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Finding Benefits of Utilizing RFID Technology in Skanska Maskin AB

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Abstract: *In this paper, we discuss benefits of RFID technology that Skanska Maskin AB at Linnarhult Gothenburg in Sweden has planed to utilize in the future. We used case study methodology in this research to find benefits of RFID at Skanska Maskin AB. We gathered qualitative data from the present system by using mediating tools such as observation and interviews. We compared present barcode system with proposed future RFID system to see the benefits and effects of the RFID technology. The store environment of Skanska Maskin AB is more complex and difficult to manage. We used Soft System Methodology (SSM) to analyze and identify both present barcode and future RFID systems in such a complex and messy situation. SSM uses "systems thinking" in learning and reflection to help understand the various perceptions come from minds of different people who involved in the problem situation. The SSM considers the importance of cultural, social and political attributes in the present system. We discussed the results of system comparison illustrating the benefit of future RFID system.*

Key words: *RFID Technology; Benefits of RFID; Soft System Methodology (SSM); Use Case Modeling (UML); Warehouse Management; Skanska Maskin AB, Bar code, Organizational Change.*

1. Introduction

Skanska Maskin AB is a leading company selling and renting construction items all over Sweden. They manufacture and repair items as well as recycle unusable items. They used barcode technology based item identification system at their warehouse and they want to change the existing system with Radio Frequency Identification (RFID) technology. They have uncertainty which benefits they can achieve by using this RFID technology at their premises. Our research goal is to find out possible benefits of future RFID system at Skanska Maskin AB over the present barcode system. RFID technology allows in supply chain management to identify store items with an item reader which is similar to the barcode item identification. The present barcode system at Skanska Maskin AB allows the barcode reader to communicate with the renting item's barcode once both are in the visual contact range. This system works fine except some physical limitations such as the durability and visibility of the barcode tag once the items return back from the customer.

Our goal was to find benefit of RFID technology by comparing the present existing barcode system and the possible future RFID system. In order to identify these two systems we have considered the factors such as system-interactions, technological implementations cultural and political changes in the present and future systems in Skanska Maskin AB. The main actor involve in this research was Skanska Maskin AB as the manufacturer, seller and renter of construction items. Customers are

the typical construction companies and the individuals who rent the item from Skanska Maskin AB. We have classified the benefits from implementation of the RFID technology such as using RFID tag, tag readers, automated data/item handling and network connections. In the following chapters of this article we have discussed in detail how we have identified the existing system and the future RFID implemented system at Skanska Maskin AB. We have used "Case Study" as the research method and we used it for careful study of the contents and longitudinal examination of item handling at Skanska Maskin AB. The mediating tools interview, field visits, observation and Soft System Methodology (SSM) used to identify the present system and the future system with RFID in a systematic way.

The data gathering with regards to items renting, returning, and repairing function have been done using above mentioned mediating tools. According to the gathered data we have identified the present and the future system. We have used SSM to create "rich picture", root definition and the "conceptual model" of the existing system. The system documentations domain model, use cases, system interaction diagrams created in using Unified Modeling Language (UML). The results of systems identification led to the comparisons of system functions renting, selling, repairing and recycling. The results of these comparisons created the benefits of the future system. The research question is, Skanska Maskin AB wants to implement RFID technology at there warehouse. They want to know that are there benefits from RFID technology over the present barcode system?

This article has organized with literature review which has included facts from related RFID implementation studies. The Method section discusses the way we have conducted our research and what methodology we have used, why and how it has used. The discussion section analyses results from the data analysis from future RFID system at Skanska Maskin AB. Further more it has been discussed the previous studies, why they are important, the relationship to other researches and suggestions for the future RFID system. The research procedure did not calculate any cost of RFID implementation. The analysis of future RFID system was totally based on the other research have being done on this field and published. The research has concluded with generalizing and recapitulating the research work.

2. Related Research

In our research, it has been found in many literatures that Radio Frequency Identification (RFID) technology (in section 2.1.) and Soft System Methodology (SSM) (in section 2.2.) have applied in different organizational context. The literatures have based on online resources, industry web sites, whitepapers, journals and press releases.

2.1. RFID Technology

Radio Frequency IDentification (RFID) is a technology that uses radio waves to uniquely identify items. RFID interrogator (reader) generates electromagnetic waves and activates the RFID tag. The interrogator converts the radio waves into digital information and sends to middle ware computer (Controller) to analyze the data [1]. There are two types of RFID tags which are active and passive [1 p80-100]. RFID offers a possible alternative to auto-ID technologies include bar codes, optical character readers and biometric identification [2].

It was perceived that the RFID technology were commonly used not only in Supply Chain Management (SCM) and other organizational environment such as libraries, retail shops, airline services, personal identifications, hotel industry, mobile asset management in office. SCM is the "management and control of all materials and information in the logistics process from acquisition of raw materials to delivery to the end

user" [4]. K. Michael and L. McCathie at University of Wollongong has found data from numerous resources that many benefits had gained different organizations by using RFID technology such that non-line-of-sight item, labor reduction, enhance visibility, asset tracking, accuracy of item level tracking and tracing, reliability, improved inventory management and security.

METRO Group, the world's third-largest retailer, attracted a lot of attention when it announced plans to use RFID throughout its supply chain and for numerous applications at its famous Future Store in Rheinberg, Germany [5]. Since then, it has gotten something much more beneficial from its RFID efforts: results. Helped by the performance of RFID readers from Intermec Technologies Corp., METRO Group is reaping the time savings, labor reductions and inventory benefits it hoped for when it began testing RFID. Encouraged by its system performance and real-world benefits, the retailer has gone beyond pilot phase and has gone live with RFID in its own daily supply chain operations [5]. US Air Force Research Laboratory has done research project of RFID in their supply chain management. Final project report result has illuminated that utilization of RFID was experienced the benefits of improvement inventory management, improve labor productivity, eliminate duplicate order, replaces manual procedures, automate receipt and acceptance, improve shipment visibility management, improve asset tracking, reduce shrinkage and enhance business process [6]. United Parcel Services inc., the world leading fright forwarder had proved that perceived benefits of RFID had gained over barcode after implementation of RFID technology [7]. World leading retailer Wall Mart is the first successive customer gain benefit from RFID technology in supply chain management on above mention area.

2.2. Soft System Methodology

There are number of methodologies exist to investigate the organizational changers due to adoption of new technology. The traditional system design approach is UML is envisioned and it does not consider the social, political and cultural aspects of the problem situation in the organization. The SSM is considered the various percepts come from minds of all actors who involve in the organization process when solving the problem. Considering the above facts we chose Soft System Methodology to analysis the present and future system changers at Skanska Machine AB with RFID. Chapter 3 has provided more detail description of particular methodology in practical use for RFID system in Skanska Maskin AB.

Within systems thinking there are two complementary traditions such as "Hard system" and "Soft system". Influenced by control and information theory, hard systems are involving simulations, often using computers and the techniques of operations research. Soft systems represent a reaction to the inability of hard systems to adequately respond to real world problems [8]. Malaysian Public Institution of Higher Education has formulated knowledge management system using SSM. They used combination of technical (Hard) and non-technical (Soft) issues business process and they considered human activities within the organization to formulate system [17]. Soft systems methodology is in the analysis of complex situations where there are divergent views about the definition of the problem – "Soft problem"[8]. In other way SSM is an approach to organizational process modeling and it can be used both for general problem solving and in the organizational change [8]. SSM has seven stages process (several iterations are needed, see Figure 1).

Stage 1: Investigate unstructured problem situation - within the real-world frame of thinking. A significant amount of information needs to be collected (e.g., organizational history, culture, structure, types and number of stakeholders, their perspectives and assumptions) [9]. In the case study of Manchester Metropolitan

University (MMU) accommodation problem was done by Jeremy Rose [12] gathered data from various actors to analyze the problem situation. The actors were student, accommodation office staff, landlords and IT staff.

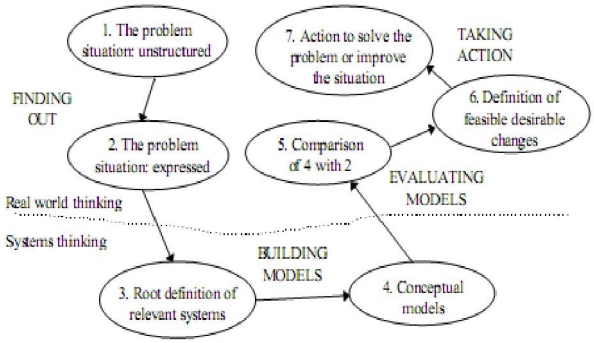


Figure 1: Soft System Methodology Seven Stage [13].

Stage 2: Express the problem situation – This rich picture describes the structure and processes of the organization and the environment in which it operates. The structure of rich picture is consist with physical layout, hierarchy, reporting structure, and the patterns of communication, formal and informal. By process is meant the organization's basic activities (i.e., resource allocation, deployment, monitoring, and control). The relation between structure and process should illustrate the problems, tasks, and elements of the environment in a way that is easy to understand. It should identify relevant themes, develop a shared understanding of different perspectives, and be a basis for further discussion [10]. Referring to Jeremy Rose [12] accommodation problem, the rich picture shows different communication of accommodation office with full of paper works, competition over beds and perception of students and landlords.

Step 3: Root definition of relevant system - At this point change from "Real world thinking" to "Systems thinking". Root definitions are written as sentences that elaborate transformation. It is a short textual definition of the aims and means of the system to be modeled. Root definitions often follow the form: A system to do **P**, by (means of) **Q**, in order to **R** telling us *what* the system will do, *how* it is to be done, and *why* it is being done (its longer-term goals) [11], [12]. There are six components that make well formulated root definition which call CATWOE (Table 1x). Referring to Jeremy Rose [12] root definition described MMU a system that produced qualified candidates for potential employers. Qualified candidates (X), by means of suitable assessment (Y) in order to demonstrate the capabilities of candidates to potential employers (Z).

Table 1: Six components of root definition [12]

Component	**Meaning**
Customer	The beneficiaries or victims of a system
Actor	The agents who carry out, or cause to be carried out, the main activities of the system
Transformation	The process by which defined inputs are transformed into defined outputs
Worldview	A viewpoint, framework, image or purpose, which makes a particular root definition meaningful
Owner	Those who own a system (have the power to close it down)
Environment	Influences external to a system that affect its operation

The transformation process is the core of the root definition, which transforms inputs into outputs.
The transformation process is evaluated by three (Es) criteria [11]. These criteria's are:
E_1-Efficacy or checking that the output is produced;
E_2-Efficiency or checking that the minimum and necessary resources being used to obtain it;
E_3-Effectiveness or checking that the transformation process is worth doing to attain the longer-term goals related to the outputs; these three criteria can be extended as:

E_4-Ethicality or checking that transformation is morally ethical;
E_5-Elegance or checking that transformation is an aesthetically pleasing;

Stage 4: Building conceptual model(s) - Conceptual models demonstrate potential activities and their logical dependencies. It is based on the agreed root definitions in stage 3 of the desired system and is measured against the three Es criteria mentioned in stage 3 [9].

Stage 5: Comparing the conceptual model(s) with the real world problem situation - The conceptual model identifies which activities need to be included in that particular real world situation. It is not concerned with how these activities will be carried out. The conceptual model will be compared with the real world to highlight possible changes in the real world [9]. At this stage it is easy to trace activities which are inadequately done or not done at all, and make recommendations for improvements [12]. This comparison will direct to proposals for real-world improvements based on the logic of the conceptual model.

Stage 6: Determining desirable and feasible changes - The activities in the conceptual model do not exist in the real world. This would then be a recommendation for change. The aim of this stage is to identify and to explore change that is systemically desirable and culturally feasible [9].

Stage 7: Action to improve the problem situation - Changers of real world problem situation will be implemented. After implementation taken place the problem situation will be changed. The iterative process cycle reduces the remaining statics (problems) [9].

