Mona Saxena

Improving the Use of SAP WMS Reporting Practices

Helsinki Metropolia University of Applied Sciences

Master's Degree

Logistics

Master's Thesis

05 June 2017

Helsinki Metropolia University of Applied Sciences

In autumn 2016, I was eagerly looking forward to a company to do my thesis. With lots of efforts put towards applying, calling and emailing several companies all around Finland, I amazingly managed to do my thesis in a company nearest to my home, which was quite a happy, winning situation. While working for my thesis, I managed to learn a lot about SAP WMS reporting in particular. Further, it has added to my professional growth by understanding the activities of warehousing in the case company. In fact, I was exposed to the fact that the third party logistics providers are used to run a spare parts warehouse. It helped me to learn how a SAP WMS can support in improving operations of a warehouse. My colleagues at the case company supported me very well and I can say heartfelt thanks for all their contributions, without those, I could have never made it, in the first place.

At first, the thesis scope appeared to be very wide for myself. The fact that there were so many reasons as to why the SAP WMS is used so poorly in the warehouse proved to be challenge. But gradually, along the way, I realized the focus and started working with a clearer picture. Hence, I would like to sincerely thank Dr. Thomas Rohweder for guiding me through all stages of the study especially while creating the most difficult current state analysis. Additionally, I wish to thank PhL Zinaida Grabovskaia, with her encouraging words, invaluable steering and support during the writing of this thesis. I would be highly mistaken, if I forget to thank my project manager, Mr. Simo Puumalainen who believed in my abilities to do this study and supported me in every possible way despite his busy schedule.

Last, but not least, I extend my thanks to my family and classmates for their overwhelming encouragement and creating perfect work life balance. Without your extensive support, this surely would have been a mission impossible!

Mona Saxena
Espoo, 05 June 2017

Abstract

Author Title Number of Pages Date	Mona Saxena Improving the Use of SAP WMS Reporting Practices 86 pages + 18 appendices 05 June 2017
Degree	Masters in Logistics
Degree Programme	Logistics
Instructors	Dr. Thomas Rohweder, Principal Lecturer, Metropolia Zinaida Grabovskaia, PhL, Senior Lecturer, Head of Industrial Management and Logistics Master's Programs Mr. Simo Puumalainen, Head of Deliver Service Process

This thesis investigates improving the use of SAP Warehouse Management System (WMS) reporting practices in the case company. The management in the case company realized that the SAP WMS is not able to provide adequate reports. The management needs reports to be able to monitor the operations of their spare parts warehouse run by a third party logistics provider. Overall, management in the case company wants to improve its operative working practices.

The research method for conducting this thesis was case study. This is due to the fact that this thesis had its evidence based on the analysis of documents, interviews, discussions and observations. The researcher was not involved in any real development activities or implementation. The research design included five steps, where the business challenge was combined with the current state analysis and the conceptual framework in order to create and finalize the proposal.

As an outcome of the current state analysis, two main challenges were identified to come up with a conceptual framework and later continue to build a proposal for the case company. Two main challenges to check the existing knowledge were described as: a) "WHAT" the management wants to be reported from SAP WMS (and that is currently missing), b) "HOW" the SAP WMS should be used in order to generate the correct reports for the managers.

The final outcome of the study provided an improvement proposal for reporting from SAP WMS in the case company. The proposal identified eight reports that the management needed for reporting. It proposed to use SAP NetWeaver Business Warehouse with SAP Business Objects for implementing the reports. It suggested that a barcode scanner integration was a must before any report implementation could take place. This is because data related to timestamps was clearly missing to be able to generate accurate reports. The final proposal was provided with an implementation plan for report generation from the SAP WMS. Last, but not least, the final proposal for the case company included five recommendations in order to aid reporting from the SAP WMS.

The final proposal along with its recommendations helps the case company in improving its use of SAP WMS for reporting practices. The case company would surely benefit from the results of this study to create well defined, accurate and structured reports. Good quality reporting would help to increase efficiency and improve their overall operative practices.

Keywords	Warehousing, SAP, WMS, Reporting, Reporting using SAP WMS, SAP NetWeaver Business Warehouse

Contents

List of Figures

List of Tables

1 Introduction

Warehousing is a critical function of supply chain in most industries globally as it involves storage of anything from raw materials to finished goods before they can be distributed to their intended users. In the last thirty years, warehousing, like many other industries, underwent a large amount of automation using information technology, software and automated intralogistics.

In engineering industries, like mining, metal, energy, water, there is a heavy reliance on machinery due to the need for high technical equipment availability; which calls for a dependence on high quality spare parts. In order to handle this need, companies often form a large spare parts organization conjoined with a warehouse to store and deliver spare parts to their customers. Additionally, companies often collaborate with third party logistics providers to operate their warehouse operations. Since, companies need to monitor the tasks performed by the third party providers, they place a high reliance on accurate reporting. Lack of accurate reporting creates ambiguity in decision making for the management regarding the operative performance of the warehouse. This may also include the quality of the services offered by the third party warehousing provider. This case company in the study is subjected to similar challenges and looks forward to good reporting practices.

1.1 Business Context

The case company of this study, is a leading Finnish technology solution provider for mineral processing and metals, energy and water (Case company Business Description, 2017). Presently, the case company has its global headquarters in Espoo, Finland. Its annual revenue in 2015 was €1201 MEUR (gurufocus.com, 2015).

The company designs and provides sustainable technology solutions and life cycle services for the customers' equipment all around the world (Case Company Operating Model, 2017). The company leads in terms of production of machinery and methods for various stages of extractive metallurgy and mineral processing. The company supplies their equipment's to turnkey project sites, energy, mining industry etc. The company additionally provides engineering and after-sales services for its products and therefore needs to handle various spare parts for its clients' equipment.

The company has its spare parts warehouse at Vantaa, Finland. This warehouse is used to store spare parts global inventory that is used to resolve supply chain needs. This warehouse helps to deliver spare parts in reasonable amount of time to global clients. The warehouse location is ideal due to its close proximity to the airport and other international delivery points. Deliveries from the warehouse are made either as direct customer deliveries (outbound) or to company warehouses (inbound). The activities which take place mostly at the warehouse include receiving, packaging to order followed by dispatching.

1.2 Business Challenge, Objective and Outcome

Presently, in the case company, the spare parts warehouse uses a SAP WMS (Warehouse Management System) for warehouse management at its Vantaa warehouse. Currently, the use of SAP WMS in the spare parts warehouse is underutilized in terms of available possibilities and is used only for dynamic bin allocation. Additionally, there are limited insights and feedback about utilization of reporting from the system. This is despite the fact that the spare parts organization uses a third party operated warehouse. Therefore, the above mentioned challenges need a thorough investigation. This is needed in order to establish the origin and improve the situation in the current use of reporting from the SAP based WMS in the spare parts warehouse.

The objective of this thesis is, therefore, *to suggest improvements for the use of SAP WMS reporting practices in order to benefit the spare parts organization at the case company.*

The intended outcome is a list of recommendations in order to improve the use of SAP WMS reporting practices for the spare parts organization at the case company in particular for its third party operated Vantaa warehouse.

1.3 Thesis Outline

This thesis would make an analysis of reports needed in the case company from its SAP WMS. The subject is studied using qualitative methods and case study. In keeping view the requirements of the case company and time constrains, this thesis is limited to providing suggestions for one specific warehouse. Further on, the findings would

additionally provide prioritized recommendations in order to aid reporting from the SAP WMS for the case company at their third party operated spare parts warehouse.

The solution development is based on the results of the current state analysis along with the body of knowledge which includes readings from journals, internet search, and various company data, such as interviews, observations, discussions, and training material used in the case company.

The thesis is written in seven sections. First, Section 1 contains an introduction. Second, Section 2 describes the method and material used in doing research for the thesis. Third, Section 3 analyzes the current state of SAP WMS in the case company in terms of warehousing and reporting. Fourth, Section 4 discusses the suggestions from available knowledge and best practice coming from literature. Fifth, Section 5 builds a proposal for the case company. Sixth, Section 6 validates the proposal. Last, Section 7 ends the thesis with discussions and conclusions.

1.4 Key Concepts of the Thesis

SAP – is an acronym for a German software, which stands for “Systeme, Anwendungen und Produkte” which in English stands for “Systems Applications and Products”. SAP is basically an ERP (Enterprise Resource Planning) software developed by the German company SAP SE. SAP ERP incorporates the key business functions of an organization. Business Processes included in SAP ERP include Operations (Sales & Distribution, Materials Management, Production Planning, Logistics Execution, and Quality Management) etc. In the context of this study, SAP software are used as part of many IT applications at the case company.

WMS – A WMS is able to maintain accurate inventory by recording of warehousing transactions (Atieh, et al., 2015), (Subramanya, et al., 2012). Therefore, it helps in automating the warehouse functions. Further, it can produce reports and handle large volumes of transactions as needed in several operations (Richards, 2014, p. 189). Hence, it helps in increasing transparency about warehouse operations to the stakeholders. In the context of this study, it means a SAP based warehouse management system which is used in the case company’s third party operated warehouse.

Spare parts organization – an organization that deals with handling spare parts, including order, storage, delivery to the customer. In the context of this study, the Spare Parts Organization in the case company, receives orders and handles the customer's requests for delivering spare parts from the third party operated warehouse.

Reporting –To produce reports, in any business, reporting consists of simple interpretation of complex data, made available by using software programs or tools displaying typically with dashboards. Additionally, companies use reporting in order to gather structural data from day-to-day business to complex analysis of KPIs for corporate management. In the context of this study, it means a function of SAP WMS that deals with reporting of deliveries done by a delivery planner as part of warehouse operations. This is used to monitor and measure inventory turns. Currently, the reporting is done from SAP WMS, which is not highly efficient.

The next section focusses on describing the methods and materials used in the study.

2 Method and Material

This section describes the methods and material used in the study. First, the research approach is explained. Second, a research design for the study is described. Third, data collection and analysis plan is discussed.

2.1 Research Approach

For this thesis, case study is selected as a research approach. There are several approaches for undertaking any research. In order to correctly determine the research approach for any study, the research question should be clear to the researcher. Case study research investigates *"HOW"* or *"WHY"* questions (Yin, 2003, p. 9). In other words, the case study approach helps to answer questions which are of exploratory in nature. The case study research method is linear; however it can additionally be iterative to ensure diligent research for each stage.

Moreover, another characteristic of a case study research is its high dependence on the case context. The case study helps in obtaining insights for the researcher in a particular business context. This is done by analyzing and interpreting the interlinked actions, events and processes involved in this context. For this purpose, case study, as an approach, generally combines data collected from different methods. These methods include archives, interviews, questionnaires and observations. Researchers could include evidence which may be only qualitative, only quantitative or a combination of qualitative and quantitative data. Generally, combination of qualitative and quantitative evidence helps to strengthen the findings for the research problem (Eisenhardt, 1989, pp. 534-538). In other words, merging the evidence from qualitative and quantitative evidence makes sure that the results are of a high level, in order to approach a problem.

Quite often, it is mentioned in case study methodology, that a case study, as a research approach, makes an effective tool when the investigator has little or no control over the occurrence of events or the processes in place (Yin, 2003, pp. 4-8). In a study, if the researcher has hardly any contribution in any of the problematic processes, it is possible to create a good picture of the case as an outsider (Eriksson & Kovalainen, 2011, pp. 115-126). Therefore, it can be stressed that the case study approach helps to present complicated business challenges in a simple, understandable way.

In this thesis, case study is selected as a research approach due to the fact that this thesis requires examining contemporary business events in their real-life context. Using the case study approach, it would help in acquiring a clear and grounded picture of evidence. Further, by using this approach, the author of the thesis would be able to use evidence from available documents, interviews, questionnaires, and observations of the events. The researcher would not be involved in development activities or implementation, which supports the final goal, namely receiving the learning from the case. This clearly tells that the case study would make a suitable approach for this thesis with a clear emphasis on qualitative data collection.

