of these in-depth case studies of two supply chains have been reported in detail in separate conference papers [31, 32]. The paper on the book logistics case describes the different places to attach RFID tags in the supply chain, and the paper on the fashion industry case study describes different tracking concepts for fashion industry.

4. Survey of cases in literature

4.1 Framework for analyzing different tracking options.

To classify different tracking cases found in literature from the studied industries, a framework is needed. The basis for the framework is a simplified supply chain [7], where the suppliers of the manufacturer are ignored, because the studied systems are designed to start at the earliest, when the product is born. The framework also includes the different possible places, where the RFID tags could be attached and the places where tracking can start. In a simplified supply chain, there are four different options to attach RFID tags and start tracking: (1) in the retailer’s facilities, both (2) outgoing from the distribution centre (DC) and (3) incoming to the DC or (4) in the manufacturing phase. These options are presented in Figure 1.

![Figure 1. Different possible places to attach an RFID tag in the simplified supply chain.](image)

The first alternative is to attach RFID tags to the products, when they are coming to the retailer’s facilities. This can be seen as the simplest option, because all the tagging of the products of the specific retailer store can be done in one place, regardless of how many suppliers that store has.

The second and third alternative is to attach tags in some of the DCs between manufacturer and retailer. In many industries, LSPs already provide several services for their customers such as packaging, attaching price tags or some other extra pieces for products in their DCs. Therefore LSPs may be willing to develop and offer RFID tagging service to their customer. Tagging cost per tag is usually cheaper in the DC than in the retailer’s facilities, because in a DC, economies of scale benefits are easier to obtain and automation can be easier to realize. In a retailer’s facilities the tagging space cost can be very high, especially if it is situated e.g. in a shopping centre. Also, if the products already have RFID tags when they arrive to the retailer’s facilities, the receiving process can become considerably faster.

There are two different phases to attach an RFID tag in the DC facilities: When the products leave the DC or already when the products arrive to the DC. In the first alternative, only certain outgoing shipments, which are going to the retailer or other supply chain member, who is able to use RFID technology, are tagged. In the second alternative, the purpose is to tag all the products of the batch coming to the DC. In the latter case, the DC can also exploit RFID tags in many of its own operations.
In the fourth option, when the attachment is done in the manufacturing phase, the tagging cost per attached tag is estimated to be the lowest, because tagging can usually be done automatically and it usually does not remarkably delay the manufacturing process. However, in this phase all the products in the batch or none are tagged, because tagging only part of the products may be too expensive to realize.

![Figure 2. Framework matrix for classifying different item-level RFID cases by the place where the RFID tag is attached and the place where tracking starts in the supply chain.](image)

Basically RFID tracking can not start before the tag is attached. In most cases tracking starts at the same time as RFID tags are attached. However, there are cases when tracking starts in later phases of the supply chain. The most common example is the Slap and Ship strategy, meaning that the company only attaches RFID tags for shipments going to certain customers who demand RFID tags, but the company itself does not exploit these tags anyhow. Based on the above analysis of literature, the matrix shown in Figure 2 sums up the factors for distinguishing between alternative item-level RFID tracking solutions designs.

### 4.2 Fashion supply chain

The RFID journal [4] refers to the report of IDTechEx, where it is estimated that in 2008 the apparel industry is purchasing approximately 200 million RFID tags. The estimation is that M&S is spending 75% of them. The cost of those millions of tags is about 38% of the value that all the retailing is spending for RFID. [4]

By searching more information about the 85 cases presented in “Apparel RFID 2009-2019” report by IDTechEx [30], it turned out that 20 cases of them were totally out of this paper’s scope, because these cases were either case/pallet level tracking solutions or they were after-sales solutions like laundry or rented working suit tracking. However, the authors had to exclude roughly about half of the remaining listed cases, because the found material was too scarce. Also in some cases the problem was to determine from the description the exact place, where the tag is attached or tracking has been started. It was possible to define the place, where the RFID tag is attached and where the tracking has been started altogether in 27 cases [24, 33-56]. These cases are presented in the classifying matrix in Figure 3.
The found cases vary a lot: There are wide implementations used several years in dozens of stores or just small tests with a few hundred tags. Some implementations have enlarged all the time while some others have ended in silence. It is also assumable that the companies interested in RFID tagging may have done several different types of pilots, but not all of them are reported. However, the 27 cases selected for further analysis give a view of different possibilities to build item-level tracking solutions for the fashion industry.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>RFID tagging</th>
<th>DC Incoming</th>
<th>DC Outgoing</th>
<th>DC Outgoing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falabella pilot, American Apparel pilot</td>
<td>0</td>
<td>Lauren Scott, Tomorrow’s Mother, Jacadi, Falabella 2nd pilot</td>
<td>Reno, Charles Vögele, American Apparel, NP Collection, Pantaloon, Goldwin Sportswear, Boboli, Dillards, Lemmi Fashion, Throttleman, Benetton, Gardeur, Sungod Enterprise Group, Serge Blanco</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>Mikuni</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Jones Apparel Group, Karstadt, M&amp;S</td>
<td>Kaufhof/Metro, New Balance</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>LC Waikiki, Mi-Tu</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
</tbody>
</table>