In our literature study, we have found many research papers which has addressed many issues of different type of organizational contextual by using SSM. The SSM has been well-liked with many organizations to address their different type of contextual organizational problem. This document has referenced number of research documents and white papers on such real world case studies. Jeremy Rose, Department of BIT, the Manchester Metropolitan University, UK has addressed issues of university accommodation of students by using SSM (accommodation office has meshed with paperwork and solution was computerization) as well as improve the efficacy, efficiency and effectiveness of the university education system [12].

3. Methodology

In this chapter in section 3.1 discusses in details who and what stakeholders, what people are and technology use by them. In the section 3.2 provides information how we elicits user requirements and data gathering. In section 3.3 presents that practical usage of SSM for future RFID system in Skanska Maskin AB warehouse.

3.1. Case Description

This section briefly describes about what is Skanska AB, Skanska IT Solution AB and the Skanska Maskin AB. Further more it expresses people and their roles and responsibilities and current technology they use.

3.1.1 Skanska AB

In 1887 Skanska AB was founded. It is internationally well recognized world leading construction and project Development Company. It is one of the world's ten largest construction companies. Skanska AB is a fortune 500 company and a member of the UN Global Compact. Their business role is constructing and developing offices, homes, roads and public-private partnership projects all over the world from small scale to massive complex once. Skanska AB is not only aim for company profit but also they wants to be a leader in quality, green construction, work safety and business ethics. There are 60,000

employees actively working in Europe, USA, and Latin America in their project sites and offices. Skanska AB is the mother company and it has sister companies; Skanska IT-Solutions and Skanska Maskin AB.

Skanska IT-Solutions is a sister company of Skanska AB. It is offering services and technology-intensive functions in the field of IT to companies in the Skanska group. Skanska IT-Solutions mission is to provide high-quality, cost-effective IT services to support Skanska's business objectives and operations.

Skanska Maskin AB is also sister company of Skanska AB and locates in three different geographical location Stockholm, Malmo and Gothenburg in Sweden. Skanska Maskin AB enrolled with business of

-selling and renting building and construction item, accessories and consumable items

When customer requires rent or buying construction items, he/she comes to sales counter at Skanska Maskin AB or contact sales representative or contact through telephone after referring catalogs. Sales representative check the item availability and prepare an order then sends it to issuing staff at warehouse. Customer collects ordered items from the warehouse or Skanska Maskin AB delivers the order items to the respective customer.

- repairing and recycling defected items

Once rented item returning to warehouse it is accepted and checked working condition by receiving staff. If the item is not usable and repairable sends to repair. If the item is not usable and not repairable then it sends to recycling.

- manufacturing construction items

If item needs to be manufactured demand of customer requirement or a new requirement comes from customer then new items manufacture.

It is challenging to Skanska Maskin AB staff to keep track and store large quantity of many different type of items in their warehouse.

3.1.2. Technology

Skanska IT-Solutions AB is fully responsible for providing and suggesting IT solutions for their own subsidiary companies. Technical Director[1] is one of key personal in Skanska IT-Solutions holds major role in data communication and data warehousing of Skanska AB. He addresses many issues of information technology related such as data security and adopting new technology to subsidiary company of Skanska AB. Senior System Analyst[2], Specialist Working with Business System (CapMan) is one of key hierarchy of Skanska International AB holds major role in developing system applications to subsidiary company of Skanska AB. IT-Data Manager[3] is head of the department and holds major role in IT-Department in Skanska Maskin AB. He has taken control all IT related matters such as project planning, implementation and change management. There are number of employees working under him, among them, System Analyst/Programmer[4],[5] is one of key category who holds total responsibilities of Inventory Registry Information System (IRIS) and innovate new methods and techniques to improve warehouse application system. Skanska Maskin AB warehouse operational functions have taken control by IRIS application. The IRIS system has especially designed and developed for Skanska Maskin AB for the purpose of data warehousing of rent and sale items, stock and finance controlling, auditing and generate reports, receiving and storing items from local and foreign

[1] Conny Roll: http://www.itsolutions.skanska.se/skanska/templates/page____333.aspx

[2] Lars Gustafsson: http://www.projectsupport.skanska.com/files/documents/Newsletters/Newsletter_April_2008.pdf

[3] Lars-Erik Johansson: http://www.excellent.se/pdf/skanska_ref.pdf

[4] Per Fagerberg: http://uk.mywebster.dk/news/skanska-maskin-ab.aspx

[5] Kristian Thisted: http://www.maskin.skanska.se/files/Nyheter/VaLinFo/VaLinFo05-1.pdf

vendors and tagging bar code to items for easy identification. After bar coding locate items in right place in the warehouse. When items sale or rent that has recorded in IRIS system.
Recently warehouse staffs use hand held computer as a mobile device for material issuance and inventory updates. The hand held computer behaves as bar code reader as well as mobile computer. Still they have unsolved problems when issuing item like Scaffolding, concrete mixers, repaired items which unable to attached barcode on them. Scaffolding and concrete mixers can not be tagged barcodes because which may easily get damaged on filed use. And also the same bar code can not use for item which is to be repaired and repaired done.

3.2. Data Sources

IT responsible personal of Skanska IT-Solutions and Maskin AB want to look forward to implement RFID technology in their warehouse and they want to know that does it creates benefits? We contacted Skanska IT-Solution and we got this requirement. After receiving the requirement document from stakeholder, we prepared project scope for finding benefits of future RFID system. We used Case-study as the research methodology which facilitates us to gather, analyze and conclude the data. We did interviews with the Skanska Maskin AB management and gathered data. We observed all the store functions, how it happen who engage with each action, how technology involve in gathering the item transaction data that we used to identify the systems.
One month later we had a meeting with the stakeholder upon our request. Our aim was to investigate the context of Skanska Maskin AB warehouse therefore we followed number of steps to gather qualitative and quantitative data. We did two semi-structured interview with key personal like IT Manager and System Analyst/ Programmers. After interviewing we visited warehouse and observed, how the store function selling, renting, repairing, manufacturing and recycling happen of Skanska Maskin AB warehouse.

The first day of field visit we gathered data from observation and interviews. The interview has been responded by IT Manager and two System Analyst/Programmers. They explained us IT involvement of typical store functions. The barcode functionalities had limitations depending on the type, amount, and way of storing. The bar code system worked fine with them for selected item. They manufactured the bar codes on hard plastic which was durable for field use. They used two different colored bar codes for easily identify defect and repaired item. They presented and explained tracking the item history and report generating. It was demonstrated that how data transmitted from barcode reader or hand held computer to IRIS system. System Analysts discussed with us and explained that various attempt to improve the bar code item handling system with hand held computers. There were few handheld computers which enable to gather and process bar code data.

We observed that the management of Skanska Maskin AB had an uncertainty of achieving benefits of RFID technology over existing barcode system. There were many other issues that they wanted to solve such that consuming much time for item issuing, receiving, stock taking and high labor cost with current bar code system. When issuing and receiving item like Scaffolding and concrete mixers had complex situation. They had difficulties of identifying item/machinery between defected and repaired. Stock differences appeared between system and physical stock (item gone missing). Impossible of tracking and tracing rented items (lost and theft). They wanted to address on above issues from RFID and also expecting quality, accuracy, efficiency, effective services from RFID technology. We created domain model, Use case

scenarios and high level sequence diagrams for typical stores functions based on empirical data which we gathered. We created use case scenarios for customer's order item, rent item, sale item, manufacture item, repair item and return item.

3.3. Proposing RFID system using SSM

Referring to literature [17], the SSM can address many issues of change management. Due to the present system transformation to the future system at Skanska Maskin AB there exist number of organizational changers such as change the operation structure, reduce labor involvement, and item handling automation. Using the SSM is the best way to handle them. Hence we have used SSM to find out benefits of RFID system in Skanska Maskin AB. The SSM have addressed considering the real world context to create the solution avoid the **envisioned UML** approach [13] [20]. The process of achieving the research goal has been identified two systems of Skanska Maskin AB which are present Barcode system and future RFID system. Stage 1 and 2 of SSM has addressed in detail the present system and stage 4 of SSM has addressed Conceptual model address the future system. The present to future system transformation has been effectively addressed by Root definition of CATWOE in stage 3. The system transformation at Skanska Maskin AB creates social, political and environment changers which affect on the company. The 7^{th} stage of SSM discusses how to handle such organization issues until it reach to stable solutions. All above suitability shows that SSM is a best methodology to use in this research.

Stage 1: Unstructured Problem Situation: Skanska Maskin AB wants to adapt for new auto-ID technology to overcome limitations of barcode technology. They have doubt about the benefits of RFID technology over existing barcode system. Not only that there are many issues to address such as consuming much time for issuing, receiving, stock taking items and high labor cost for item handling with current bar code system. When issuing and receiving item like Scaffolding and concrete mixers there exist complex situations. Having difficulties of identifying item/machinery between defected and repaired once. Stock differences have appeared between system and physical stock (item gone missing). Impossible of tracking and tracing rented items (lost and theft).

Stage 2: Express the problem situation - Then we analyze and express the problem situation by drawing a rich picture (See Appendix B) which is a kind of diagrammatic representation of Skanska Maskin AB warehouse operations. The picture capturing much information relating to problem situation and also show boundaries, structure, information flows and communication channel which related to human activity in Skanska Maskin AB. It is way of presenting problem situation which differs from traditional Unified Modeling Language (UML) sequential diagrams or class diagrams.

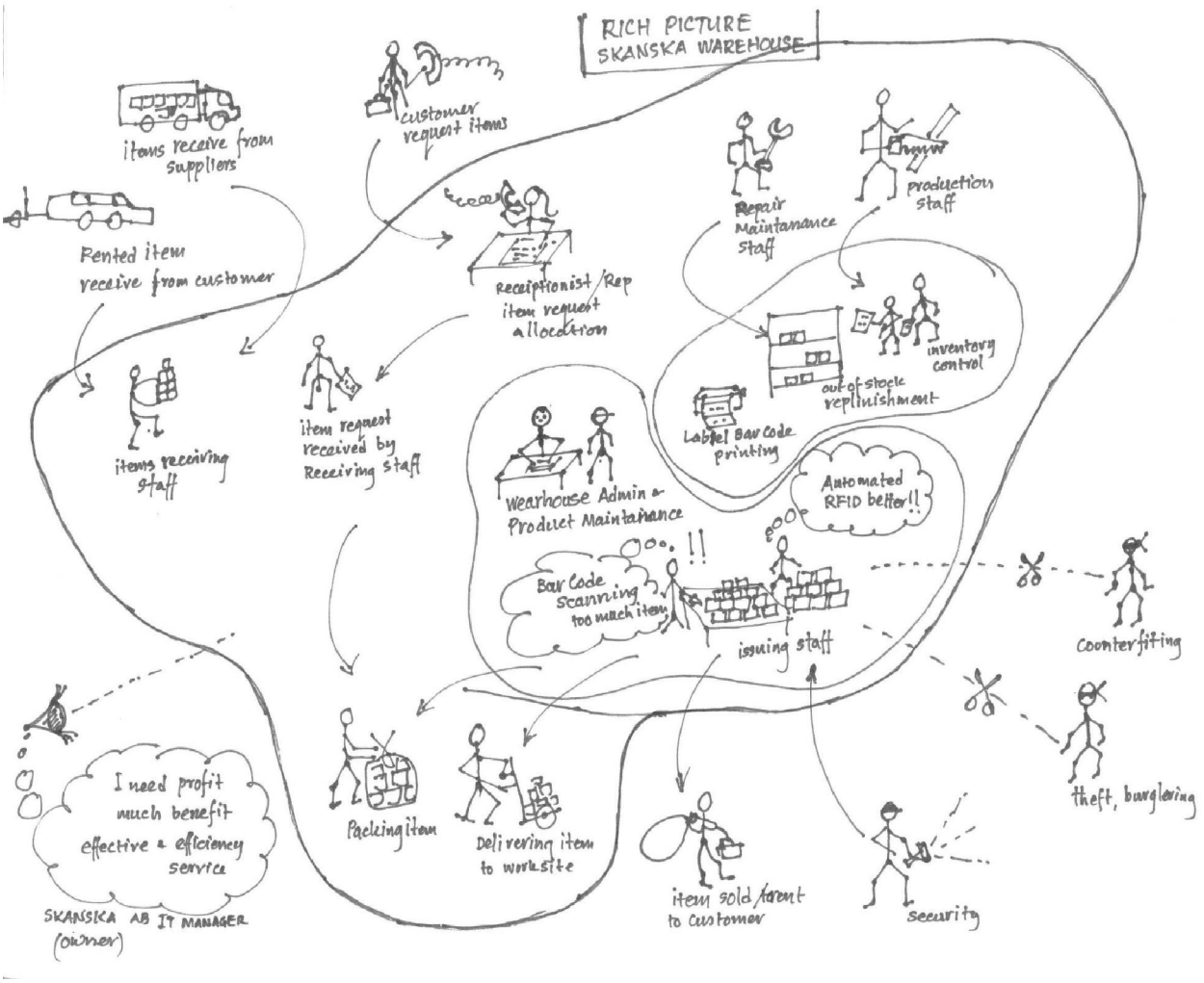


Figure 01: Rich picture of problem situation of existing system in Skanska Maskin AB.