Next, defining of the research question becomes the most important step in doing the case study. The research question in the thesis can be interpreted as the “How” question (*How should the SAP WMS be used to be able to improve the reporting in the spare parts organization at the case company?*) and therefore the selection of case study as an approach is justified.

The research design described below demonstrates the linear nature of the case study as an approach.

2.2 Research Design

The research design aims to meet to the objective of this study. Therefore, it shows the steps taken for conducting the study to suggest improvements for the use of SAP WMS reporting practices. The research design used in this study is shown in Figure 1 below.

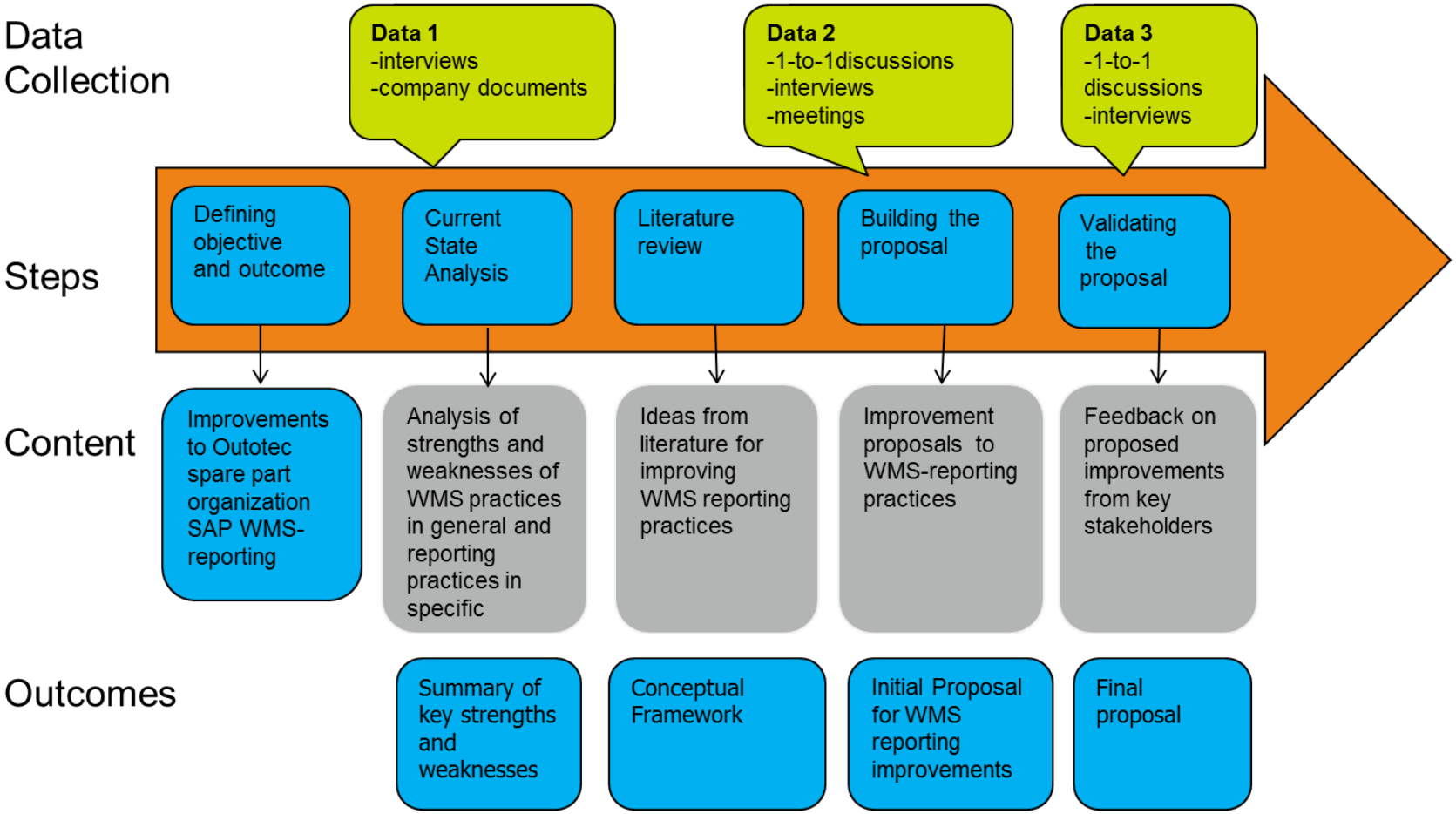


Figure 1. Research design of this thesis.

As shown in Figure 1 above, each of the steps have a content and an outcome. The research design shows that three levels of data collection are needed in order to conduct the study in a sensible manner. In addition to this, the thesis uses the following steps. The first step is to define the objective and outcome of the study. The objective and outcome are defined by having few discussions with the management at the case company.

Once the objective is defined, the next step is the current state analysis (CSA). In CSA, the use of SAP WMS for spare Parts organization is analyzed in terms of its use for warehousing and reporting in particular. This step includes gathering of data (Data 1) in the form of company's internal documents and interviewing key stakeholders involved in the process. CSA helps to generate a clear understanding of strengths and weaknesses in the case company in terms of use of SAP WMS for warehousing and reporting in particular.

In the next step, after CSA, best practice from relevant literature is searched. The literature sources include information from company database and literature from various sources such as books, journals, online material etc. This literature review helps to generate the conceptual framework of the study pointing to key elements in reporting from SAP WMS.

In the next step, an initial proposal is built. This includes collecting data (Data 2) by doing another set of interviews, one-to-one discussions from several key stakeholders. This initial proposal suggests improvements to the current reporting practices. It does that by drawing suggestions from the literature review and merging them with the case company specifics, as established previously in the CSA stage.

In the final step, the proposal is validated. This involves presentation of the initial proposal to collect feedback data (Data 3) in one-to-one discussions and interviews with the key stakeholders. After the feedback is analyzed and processed, the final proposal is created. The outcome of this stage additionally includes the set of recommendations for improving the use of SAP WMS for reporting.

The next subsection describes the data collection and analysis plan used for the study.

2.3 Data Collection and Analysis Plan

In this study, the data is collected in three stages, Data 1-3. The three stages of data collections are shown in Table 1 below.

Table 1. Data sources of each round of data collection.

Data round	Data Type	Content	Analysis
Data 1	Interviews, discussions and Workshops Observations Internal Documents	• Conduct interviews and workshops with stakeholders confirming the warehousing and reporting practices. • Observations from warehousing and reporting practices to show the problem areas. • Analysis of the case company documents for warehousing and reporting	• From texts, recordings and field notes. • Results are analysed and discussed in Section 3
Data 2	Interviews and Discussions	• Interviews and discussions held with managers and other relevant stakeholders. This would allow to learn about the features that the improved practices should bring in to the firm	• From recordings and field notes. • Results are analysed and discussed in Section 5
Data 3	Feedback Interview and Discussion	• Feedback on the initially proposed practices to refine it.	• From recordings and field notes. • Results are analysed and discussed in Section 6

As shown in Table 1 above, it is clear that primarily data would be collected from interviews and observations made by the researcher. This data would be supported by the analysis of internal case company documents related to the warehousing and reporting practices. The three main sources of data for the study in each round are mentioned as follows:

A. Interviews, Discussions, Workshop(s)

The main data collection for this study comes from internal interviews and discussions held face-to-face or online, due to the nature of this thesis, which is a qualitative study. The details of interviews and discussions conducted in this study are shown in Table 2 below.

Table 2. Details of interviews, discussions and workshops in Data 1-3 rounds.

	Department	***Location***	***Date***	***Duration***	***Event***
Data 1					
1	Director, Quotation and Inventory Management	Espoo	21.02.2017	37 minutes	Interview
2	Warehouse operator	Vantaa	28.02.2017	45 minutes	Discussion
3	Warehouse operator	Vantaa	28.02.2017	45 minutes	Discussion
4	Warehouse Supervisor	Vantaa	28.02.2017	45 minutes	Discussion
5	Director, Technical Markets Unit, Spare and Wear Parts	Espoo	06.03.2017	33 minutes	Interview
6	Manager, Development and Deployment	Lappeenranta	23.02.2017	32 minutes	Interview
7	Manager Global Transportation Management	Lappeenranta	14.02.2017	35 minutes	Interview
8	Logistics Manager	Espoo	14.02.2017	35 minutes	Interview
9	Delivery Planner	Espoo	13.02.2017	33 minutes	Interview
10	Director Application Services	Espoo	10.02.2017	15 minutes +26 minutes	Interview, Discussion
Data 2					
1	Director, Technical Markets Unit, Spare and Wear Parts	Espoo	31.03.2017	15 minutes	Discussion
2	Director Application Services	Espoo	23.03.2017	35 minutes	Interview
3	Logistics Manager	Espoo	29.03.2017	35 minutes	Interview
4	Manager Global Transportation Management	Lappeenranta	29.03.2017	30 minutes	Interview
5	Delivery Planner	Espoo	29.03.2017	30 minutes	Interview
Data 3					
1	Director, Technical Markets Unit, Spare and Wear Parts	Espoo	08.05.2017	35 minutes	Discussion, Interview
2	Delivery Planner	Espoo	05.05.2017	35 minutes	Discussion, Interview
3	Logistics Manager	Espoo	09.05.2017	25 minutes	Discussion, Interview
4	Manager Global Transportation Management	Espoo	09.05.2017	25 minutes	Discussion, Interview

As shown in Table 2 above, most of the interviews and discussions conducted in the case study were held at the headquarters of the case company in Espoo. Additionally, few were held at their third party operated warehouse in Vantaa. There are three rounds of data collection which are described as follows.

First, Data 1 round, the interviews and discussions were conducted with managers and stakeholders from warehousing, spare parts management and IT functions. These departments were selected since they are involved in reporting from the SAP WMS, and the outcome of this study would provide beneficial improvements for the same. For collecting Data 1 round, two sets of questions were prepared. The first set of questions used for interviewing spare parts management personnel in the Espoo office are placed in Appendix 1.The second set of questions used for interviewing the warehouse personnel are placed in Appendix 2. The findings or data collected from Data round 1 are stated in the current state analysis (Section 3) of this study.

Second, Data 2 round, interviews and discussions were held with management and other relevant stakeholders. This was done to come up with a draft proposal with needed improvements for the case company. The set of questions used for interviewing the stakeholders are placed in Appendix 4. The findings or data collected from round 2 are mentioned in the initial proposal building (Section 5) of this study.

Third, Data 3 was sourced from the feedback of the stakeholders. This was done in order to verify certain aspects of the proposed improvement practices mentioned earlier in the draft proposal. The set of questions used for interviewing the stakeholders are placed in Appendix 11. The findings from round 3 would be mentioned in the initial proposal building (Section 5) of this study.

B. Internal Documentation of the Case Company

This study used internal case company documents related to warehousing and reporting. This list of the relevant documentation utilized in the study is shown in Table 3 below.

Table 3. List of internal documents for the case company.

	Document Title	Amount	Detail	Location
1	Outbound Logistics and Invoicing training	66 slides	Steps of outbound and inbound logistics	Internal website
2	Procurement and Warehousing – Extra SAP Monitoring Transactions	47 slides	SAP Transactions of procurement and reporting in warehousing	Internal website
3	Deliver Services spare parts order handling processes training material	63 slides	Delivery of spare parts order along with service provision.	Internal website
4	Worklist for Warehouse operator(deliveries)	7 slides	Worklist in terms of warehouse operations in terms of deliveries.	Internal website
5	OU109001602_Ro_Goods_Receipt_to_WM	29 slides	Inbound logistics steps to warehouse supposed to use SAP WMS	Internal website
6	OU109001606_Ro_Goods_Movements_WM	29 slides	Goods movement steps in the warehouse supposed to use SAP WMS	Internal website
7	OU109001612_Ro_Inventory_Counting_WM	21 slides	Goods movement steps in the warehouse supposed to use SAP WMS	Internal website

As shown in Table 3 above, this study analyzed internal training documentation from the case company, for understanding their processes of inbound logistics, outbound logistics and goods movements. This was done to understand the application of SAP WMS in warehousing and reporting in particular.

