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Assessing the Effects of Enhanced Supply Chain Visibility Through RFID

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ABSTRACT

The majority of RFID implementations can be traced back either to mandates issued by companies or institutions with significant market power like Wal-Mart or the U.S. Department of Defense, or to the replacement of existing Auto-ID technologies like barcodes. Only sporadically is RFID being used to derive superior information about current processes in order to create supply chain visibility. In this contribution, we examine the visibility potentials of RFID technology within the context of SCM and we propose a four-step approach to assessing the results that can be achieved through visibility.

Keywords

RFID, Visibility, SCM, ROI

INTRODUCTION

At the beginning of this decade, RFID came to the fore of companies searching for cost reduction potentials for operating their supply chains. Technical reports and scientific contributions promoted RFID as the silver bullet for SCM problems. In many cases, however, the possibilities were overrated and initial pilot projects were overshadowed by obstacles like ill-conceived technology, lack of standardization, and high costs. In the aftermath, we have seen technological progress and increased standardization efforts, as well as falling costs of RFID hard- and software. These developments led to a series of RFID roll outs. So far, the majority of RFID implementations can be traced back either to mandates issued by companies or institutions with significant market power like Wal-Mart or the U.S. Department of Defense (resulting in so called “slap-and-ship” approaches), or to the replacement of existing Auto-ID technologies like barcodes (automation effects) (Brown, 2007). Only sporadically is RFID being used to derive superior information about current processes in order to create supply chain visibility (Hardgrave, Amstrong and Riemenschneider, 2007). One reason for this could be the difficulty in calculating the return on investment (ROI) of an RFID installation which is supposed to target visibility.

We believe that the future of RFID lies in the creation of supply chain visibility beyond mere automation. Only in this way can whole potential of this technology be unfolded. But before this can happen, the management must be provided with adequate tools to gauge the possibilities that RFID offers. In this contribution we propose a four-step approach to assessing the results that can be achieved by implementing RFID for visibility purposes. To this end, we briefly discuss general RFID effects and we present selected RFID projects ranging from simple slap-and-ship procedures to complex visibility-creating installations. Afterwards, we examine the RFID visibility potentials concentrating on the data granularity dimensions which are the adjusting screws in RFID systems regarding the SC visibility. We then introduce a four-step approach to assess visibility effects and apply it to an exemplary scenario. Subsequently, we contrast the SCM requirements with the RFID potentials to show that an optimum level of visibility does, in fact, exist. Finally, we give a summary and a brief outlook. Figure 1 summarizes the structure of the paper.

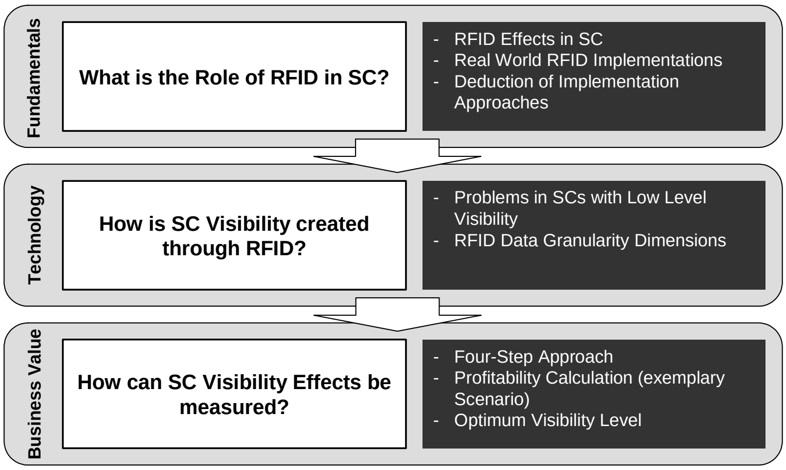


Figure 1. Structure of the Paper

RFID AND SUPPLY CHAIN VISIBILITY

RFID Information Effects as Basis for Visibility Creation

IT effects can be divided into three general groups: automation, transformation, and information effects (Melville, Kraemer and Gurbaxani, 2004). From these, the following implications arise for the implementation of RFID in the SC. Process efficiency is increased through *automation effects*, in that recurring function processes are transferred from humans to machines. RFID technology increases the degree of automation of traditional Auto-ID systems (Michael and McCathie, 2005). For instance, the German business group Metro decreased the time it took to process palettes in its incoming goods department from 90 to 70 seconds through the implementation of RFID (METRO Group, 2005). *Transformation effects* lead to the redesign of processes. Process innovations based on RFID technology are possible particularly through the storage of product-related data on tags (Sheffi, 2004). In addition to pure data storage, tags equipped with microprocessors can perform their own calculations, thus enabling autonomous transport networks on the basis of multi-agent-based control (Garcia Higuera and Cenjor Montalvo, 2007). The *information effects* lead to more efficient processing and provision of information in the SC. The pertinent objectives are among others (Simchi-Levi, Kaminsky and Simchi-Levi, 2002):