Figure 3. Found RFID trials and applications in the fashion industry classified by the place where the RFID tag is attached and the place where tracking starts in the supply chain.

The aim in about half of the cases is that the products are tagged already in the manufacturing phase and the tracking also starts, when the products leave from the manufacturer. In most of these cases the purpose is to track the products in several places in the whole supply chain. However, in some of these cases tracking ends before arriving to the retail store and in one case the tracking happens only inside the production facilities in order to improve efficiency of the clothes factory. Four cases were found, where the tag is attached already in the production phase, but tracking starts, when the products arrive to the DC. Also two more cases were found, where the tag is attached already in the production phase, but tracking starts, when the products arrive to the retail store. One case was found, where the RFID tag is attached and tracking starts when the products arrive to the DC. Five cases were found, where the RFID tag is attached for the products going to the certain stores in DC. In two cases of these, the tag is also exploited in DC e.g. to verifying the correctness of shipment. In the rest three cases DC only attaches the tag, but does not use these tags for tracking purposes. Also two cases were found, where the products are tagged, when they come to the retail store.
4.3 Book supply chain

There have been several reported RFID trials and applications in the book industry around the world. Hou and Huang [57] presented six possible RFID application models for Taiwanese printing industry supply chain, but only two of them can be realized as item-level tagging. The Dutch bookstore chain Selexyz has set up three so called “intelligent” bookstores. Each of the books that are sent to these stores is marked with an RFID tag in the local book supplier company [58, 59]. In Portugal, Byblos has a bookstore, where all of its 350 000 books, games and videos are equipped with RFID tags. Byblos tracks its items itself by attaching an RFID tag for every product, when they are coming to the bookstore. [60]. In Japan, METI RFID trial included, e.g., item-level RFID tagging of 100 000 books during the manufacturing process [61] and a publisher Shogakukan is attaching RFID tags for its books to improve the handling of book flows between the publisher and retailers [62]. The four cases found in the book industry are presented in the classification matrix in Figure 4.

<table>
<thead>
<tr>
<th>(4) Manufacturer</th>
<th>METI trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3) DC Incoming</td>
<td>-</td>
</tr>
<tr>
<td>(2) DC Outgoing</td>
<td>Selexyz</td>
</tr>
<tr>
<td>(1) Retailer</td>
<td>Byblos</td>
</tr>
</tbody>
</table>

Figure 4 Found RFID trials and applications from the book and industry classified by the place where the RFID tag is attached and the place where tracking starts in the supply chain.

4.4 Literature analysis summary

In most cases, tagging and tracking starts at the same time. Still, there are some exceptions. In some situations a manufacturer attaches an RFID tag, but starting of tracking is postponed until the products come to the DC or retailer’s facilities. Sometimes an RFID tag is attached, when the products leave DC, but only retailer uses these tags for tracking. Usually postponement of tracking start is a consequence of the small amount of the RFID tagged products compared to the total amount of products that the actor is handling.

The comparison of Figures 3 and 4 shows that the book supply chain RFID tracking applications are concentrated between the retailer and DC outgoing while in the fashion supply chains tracking and tagging usually start more upstream. The share of supply chain wide tracking solution in fashion industry is relatively high, even if the best-known and the largest implementations include only downstream of supply chain. In the fashion supply chains, seven out of ten possible tracking and tagging starting combinations are or have been in use. The lacking combinations can be found inside the following two situations: (1) DC does not tag the incoming products, if it is not going to exploit the tag itself. (2) If a product arriving to DC has already a tag, the DC either exploits the tag immediately from the moment when the product arrives or it does not exploit the tag at all. It is also remarkable that the found trials in the combination of tagging in manufacturing phase and tracking only at retailer have been temporary solutions, which have later been developed to start tracking more upstream.
5. **In-depth case studies**

5.1 **Fashion supply chain case**

In this study, a big Finnish LSP company was interested in offering an RFID solution for its customers in fashion logistics. Identifying the needs of the fashion companies was one important issue to be solved and quantifying the customer benefits was another. The purpose of the study was to propose a tracking solution that would fulfil the needs of many different customers and could actually be taken into production use.