This rich picture has expressed present problem existing system. The view from the Skanska Maskin AB IT manager expects a profit from the overall business. There exist company boundary to separate the company and its external actors. The external actors are security, burglary, counterfeiting, and supply. Inside the company boundary pictures has showed that the company functions and their flows. In the core boundary the problem situation exists. It has existed items that can not handle with the limitation of Barcode technology. Stock taking has consumed more time and resources within the present system. The solution is the RFID technology for future system.

Step 3: Root definition of relevant system - By using this rich picture, we define the root definition for Skanska warehouse. The Skanska Maskin AB warehouse is owned and operated by Auto-ID system to rent and sell item to customer (RS) by means of RFID Technology (RT) in order to gain benefits (B). This is not everything Skanska warehouse does; this is a part of wider system. There is other issue base root definitions like the Skanska warehouse owned and operated system to implement a quality service (QS), by devising and operating procedures to delight its customers (OP), in order to improve warehouse services(I).

The existing auto-ID (barcode) system changes into the future RFID system call transformation process that is heart of conceptual system of Skanska Maskin AB. This transformation process and Skanska warehouse worldview together create very powerful concept which defines the belief that make transformation reasonable.

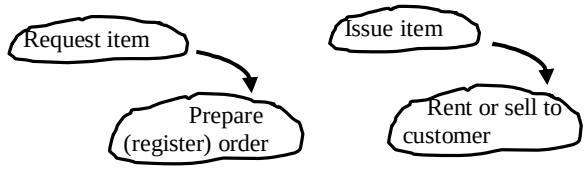
From the Skanska Maskin IT-Administrative view point, following component has identified from the root definition.

Component	**Meaning of Skanska warehouse perspective**
Customer	Customers who rent and buy items from Skanska Maskin AB
Actor	Skanska Maskin AB staffs who wish to exercise a technology
Transformation	Unmanaged Auto-ID system transform to managed Auto-ID (RFID technology) system [17]
Worldview	The belief that technology transformation to RFID is a good way of demonstrating the qualities and gain benefits to customer as well as Skanska.
Owner	IT Management of Skanska AB
Environment	RFID technical standards and Skanska warehouse policies

Table 1: Component of Root Definition CATWOE

This transformation process can be evaluated by monitor and control of three Es criteria such as:
Efficacy: Does the RFID system fully function in Skanska warehouse.
Efficiency: Does the RFID system worthwhile and used minimum resources.
Effectiveness: Does Skanska Maskin achieve benefits from RFID system over barcode [18].

Stage 4: Building conceptual model - Base on root definition, conceptual model (see Appendix B: Domain model of Skanska Maskin warehouse) demonstrate potential activities and their logical dependencies. The potential activities such as request item, issue item, repair item, manufacture item, return item, make inventory, etc. are common in Skanska Maskin AB and their logical dependencies are prepare (register) order, rent or sell to customer, turn-in recycle or accept for repair, rent or sell to customer, need repairing or take into stock, adjust inventory differences, etc. On above six potential activities and their logical dependencies were common in Skanska Maskin AB.



As shown in this picture, each activity may join by arrow and arrow head indicates that an activity depend upon other. That type of number of activities make understandable model.

Figure 3 shows that logical expansion of the root definition mention above creates a conceptual model of new RFID system at Skanska Maskin AB. This type of detailed model (in Figure 3) represents an interaction of human activity (warehouse staff) that can be used to create a well-structured evaluation of the state of the real situation at the Skanska Maskin warehouse.

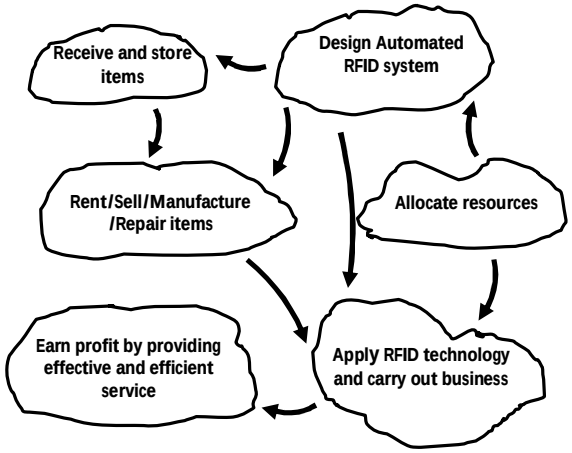
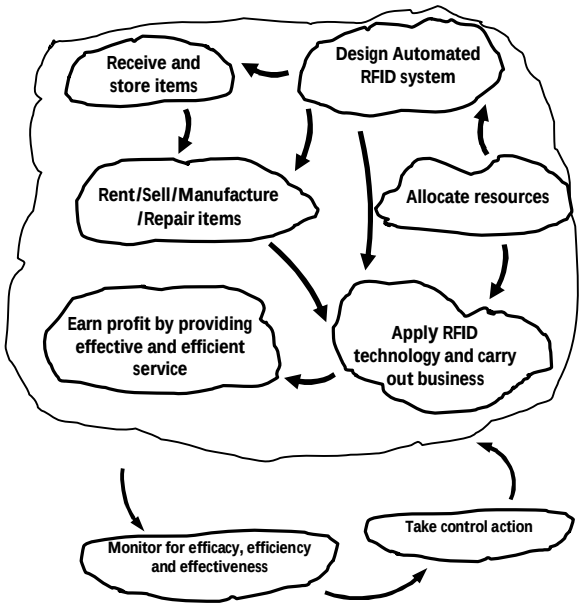


Figure 3: Components of the RFID system model and communication relationship

Taking into account of major activities in the sub model (rent/ sell/ manufacture/ repair items) in the conceptual model, the high level Use-cases have been created (see Appendix C) to describe the system behavior in details of each activities. Using the use cases, sequence diagrams (see Appendix D) have been generated to compare benefits of future system (RFID) over existing Auto-ID system (Bar code) at Skanska Maskin AB warehouse. To check performance measures for new system, monitor and control criteria have to be added into conceptual model.



Efficacy: warehouse transaction continue with uninterruptable and accurately.

Efficiency: it takes less time and less labor for many transactions.

Effectiveness: Skanska Maskin AB get full benefit in useful way from RFID.

Stage 5: Comparing the conceptual model(s) with the real world problem situation –

After developing the conceptual model for future system (RFID) of Skanska Maskin, we have compared those two systems by using interaction diagrams of each system. It has been confirmed that each problem situations has been answered from RFID system.

At once number of items can pass through the RFID interrogator which takes less time for doing transaction of issuing and receiving. System can monitor and record defected item and repaired item. System is round the clock active and items can not go missing due to auto metical data saving when items are leaving from warehouse. Zero stock differs between physical stock and system stock. Easily Items can track and trace.

Stage 6: Determining desirable and feasible changes – RFID system is really a technical improvement for Skanska Maskin AB. It has exactly fitted ethically and culturally to the Skanska Maskin AB. Unless RFID system has not taken place in Skanska Maskin AB that may not gain profitable benefits from RFID over Bar code. Due to RFID system taking over the bar code system, changers can be happened within the Skanska Maskin AB organization structure, procedures and attitudes of employees [19].

Stage 7: Action to improve the problem situation - Changing an organization of Skanska Maskin AB with new system means that there are new problems will arise. Then all newly created problems should be investigated and debated. This is iterative process which has to be iterated number of time until final static remove. When all problems resolved then RFID system can be possible to implement.

4. Discussion

We started our research by establishing communication with IT Managers at Skanska IT-Solution AB. We received thesis requirement from them and held communication through emails and telephone. We were invited for a field

visit at Skanska Maskin AB in Linnarhult Gothenburg. The aim of our field visit was to collect qualitative data regarding the research problem. We used semi structured interview and observation as a mediating tools. Skanska Maskin AB presented their present system and it operational functions to us. We conducted interviews to gather data for each specific store function. The store staffs such as IT manager and System Analysts answered the interviews with their views of present store functions and future system. Through the interviews and observation we revealed how the technology and human recourses utilize to perform store functions such as renting items, selling items and repairing items. We observed present barcode operation in different store functions in different situations. Barcodes were prepared by store staff when a new item arrives to store and the information of the item stored in the barcode. This barcode read and collected data, once an item rent out, sell, receive back after rent and recycle. All these observations were counted for the generation of the empirical data in the end of the research. Skanska Maskin AB recently introduced handheld barcode readers instead of usual stationed barcode readers at their counters to reduce for item handling. They said that they were interested to change present system to RFID with improving handheld barcode readers. They wanted to see the benefits of RFID system. A beneficial and successful future RFID system at Skanska Maskin AB can influence to implement RFID system to the other branches of Skanska Maskin AB in Scandinavia.

Our approach to find benefit was based on two major steps. In the first step, we gathered data by observation and interviews on the present system. The gathered data was utilized with SSM to create and identify both present and future system. The illustration of rich picture of Soft System Methodology helps to identify the present system which contained the complex situation. The stage three and stage four of SSM created future system. Stage five made more accurate the future system and stage seven created final future system. The second step of our approach was to compare the created to systems to reach our research goal.

We assumed that the domain model of Skanska Maskin AB was same as the present and future systems. We identified and analyzed the Skanska Maskin AB domain (See Appendix B). The domain consisted with following components; customer request, payment, store, items, accounting, sale, rental, return, repair, manufacture, recycling. These components interconnected with each other to perform better work flow. We did not consider interaction between human activities and components in the present bar code system shows in Figure 4. The interaction diagrams (See Appendix D, E) filtered out number of process happen when items issue (rent or sell), return, repair, manufacture, recycle, customer request, accounts update, etc.

Bar code auto-identification system used for daily store operations such as renting out, selling, returning, recycling and manufacturing items. The inventory control, stock taking and item storing used bar code identification. There was a unique identification number for each item which store in a barcode tag. The bar code tag attached to the item. This identification number was read by a tag reader. The tag reader read the tag only it was on line-of-sight and visual contact. The bar code reader read a tag at a time. Once a customer order was received by Skanska Maskin AB, store staff collected the items from shelf in store to dispatch the items for customer. On this process store staff used hand held or stationed bar code reader to register item for issuing. Depending on the type of item and item condition, the store staff updated the item status in the system or by manually attaching sticker. The bar code reader gathered all information of items and sent it to warehouse

management system. The system updated item status in the database.