C. Observations

This study relied on observations of warehousing and reporting functions which were made by the researcher. This was done in addition to the interviews and analysis of internal documentation to obtain a comprehensive understanding of the current situation (for Data 1).

The current state analysis for this study comes in the next section.

3 Current State Analysis

This section begins with description of key terms in warehouse management system which are of significant importance in further discussion of this study. Later in the section, there is a discussion of results of the current state analysis. The results describe the current use of SAP WMS in warehousing and reporting practices in particular. This section is crucial as it identifies the strengths and weaknesses of the current warehousing and reporting practices with respect to SAP WMS. The current practices are evaluated from the case company's point of view.

3.1 Key Terms in Warehouse Management System

This subsection mentions all the terms that are needed to understand the functionalities and features of warehouse management system.

Inventory – in general, means a collection of goods or products. An inventory is very necessary for any product business and need to be well managed. Inventories are part of supply chain which result in either the inflow (accumulation of goods) or outflow processes (transportation or production of goods) (Stadtler, et al., 2015, p. 47). Therefore, inventory forms the largest item in the current assets category and inventory problems can easily contribute to losses or failures. In the case company, it means all the spare parts which are stored at the third party operated warehouse.

Inventory Management (IM) in general, means that only an optimal number of goods or inventory are stored in the warehouse. The basic principle about inventory management is to balance the costs coming from keeping the inventories and the actual benefits coming from it (Stadtler, et al., 2015, p. 52). In the case company context, it "involves activities in maintaining the optimum number of each inventory item" (Internal document: OPAL User Training). Therefore, the objective of inventory management is to provide uninterrupted production, sales, and /or customer-service levels at the minimum cost. Inventory Management in the case company, involves several functions. This is shown in Figure 2 below.

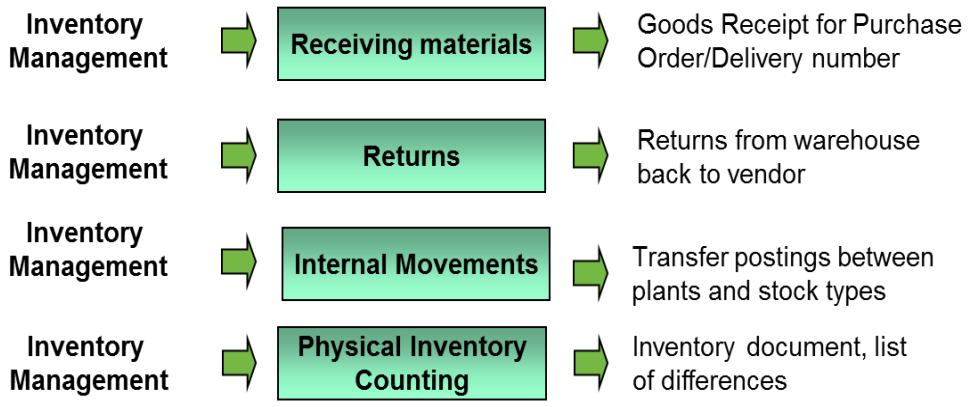


Figure 2. Inventory Management in the case company (Internal document: OPAL User Training).

As shown in Figure 2 above, inventory management in the case company is used for receiving materials, returns from warehouse to vendor, transferring postings between plants and stock types, creating inventory documents with list of differences.

Warehouse - in general, means a place for keeping, storing and sorting goods before they can be moved in the supply chain (Richards, 2014, pp. 5-35). In this case study, it refers to a third party operated warehouse in Vantaa.

Warehouse Management (WM) in general, aims to control the movement and storage of materials within a warehouse. A system that does this is called a Warehouse Management System or WMS. They can be a standalone system to an enterprise resource planning (ERP) system. A WMS can quickly process data and coordinate movements within the warehouse. It can handle large volumes of transactions and generate reports for various processes within the warehouse (Richards, 2014, pp. 188-189). In the case company context, WM is done by using a SAP based system. It comprises of a layer under inventory management where maintenance is followed from the bin perspective as shown in Figure 3 below (Internal document: OPAL User Training).

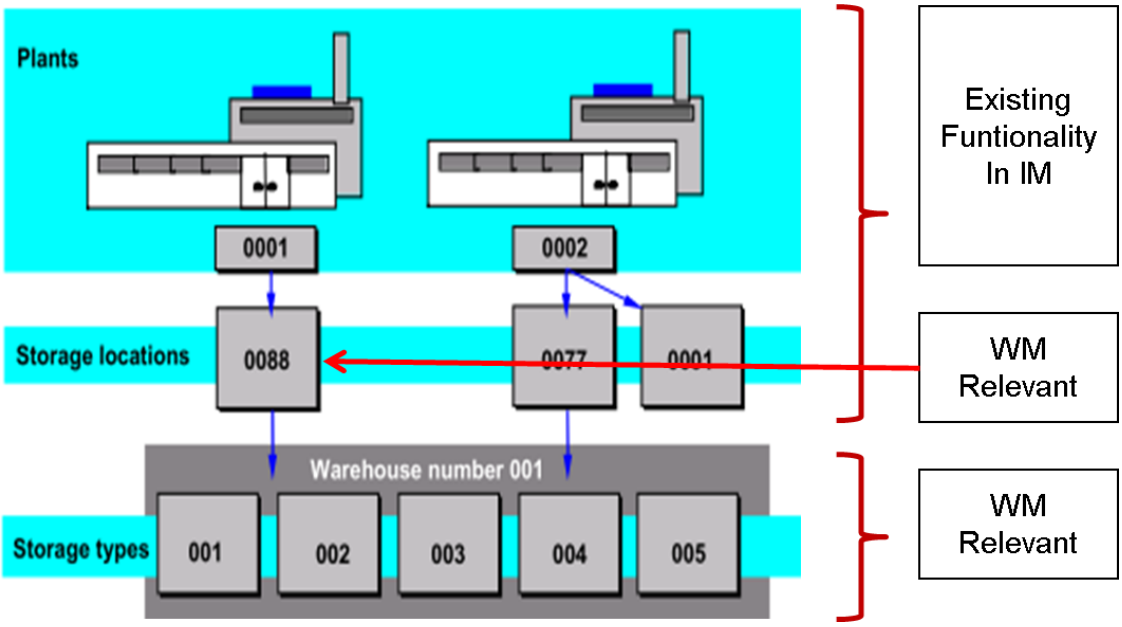


Figure 3. Structure of IM and WM in the case company (Internal document: OPAL User Training).

As shown in Figure 3 above, WM comes has real storage locations and storages types. Further, WM is an integral part of logistics execution which controls the movements in and out of the company's warehouse. WM provides functionalities such as stock management, bin levelling, planning and monitoring tools, control of goods movements etc. All goods movements whether inbound or outbound result in WM transaction in the SAP system.

Company code – the smallest code organizational unit for which a complete self-contained set of accounts can be drawn up for purposes of external reporting. There can be many plants under a company code.

Delivery – can be defined as the act of delivering or distributing goods, mail, etc. In order to deliver goods to the customer, recorded in the SAP system. Ideally, the sales orders due for delivery are monitored and deliveries are created for available items. In the case company, deliveries are created for spare parts, technical service sales including spare parts, repair processes and customer returns. Delivery types can be classified in SAP according to the purpose, for example outbound delivery has type YLF, and returns delivery has type YLR etc.

Goods Issue (GI) – involves withdrawal of a material from stock. GI is posted to SAP when goods are removed from the warehouse. Goods issue is posted by the

warehouse operator for the delivery. Deliveries for goods issue can be monitored in SAP system. Goods issue leads to reduction of warehouse stock. It posts the value changes to the stock accounts in inventory accounting.

Goods Receipts (GR) – involves physical inbound movement of materials. GR is posted to a SAP system whenever goods are received either to consumption or to stock. The SAP system is capable to differentiating between two types of goods receipt. First, goods receipt happens with reference to a purchase order (PO) and other happens with reference to a purchase order. When materials are received, stickers are automatically printed by the system to a local printer, in case the SAP WMS is used.

Material Document – a document that becomes a proof of one or more material movements and acts as a source of information for applications further on the chain. It is created by the SAP system when goods are received in to the warehouse and GR was posted initially. Material document tracks the type of material moved, its amount, and the time of movement, the final position of movement and the reason for the movement.

Packing goods – the act of physically packing the goods, before being delivered to the customer. In the case company, the goods are packed by the warehouse operator. Goods to be packed are listed on the packaging request as an output when the delivery is saved. Packing is compulsory for items such as spare parts. Packing is needed in order to print documents which can be sent to the customer along with the goods. After packing is done, all required information (e.g. weight and volume) can be entered to handling units.

Picking – It can be defined as “as the activity by which a small number of goods are extracted from a warehousing system, to satisfy a number of independent customer orders” (Murray, 2017). In the case company picking is done after delivery creation, and during picking the goods are physically picked. The picking is confirmed in the SAP system.

Plant – a unit in a company where materials are either produced, or goods and services are provided.

Posting Change Notice – posting change notice is automatically created in the SAP WMS, when transfer postings are processed in the system. These can be used as a basis of Transfer Order (TO) creation.

Quant – it is the actual content or material quantity of any storage bin.

SAP Transaction – A transaction in SAP is like a software program in normal computer languages, and is identified by a four-character transaction code. A transaction can be initiated directly from the command field on the presentation interface or from the corresponding menu option.

Storage location (Sloc) – is maintained within a plant and stores materials or goods.

Stock Types – materials can be posted to either to unrestricted, block or quality inspection stock.

Storage Bin – is the location where the materials are stored within a warehouse.

Storage Type – is a type of storage area in a warehouse consisting of one or more storage bins. Storage type actually defines the source or destination of a movement. In an SAP system, predefined storage strategies for stock removal and placement help to determine the storage type selected and proposed by the system.

Transfer Order (TO) – is used for executing goods movements in warehouse management setup indicating the system as about the items, their quantity, their origin and destination. Transfer Orders can be created either manually or can be automatic, either from scratch or from transfer requirements.

Transfer Postings – a transfer posting is a general term for stock transfers and changes in stock type of a material for example to a blocked stock. It is not relevant whether the posting occurs in conjunction with a physical movement or without any movement. They happen when materials are transferred or moved from one storage location to another. Stock transfers can occur either within a single plant or between two different plants but the plants need to belong to the same legal company code.

Transfer Requirement – a document that is created automatically from a material document relevant for Warehouse Management (WM).

Warehouse Number – is defined as a number which identifies a complex, physical warehouse structure within a warehouse management system (WMS).

This subsection laid the foundation with key terms for understanding the warehouse management system. The next subsection would introduce the CSA for this study.

3.2 Overview of the CSA Stage

The Current State Analysis (CSA) aims at defining the current warehousing practices while utilizing the SAP WMS. It includes the SAP WMS which is being used at one of the third party operated warehouse in the case company. The CSA was conducted in four steps which are mentioned as follows:

First, a study of internal documentation was done. The study included documents about inbound and outbound logistics processes in the warehouse, goods receipt for purchase orders using SAP WMS, goods movement using SAP WMS, inventory counting using SAP WMS and goods issue and goods returns using SAP WMS.

Second, the current process of warehousing was studied by doing a field trip to the third party operated warehouse in Vantaa.

Third, the current SAP WMS was examined by checking its working capabilities in person by the researcher.

Fourth, by interviewing two sets of stakeholders (Data 1). First, stakeholders were from spare parts business management at the case company headquarters in Espoo. Second, stakeholders were the warehouse personnel in Vantaa which included the warehouse workers, warehouse supervisors etc.

Thus, Data 1 was collected in order to create in-depth understanding of challenges of using SAP WMS by both the stakeholders from the spare parts management and warehouse personnel. The combined views helped to generate clarity about the current SAP WM practices. The current uses of the SAP WMS in the case company are discussed in detail in the next subsection.