- Accessibility and visibility of information: RFID increases the SC visibility processes through detailed representation of the material flows in information systems.
- Decision-making based on complete SC information: The requirement planning, which is often executed in isolation by the SC participants, creates the bullwhip effect (increasingly large fluctuations in order size the further a company is away from the end consumer) (Lee, Padmanabhan and Whang, 1997). This effect occurs primarily because of missing or delayed information. Integrated planning based on RFID data can contribute to better decision-making.

The effects mentioned differ depending on the scope of the RFID implementation. Since we focus on visibility potentials we will, in particular, emphasize the information effects in subsequent sections. We would like to use some motivational examples of different kinds of RFID usage in the next section before sharing our understanding of how to distinguish the different implementation approaches.

Motivational Examples

Mandates of Wal-Mart and the U.S. Department of Defense

Wal-Mart launched its RFID initiative in 2003, when it issued the first RFID mandate to its top 100 suppliers challenging them to begin tagging pallets of merchandise by January of 2005 (Hunt, Pugila and Pugila, 2007). In 2006, Wal-Mart expanded its RFID initiative to an additional 300 prime vendors. The U.S. Department of Defense (DoD) described its "RFID Policy" in a memorandum issued in 2004 (Hunt et al., 2007). According to this, DoD suppliers must ensure that all consolidated shipments moving to, from, or between overseas locations are tagged, and they must expand the active RFID infrastructure to provide global in-transit visibility. Although Wal-Mart and DoD have postulated how suppliers should benefit from the implementation of RFID (better information, smart recalls, faster shipping), many suppliers did not recognize benefits for themselves. In many cases, they are tagging the logistical units just before the shipment to fulfill the mandate.

RFID at Daimler

Daimler introduced RFID to support their manual kanban process at their production plant in Stuttgart-Zuffenhausen, Germany in 2007. The production plant is divided into a warehouse and a production area. The material used at the assembly line is provided by the warehouse in cases containing kanban cards (Bodlien, Christmann-Jacoby, 2000). After usage of the material the kanban cards are collected and brought back to the warehouse where purchase orders for the suppliers are placed related to the empty kanban boxes. Inaccuracy during this manual process makes it necessary to conduct a daily physical inventory control. During the project, RFID-enabled kanban cards were introduced which are read at the gate between the warehouse and production area. The reading of the RFID-enabled kanban cards leads to automatic transactions in the ERP system. Besides, errors due to manual processes are avoided, the daily physical inventory becomes obsolete, and Daimler can use an automated lean consumption-based strategy for purchasing. This project was awarded with the Euro-ID RFID Award as a potential reference implementation for discrete parts manufacturing.

Department Store Kaufhof Warenhaus AG

Department Store Kaufhof Warenhaus AG (Kaufhof) is a leading European retailer with about 126 stores, a sales volume of $5.47 billion in 2006, 25,000 employees, and approximately two million customers every day (METRO Group, 2007). Kaufhof makes about 35% of its total sales from fashion (Loebbecke, Palmer and Huyskens, 2006). At the end of 2007, Kaufhof started a new RFID pilot project in one of their stores by tagging 30,000 articles at item-level on an RFID-enabled sales floor. The management expressed that improving customer satisfaction is the main goal of the project by reducing out-of-stock situations and improving customer service (Schlick, 2007). The number of out-of-stock situations is minimized by using integrated inventory management including RFID gates at goods receipt, tracking merchandise during transportation from the backroom to the sales floor, and the usage of mobile RFID readers and smart shelves which help the personnel to always be aware of the volume of merchandise in stock facilitating them to help customers searching for specific items on the sales floor. To further improve customer service, Kaufhof implemented intelligent mirrors, and intelligent changing rooms which recognize the merchandise by its EPC and offer information like price, material, and care instructions as well as complementary products, further sizes, and colours, on an integrated display.