According to future system analysis, the item identification does without line-of-sight and visual contact between the item and the reader. The item has to be in the premises of item reading range of the RFID interrogator. The time takes to read many items are not depended on their quantity. Once item has ordered from the store, the store staff collects items and passes through the RFID interrogator to issuing counter. The RFID interrogator reads all RFID tags at once and sends the data to RFID controller to update the database. Once an item return to store after using by the customer, the item receiving staff receive the item and pass through the RFID interrogator. If customer returns many items the RFID interrogator read all at once which eliminate of the line-of-sight and reduces time to read items. The store staff checks the working condition of the item and updates the item status such as “ready to rent”, “not usable and repairable” and “not usable and not repairable”. Once an item status is updated as “not usable and repairable” the item automatically moves to repairing section. The repair staffs receive the item and do the necessary repairers. After the item repairing the store staff update the item status and item moves automatically to correct storing location. Once the item status is as “not usable and not repairable” removes the item from the inventory and updates the stock and sends it automatically to recycle location. Once the item status change there is an effect on item quantity, if the item quantity “out of stock” or “reached order point” then system automatically trigger and generate manufacturing order or purchasing order. This eliminates shrinkage of items in the Skanska Maskin AB warehouse.

We compared on above two systems in order to identify the benefits by using interaction diagrams which belongs to each system. This comparison created the following benefits. Reduced Cost, Operational Efficacy, Improved Visibility and Improved Customer Services are the major benefits we found in the research. These benefits can be discuss as the ability to generate an accurate picture of the store item inventory which reduces the inventory cost and the data in the system will be up-to-date. Once the items rented out the item inventory updates real time so there is no time delays in all the system functions consider to the present exciting system. The automated item moving hardware can identify the items and move them to the respective location. These processes intern have saved the time and human resources to the company. Same way the cost for item production handling can be automated depending on the type of the production items. The real-time item inventory pictures can track and monitor loses and misplaces items in the future system easily.

4.1. Reduce Cost

Referring to the present system interaction diagrams [ref. Figure 4 & 5 sequence diagram], the present system’s time consumption for item handling relies on the quantity of the items. Barcode reading system read an item at a time until all items registered to the system. The time consumption increases accordingly with number of items in the order. This problem gets complicates and consumes more time to identify items depending on the type of them. Time consumption varies where the position of the tag on the item attached and the line of sight between reader and the tag. As an example, once an item is rented out visibility of the bar code decrease: a concrete mixers bar code is beyond readable due to damage of its surface. In such occasion the receiving staff needs to do manual identification using item inventory number. It is major time consuming task and extra resources allocation to the company. Base on above facts more resources such as labor and technology have to be allocated to handle items accordingly.

In the future system, RFID reader is capable to read all the items at once. That means the future system eliminate line of sight and other environmental limitations such as bad visibility, working environment of item handling. It saves resources which involves handle items [ref. Figure 4 & 5 sequence diagram]. Above mention system benefits can be derived from number of item interactions with the system such as items selling, renting, receiving, manufacturing and repairing. The human resource involvement for item handling decreases in the future RFID system the way of item reading as mention on above. By considering these facts we identified that future system reduced cost for item handing compare to the present system. The scaffolding and concrete mixers which have attached RFID tags can maneuver with minimum labor and time compare to present system.

4.2. Operational Efficiency

Referring to the reduce cost benefits in section 4.1 the future system is capable of handling more items in less time. The RFID technology allows updating real time data and improves the item visibility to the company management. The present system takes days to update inventory. Stock taking is done by manually with warehouse personal by item wise counting. The future RFID system capable to do that within hours due to RFID technology enable shelf which capable of frequently update items on the shelf [21]. These RFID shelves act as RFID interrogator and send information to controller to update store database accordingly. This reduces more labor involvement in stock taking and delays of inventory.

The present system at Skanska Maskin AB is vulnerable of item counterfeiting, loss and theft. This happens due to the item status delay to update in the database with barcode system. In the future system, there exists an exact item status for all items and no any delay. The RFID system is capable of always available of all items at Skanska Maskin AB. These results have eliminated item out-of-stock situation and shrinkage in the future system.

The RFID technology is facilitating to the store management to automate the item handling depending on the item environment. All above functionalities save time and reduced distribution labor costs in the future RFID system due to this time saving less work load assign to a single staff. These results make organizational changers such as reduce staff or assigned for other roles and responsibilities.

4.3. Improved Visibility

The present barcode system in Skanska Maskin AB uses two different colored barcode tags to identify the defect items (pink) and repaired (yellow) items. The visibility of the barcode tag is limited and depends on physical factors such as item located environment and size of item. According to the benefits describe in section 4.2 RFID system creates item visibility. This item visibility makes a clear picture of store items availability that considers warehouse management to take managerial decisions effectively. The item visibility provides by the future RFID system does not depend on above mentioned physical factors and it is visible through intranet at Skanska AB. The future RFID system is better than the present barcode system at Skanska Maskin AB which is capable of doing item tracking and tracing.

There are some restriction and difficulties to apply the barcode technology to some items such as concrete mixers and scaffolding. The barcode can not use in such items due to the operational environment. Most of the time barcode get damaged and disappeared. With the future RFID system this can be eliminated by having embedded RFID tags which does not required any line-of-sight to read.

4.4. Improved Customer Service

Referring to all above benefits of the future RFID system, items are highly available and no in-between status with real time information. Customers are having more chances to access many items at Skanska Maskin AB. The customers can know the availability of the items immediately through the internet using the online web services; the web access can be easily connected to the real time store information.

With the future RFID system the labor involvement getting decreased and reduced human errors. The error free environments attract more customers to the Skanska Maskin AB. Reduction of labor cost gain profit for the Skanska Maskin AB and benefit for the customers offering a better price for an item. All type of transactions and documentations in the future system happens effectively and efficiently due to real time information.

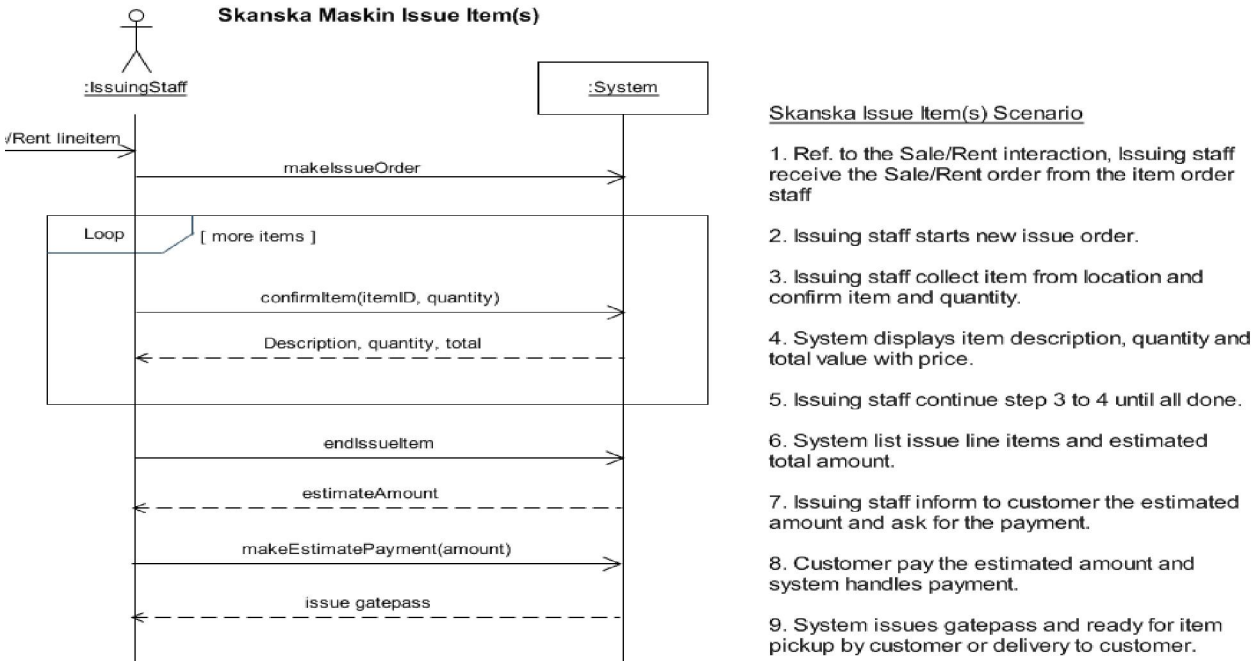


Figure 4: Interaction diagram of issuing items by using Bar code system

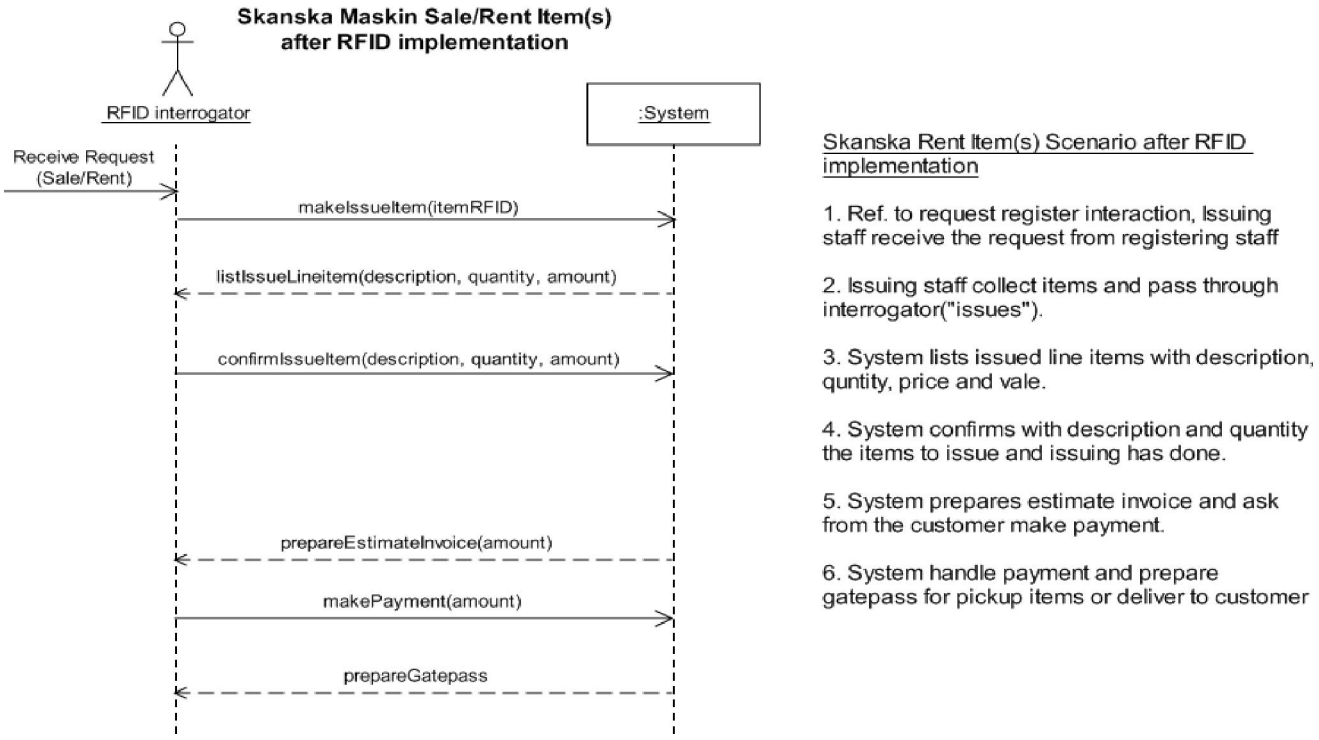


Figure 5: Interaction diagram of issuing items by using RFID system

5. Conclusion

The potential benefits of future RFID system are Reduce Cost, Operational Efficiency, Improved Visibility, and Improved Customer Service. (a) Reduce Cost: Comparing the both system it is significant that there exist and overall cost reduction in the future RFID system. It happens due to time saving on item reading, automation item handling and reduction of manpower, removing the item reading limitations of barcode system. (b) Operational Efficiency: In the future RFID system item reading time comparison to barcode is dramatically reduce. The RFID reader can read many items at once comparison to the barcode reader which reads one item at a time. This makes efficient operations at Skanska Maskin AB. The labor involvements to handle items are reduced comparison to barcode system. In the future system RFID system can identify items and automatically moves items into the correct location at warehouse in Skanska Maskin AB. The future RFID system is a better solution to unpredictable demand condition, operational activities analysis and forecasting [22]. (c) Improved Visibility: The future RFID system is ability to share information and improving inventory control, real-time inventory, reduce shrinkage, visibility of order which in turn maximizes business profit for Skanska Maskin AB. The speed of demand for item selling, renting, manufacturing, customer data handling, and customer order assortment are intermediate function in improving real-time inventory within the future RFID system. (d) Improved Customer Service: Considering all above facts future RFID system can provide better customer service in area of renting, selling, manufacturing items, handling accounts and transactions.