Three different tracking concepts were identified in the case study: (1) The clothes are tagged already in the manufacturing phase and are tracked throughout the whole supply chain. (2) The clothes are tagged already in the manufacturing phase, but tracking between manufacturing sites and the DC of the LSP is not introduced. (3) Tagging and tracking start is done in the DC of the LSP. The analysis indicated that the most economical concept from the supply chain point of view is, at least in the beginning, the second concept: tagging in the manufacturing phase, but delaying tracking start to the DC of the LSP. As the products are mainly manufactured in East Asia and the LSP in the study acts primarily in Northern Europe, it would be expensive and difficult for the LSP to arrange complete tracking, when the products are handled by other LSP companies. However, the third concept is also possible, if the products are sourced through very different channels or the amounts of goods are small.

5.2 **Book supply chain case**

The purpose of the Finnish book supply chain case study was to understand, how different supply chain participants can get the biggest benefits of using RFID technology in their operations. The project participants publish 20%, print 40%, handle and store about 60% of books sold in Finland. The participating bookstore chain sells about 20% of all the books sold through all distribution channels to the end customer in Finland. The speciality in Finnish book industry supply chain is that the biggest book LSP is mainly owned by the other major actors of Finnish book supply chain (publishers, retailers, printing houses). Therefore the cooperation between different partners of the book supply chain has a long tradition.

The main result of the study was that tagging in the printing house is the most economical for the end-to-end supply chain point of view if at least 27% of the books end up in a retailer, who is able to exploit the tags. Otherwise, it is more beneficial to consider the postponement of RFID tagging attachment to the DC in the phase, when books are going to be delivered to the retailer able to use RFID technology. Postponement of tagging in the retailers’ facilities seems to be ineffective, because the major part of the benefits come from improved receiving of books in the bookstores. However, even if the printing house alternative has been selected as a primary place for attaching RFID tags, also some tagging will have to happen in the DC and even in the bookstore. There will always arrive books from around the world to the wholesaler, and it will take a long time (if ever) until all of them are equipped with RFID tags already in the manufacturing phase. Also bookstores sometimes order individual books directly from the publisher or a foreign wholesaler.

The unbalanced division of the costs and the benefits can cause problems in this case. The bookstore gets the biggest benefits, while the benefits of RFID technology for other parties are small compared to the costs. Printing house may be able to move the increased costs to the publisher by quoting printing prices without and with tags, but the publisher instead might find it too difficult to sell the same books with considerably higher price to a retailer who can exploit RFID technology than it sells for other retailers. Therefore the implementation of the proposed supply chain wide tracking system may require significant development of appropriate business models that share the costs and benefits between supply chain parties.
5.3 Comparison of the two case supply chains

The perceived benefits of RFID tracking in both types of supply chain are similar: (1) Products are relatively expensive and vulnerable for theft. (2) The product variety is high, and the different products are difficult to separate by a quick sight (different titles of books and different sizes of the clothes). (3) Major part of the products is handled by specialized actor, who is focused on that particular product in every phase of the supply chain. (Printing houses and clothes factories, specialized LSPs, and book and fashion stores). (4) Sales forecasting is difficult and wrong decisions are harmful, because supplementary orders from manufacturer takes time and a majority of the products have short sales peak after which the price of the products diminishes considerably. (5) End customers usually do not know exactly, what they are going to buy, when they are going to fashion or book store.

Postponing tracking start in both studied supply chains can be explained by the fact that retailers are the primary beneficiaries. The benefits of the RFID technology in these two types of supply chain are expected to mainly come in forms of increased sale and decreased need for manual work especially in retailers’ facilities as a result of faster receiving of shipments and inventory. Increased sales is expected to come, when customers or staff do not need to use so much time to find the right title of the book or proper size clothes in the store, and when the staff can more easily find the sold out or lost products and order replenishment faster. Other benefits come from decreased loss of products in the whole supply chain and more accurate deliveries. The RFID technology also allows more cost-effective solutions for ordering and delivering single products to specific stores.

However, tagging and starting tracking further upstream is attractive economically. In both in-depth case studies, the payback time, when the benefits are bigger than the costs incurred in the supply chain wide RFID technology implementation and use is relatively short, if the technology is in a wide use. Therefore the investment for supply chain wide RFID tracking system can be very profitable if the supply chain as a whole can be mobilized.