Deduction of RFID Implementation Approaches

The examples described show that the adoption of RFID takes place on different levels. The minimalistic adoption, whether it is because of mandates or other superior trading partners, like seen at Wal-Mart and the DoD, constitutes the *slap-and-ship* approach. The next level of adoption aims at using benefits accompanying the use of RFID technology including the reduction of labor costs and/or improvement of processes throughput by *automation*. At Daimler we saw manual processes being error-prone and, consequently, leading to inaccuracy. RFID therefore is used for automating manual process steps to improve accuracy and processing speed. At Daimler, we learned that RFID has been implemented to automate processes like goods receipt, goods issue, and quality inspections. We rank these application areas as automation-centric. The highest level of RFID adoption aims at more than mere automation – real-world data is gathered to provide higher SC *visibility*. Table 1 systemizes the different RFID implementation approaches.

Approach	**Goal**	**Main Costs**	**Quantifiability of Benefits**	**ROI**
Slap-and-ship	Compliance	Tagging	No benefits	Negative
Automation	Process efficiency	Tagging, reader infrastructure	Rather easy to quantify	Rather positive
Visibility	Gain business value by more exact and current image of the SC	Tagging, reader infrastructure, and configuration of RFID middleware and information systems	Rather difficult to quantify	Uncertain

Table 1. Systemization of different RFID Implementation Approaches

RFID VISIBILITY POTENTIALS

While the barcode of a particular article is typically scanned solely after production and at the point of sale, RFID tags could be read every time there is a change in location. In general, a higher SC visibility level is achieved when *data granularity* can be increased. We can systemize data granularity in RFID systems by means of five dimensions:

Local Granularity

The increase in local granularity occurs through the installation of additional data collection points. We get a clearer picture of the processes because the data is read more often. Thus, we can trace the path of the logistical object through the SC more exactly. Instead – as is common today – of only being aware of the beginning (product manufacture) and the end (point of sale) of the process, information concerning important intra-process steps (e.g. object is located in production step *x*) is known.

Temporal Granularity

Through the "always on"-character of RFID technology, object movements are recorded in real time. The data granularity can be influenced by choosing the length of read intervals (every five minutes, every hour etc.). The increase in visibility results from the fact that real-world changes (condition, position) are visible immediately. Thus, current information is available to the management for the decision-making process.

Tagging Level

RFID makes possible unequivocal recognition at all levels of loading (palette, box, and item). Above all, item level tagging leads to a data granularity which until now was impossible to achieve with traditional Auto-ID processes. The management receives information concerning the movements of every single object that is RFID tagged.

Data Richness

This dimension of data granularity increases with the collection and storage of additional data on the object (specific product features or condition and environment data). The comprehensive information contributes to an increase in visibility, whereby decisions are based on a larger data pool, and, therefore, take more problem variables into account. It must be clarified whether only the ID or also additional data (including environmental data picked up by sensors) are necessary.

Object Coverage

Data granularity increases the more objects are tagged. Complete object coverage delivers data on all logistical objects in the SC. The decision in this aspect concerns the number of necessary tags, which increase with higher object coverage. It is to question, for which logistical objects visibility should be created/increased.

ASSESSING THE BUSINESS VALUE OF RFID CREATED SUPPLY CHAIN VISIBILITY

A Four-Step Approach to Assess RFID Visibility Effects

In RFID literature, there is, in general little argumentative connection between visibility and results concerning business objectives. Yet this causal relationship is the single most important aspect when assessing an RFID project: How does the higher visibility (which is achieved through the investment in RFID and therefore relates to costs) translate into better business results (the benefits that have to be quantified)? We introduce a four-step approach in order to clarify the effects on business results of the increase in visibility achieved through the implementation of RFID (see Figure 2).