The future RFID system creates organizational changers at Skanska Maskin AB. In the

warehouse environment following changers are taken place such as way of item receiving, selling, renting, moving, storing, repairing, manufacturing and recycling. The other changers are hardware changers, warehouse and office layout, business process, appropriate data collection methods and locations changers. The structural changers of warehouse and employee role and responsibilities change with the future RFID system. It may result termination of over staff and remains very few well experienced staff at the Skanska Maskin AB. The new technology involvement in the business process results the labor reduction. It is global problem which face the modern society. The solutions for this labor reduction and unemployment increase have to handle globally. If the Skanska Maskin AB does not adhere to this new technological changers such as RFID implantation which make a draw back to company itself. This happens due to other competitor companies are adapting to the new technology and create cheap and better quality products and services. The iterative SSM is a one solution to handle the labor reduction problem at Skanska Maskin AB. The side effect of future RFID system, excess labor is a new problem situation which created within the organization. This has to be analyzed with new rich picture, new root definition and new conceptual model in order to create new solution.

In the future RFID system eliminate number of warehouse assistant who may involve with item issuing, receiving, storing, and stock counting. The managerial tasks change with real-time accurate information. The information alignment of store item helps the managers to take correct decisions and prediction for future business issues. The item status changers update real-time situation therefore information alignment occurred. There will be extra financial expenditure and recourses to spend in the begging of future RFID system installation. This can be utilized on installation of hardware, software, training staff. It takes time to adapt and produce a cost effective output from the future RFID system. This reduces profit to Skanska Maskin AB when the system changers happen but in the long run RFID system creates profits. The future RFID system will continue to mature with organizational and system changers. Costs will need to continue to fall to levels comparable to current technology formats used today such as barcode identification. The security and privacy concerns, item management and item tagging is not likely to become a significant issue. Tag costs are the major variable cost component for RFID technology, and also Software, systems integration, process redesign and organizational impacts will be significant to consider when the system design.

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This thesis is base on project of RFID implementation at Skanska Maskin AB in Linnerhult. The purpose of this project was to investigate benefits of RFID implementation. The benefits have been derived by investigating existing system and the future system with RFID based on research which academically published.

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Appendix A.

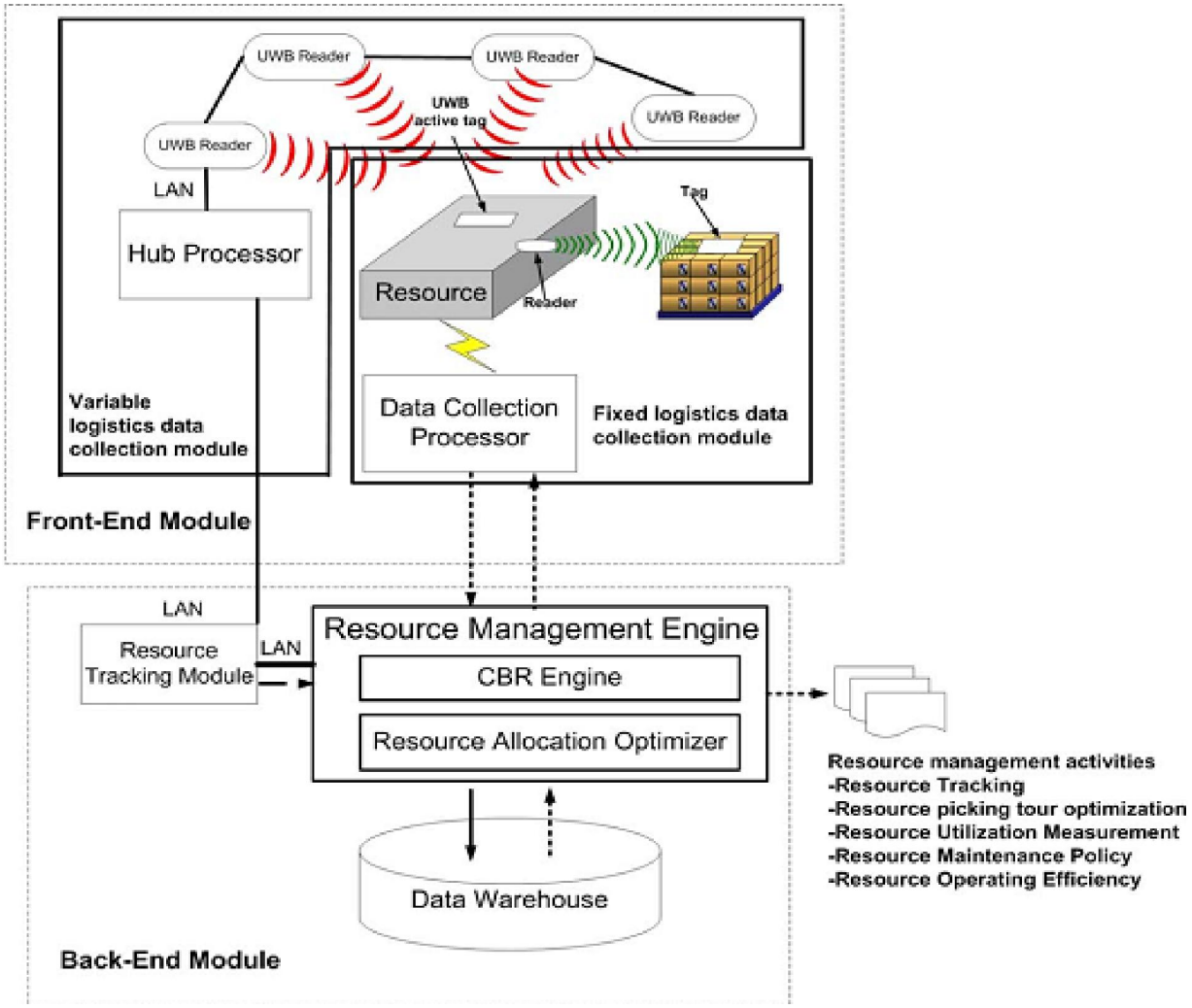
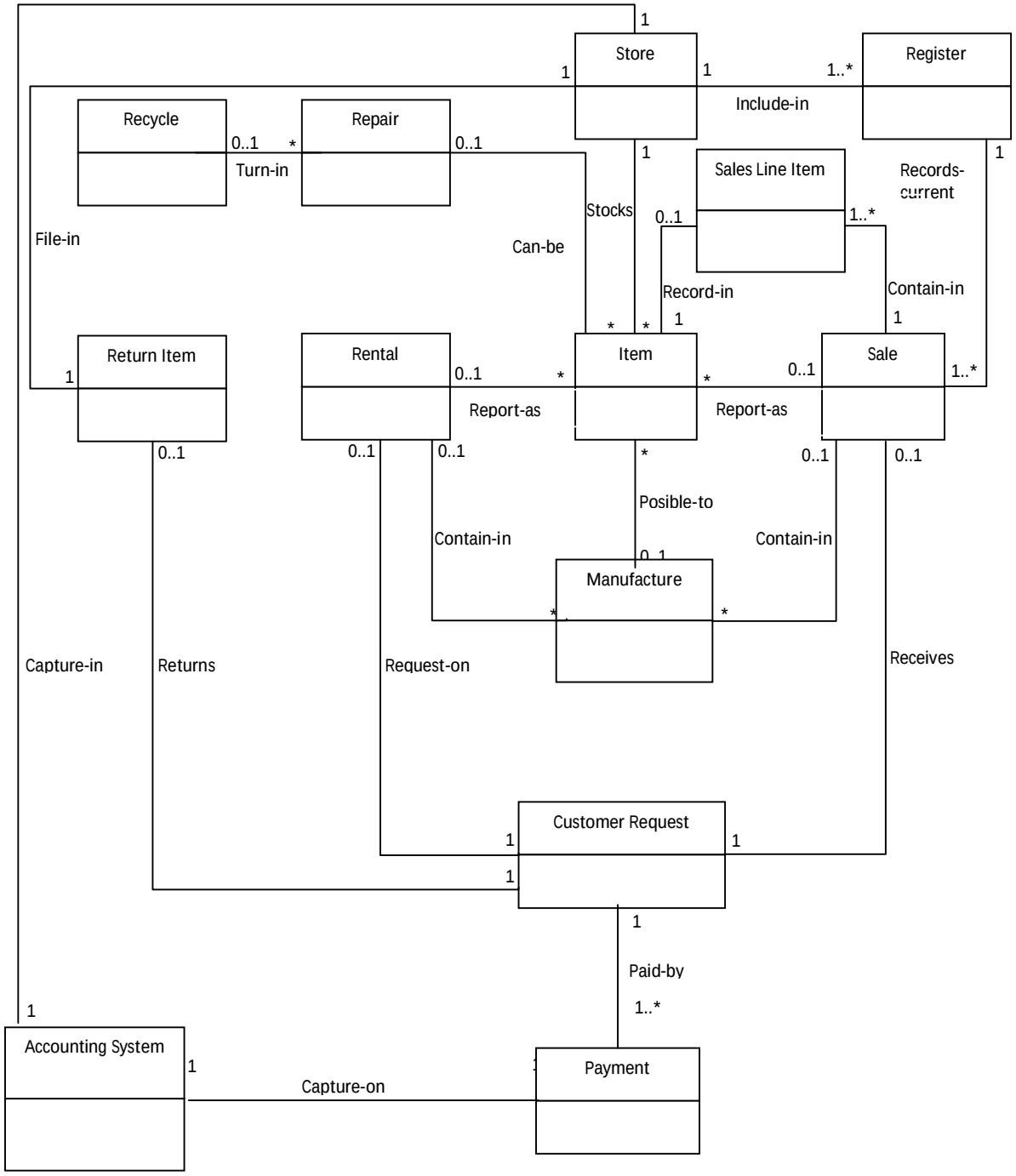


Figure 6: RFID implemented warehouse management system [18]

The Figure 6: shows that the system architecture of the ware house management system. It is organized with two main modules. The front-end module is consisting of two data collection modules. The fixed logistic data collection module is collecting the data from the items by the use of the RFID readers located in the number of places of the warehouse. The collected data read through the Ultra Wide Band technology readers (UWB) which is in the variable logistic data collection module. These data send to the next Back-End module which consists of the Resource Tracking Module. The resource Management Engine is responsible of number of activities; Resource tracking, Resource picking tour optimization, Resource utilization, Resource maintains policy and Resource Operation Efficiency. Back-End processed data save in the Database.