3.3 Current Use of SAP WMS in the Case Company

The case company has specific documentation on (a) inbound, (b) within warehouse and (c) outbound logistics while using SAP WMS. For Inbound logistics, it is possible to do goods receipt with the SAP WMS. Logistics within the warehouse, SAP WMS can be used for goods movements, goods returns from the customer and inventory counting. Further, as part of outbound logistics, goods issue can be done using SAP WMS. These specific usages of SAP WMS are described in the following subsections.

3.3.1 Inbound Logistics: Goods Receipt to PO with Label Printing using SAP WMS

For Inbound logistics, it is possible to do goods receipt with the SAP WMS. For the case company, the process of inbound logistics involves goods receipt at the warehouse. This is shown in Figure 4 below.

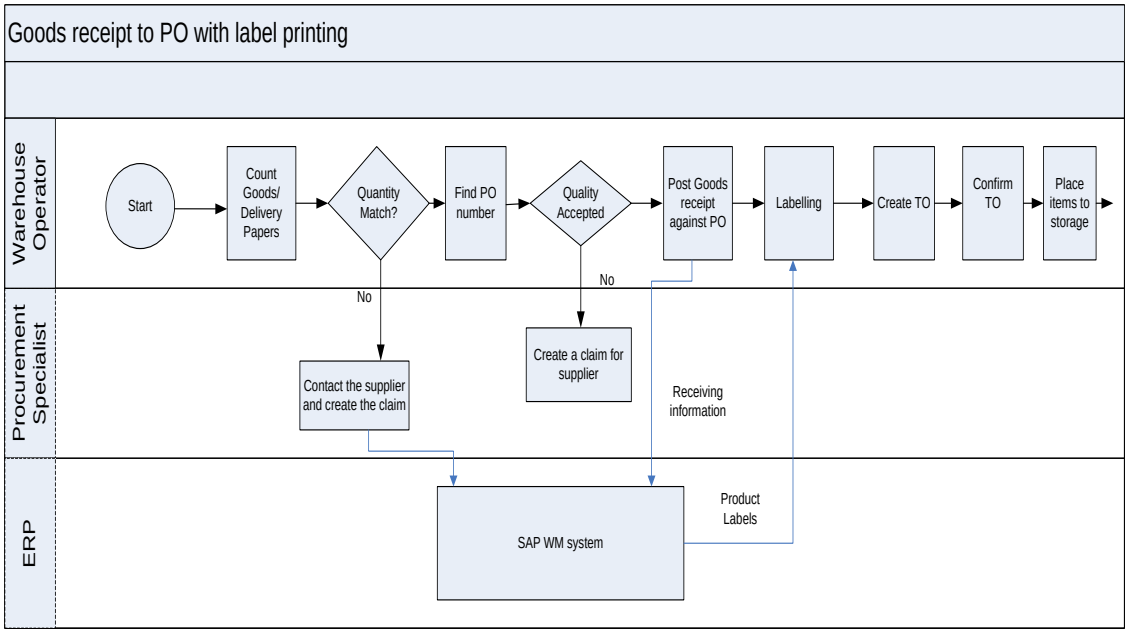


Figure 4. Goods receipt to Purchase Order (PO) using a SAP WMS (Internal document: OPAL User Training).

As shown in Figure 4 above, goods receipt to Purchase Order (PO) using a SAP WMS involves three steps. First, the warehouse operator checks the quantity of the goods delivered. In the case of mismatch, the procurement specialist is informed who in turn contacts the supplier and asks for a claim via SAP WMS. Otherwise, the warehouse operator finds the associated purchase order and undertakes a quality check of the

received goods. If the quality is not good enough, a claim for the supplier is created by a procurement specialist. Otherwise, a post goods receipt against a purchase order or a particular delivery number is done. This is saved in the SAP WMS. Second, warehouse operator creates labels for goods automatically triggered from SAP WMS. This is done in case the goods previously passed a quality inspection. Third, warehouse operator creates transfer order and confirms those using SAP WMS before placing the goods to storage in bins or shelves.

3.3.2 Logistics within the Warehouse

Logistics within the warehouse in the case company, uses SAP WMS for three main purposes, a) goods movements, b) goods returns from the customers, c) inventory counting. These specific usages of SAP WMS within the warehouse would be described in the following three subsections.

3.3.2.1 Goods Movement Using SAP WMS

In the case company, SAP WMS is used for goods movements between warehouses. It happens between two warehouses, where both possess a functional SAP WMS. For example, this happens from warehouse 311 at 1000(Vantaa) storage location to 2000 (Hamina) storage location. Warehouse 311 has a functional SAP WMS in place. Thus, goods movement happens at storage level within warehouses which are under the same plant and under the same company code. This is shown Figure 5 below.

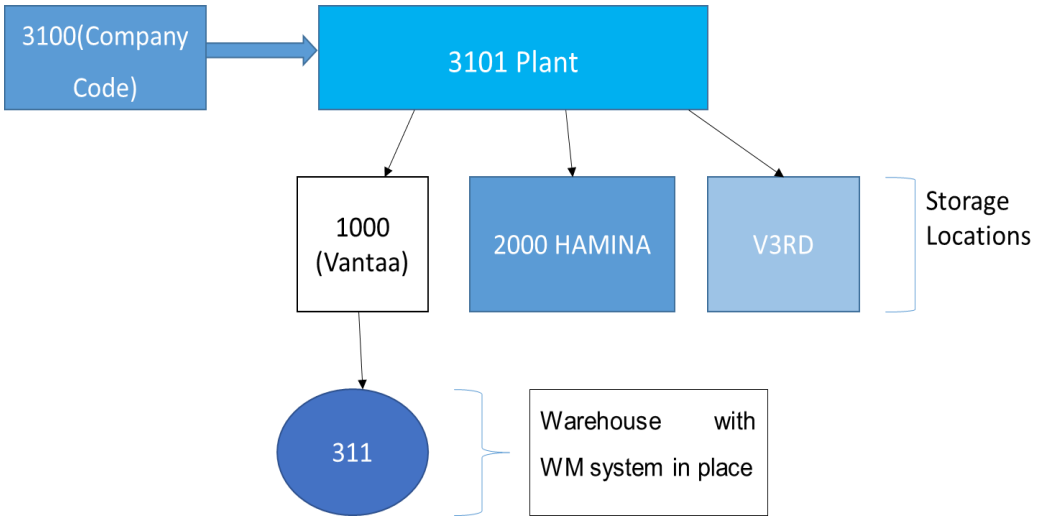


Figure 5. Basic structure for goods movement between warehouses at storage level in the case company.

As shown in Figure 5 above, it can be mentioned that the movement of goods from 1000(Vantaa) to 2000 (Hamina) utilizes SAP WMS. At the time of transfer, transfer orders are created based on transfer postings. When the transfer posting is done, it would lead to creation of posting change notice in the warehouse management system. During the goods movements, SAP transactions are used in WMS. The list of few needed transactions along with the tasks performed is shown in Table 4 below.

Table 4. SAP transactions used for goods movements in the WMS.

	Purpose of SAP transactions used in WMS	**SAP Transaction**
1	Viewing warehouse stock per material in WMS	LS24/LS26
2	Bin to bin transfers in the WMS, using manually created transfer orders	LT01
3	Bin to bin transfers in the WMS, using transfer orders	LT10
4	Checking of stock per storage type/bin	LX02
5	Movement of goods from QI stock to unrestricted stock, when TO from posting change notice exists in the background	LB12
6	Confirm Transfer Order	LT22
7	Scrap a non-moving item by creating a transfer order from transfer requirement	LT04
8	Scrap a defect material from WM warehouse by initially creating a manual transfer order and confirm transfer order	LT12

As shown in Table 4 above, the case company uses several transactions for goods movements within a warehouse. Next, the second use of SAP WMS (Goods Returns) within warehouse logistics is described.

3.3.2.2 Goods Returns Using SAP WMS

In the case company, it is possible that the customer would return all types of goods. For any physical return of goods, a return delivery document is automatically created in SAP WMS as soon as the return sales order is saved. This is shown in Figure 6 below.

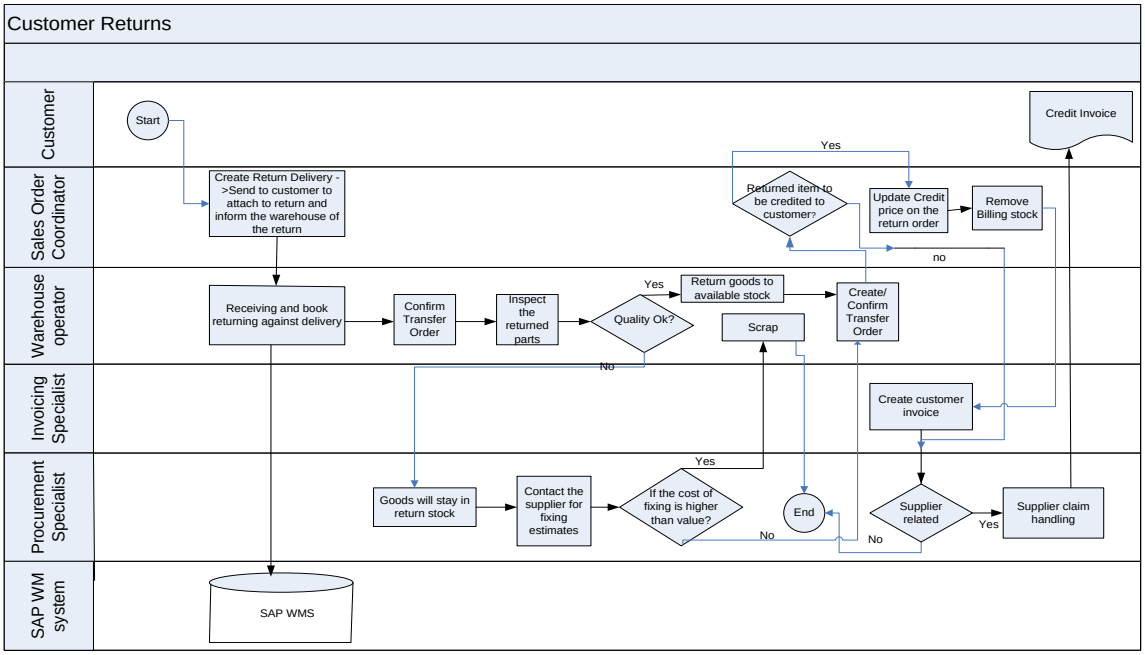


Figure 6. Goods returns process while using SAP WMS (Internal document: OPAL User Training).

As shown in Figure 6 above, SAP transaction VL71 is used in order to trigger the transfer order for the return delivery. Further, this transfer order can be confirmed using SAP transaction LT12. As a result of return delivery, goods receipt is performed by warehouse operator. Then, an inspection of the returned parts is done. If the quality is good, goods are placed to the available stock. If the quality is not good, then goods are placed back to the returns stock. Next, the supplier is contacted to find out the cost of fixing the bad quality spare parts. If the cost of repairing or fixing is higher than the value of the good, then those defective parts are scrapped. Otherwise, a confirmation of transfer order is done via the SAP WMS.

Further, SAP WMS is used for inventory counting within the warehouse. This specific usage of SAP WMS within the warehouse would be described in the next subsection.

3.3.2.3 Inventory Counting

In the case company, SAP WMS is used for inventory counting. This is shown in Figure 7 below.