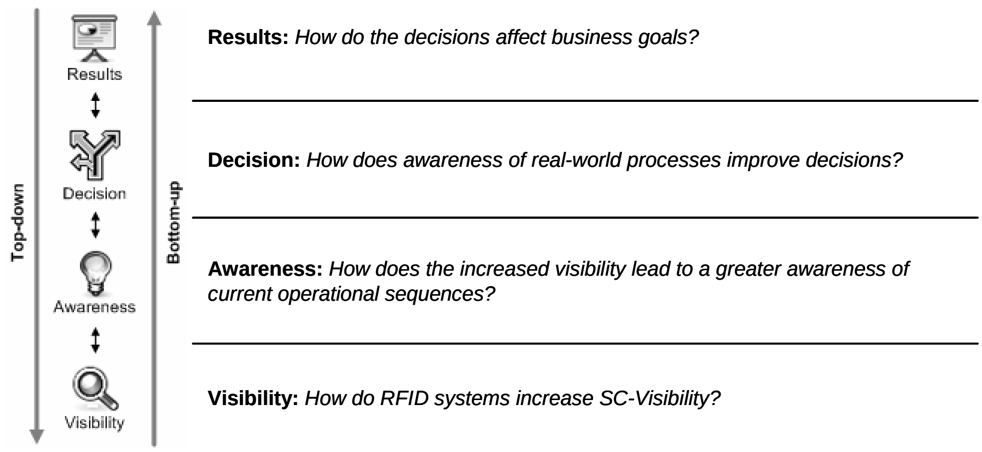


Figure 2. The Four-Step Approach

The individual steps are based on the following considerations:

- **Visibility:** In this step, it must be clarified what visibility potential RFID possesses. For instance, concerning the demand supply planning RFID can provide us with information about current stock levels in all warehouses of the SC and material flows through the SC.
- **Awareness:** The increase in visibility leads to a clearer picture of SC processes. An understanding of the operational sequences which are now visible in greater detail must be created in this step. For instance, we can determine actual stock levels or production quantities.
- **Decision:** The decisions made at this point are based on more exact data of the SC processes, which is why they are more target-oriented. For instance, based on the increased awareness we are able to adjust our stocks and initiate orders more exactly.
- **Results:** In this step, the contribution towards the achievement of business objectives represented by the increase in visibility must be examined. Finally, the cause-effect principle (increase in visibility – achievement of business objective) will be clarified here. For instance, the results of a more exact adjustment of stock and an optimized ordering policy are a reduction of the bullwhip effect and improved delivery reliability.

The questions can be answered from the bottom-up (as was just described), as well as from the top-down perspective. The bottom-up approach eventually leads to the question as to which business objectives can be reached with the achieved level of visibility being answered. The top-down approach provides the required visibility level based on the expressed to-be results.

In table 2, we apply the proposed approach to selected SCM processes (following Simchi-Levi, Kaminsky and Simchi-Levi, 2002; Stadler, 2005; Beamon, 1999; Heinrich, 2005; Chen, Federgruen and Zheng, 2001; Lee, 2004). Analogies to the motivational examples presented earlier can be found.

SCM Process	Visibility	Awareness	Decision	Result
Demand Supply Planning	Current stock levels and material flows can be identified	Stock levels and material flows of all SC partners can be determined and compared to current demand in real-time	More exact adjustment of stock and initiation of orders along the supply chain	Reduction of the bullwhip effect
Receive Product	Correctness of shipments (products, quantities, time, documentation) can be identified	Automatic determination of purchase order fulfillment	Reaction like refusal of goods or re-ordering of missing goods Transparent evaluation of supplier	Less obsolescence inventory Better relationship to and motivation of suppliers
Picking & Packaging	Comparison of sales order and delivery takes place	Automatic inspection for perfect sales order fulfillment	In case of discrepancies, counteractive actions can be taken (e.g. the customer can be informed of the quantity difference in advance)	Optimized sales order fulfillment rate and improved customer rating Penalties can be avoided, or bonuses achieved
Ship Product	Processing times are monitored Product can be identified in transit Environmental data (temperature, pressure, impacts, proximity to other objects) can be measured	Idle times and processing times during shipment can be determined In transit inspection for perfect sales order fulfillment is possible Quality assessment of goods is possible in real-time, thus, before arrival	Processing times can be optimized Counteractive measures can be taken (e.g. rerouting the delivery truck) Research into the cause of quality problems is possible	Shorter delivery times Fewer misrouted goods Increase in delivery reliability Increase in quality and customer satisfaction
In-retail shop activities	Products brought from the backroom to the sales floor can be identified Shelf stock is visible Misplaced products are visible Replenishment accuracy/timeliness are transparent	Products in the backroom can be distinguished from those on the sales floor Out-of-Stock situations can be recognized Misplaced products and their location can be determined	Effective initiation of replenishment and (re-)ordering Replacement of misplaced products Optimization of product placement Usage of cross-selling potential	Fewer Out-of-Stock situations Lower replenishment costs Better customer service Increase in sales volume More appropriate product offer

Table 2. Application of the Four-Step Approach to SCM Processes

Profitability Calculation in Different Scenarios

In the following, we discuss the profitability calculation in the deduced RFID implementation approaches.