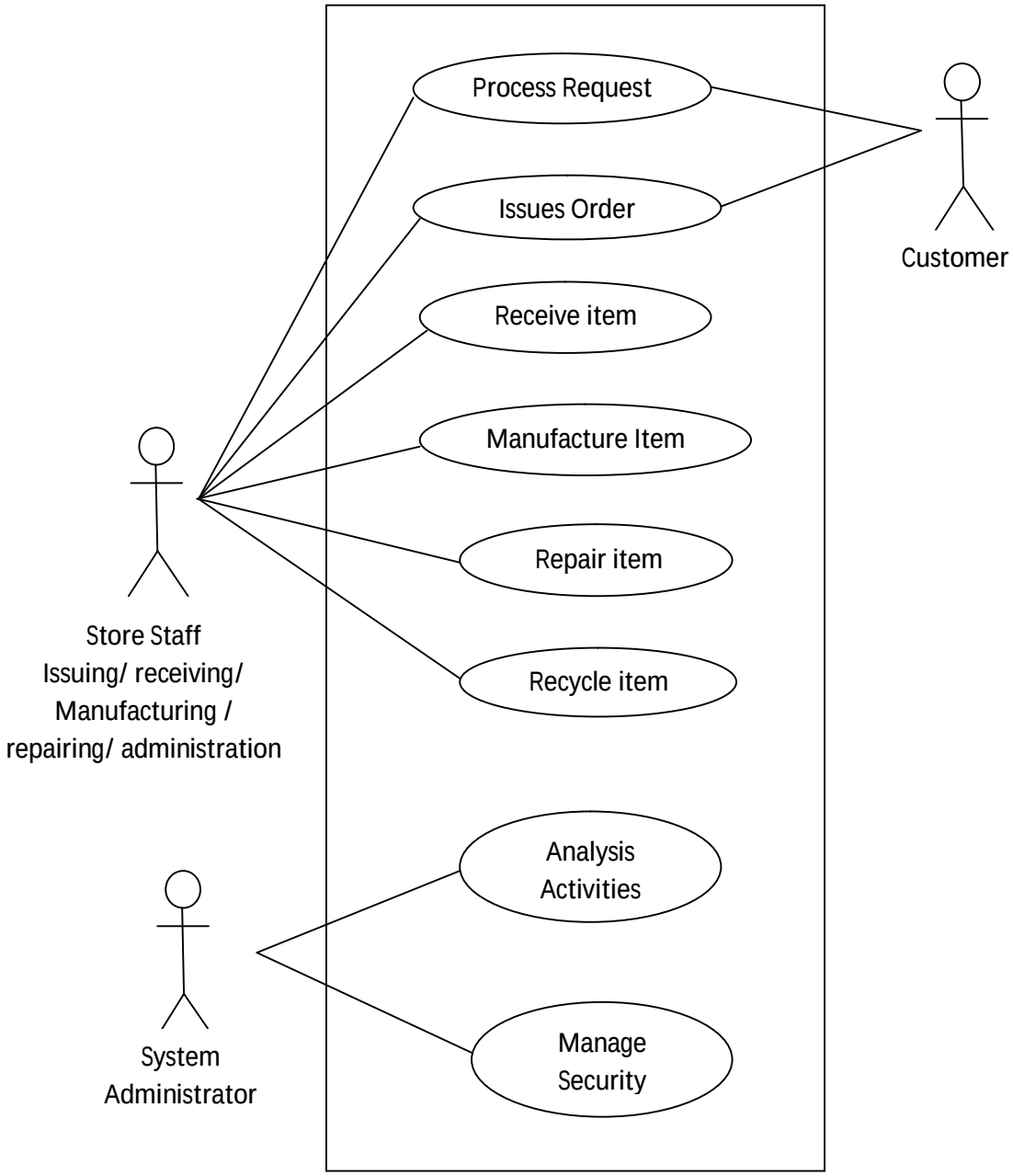
Appendix B

Domain Model of Skanska Maskin AB Warehouse



Appendix C.

User case diagrams: Skanska Maskin AB warehouse interaction with actors



Appendix D.

EXISTING SYSTEM SENARIO

A. Use Cases

A.1 Use Case UC1 : Customer Order an Item(s) from Skanska Maskin AB

Scope : Order register in material handling system (Inventory Register Information System – IRIS)

Level : System goal – receive customer **Preconditions**: Receiving Order enable by phone, e-mail, fax and post

Post-conditions : IRIS system receive the order, order is in progress order

Primary Actor : Customer, Store staff

Main Success Scenario:

1. Customer makes order by telephone/email/fax/post to Skanska Maskin AB
2. Receptionist/Representative receives the order by telephone/email/fax/post
3. Receptionist/Representative selects the right item/s that customer needs
4. Register the order in IRIS

Alternate Flows:

3a. Item is not available to rent/sell

3b. Create new manufacture order

A.2 Use Case UC2 : Skanska Maskin AB Rent an Item(s)

Scope : Renting item from IRIS system

Level : System goal – Rent Items

Primary Actor : IRIS controller, Customer

Preconditions : Existing new order for renting is on process

Post-conditions : Deliver the item(s) to the right customer

Main Success Scenario:

1. Store staff collects the item(s) from location, according to the order
2. Ordered item(s) send to the issuing counter
3. Issuing counter register ordered item(s) in IRIS system (under rental)
4. Issuing staff makes ready ordered item(s) for delivery
5. Customer receive the items with gate-pass and estimated invoice

Alternate Flows:

5a. when customer not present to collect item(s), delivers the item(s) to the right location

5b. if service personal is included in the order, send service personal to the customer

A.3 Use Case UC3 : Skanska Maskin AB Sell an Item(s)

Scope : Selling item(s) to customer

Level : System goal – Sell Items

Primary Actor : IRIS controller, Store staff

Preconditions : Existing new order for selling item(s) is on process

Post-conditions : Deliver the item(s) to the right customer

Main Success Scenario :

1. Store staff collects the item(s) from location, according to the order
2. Ordered item(s) send to the issuing counter
3. Issuing counter register ordered item(s) in IRIS system (under sell)
4. Issuing staff makes ready ordered item(s) for delivery
5. Customer receive the items with gate-pass and estimated invoice

Alternate Flows:

5a. when customer not present to collect item(s), delivers the item(s) to the right location

5b. if service personal is included in the order, send service personal to the customer

A.4 Use Case UC4 : Skanska Maskin AB Manufacture an Item(s)

Scope : Manufacturing Item(s) for Renting and Selling

Level : System goal – Manufacture Item(s)

Primary Actor : Production staff, IRIS controller

Preconditions : Customer makes an order; item(s) does not exist in the stores/inventory

Post-conditions : Item(s) available for rent or sell

Main Success Scenario :

1. Store staff receives the order
2. Item does not exist in the store or inventory or item(s) is suitable for manufacture
3. Create manufacturing order
4. Production staff receives manufacturing order and manufacture the new item(s)
5. Send new item to store update the IRIS system

Alternate Flows:

2a. Item is less quantity reported to be manufacture

2b. Item returned after renting, and it is not usable and recyclable

A.5 Use Case UC5 : Skanska Maskin AB Repair an Item(s)

Scope : Repairing machinery item(s)

Level : System goal – Repair Item(s)

Primary Actor : Customer, Repair & maintenances staff, Store staff

Preconditions : Customer returns Item(s) to receiving staff and not useable and repairable

Post-conditions : Item(s) ready to rent or sell

Main Success Scenario:

1. Receiving staff send item(s) to repair section
2. Repair section receives the item(s) and does the repair
3. Send the repaired item(s) to store
4. Update the IRIS system and item(s) is ready to issue

Alternate Flows:

2a. If item(s) is beyond repairable send the item(s) for recycling

A.6 Use Case UC6 : Customer Return Item(s)

Scope : After renting, item(s) received by store staff

Level : System goal – Return Items

Primary Actor : Customer, Store staff, IRIS controller

Preconditions : Customer hand-over the item(s) to the receiving staff

Post-conditions : Receiving staff place the item on correct place

Main Success Scenario:

1. Store staff categorize the received item(s) as ready to rent, not usable and repairable, or not usable and not repairable,
2. Ready to rent item(s) sent to the correct location and update inventory
3. Not usable and repairable item(s) sent to repair & maintenance section
4. Not usable and not repairable item(s) sent to recycling and update inventory

Alternate Flows:

NA

FUTURE SYSTEM SENARIO

B. Use Cases

B.1 Use Case UC1 : Customer Order an Item(s) from Skanska Maskin AB

Scope : The order register in material handling system (Inventory Register Information System – IRIS)

Level : System goal – receive customer order

Primary Actor : Customer, Store staff

Preconditions : Receiving Order enable by phone, e-mail, fax and post

Post-conditions : IRIS system receive the order, order is in progress

Main Success Scenario:

1. Customer makes order through telephone/email/fax/post/website to Skanska Maskin AB
2. Receptionist/Representative receives the order by telephone/email/fax/post/website
3. Receptionist/Representative selects the right item(s) that customer needs
4. Register the order in IRIS

Alternate Flows:

3a. Customer makes order through Skanska Maskin AB web site

3b. Item is not available to rent/sell

3c. Create new production order

B.2 Use Case UC2 : Skanska Maskin AB Rent an Item(s)

Scope : Renting item from IRIS system

Level : System goal – Issue Items

Primary Actor : RFID Interrogator, IRIS controller, Store Staff

Preconditions : Existing new order for renting is on process

Post-conditions : Deliver the item(s) to the right customer

Main Success Scenario :

1. Store staff collects the item(s) from location, according to the order
2. Ordered items pass through RFID interrogator (RFID reader) and sent to delivery section
3. RFID automated system registers Ordered item(s) in IRIS system under rental
4. Generate the issue order automatically and received by the store staff
5. Store staff makes ready for delivery the item(s) that ordered
6. Customer receive the items with gate pass and estimated invoice

Alternate Flows:

6a. when customer not present to collect item(s), delivers the item(s) to the right location

6b. if service personal is included in the order, send service personal to the customer

B.3 Use Case UC3 : Skanska Maskin AB Sell an Item(s)

Scope : Selling item(s) to customer

Level : System goal – Sell Items

Primary Actor : RFID Interrogator, IRIS controller, Store staff

Preconditions : Existing new order for selling item(s) is on process

Post-conditions : Deliver the item(s) to the right customer

Main Success Scenario :

1. Store staff collects the item(s) from location, according to the order
2. Ordered items pass through the interrogator (RFID reader) and send to delivery section
3. RFID automated system registers Ordered item(s) in IRIS system under sell
4. Generate the issue order automatically and received by the store staff
5. Store staff makes ready for delivery the item(s) ordered
6. Customer receive the items with gate pass and estimated invoice

Alternate Flows:

6a. when customer not present to collect item(s), delivers the item(s) to the right location

6b. if service personal is included in the order, send service personal to the customer

B.4 Use Case UC4 : Skanska Maskin AB Manufacture an Item(s)

Scope : Manufacturing Item(s) for Renting and Selling

Level : System goal – Manufacture Item(s)

Primary Actor : RFID Interrogator, Production staff, IRIS controller

Preconditions : Customer order an item, item does not exist in the stores

Post-conditions : Item(s) available for rent

Main Success Scenario:

1. Store staff receives the order
2. Item does not exist in the store or inventory or item(s) is suitable for manufacture
3. Create manufacturing order
4. Production staff receives manufacturing order, manufacture the new item and implement the RFID tag
5. Item(s) pass through interrogator and received by the stores
6. IRIS system updated

Alternate Flows:

2a. Item is less quantity reported to be manufacture

2b. Item returned after renting, and it is not usable and recyclable

B.5 Use Case UC5 : Skanska Maskin AB Repair an Item(s)

Scope : Repairing machinery item(s)

Level : System goal – Repair Item(s)

Primary Actor : Customer, Repair & maintenances staff, Store staff

Preconditions : Customer returns Item(s) to receiving staff and not useable and repairable

Post-conditions : Item(s) ready to rent or sell

Main Success Scenario:

1. Receiving staff send item(s) to repair section through the RFID interrogator
2. Repair section receives the item(s) and does the repair
3. After repairing, sending the item to store through the RFID interrogator
4. Update the IRIS system and item(s) is ready to issue