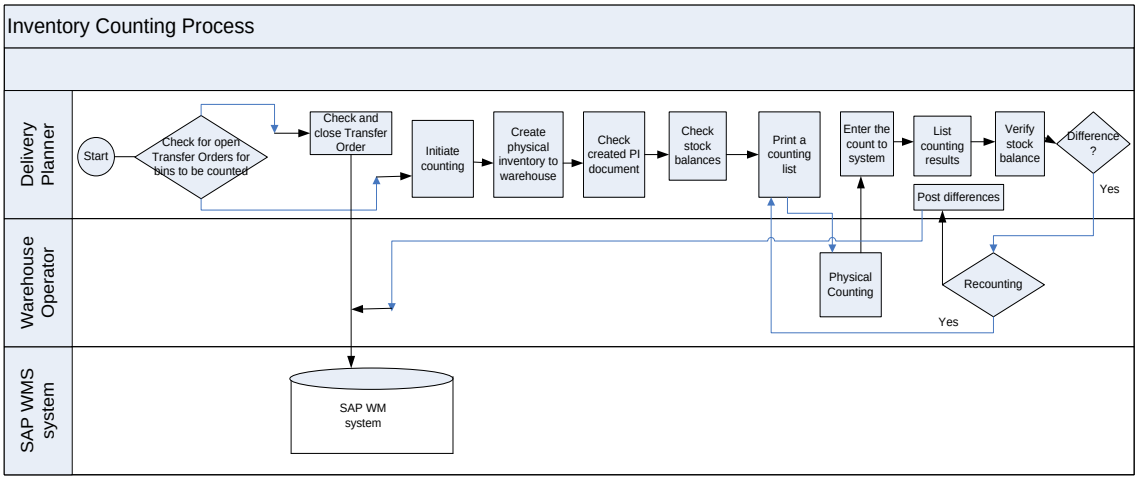


Figure 7. Inventory counting process using SAP WMS (Internal document: OPAL User Training).

As shown in Figure 7 above, during inventory counting, the delivery planner first checks for any open transfer orders for bins to be counted. In case if there are any open transfer orders, they are closed by the delivery planner on the SAP WMS. In case there are no open transfer orders for the bins, the counting is initiated by creating a physical inventory to warehouse. A further check of the physical inventory document and stock balances is done. This leads to creation and printing of a counting list.

Next, the physical counting is done by a warehouse operator. The warehouse operator posts the results of the counting to delivery planner. As a result, the delivery planner enters the count to the system and verifies stock balance. In case of a difference, re-initiation of counting is done via the warehouse operator. If recounting takes place, then the counting list is sent back to the delivery planner. If no recounting takes place, then warehouse operator simply posts the difference to the delivery planner. The delivery planner posts the differences to the SAP WMS.

This completes the uses of SAP WMS for logistics within the warehouse. The next subsection would describe goods issue as part of the outbound logistics using SAP WMS in the case company.

3.3.3 Outbound Logistics

It involves the movement of materials associated with storing, transporting, and distributing goods to the customers. In the case company, goods are issued using SAP WMS as part of outbound logistics process. This is described in the next subsection.

3.3.3.1 Goods Issue

The case company uses SAP WMS for goods issue to the customer as part of outbound logistics. This is shown in Figure 8 below.

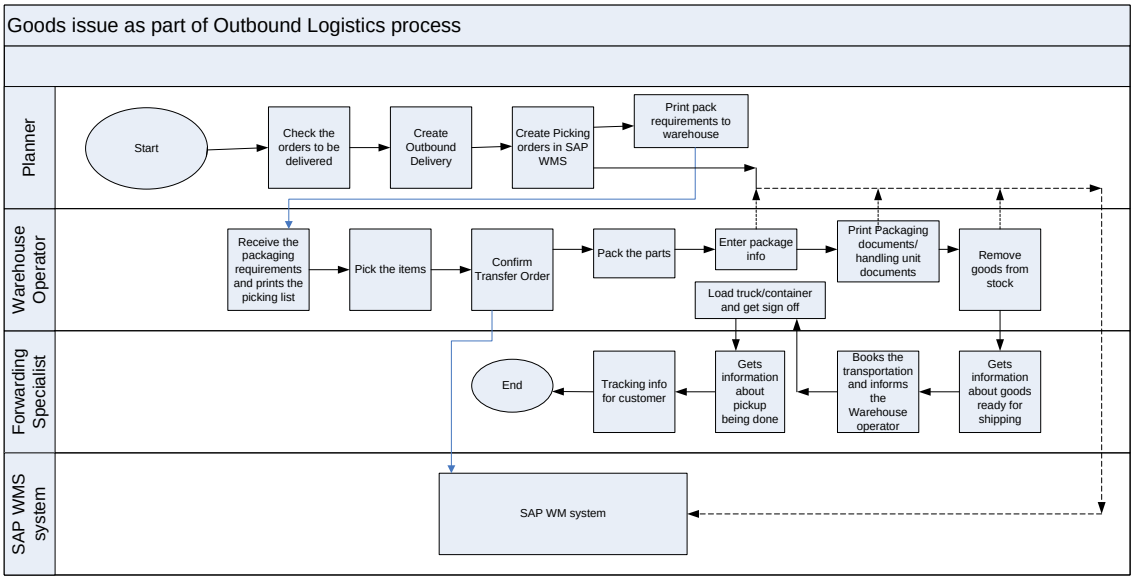


Figure 8. Goods issue as part of outbound logistics using SAP WMS (Internal document: OPAL User Training).

As shown in Figure 8 above, the first step calls that the delivery planner check the orders to be delivered. Next, the outbound delivery and picking orders are created in the SAP WMS. Next, delivery planner prints the packaging requirements to the warehouse which is sent to the warehouse operator. The warehouse operator prints the picking list and confirms the transfer order using transaction LT12 in SAP WMS. Next, the parts are packed, the package information is entered, and packaging documents are printed. Then the goods are removed from the stock. For all these steps, information is exchanged via SAP WMS.

The goods are actually removed from the stock by the warehouse operator and passed to a forwarding specialist. The forwarding specialist readies the goods for shipping. This is done by booking transportation and informing the warehouse operator. The warehouse

operator receives the truck or container loaded and prepares the necessary sign off. Additionally, the information is sent about picking up to the forwarding specialist. The forwarding specialist tracks the information regarding the customer and ends the process.

This completes the description of uses of SAP WMS for different processes in the case company. The next subsection discusses the roles and responsibilities of different persons in the case company using the SAP WMS in the warehouse.

3.4 Roles and Responsibilities Using SAP WMS in the Warehouse

In the case company, there are a number of roles involved in the usage of SAP WMS in the warehouse. This is described as follows:

First, *Warehouse Operator* (Receiving) conducts inbound warehouse activities (receiving, defined inspection activities, put-away and shelving). He is responsible for quality inspection and blocking the de-qualified goods. Further, he is responsible for communicating about discrepancies for inbound goods to procurement. He decides if the received goods pass the quality inspection or if they fail the inspection.

Second, *Warehouse Operator* (Deliveries) conducts outbound warehouse activities (picking and packing). He is responsible for several things which include security and risk checking, picking and packing, correcting information related to the picking and packing, inventory and stock balances and drivers signature. He conducts cycle counting and scrapping activities. Further, he is responsible for reporting QEHS issues in the warehouse. Last but not least, he is additionally responsible for communicating discrepancies and inventory errors in outbound activities in sales.

Third, *Sales Order Coordinator* handles sales order creation to systems and manages open order backlogs.

Fourth, *Procurement Specialist* executes procurement activities, such as Request for Quotation (RFQ) and purchase order creation, follow-up, vendor invoice verification. He updates all information coming from the supplier for example lead times, price, validity, customs code and other logistics information.

Fifth, *Delivery Planner* handles picking documentation (delivery) creation of sales orders to the warehouse, follows and prioritizes deliveries, communicates to sales about

conflicts in availability for orders that are required to be delivered. Further, he monitors open orders backlog. Last but not least, he handles transportation arrangements and inventory planning for the defined inventory location

Sixth, *Forwarding Specialist* typically handles inbound and outbound forwarding activities and transportation arrangements. He is responsible for four activities. First, instructing the transportation and booking the transportation. Second, preparing the shipping documents and providing the supplier with the export documentation. Third, import activities for inbound shipments. Fourth, communicating necessary documentation to forwarding partners. He basically decides the required customs documentation.

The next subsection would describe the findings from the current state analysis.

3.5 Findings from the Current State Analysis (Data Collection 1)

The result from the Current State Analysis clearly help to identify the entities which are working well with the current SAP WMS, and if any issues can be found. Further, in order to improve the usage of SAP WMS in the case company's third party operated warehouse, the findings need to be worked up and solved effectively. The key findings are grouped into strengths and weaknesses and discussed in the next two subsections.

3.5.1 Strengths of the Current Use of SAP WMS in the Warehouse

Based on the interview findings mentioned in Appendix 3, the SAP WMS works well in a few ways in the case company's third party warehouse. The strengths of the current SAP WMS based on interviews are summarized in Figure 9 below.

Strengths of the use of the current SAP WMS:

- The system works and provides dynamic bin allocation which is used well in the warehouse
- It helps in accurate real time stock visibility and traceability of spare parts from head office to the warehouse.
- It helps with reduction in mispicks by warehouse workers.
- Functions of WMS are currently utilized quite well: goods receipt with label printing, movements of goods within the warehouse, inventory

Figure 9. Summary of strengths of the current use of SAP WMS in the case company.

As shown in Figure 9 above, at first, currently the function of allocating dynamic bins for storage of goods is utilized well in the warehouse.

> *"There was in the earlier days, a perception that dynamic bin allocation was very important which leads to a WMS in some warehouses" (Director, Quotation and Inventory Management)*

Second, the SAP WMS is able to provide information in real time about stocks of spare parts and their exact quantities.

> *"SAP WMS tells me if possess the needed parts are in stock and in what quantity" (Delivery Planner)*

Third, the SAP WMS is able to provide information to the pickers as to where the goods are stored in the warehouse. This helps in reducing the number of incorrect picking done by warehouse operators.

> *"SAP WMS tells us the location of products" (Warehouse supervisor)*

Fourth, the SAP WMS is used for goods receipt.

> *"Once the goods are received by the warehouse operator, the labels are printed from the WMS" (Delivery Planner)*

Fifth, the SAP WMS is used in movements of goods within the warehouse.

> *"By creating transfer order, SAP WMS supports goods transfer from one bin to the other for storage in the warehouse"(Delivery Planner)*

Sixth, the SAP WMS is used for inventory counting in the warehouse.

> *"Once the count is sent to me by the warehouse operator, I check the stock balance and finally post the differences to the WMS" (Delivery Planner)*

Seventh, the SAP WMS is used for goods returns from the warehouse.

> *"SAP WMS is used for creating transfer order for returned items" (Delivery Planner)*

Eight, the SAP WMS is used for generic goods issue from the warehouse.

> *"I check the orders to be delivered. Then I create the outbound delivery and picking orders in SAP WMS. After that I print the packaging requirements to the warehouse operator. The warehouse operator prints the picking list and confirms the transfer order in SAP WMS" (Delivery Planner)*

Additionally, it was noted that the setup is fairly simple since very few features are configured by the system provider.

> *"But based on the information, I was able to obtain our WMS is not extremely sophisticated." (Director, Application Services)*

In general, the system supports printing of labels and other warehousing features without frequently crashing. Hence, the SAP WMS can be said to be a reliable and stable system.

These comments from the interviews support the fact that there are few visible strengths found in the SAP WMS which are being currently utilized by the users. The next subsection describes the weakness of the SAP WMS in the warehouse.

3.5.2 Weaknesses of the Current Use of SAP WMS in the Warehouse

This subsection discusses the weaknesses of the current SAP WMS. The weaknesses are presented based on interview results (Data 1) mentioned in Appendix 3. This is shown in Figure 10 below.