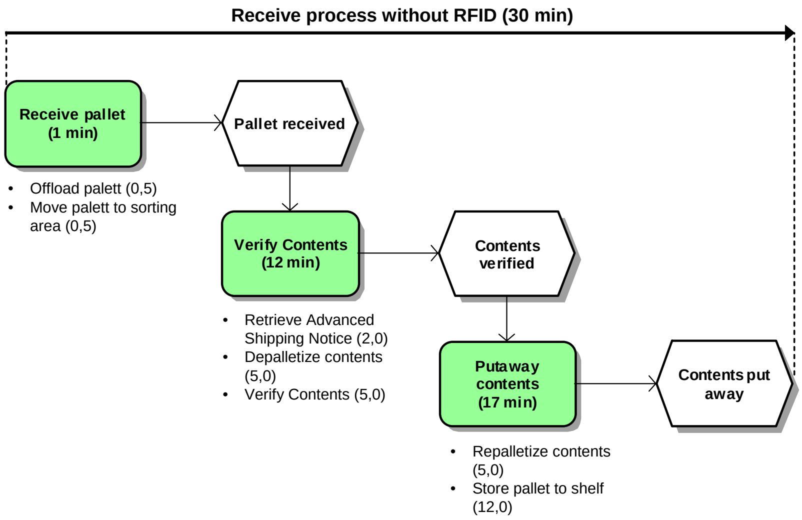
Scenario 1: Fulfilling Mandates through Slap-and-Ship

If SC partners decide to adopt the slap-and-ship approach their goal is to minimize costs linked with the mandates. In general, there are two possibilities to implement the slap-and-ship concept: the tags can be affixed in-house or they can be affixed by a third-party logistics provider who is responsible for the transport and paid per logistical unit. The calculation of additional costs is in both cases trivial. The in-house solution includes costs of tags and costs of affixing the tag to the logistical unit. The downside of the slap-and-ship approach is that it does not create any benefits and, thus, does not represent any business value to the company.

Scenario 2: Increasing automation through RFID

Calculating the ROI for an automation solution proves to be simple, too. Although, in certain cases, there may be some soft benefits that can be realised by automating processes and that are difficult to value precisely, the majority of benefits are quantifiable. Basically, the automation effects can be reduced to two cases: process steps can be accomplished faster (e.g. automatic RFID identification replaces manual barcode scanning), or process steps can be removed (e.g. manual check for completeness). We can calculate the time-saving potential by comparing the current as-is state with the RFID-enhanced to-be state and, based on labor cost we can calculate the cost reduction and cost avoidance through process improvement. The cost side consists mainly of the RFID hardware (reader, controller, server, wiring), software (middleware, optionally application software), tags, installation and maintenance. A comparison of the costs and benefits mentioned leads to the ROI and permits an assessment of the profitability of the RFID implementation.

To illustrate the profitability calculation of automation effects, we will take a closer look at the receive process of a Distribution Center (DC). Figure 3 shows the process of receiving and storing a pallet in the traditional way which takes 30 minutes. Assuming that the warehouse hourly factor amounts to $90 per hour, we arrive at total costs of $45 per pallet.



Steps	Time (min)
Receive Pallet	*1,0*
Offload pallet	0,5
Move pallet to sorting area	0,5
Verify Contents	*12,0*
Retrieve ASN	2,0
Depalletize contents	5,0
Verify contents	5,0
Putaway Contents	*17,0*
Repalletize contents	5,0
Store pallet to shelf	12,0
Total	**30,0**
Hourly Factor	$90
Total Cost	**$45**

Figure 3. Receive Process: As-Is State

Now we will contemplate the RFID-enhanced receive process depicted in Figure 4. In this scenario, the pallets and boxes are tagged and a gate reader is installed at the receiving dock. Whereas the first process step (receive pallet) remains untouched, the following steps are highly-affected by the automation through RFID. We do not need to retrieve the Advanced Shipping Notice (ASN) manually anymore and the content can remain on the pallet while it is driven through the gate reader. The system verifies the content automatically and sends an alert in case of discrepancies. If the delivery is correct, the pallet can be stored to the shelf right away. Through the use of RFID the time spent for the receive process has been reduced by more than 50 percent. This means that the logistics costs for receiving the pallet have been reduced from $45 to $21.