Alternate Flows:

2a. If item(s) is beyond repairable send the item(s) for recycling

B.6 Use Case UC6 : Customer Return Item(s)

Scope : After renting, item(s) received by store staff

Level : System goal – Return Items

Primary Actor : RFID interrogator, Customer, Store staff, IRIS controller

Preconditions : Customer hand-over the item(s) to the receiving staff

Post-conditions : Receiving staff place the item on correct place

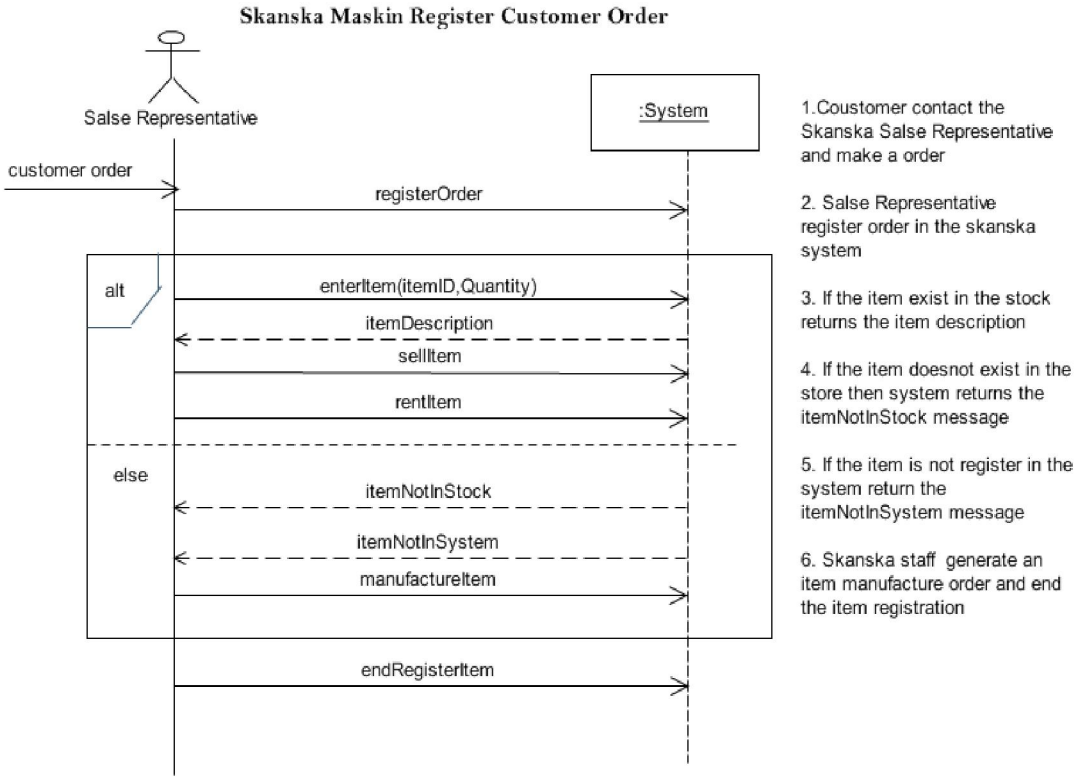
Main Success Scenario:

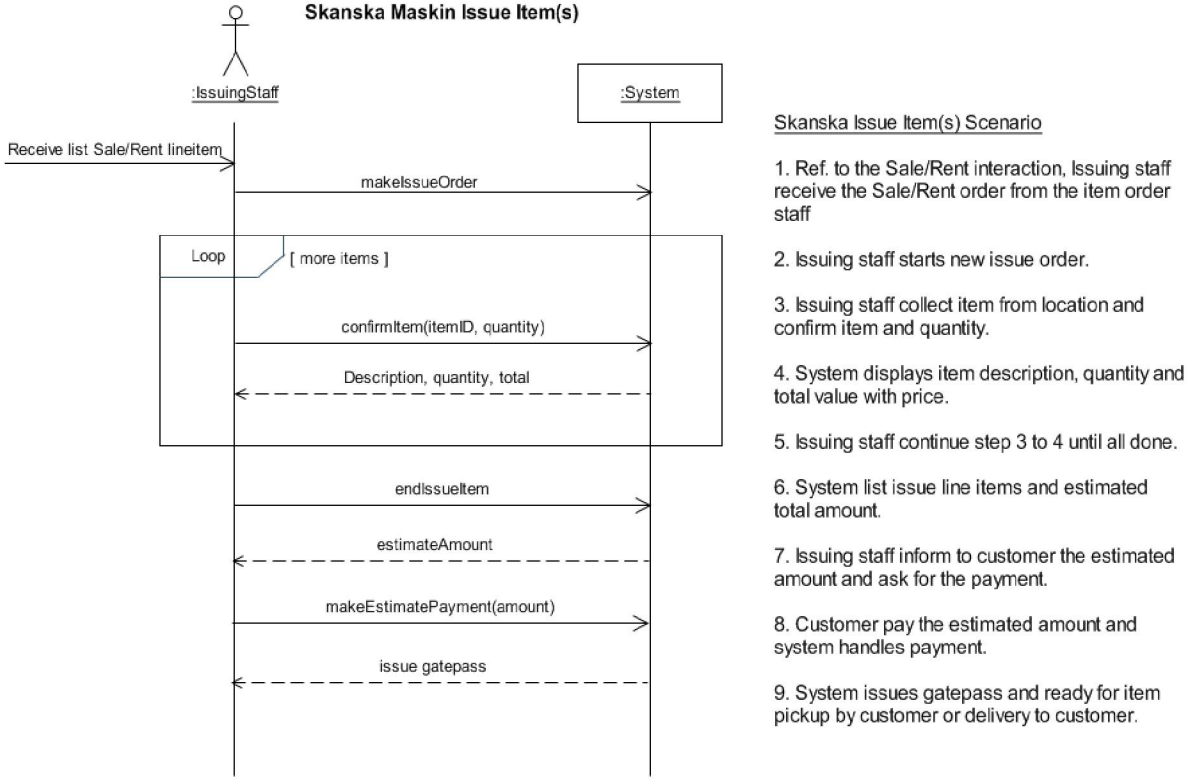
1. Receiving staff categorize the item(s) as ready to rent, not usable and repairable, or not usable and not repairable
2. Ready to rent item(s) sent to the correct location and update inventory through RFID interrogator
3. Not usable and repairable item(s) sent to repair & maintenance section through RFID interrogator
4. Not usable and not repairable item(s) sent to recycling and update inventory through RFID interrogator

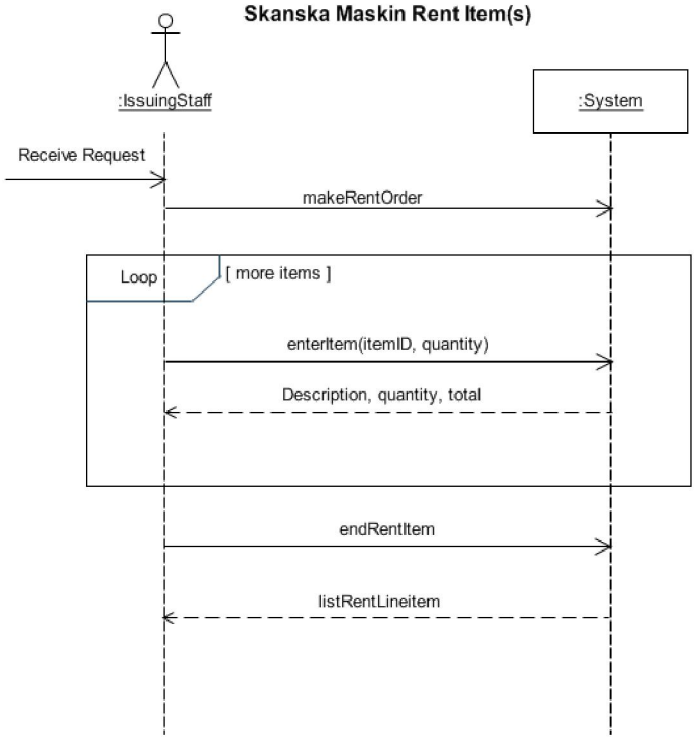
Alternate Flows:

NA

Appendix E.


Skanska Maskin Register Customer Order
Salse Representative
:System
customer order
registerOrder
alt
enterItem(itemID,Quantity)
itemDescription
sellItem
rentItem
else
itemNotInStock
itemNotInSystem
manufactureItem
endRegisterItem
1.Coustomer contact the Skanska Salse Representative and make a order
2. Salse Representative register order in the skanska system
3. If the item exist in the stock returns the item description
4. If the item doesnot exist in the store then system returns the itemNotInStock message
5. If the item is not register in the system return the itemNotInSystem message
6. Skanska staff generate an item manufacture order and end the item registration


Skanska Maskin Issue Item(s)
:IssuingStaff
:System
Receive list Sale/Rent lineitem
makeIssueOrder
Loop
[more items]
confirmItem(itemID, quantity)
Description, quantity, total
endIssueItem
estimateAmount
makeEstimatePayment(amount)
issue gatepass
Skanska Issue Item(s) Scenario
1. Ref. to the Sale/Rent interaction, Issuing staff receive the Sale/Rent order from the item order staff
2. Issuing staff starts new issue order.
3. Issuing staff collect item from location and confirm item and quantity.
4. System displays item description, quantity and total value with price.
5. Issuing staff continue step 3 to 4 until all done.
6. System list issue line items and estimated total amount.
7. Issuing staff inform to customer the estimated amount and ask for the payment.
8. Customer pay the estimated amount and system handles payment.
9. System issues gatepass and ready for item pickup by customer or delivery to customer.



Skanska Rent Item(s) Scenario

1. Refering to request register interaction, Issuing staff receive the request from registering staff

2. Issuing staff makes new rent order.

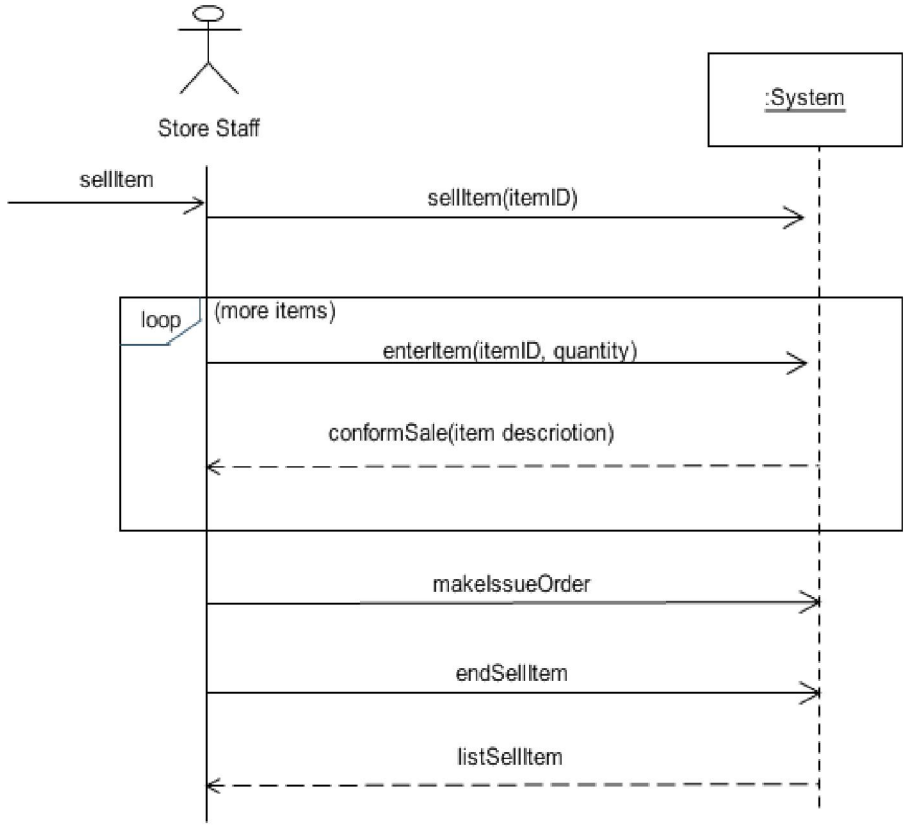
3. Issuing staff enter item identifier and quantity.