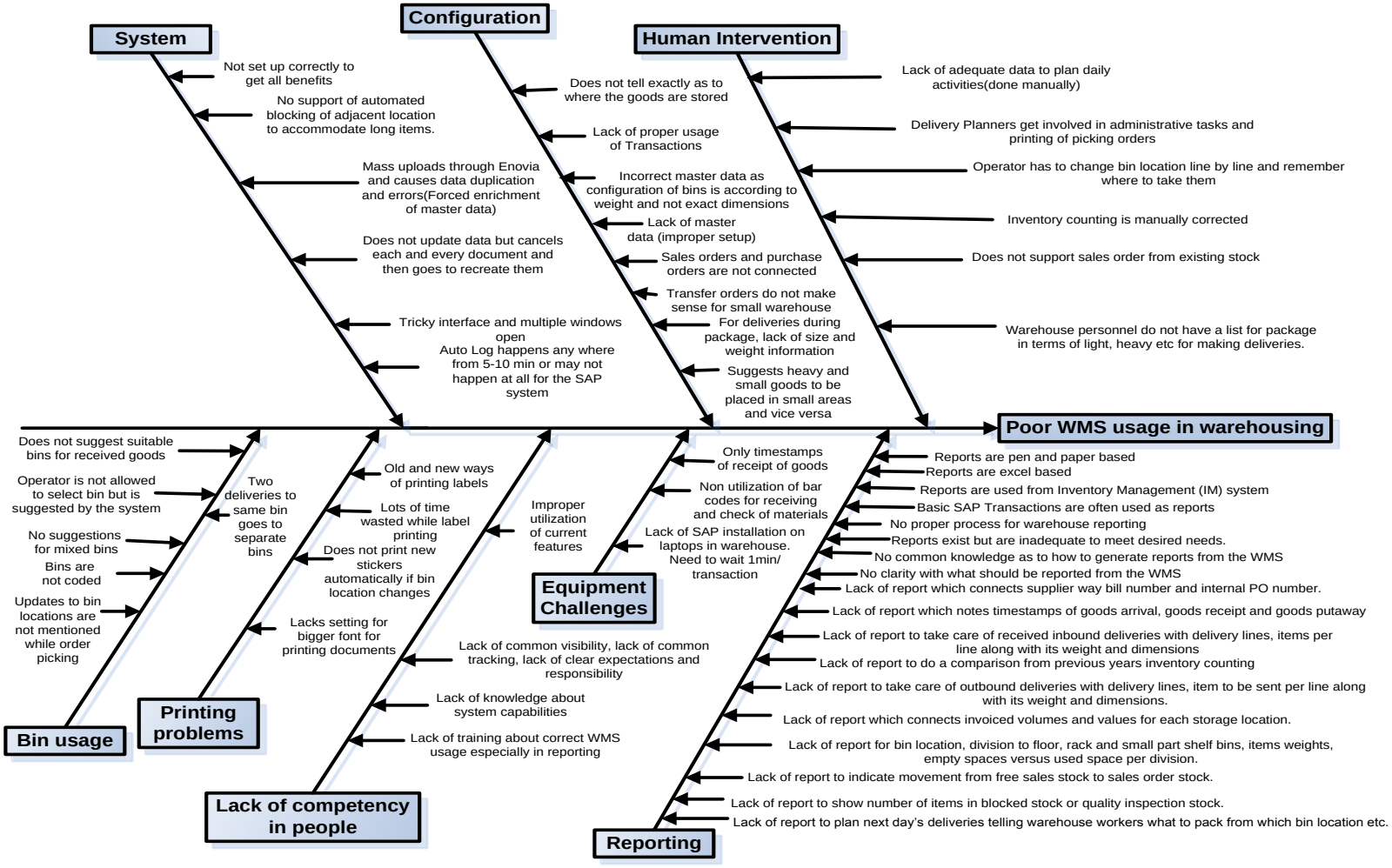


Figure 10. Weaknesses of the current SAP WMS.

As shown in Figure 10 above, there are multiple weaknesses related to the current use of SAP WMS in the warehouse which were revealed from the current state analysis. In general, as one respondent noticed:

> *"We are not utilizing really the system qualities in this sense at all."(Director, Application Services)*

This statement illustrates that, currently, there are a lot of weaknesses related to common visibility, lack of clarity in terms of responsibility for the correct use of SAP WMS. This point to a general lack of knowledge about genuine capabilities of system.

As shown in Figure 10 above, the weaknesses of the current use of SAP WMS in the warehouse can be summarized into eight groups:

Weakness group 1 relates to the system. This contributes to improper usage of SAP WMS. During the analysis, it was mentioned that system is very tricky with the possibility to open multiple windows. The SAP WMS logs out automatically every 5-10 min which causes immense frustration to the warehouse workers. Many of interviewees felt, that the system was not setup correctly.

> *"But for whatever reason, sometimes there as mass uploads through Enovia for lots of information that is already there in the SAP system." (Logistics Manager)*

This leads to an overall inefficient SAP WMS which cannot be used as the data is often corrupted.

Weakness group 2 relates to improper configuration done in SAP WMS. There are several configuration issues which leads to improper usage of SAP WMS. These include lack of correct master data as the system is only able to allocate storage bins in the warehouse based on weight and not based on product dimensions like size.

> *"Integrity of master data is surely a problem. So that makes it hard to achieve any of its benefits."(Director, Quotation and Inventory Management)*

This leads to inefficient and non-effective utilization of storage space in the warehouse.

Weakness group 3 relates to human intervention instead of using SAP WMS. The case company has to use delivery planners to take care of administrative tasks and printing picking orders which should be done automatically via SAP WMS.

> *"I have to put my people to run a 3rd party warehouse. I often think- am I receiving my ROI or any value?"(Director, Spare and Wear Parts)*

Moreover, the warehouse personnel do not receive the list to do their daily packaging tasks in terms of heavy or light goods. This indicates that there is a low usage of SAP WMS which causes the costs to increase, more time used than if the SAP WMS system was effectively used in the first place.

Weakness group 4 relates to bin usage. There is heavy reliance on the warehouse workers in choosing appropriate bins for goods storage and goods retrieval. The bins are not coded and there are no suggestions for mixed bins provided by the SAP WMS. Sometimes, two deliveries for the same item are sent to two separate bins. There is no possibility for the warehouse operator to select the bins since bins are automatically suggested by the system.

> *"There is no bin information; you just know that there is something. There is 3 of these goods somewhere in the warehouse". (Director, Application Services)*

This causes time losses, productivity losses due to repetitive tasks being done by personnel. Ideally, the personnel could be performing different, more productive and challenging tasks if the SAP WMS was used well for automation.

Weakness group 5 relates to printing problems while using SAP WMS. The system only supports small fonts for printing of documents. The current SAP WMS does not print stickers automatically when the bin locations are changed.

> *"I think the whole sticker or the label printing does not work as it is supposed to be."(Delivery Planner)*

This causes a lot of time wastage while printing labels and does not lead to effective usage of SAP WMS.

Weakness group 6 relates to lack of competency in people while using SAP WMS. This includes lack of common visibility, lack of common tracking, lack of clear expectations and responsibility while using the SAP WMS. Further, most people lack training about correct SAP WMS usage especially for reporting. This leads to improper usage of the SAP WMS.

> *"It is clear to me is that many people really are not aware of true capabilities of SAP WMS. It can do a lot more than it is being used for at the moment." (Director, Application Services)*

This clearly indicates lack of competency and training in terms of using the SAP WMS among the workers in the warehouse and management personnel in the headquarters of the case company.

Weakness group 7 relates to equipment challenges which should be used in parallel to SAP WMS. Currently, there is no utilization of barcode readers for receiving and checking of materials.

> *"Barcode implementation is currently on hold. For a professional warehouse, it is necessary to scan exactly at the place where the workers are standing. That would be helping us and the service provider. I would say that we would save quite a lot of money as well with the fees of the outsourced warehouse, if we had the key systems doing things automatically."(*Director, Spare and Wear Parts)

Further, timestamps of goods are taken only during receipt by the usage of SAP WMS system and labels are printed. There are no timestamps for other movements within the warehouse for example, when the goods are picked to be packed or ready for dispatch. Last, but not least there is lack of SAP installation in the laptops of warehouse workers. They must connect to a SAP server and sometimes it requires them to wait for 1 min per transaction. This leads to immense frustration among the warehouse workers.

Weakness group 8 relates to weakness in using the reporting function. This group is discussed separately below.

3.5.3 Weaknesses in Reporting Functionality in the Current Use of SAP WMS in the Warehouse

In the case company, reporting from different warehousing processes forms one of core components of spare parts business. This is due to the fact that accurate reporting can easily say if certain spare parts exist in the warehouse, location of those specific spare parts in bins or particular storage locations. Reporting can inform the management about optimal performance in terms of manpower and resource utilization. This is critical since the case company uses a third party operated warehouse for its spare parts business.

However, in the case company, there is an acute shortage of reporting internally as well as from the third party warehouse provider. The system with the current setup, is incapable of providing any intelligent or usable reports. There is no information as to when the goods are received, when then are issues, the amount of time it takes to do picking, packing and delivery of the necessary spare parts to the end customers. Additionally, the system does not provide any insights to bin utilization rate or the number of products returned.

In terms of reporting provided by the third party warehouse provider, currently, only inbound and outbound volumes and handling times are sent. Further, the third party warehousing services provider provides manual reporting (handwritten form or in the form of entries in excel sheets). Reporting is a done by the warehouse administrator at the third party warehousing service provider on a daily basis. However, the managers at the case company check those reports only monthly/quarterly. The reports sent are provided for indicative reporting. However, the managers in the case company feel that since the reports provided to them by the third party warehousing provider are manual; the results can neither be trusted nor used as real Key Performance Indicators (KPIs).

The way reporting is done causes lots of dissatisfaction to stakeholders from both the very top management level to actual warehouse workers. This example below tells that the key challenge is that, currently, the personnel just do not know the types of reports which exist in SAP WMS and they lack awareness about correct usage of reporting functionality from SAP WMS in order to monitor the warehouse operations.

> *"I really do not see any functional reports" coming out of SAP from the warehouse. "Are there any?" I do not know the kind of reports there are. At least those I know about are not sufficient for monitoring of the warehouse function."(Logistics Manager, Manager Global Transportation Management)*

This clearly suggests that there are certain gaps in terms of realization of reporting needs.

As seen earlier, currently the SAP WMS is utilized mainly in five processes. The gaps in reporting needs from these processes were identified as part of CSA and are mentioned in detail in Appendix 5. These reporting needs related to five processes are summarized in Table 5 below.

Table 5. Gaps identified in reporting usage by five processes currently served by SAP WMS.

Name of the process	Description of identified gap in terms of reporting
1. Goods receipt with label printing	A. Lack of report which connects the supplier waybill number and the internal PO number.
	B. Lack of report which notes the timestamp of goods arrival, goods receipt for ICA goods
	C. Lack of report to take care of received inbound deliveries with a show of date and time (timestamps) of goods arrival, delivery lines, items received per line along with its weight and dimensions.
2. Goods movements	A. Lack of report which tells when inbound goods are put away (placed in shelves).

Name of the process	Description of identified gap in terms of reporting
within the warehouse	
B. Inventory Counting	A. Lack of report to do a comparison from the previous years' inventory counting.
C. Goods returns	A. Lack of report indicating outbound activity from the warehouse showing timestamp of delivery creation, goods issue and actual time when picking is done.
D. Goods issue	A. Lack of report indicating outbound activity from the warehouse showing timestamp of delivery creation, goods issue and actual time when picking is done.
	B. Lack of report indicating date and time of goods shipped (outbound timestamps), number of delivery lines, items per delivery line, weight and size of individual items.

As shown in Table 5 above, there are clearly identified gaps in terms of reports related to the five main processes using the SAP WMS. Further, some more reporting gaps were identified to other processes which could use SAP WMS. These reports would highly benefit the business, if they would be generated. These are mentioned in Table 6 below.

Table 6. Gaps identified in reporting usage by other processes or activities.