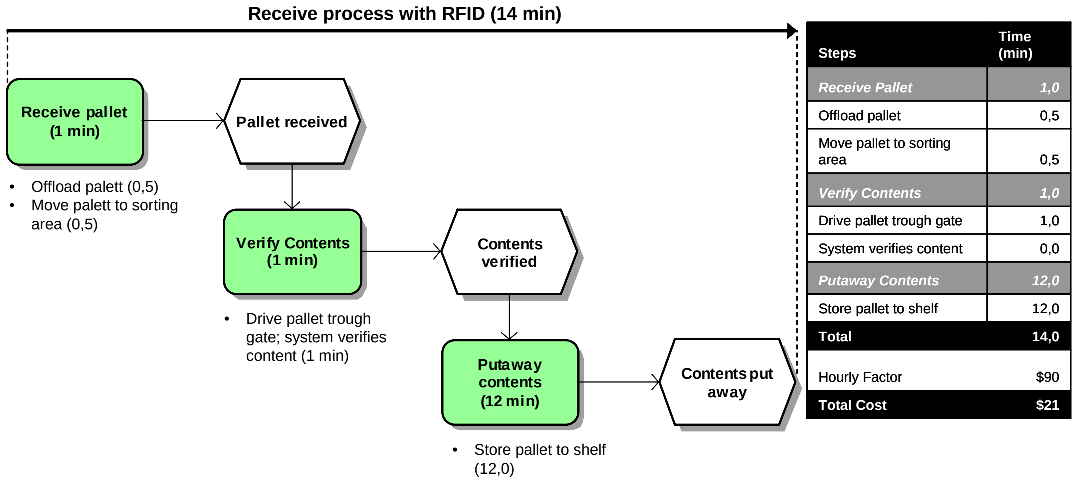


Figure 4. Receive Process: Target State

When we assume that the DC receives 60 pallets per day, we arrive at an annual savings in the amount of $288,000 (200 days/year). Here it should be considered that those savings can only occur if personnel can be reduced at this specific amount. For our exemplary examination we presuppose that this reduction can be fulfilled.

The benefits have to be compared to costs of the RFID implementation. In this case, the pallets and boxes have to be tagged and the receiving and shipping docks have to be equipped with RFID readers. Additionally, there are costs for the software, installation and maintenance. Table 3 summarizes the benefits and costs and calculates the ROI.

Benefits		**Comments**
Reduced Labor	288.000	
Total Yearly Benefit	**288.000**	
One-Time Costs		
Hardware		
Handheld Readers	6.000	6 handheld readers ($1000 per reader)
Fixed Readers	28.800	6 fixed readers with 4 antennas each ($4000 per reader and $200 per antenna)
Installation	2.400	$400 per reader
Software		
Middleware	60.000	
Installation and Configuration	34.000	
Total One-Time Costs	**131.200**	
Recurring Costs		
Maintanance	18.960	20% of hardware and software costs
Tags	132.300	12000 pallets and 240000 boxes per year ($0,50 per tag including tagging costs) plus 5% defective tags = 264600 tags required
Total Yearly Recurring Costs	**151.260**	
ROI calculation (5 year)		Interest rate 5%
Present value of benefits	1.309.234	
Present value of costs	818.820	
ROI	**160%**	

Table 3. ROI of the Automation Solution

Scenario 3: Creating Visibility through RFID

The calculation described cannot be performed for a visibility RFID project – the cost elements may remain the same, but the benefits usually cannot be derived from process flow diagrams. Visibility effects have to be approached differently. However, they still have to be quantified in some way to allow an assessment of the profitability. Using the proposed four-step approach we can assess the visibility effects of RFID.

The automation solution described in the previous chapter has streamlined the receiving process, but there remain unresolved problems due to the lack of visibility, like misplaced goods and picking errors. The DC is still a black box: we know its input and output but have little awareness of internal processes. To address these problems the visibility inside the DC has to be increased.

Visibility. In the DC we can identify the following visibility requirements and assign the following RFID potentials (see table 4).

Visibility requirements	RFID Visibility potentials
Storage of goods (put away errors?)	Installation of readers on the shelves monitoring the shelf content
Picking of goods (proper combination?)	Installation of readers in the picking area
Loading goods onto truck (right load on the right truck?)	Installation of readers at the loading platform or inside the truck

Table 4. Visibility Requirements and RFID Potentials

As shown in the table, to achieve the desired visibility the local granularity has to be increased e.g. more reading points are needed to deliver the relevant information about processes inside the DC. Because the minimum logistical units that have to be monitored are boxes we do not have to change the tagging level.