4. System displays item description, quantity and total of available stock.

5. Issuing staff continue step 3 to 4 until all done.

6. System list rent line items.

Skanska Maskin sell Item/Items



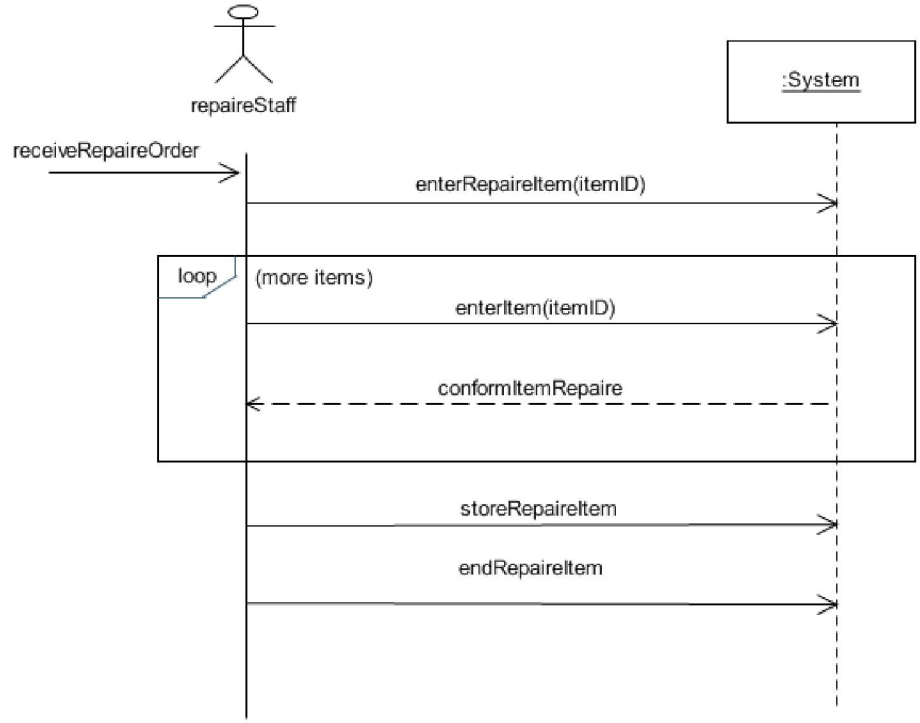
1. Refering to "register item" the store staff receive the sell order

2. The system dispaly the sell item description and collact order items/item

4. The store staff prepare the issue order

5.To finilize the order the endSell function will be execute the system generate the item list

Skanska Maskin Repaire Item/Items

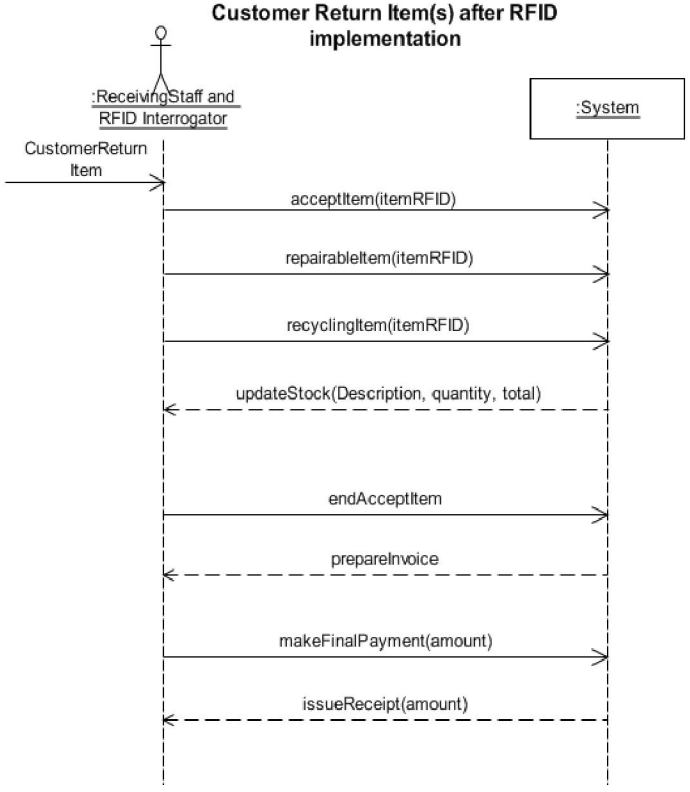


1. Refering to the item reigistering the repaire staff receive the repaire order and enter the repaire item/s description system conform the item repaire

2.The repaire staff update the store information with the repaired item

3. Skanska repaire staff finalize the item repaire with endRepaireItem

Customer Return Item(s) after RFID implementation



Customer Return Item(s) Scenario after RFID implementation

1. Customer arrives at receiving section with items and/or services to hand over (returning).

2. Receiving staff accepts item and catagorize them repairable, not repairable (recycling).

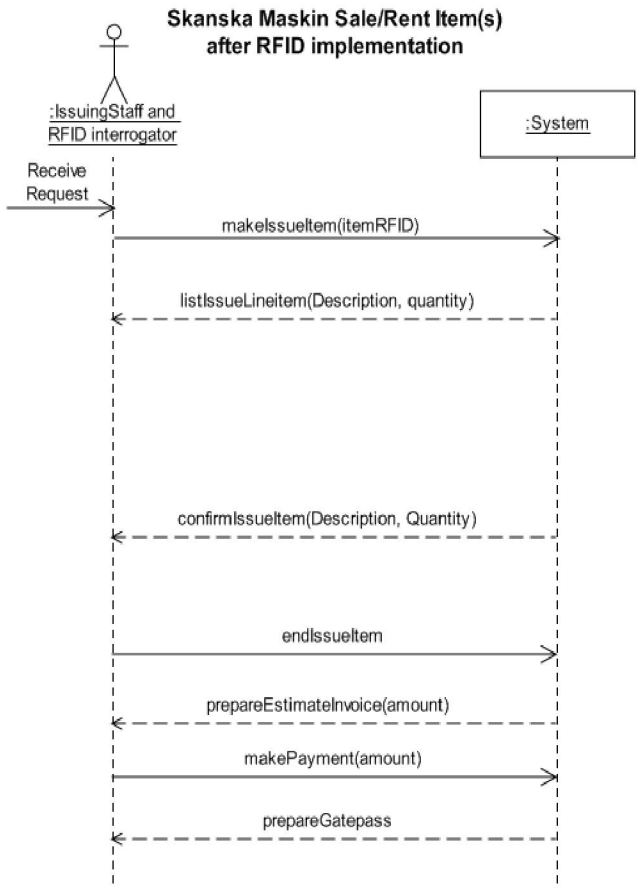
3. System update stock and display list of item accepted and which item send for repair and recycling.

4. Receiving staff finish with accepting item.

5. System prepares invoice and receiving staff inform to customer to pay final payment.

6. Customer pay amount and system handle payment.

7. System issues receipt for customer.



Skanska Rent Item(s) Scenario after RFID implementation

1. Ref. to request register interaction, Issuing staff receive the request from registering staff

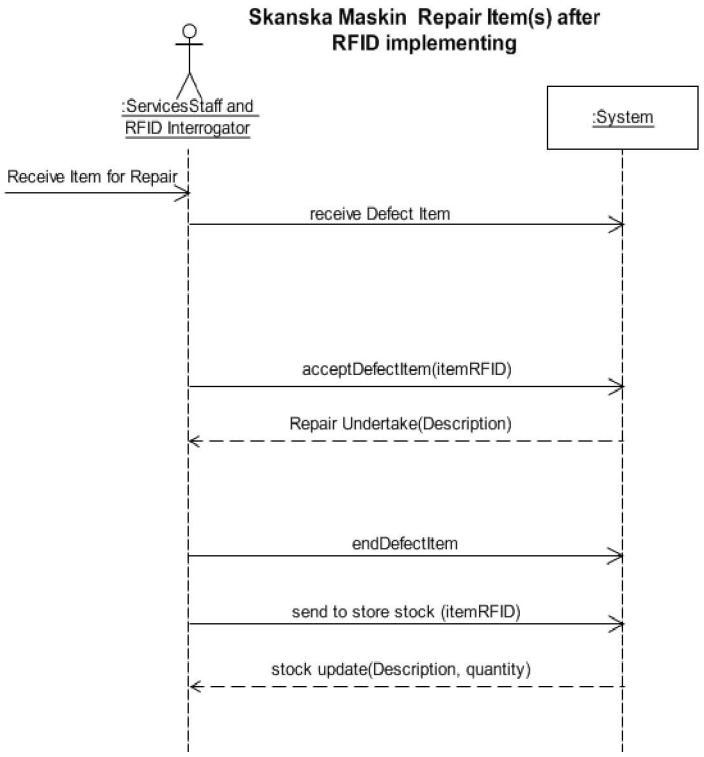
2. Issuing staff collect items from location and pass through interrogator("issues").

3. System lists issued line items with description, quntity, price and vale.

4. System confirms with description and quantity the items to issue and issuing has done.

5. System prepares estimate invoice and ask from the customer make payment.

6. System handle payment and prepare gatepass for pickup items or deliver to customer



Skanska Repair Item(s) Scenario after RFID Implemention

1. Ref. to customer return item interaction, Services staff receive item repair request from the item receing staff.

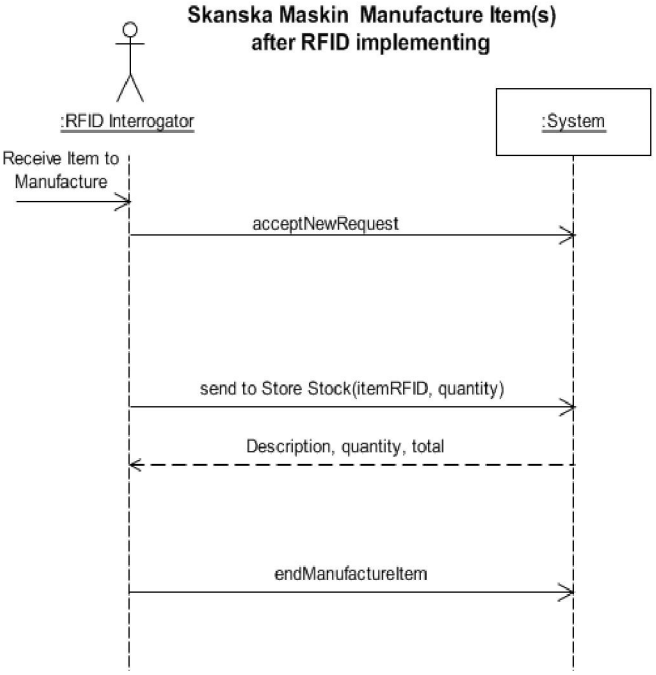
2. Services staff receives defect item.

3. Services staff accept the item through interrogator.

4. System displays the item description, quantity have under repair.

5. After repair has done, Services staff send the item to store stock.

7. System displays item description and added quntity with total in stock.



Skanska Manufacture Item(s) Scenario after RFID implemention

1. Ref. to item request interaction, Production staff receives the item manufacture request from the Sales Representative.

2. Production staff accepts new request and manufacture item.

3. After manufacturing item, Production staff send the item to store stock through RFID interrogator.

4. System displays item description and added quantity.

5. Production staff continue step 3 to 4 until all done.