Name of the process	Description of identified gap in terms of reporting
1. Forwarding and invoicing	Lack of report which connects invoiced volumes and values for each storage location.
2. Bin utilization	Lack of report which would show the total number of SKUs, which items are located in which Bin location, division to the floor, rack and small part shelf bins, items weights, empty space vs. used space per division.
3. Goods transfer	Lack of report to indicate movement from the free sales stock to the sales order stock.
	Lack of report to show number of items in blocked stock or quality inspection stock.
	Lack of report to plan the next day's deliveries. It would tell the warehouse workers how many items to pick up, from which bin location etc.

As shown in Table 6 above, there were additional gaps identified in reporting on top of those found in the five main processes using the SAP WMS.

Therefore, this subsection mentioned the weaknesses in reporting practices with respect to usage of SAP WMS. It identified the gaps in reporting areas for five processes currently served by SAP WMS. Additionally, it identified few other processes areas which if reported well would be highly beneficial for the business.

The next subsection would summarize the key findings and areas for improvements from the CSA.

3.6 Summary of Key Findings and Selected Areas for Improvement

The findings of the current state analysis are summarized in this subsection and refers to the previous subsections in which majority of findings were checked. However, the strengths were clearly summarized in the previous subsection, hence they would not be repeated here. Therefore, only the weaknesses of the current use of WMS would be summarized here. This is shown in Figure 11 below.

Weaknesses in the use of the current SAP WMS:

- SAP WMS is not used since the system is tricky with multiple windows and longer periods of logouts causing frustration to workers.
- SAP WMS cannot be used well as the back end is incorrectly configured with incorrect and missing master data.
- SAP WMS cannot be fully used due to human intervention as delivery planners to take care of administrative tasks and printing picking orders.
- SAP WMS provides automatic bin for storage but this is not used
- SAP WMS does not print stickers automatically when the bin location changes
- SAP WMS cannot be used well as the users lack training and knowledge
- SAP WMS is not supported by the needed equipment such as barcode readers
- SAP WMS does not provide reports to the management as expected.

Figure 11. Summary of weaknesses of the current use of SAP WMS in the case company.

As shown in Figure 11 above, for the next step of this study, out of all the weaknesses, one major weakness can be clearly prioritized as requiring some immediate action. This one particular weakness is to be identified as the focus for improvement in the study.

As for the *Lack of reporting*, this weakness causes many problems since there is a clear need from the management side to monitor the warehouse remotely from the office in Espoo. Currently, most managers find the reporting from SAP WMS as inadequate. Reports from SAP WMS do not provide any clear insights time of goods receipt or goods issue or time elapsed between the goods receipt and goods issues. Additionally, there are no reports about any of the goods returned. This causes the management to depend on the information provided by the third party warehouse operating team. Occasionally, the managers need to appoint additional internal staff to be involved into day-to-day administration of warehouse. As a result, many managers are doubtful about the value

for money that they receive by using the third party operated warehouse due to especially this lack of visibility.

Business impact of not having a proper reporting function is high. Ideally, the SAP WMS should support making the key decisions by the management. Currently, lack of adequate reports cannot help in making decisions regarding operational efficiency of the warehouse. They cannot determine the quality of service provided by the third party warehouse provider without adequate reporting. So far, most of the stakeholders in warehousing in the case company are unable any reliable statistics or KPIs as there are no clear indicators available in any report format. Further, in the case company, good reporting would leverage the capabilities in achieving operational excellence. This should eventually help in achieving the organization's strategic goals in terms of SMOE (Sales and Marketing Operations Excellence) of the spare parts organization towards its customers.

Lastly, with a good number of reports available through various queries, would help to combine available data, thus reducing the existence of functional silos in the case company. If information is available, it would help to control the processes related to efficient collection, storage and distribution of spare parts in the warehouse. A set of effective reports would help to perform targeted analyses to be displayed in spreadsheets, reports and dashboards.

Summing up, *Reporting* forms a crucial element in operational efficiency and effectiveness. This is because it offers the stakeholders (often managers) a precise view of the most important warehouse management functions in a visual format. It helps them to make decisions regarding KPIs and make plans for the upcoming tasks in an organized manner. Therefore, high quality reporting might support all the other weakness areas as it has a clear impact on all processes in the current SAP WMS. If generalized, the under-use of reporting includes these two specific challenges:

A. the management needs to agree "WHAT" they want to be reported from SAP WMS (and that is currently missing)
B. the managers do not know "HOW" to use the SAP WMS in order to generate the correct reports

In conclusion of the CSA, it can be said that, out of the eight categories of weaknesses (see the fishbone), *Reporting* is selected for further tackling in this study. *Reporting* is

selected in order to improve the current usage of SAP WMS in those areas that need development to remove the existing weaknesses in the warehousing process.

This completes the CSA section of the study. The findings from this CSA would be utilized in order to come up with a conceptual framework in the next section of the study.

4 Existing Knowledge on SAP WMS Reporting

This section discusses the tools found from literature sources along with the existing knowledge to provide with a conceptual framework. This section is structured as follows, it begins with a brief overview of SAP and SAP WMS. This is followed by description of measurements and KPIs used in warehouse management. Next, the reporting functionality in SAP WMS is discussed. This section concludes with a conceptual framework for improving reporting from SAP WMS. The above mentioned steps are described in the following subsections.

4.1 Brief Overview of SAP and SAP-based WMS

As mentioned earlier, SAP is an acronym for German software which in English stands for "Systems, Applications and Products." The original idea behind *SAP* was to provide the customers with the ability to interact with a common corporate database for a comprehensive range of applications (Rouse, 2009). As such, it is typically made of a number of separate applications that can communicate with each other and share a common database. The SAP system can support to automate the core business processes and helps to ensure regulatory compliance, risk reduction and provide accurate reporting. SAP system is able to integrate all the core processes needed to run a company for example, finance, HR, manufacturing, supply chain, services, procurement etc.

SAP makes one of the most popular type of an ERP (Enterprise resource planning) system. The fact that SAP is able to integrate these processes into a single system, makes it a true ERP (SAP, 2017). Therefore, by making use of latest technologies a SAP ERP system can facilitate the flow of real-time information across departments. This helps to eliminate lack of information sharing between various departments or creation of information silos in a large company. Additionally, this helps the firms to make data-driven decisions and manage performance concurrently.

“The SAP WMS provides flexible, automated support in processing all goods movements and in managing stocks in a warehouse. The system supports scheduled and efficient processing of all logistics processes within a warehouse” (SAP Warehouse Management System, 2017). The features of a SAP WMS are shown in Figure 12 below.

Figure 12. Features of SAP WMS (SAP Warehouse Management System, 2017).

As shown in Figure 12 above, SAP based WMS includes storage bin management, planning and monitoring, warehouse movements, radio frequency connection and warehouse control. SAP based WMS allows the mapping of an entire warehouse complex in detail from plant level to storage bin level. It helps to gain an understanding of all materials in a warehouse along with their location in the warehouse complex (SAP Warehouse Management System, 2017). Therefore, SAP WMS helps to optimize the use of storage bins and warehouse movements in a warehouse.

SAP WMS basically integrates all the business processes in the warehouse. For example, inventory management, delivery processing, transportation, production, procurement and distribution of goods. This is shown in Figure 13 below.

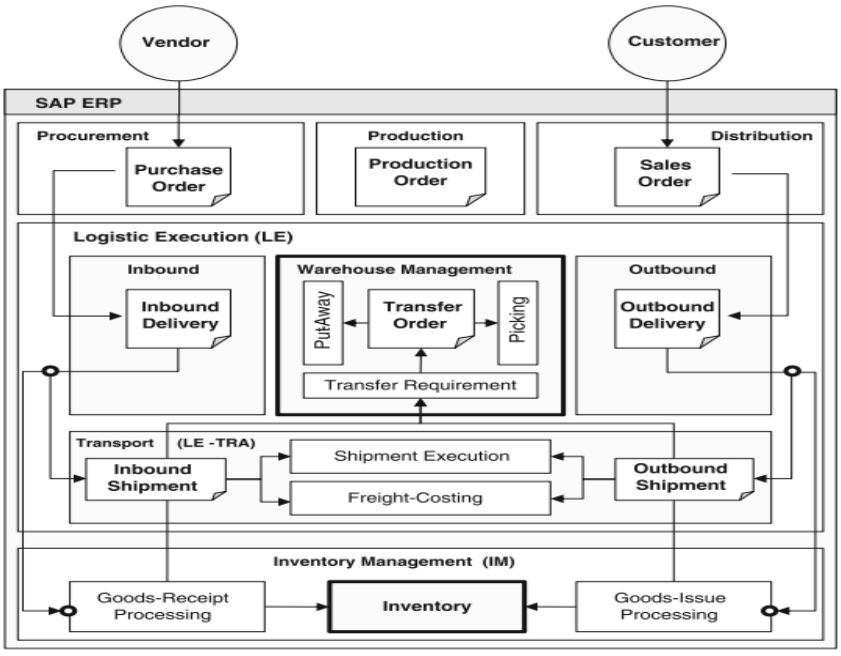


Figure 13. SAP WMS with business processes integrations (Kappauf, et al., 2012, p. 137)

As shown in Figure 13 above, it can be seen that all the major functions of a warehouse management can be easily performed with a SAP WMS. In Figure 13, operations happen on both the sides of the image. First, on the left hand side it shows that the procurement of goods from a vendor is done from a SAP WMS system using a Purchase Order. It results in an inbound delivery of goods as part of Logistics Execution (LE) and in terms of transport (as part of LE-TRA), it is termed as Inbound Shipment. Further, in terms of Inventory Management (IM), it calls for goods to be received and kept as part of the inventory in the Warehouse. Once the goods are in the warehouse, they are part of a transfer requirement and further part of transfer order for put away as part of Warehouse Management.

Next, as shown on the right hand side, once the customer makes a sales order for a product, the goods are picked from the warehouse after the creation of transfer requirement and further a transfer order. This is done as part of outbound delivery. Next the shipment is executed and freight costs are calculated for the outbound shipment. Last but not least, goods issue processing is done so that the inventory stocks are reduced.

This subsection completes here with a brief overview of SAP and SAP-based WMS. The measurements in warehousing management are discussed in the next subsection.

4.2 Measurements and KPIs Used in Warehousing Management

Warehouse management includes the complete art of warehouse operation and distribution system in order to operate a warehouse efficiently. In addition to inventory management functions such as management of quantities, storage locations, planning of transport, warehouse management consists of methods and means to control the system status and choose an operating and optimization strategy (Hompel & Schmidt, 2007, p. 7). This clearly tells that warehouse management is a complex task and requires understanding of several processes and activities in order to be able to manage the warehouse properly.

A high performing warehouse operation requires that the processes are controlled so that there is accuracy, quality, timeliness and cost effectiveness in all activities that are performed. In order to establish control, warehouse operation should ideally measure and report their performance and productivity. This is done to ensure customer satisfaction, steps for continuous improvements, to figure out potential areas for improvements before they become a major issue, to train their employees in the needed

areas and to reward their staff as and when needed (Richards, 2014, p. 294). These are some of the important reasons behind measuring the warehouse performance.

Traditionally, warehouse performance indicators are divided into “hard” and “soft” metrics. The first one, “hard” can be calculated mathematically uses quantitative measures such as order cycle time, fill rates etc. The second one, “soft” requires sophisticated tools uses qualitative measures such as manger’s view of the customer satisfaction and loyalty (Staudt, et al., 2015, p. 5530). Therefore, most often the “hard” metrics act as direct indicators while “soft” metrics act as indirect indicators.

Performance measures and metrics are important for effective management of logistics operations especially warehousing. This is because they help the mangers to make correct decisions in order to increase organizational competitiveness (Gunasekaran & Kobu, 2007, p. 2819). Performance can be measured by using Key Performance Indicators or KPIs. KPIs can be defined as a measurable value that shows how effectively a company can achieve its key business objectives. Most companies use KPIs at multiple levels to evaluate their success at reaching targets (klipfolio.com, 2017). This is because using KPIs at one level may not display the overall results for a business firm. While, high-level KPIs may focus on the overall performance of the enterprise, low-level KPIs generally focus on processes at individual department level such as sales, marketing etc. For this study, it is important to match the KPIs to few particular processes (among many processes in warehousing management that demonstrated difficulties in reporting functionality related to the performance measurements).