Awareness. As a result of shelf monitoring the DC personnel is able to identify errors in the put away process. The readers at the conveyor belt monitor the picking process and deliver information about potential errors. Through the installation of readers in the shipping area, we are able to see if the right goods are being loaded onto the right truck. Thus, the created visibility level allows us to keep the three main sources of errors in the DC in view (see Figure 5).

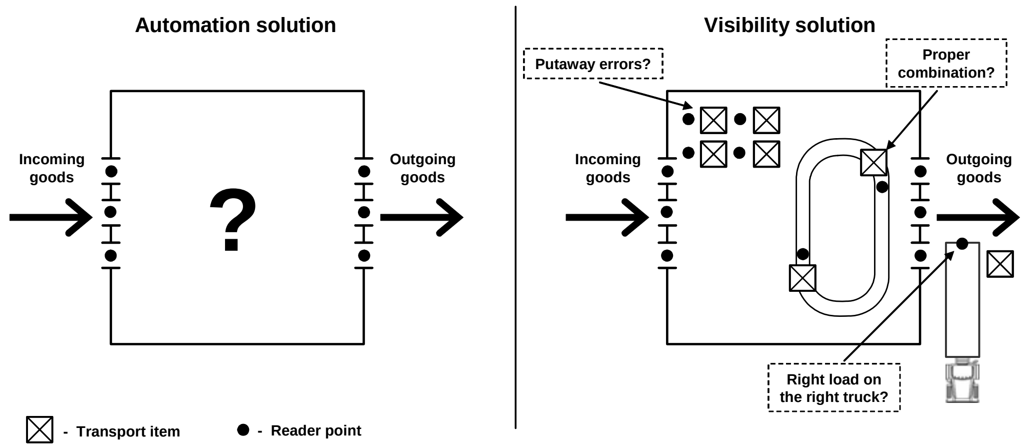


Figure 5. Automation and Visibility in the DC

Decision. We are now able to make superior decisions based on the more detailed information about current operational sequences inside the DC. For instance, in the case of put away errors, we can alert the warehouse personnel to restock the item on the correct shelf. Thus, we can eliminate misplaced goods and avoid situations where a certain pallet or box cannot be found. In an analogous manner, we can prevent picking and loading errors.

Results. So far, we have analysed the visibility requirements and potentials, as well as the effects of the increased awareness on SC decisions. Now the question has to be answered as to how these decisions translate into business results.

Let us assume we have observed that, in the past, lost assets in the DC averaged $60,000 per year. If approximately half of the lost assets can be attributed to misplaced items, then, by monitoring the put away process, we can avoid costs in the amount of $30,000 annually. Moreover, the searching costs can be reduced if assets in the warehouse can be located exactly. Assuming that the warehouse personnel dedicates, on average, one hour daily to searching activities we arrive at annual savings in the amount of $18,000.

Errors during the picking processes and loading process are usually detected when the shipment arrives at the retail store. Each wrong delivery affects the customer rating negatively. RFID detects wrong units or incorrect quantity of goods at the point of creation and prevents follow-up costs due to errors. An increase in optimized sales order fulfilment is hard to quantify. One possible approach could be to consider conventional penalties which can be declared by the retailer in the case of a wrong delivery. If those penalties amount to $80 000 per year, we could estimate that, by improving the picking process through RFID, we can prevent three-fourths of them and arrive at savings in the amount of $60,000.

Based on the improved visibility, we can also reduce the excess inventory. Let us assume that we have assets amounting to $6 million and the imputed interest rate of the working capital is 5 percent. If we estimate that we can reduce the excess inventory by 10 percent, we can reduce the costs of capital tied up by $30,000.

On the cost side, we have additional one-time expenses for the required reader infrastructure. In our exemplary scenario, we need another 13 fixed readers (8 readers for the shelves, 2 readers for the conveyor belt, and 3 additional readers at the shipping dock) and 6 handheld readers for the warehouse personnel in case manual reading is required. Besides, more powerful middleware is needed. In summary, Table 5 illustrates the profitability calculation for the visibility scenario.