A reason why fashion supply chains have been more active in piloting RFID can also be identified by comparing the cases. In the fashion industry, the supply chains are different and the LSP has a different role. In the book industry, different bookstore chains do not usually specialize by selling books coming from only a certain publisher, but in the fashion industry, it is more common that there are stores that sell clothes with only a certain brand. The dominant book LSP in Finland is owned by the other main actors of Finnish book supply chain, and therefore has more limited possibilities to lead an industry wide RFID tracking system development, if all the major book supply chain parties are not in favour of the project. The fashion LSP can in smaller steps start to develop a supply chain wide RFID tracking system with certain brands that have their own brand retailer stores.

The starting hypothesis of the case studies was that the early attachment of the RFID tag is the most economical. There are also numerous existing RFID applications in these industries, where RFID tags are attached already in the manufacturing phase. However, in both industries it seems that it is sometimes justified to postpone RFID tagging to the later parts of the supply chain. The obvious reason for postponement is that if RFID tracking is not widely utilized by retailers, then RFID tagging becomes more expensive in the production phase and the unit cost benefits of early placement do not make up the cost difference. Even though there are examples in the literature, where RFID tracking is designed to improve the effectiveness of manufacturer or DC, both in-depth cases showed that these benefits remain usually small comparing with the potential benefits that retailers would get.
6. Discussion

According to the literature review and in-depth studies, a common aim is that all the products are RFID tagged in the manufacturing phase and tracking covers the whole supply chain. However, as the supply chains usually consist of several actors, and the costs and benefits of tracking are difficult to share equally, general agreement about building supply chain wide tracking system at once is not likely. Therefore the first RFID tracking implementations usually cover only a part of the supply chain. However, these systems may later be modified by tagging and starting tracking further upstream.

As already mentioned, the best-known and the largest RFID implementations are mandated by the retailer. Depending on the industry and its supply chains, the retailer has two options to enlarge the scope of the simplest system. The first option is to ask DC to attach RFID tags for the products coming to that retailer. Gradually the DC may also start exploiting the technology. Tracking could be started when tags are attached for outgoing shipments, and later the DC may exploit the technology by attaching RFID tags also for incoming products, which enables tracking products inside the DC. The DC may find cost savings when asking the manufacturer to attach RFID tags for the products coming to the DC. This also enables the manufacturer to use these RFID tags for tracking, which then completes the supply chain wide tracking system. The second option for the retailer is to ask directly manufacturers to attach RFID tags for the products. When manufacturers attach these tags, it would be possible for manufacturers and DC to track the products all the way from the manufacturing phase. Figure 5 summarizes these options.

Other supply chain parties can also be active actors in building supply chain wide RFID tracking systems. If the DC takes the RFID initiative, DC could offer RFID tracking solutions as a service for retailers by tagging the products going to these retailers. When certain amounts of retailers use RFID tagged products, the DC may start to tag and track incoming products and later ask manufacturers to do that. In some cases, the manufacturer can bring added value for the end user or some other party by adding an RFID tag to its products. In that case, it would be rather easy for DC and retailer to use the same tag for tracking purposes. These RFID initiatives made by the DC or the manufacturer can be seen as a part of the same system development presented in Figure 5. The DC’s initiative just starts from the middle of the first alternative, and the manufacturer’s initiative starts in the left-up corner of the matrix.

\[\text{Figure 5. Two different road-maps for developing supply chain wide tracking systems.}\]
Some interesting notions can be seen when analyzing Figure 5. Moving upwards in the matrix usually means the obtainable cost decreases if the volumes are big enough. Moving to the right increases the costs, because extended tracking requires investments and adds work task. However, moving to the right is the only way to increase benefits, as moving tagging upwards does not alone bring any supply chain improvements. Therefore the road map path 2 in Figure 5 describes a system development, where the costs are at first minimized by increasing the volume and then the investments for better tracking are made by different supply chain actors as the business case is clear enough. The improvements on the other path where tagging and tracking move upstream jointly, can be seen as the development path making simultaneous trade-offs between costs and benefits.

The book retailers are seldom specialized in selling only products coming from single publisher. Also in the bookstores, the books are arranged by the topic, not by a publisher. Therefore the first road map path is more probable in the book supply chain, because at least in Finland, these chains consist of hundreds of publishers and printing houses, but only a few book DCs. Different fashion clothes brands instead may have specific stores or they may have their own sections e.g. in the department stores. That enables the adoption of tracking systems in both ways in fashion supply chains.

7. References