Benefits		Comments
Reduced Labor	288.000	
Cost Avoidance Putaway Errors	30.000	
Cost Avoidance Searching	18.000	
Cost Avoidance Penalties	60.000	
Reduced Excess Assets	30.000	
Total Yearly Benefit	**426.000**	
One-Time Costs		
Hardware		
Handheld Readers	12.000	12 handheld readers ($1000 per reader)
Fixed Readers	91.200	19 fixed readers with 4 antennas each ($4000 per reader and $200 per antenna)
Installation	7.600	
Software		
Middleware	90.000	Enhanced functionality needed
Installation and Configuration	46.000	
Total One-Time Costs	**246.800**	
Recurring Costs		
Maintanance	38.640	20% of hardware and software costs
Tags	132.300	12000 pallets and 240000 boxes per year ($0,50 per tag including tagging costs) plus 5% defective tags = 264600 tags required
Total Yearly Recurring Costs	**170.940**	
ROI Calculation (5 Year)		Interest rate 5%
Present Value of Benefits	1.936.575	
Present Value of Costs	1.023.885	
ROI	**189%**	

Table 5. ROI of the Visibility Solution

As we can see, the visibility scenario has a higher ROI than the automation scenario. Based on the four-step approach we were able to estimate the results that can be achieved through visibility creation. Thus, we could compare both implementation approaches and rank them according to the ROI.

Optimum Visibility Level

As made clear in the previous section, RFID, through its capability to create a more exact and current image of the real-world in the digital world, is able to meet the need for visibility in SCM. An investment in RFID technology in order to increase visibility represents a strategic decision, one which should precede exact planning, especially as it concerns the choice of tags, the number and placement of readers, and the connection to backend systems. In addition, the identified visibility requirements must be satisfied from an economic standpoint. If an increase in visibility does not lead to optimized SCM, then it is either unjustified from a cost-benefit perspective, or unreasonable with respect to information overload. There is an appropriate degree of visibility – the equilibrium between the SCM visibility requirements and RFID visibility potentials. In conclusion, Figure 6 shows that the equilibrium between the visibility requirements and potentials is situated where additional costs of visibility exceed additional benefits (cost avoidance plus revenue enhancement).

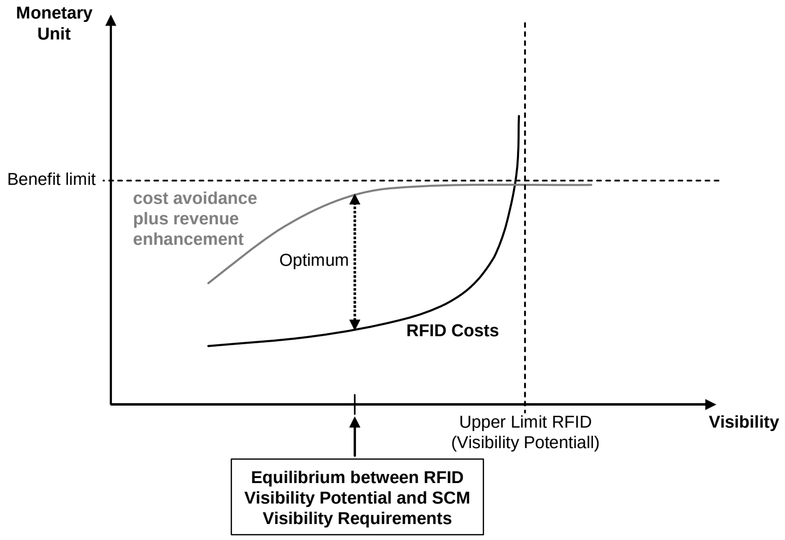


Figure 6. Equilibrium between Visibility Requirements and Potentials

SUMMARY AND OUTLOOK

In this contribution, we classified RFID information effects and presented several real-world examples showing the different implementation approaches slap-and-ship, automation, and visibility. After that we described the RFID potentials for creating SC visibility. Furthermore, we showed how to assess RFID visibility effects using the proposed four-step approach (visibility ↔ awareness ↔ decision ↔ results). For practitioners, this concept represents a structured onset to relate visibility with business results. Furthermore, we applied our approach to selected processes of SCM and conducted profitability calculations for the different implementation scenarios. In the end we stated that the challenge of RFID in SCM is to find that configuration of RFID data granularity which maximizes the ROI. We see further research potential in the area of the determination of the optimum visibility level. To this end, non-monetary aspects like the increase in customer satisfaction have to be incorporated in our approach. Besides, especially in visibility-creating RFID implementations, the configuration of RFID middleware and backend information systems is challenging. Accordingly, further research on this topic is necessary.

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