First, Process 1 from CSA, which is identified as *Weakness 1,* relates to *Goods Receipt to PO with label printing using SAP WMS*. It involves goods received to the warehouse after being checked by the warehouse operator against a PO. If the goods receipt is successful, post goods receipt is done and labels are printed by the SAP WMS. The KPIs for this process could include the following measurements as shown in Table 7 below.

Table 7. KPIs identified for reporting usage for Inbound Goods Receipt.

Key Performance Indicator	**Definition**	**Authors**
Receiving time	Unloading time	(Gu, et al., 2007, p. 4);
Dock to stock time	Amount of time it takes to get the shipments from the dock to inventory floor without inspection	(Subramanya, et al., 2012, p. 16)

As shown in Table 7 above, two relevant KPIs are identified for reporting usage for inbound goods receipt.

Second, Process 2 from CSA, which is identified as *Weakness 2,* relates to *Goods Movements within the warehouse with SAP WMS*. It involves transfer of goods between different locations within the warehouse. At the time of transfer, transfer orders are created based on transfer postings in SAP WMS. When the transfer posting is done, it would lead to creation of posting change notice in the SAP WMS.The KPIs for this process could include the following measurements shown in Table 8 below.

Table 8. KPIs identified for reporting for Goods Movements within the Warehouse.

Key Performance Indicator	Definition	Authors
Put away time	Lead time since a product(s) has been unloaded to when it is stored in its designated place	(Koster & Tho Le-Duc, 2007, p. 483);
Order picking time	Lead time to pick an order delivery line	(Staudt, et al., 2015, p. 5532)
Order lead time	Lead time from order placement to shipment	(Yang, 2000, p. 162); (Subramanya, et al., 2012, p. 16)
Picking productivity	Total number of products picked per labour hours in picking activity	(Kiefer & Novack, 1999, p. 23)
Shipping productivity	Total number of products shipped per time period	(Kiefer & Novack, 1999, p. 23); (De Koster & Warffemius, 2005, p. 767)

As shown in Table 8 above, five relevant KPIs are identified for reporting usage for goods movements within the warehouse.

Third, Process 3 from CSA, which is identified as *Weakness 3,* relates to Inventory *Counting using SAP WMS*. The KPIs for this process could include the following measurements shown in Table 9 below.

Table 9. KPIs identified for Inventory Counting in the Warehouse.

Key Performance Indicator	Definition	Authors
Physical inventory accuracy	Measures the accuracy (by locations and units) of the physical inventory compared to the reported inventory.	(Kiefer & Novack, 1999, p. 23); (Subramanya, et al., 2012, p. 16); (WERC, 2008)
Storage accuracy	Storing products in proper locations	(Staudt, et al., 2015, p. 5534);
Inventory Space utilization	Rate of space occupied by storage	(Subramanya, et al., 2012, p. 16)
Inventory cost	Total storage cost/unit	(Staudt, et al., 2015, p. 5535)
Hit/Miss Accuracy	Hit/Miss Accuracy is the percentage of the total number of cycle count entries that fall within the hit/miss	(DashBoardZone, 2017)

Key Performance Indicator	Definition	Authors
	tolerance as compared to the total number of cycle count entries made.	
Gross Adjustments-Rate	The gross value of the adjustments made during cycle counting to the total system inventory value of the counted items at the time if completion of cycle count entries.	(DashBoardZone, 2017)

As shown in Table 9 above, six relevant KPIs are identified for reporting usage for inventory counting in the warehouse.

Fourth, Process 4 from CSA, which is identified as *Weakness 4,* relates to *Goods Returns using SAP WMS*. The KPIs for this process could include the following measurements shown in Table 10 below.

Table 10. KPIs identified for Goods Returns to the warehouse.

Key Performance Indicator	Definition	Authors
Scrap rate	Rate of product loss and damage	(Staudt, et al., 2015, p. 5534)
Stock out rate	No of product loss and damage	(Staudt, et al., 2015, p. 5535)
Cargo damage rate	Number of orders damaged during delivery activity.	(Kiefer & Novack, 1999, p. 23); (Staudt, et al., 2015, p. 5534)
Rate of Return	Number of units returned divided by the number of units sold	(Legacy Supply Chain Services, 2017)

As shown in Table 10 above, six relevant KPIs are identified for reporting usage for goods returns to the warehouse.

Fifth, Process 5 from CSA, which is identified as *Weakness 5,* relates to *Goods Issue using SAP WMS* (based on the CSA). The KPIs for this process could include the following measurements shown in Table 11 below.

Table 11. KPIs identified for goods issue from the warehouse.

Key Performance Indicator	Definition	Authors
On time delivery	Number of orders received by the customer on or before committed date	(Staudt, et al., 2015, p. 5534)
Throughput	Items/m2 per day	(Staudt, et al., 2015, p. 5534)
Outbound space utilization	Utilization of the area inside the warehouse used for retrieving, order picking, packing and shipping	(Johnson, et al., 2010, p. 228)
Warehouse Order Cycle Time	The elapsed time from when an order is released to the warehouse floor until it is picked, packed, and ready for shipping	(Frazelle, 2002, p. 55)

Shipping Accuracy	Number of errors free orders shipped	(De Koster & Balk, 2008, p. 183); (WERC, 2008)
Delivery accuracy	Number of orders distributed without incidents.	(Kiefer & Novack, 1999, p. 23)

As shown in Table 11 above, six relevant KPIs are identified for reporting usage for goods issue from the warehouse.

In addition to the above mentioned KPIs, there are some KPIs which would include measurements needed by the business side. These are shown in Table 12 below.

Table 12. KPIs identified for business use from the warehouse.

Key Performance Indicator	Definition	Authors
Labour productivity	Ratio of the total number of items managed to the amount of item-handling working hours.	(Marco & Mangano, 2011, pp. 416-418)
Labour Cost	Cost of personnel involved in warehouse operations	(Staudt, et al., 2015, p. 5535) (Cagliano, et al., 2011, p. 181)
Maintenance Cost	Equipment Maintenance	(Marco & Mangano, 2011, p. 411)

As shown in Table 12 above, three relevant KPIs are identified for reporting usage for business from the warehouse.

Additionally, it can said that the KPIs mentioned above would clearly help the case company in performance measurements related to their warehouse operations. They would form a basis for higher level of reporting for a particular period. This is because the KPIs represent the interest of the senior management.

This completes the description of the measurements and KPIs which can be utilized in reports from the warehouse.The next subsection would describe reporting functionality in SAP WMS describing the relations with measurements and KPIs mentioned above.

4.3 Reporting Functionality in WMS (related to Measurements and KPIs)

Reporting functionality enables a large group of people to easily access real-time enterprise information, and modify the information into various formats. As such, it becomes critical to the success of any organization. The Warehouse Management Systems are used to gather and control all warehouse related information, and therefore they need to be put to a good use to benefit the organization (Hompel & Schmidt, 2007, p. 18). In keeping view of this study, the next subsections of this study would discuss three possibilities of reporting with respect to a SAP WMS system.

4.3.1 SAP Warehouse Management System (WMS) as part of SAP ERP

SAP WMS is an integral part of SAP ERP system, therefore reporting becomes possible by using SAP transactions. SAP WMS can be used to effectively plan an entire logistics cycle as part of SAP ERP system without any separate license. This is different from using SAP WMS with tools like SAP NetWeaver Business Warehouse, where a separate license must be bought (Stechies.com, 2008). SAP WMS is integrated to several other modules like production planning, sales, material management etc. Hence, the data coming from various modules in SAP can be easily merged and analyzed.

SAP WMS allows users to integrate with bar code scanners so that data collected from scanners could be easily used for reporting purpose. However, SAP WMS, provides very limited reporting capabilities on its own in the form of standard reports. This standard reports which are available require large number of additional tasks to be done outside of a SAP WMS for generating a reasonable quality report. For example, the calculation of KPIs is one of the tasks which is done manually, when the report is generated from SAP WMS and converted to an Excel spreadsheet. Therefore, SAP WMS as part of SAP ERP would not be discussed in detail for this study.

SAP WMS is able to generate flexible reporting with two other reporting tools. First, SAP Logistics Information System (LIS) which is a part of SAP ERP itself and, second, a separate tool, for example, SAP NetWeaver Business Warehouse. Both these applications can be used to generate KPIs spanning multiple processes (Kappauf, et al., 2012, p. 267). This way reporting can help in bringing out the needed measurements for a firm while creating reports for the warehouse. These two tools would be described in the following two subsections.

4.3.2 Logistics Information System (LIS) as part of SAP ERP system

Logistics Information System (LIS) as an individual application in the ERP system. It provides statistical processing of logistics data. It is used for generation of statistical overviews for warehouse, sales and distribution and transportation processes. This is because data coming from various sub-modules in SAP can be easily merged and analyzed. LIS can be used to effectively plan an entire logistics cycle in SAP without any separate license, as compared to SAP BW (Stechies.com, 2008). As a tool, LIS allows users to customize the reports based on reporting requirements making it a flexible

reporting and analytical tool (Stechies.com, 2008). The basic logistics key figures and overviews providing the standard analysis is shown in Figure 14 below.

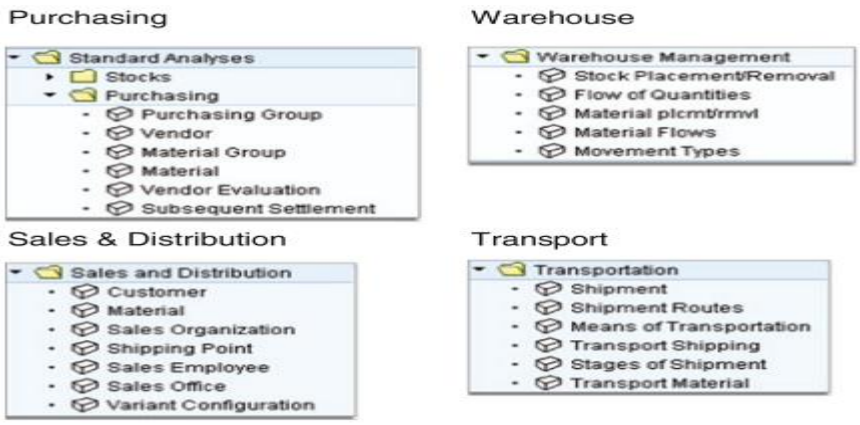


Figure 14. Standard analyses of LIS (Kappauf, et al., 2012, p. 271).

As shown in Figure 14 above, standard analysis for Warehouse Management has very few reports. The available standard reports in LIS systems can be used by activating information structures SO90 and SO91. LIS has a very simple setup and provides limited functionality, especially in terms of having no content for KPIs. Therefore, any KPI calculation from the reports generated from SAP LIS as part of ERP system would require manual calculations using Excel spreadsheet. This is unsuitable for management which requires automatic calculations from the system. Hence, SAP LIS is discussed here only in brief. For a company-wide reporting, most of the times SAP NetWeaver Business Warehouse can be used. This is described in the next subsection.

4.3.3 SAP NetWeaver Business Warehouse

SAP NetWeaver Business Warehouse (hereafter SAP BW) is a separate SAP tool that can be procured to provide reporting. It can use data from SAP systems, non-SAP systems and structured files for example, Excel spreadsheets. Data can be displayed in either in a spreadsheet structure or as a dashboard with signal lights, speedometer graphs or diagrams. Using SAP BW, the authorized personnel in a company are able to access the available data at the push of a button. This helps them to make decisions and effectively control their day-to-day business activities. SAP BW comprises of data with its administration for data definition, updating, aggregation and queries in addition to BW content that defines data storage and queries based on content (Kappauf, et al., 2012, p. 276). A part of the InfoProvider supplied with SAP from the logistics domain is shown in Figure 15 below:

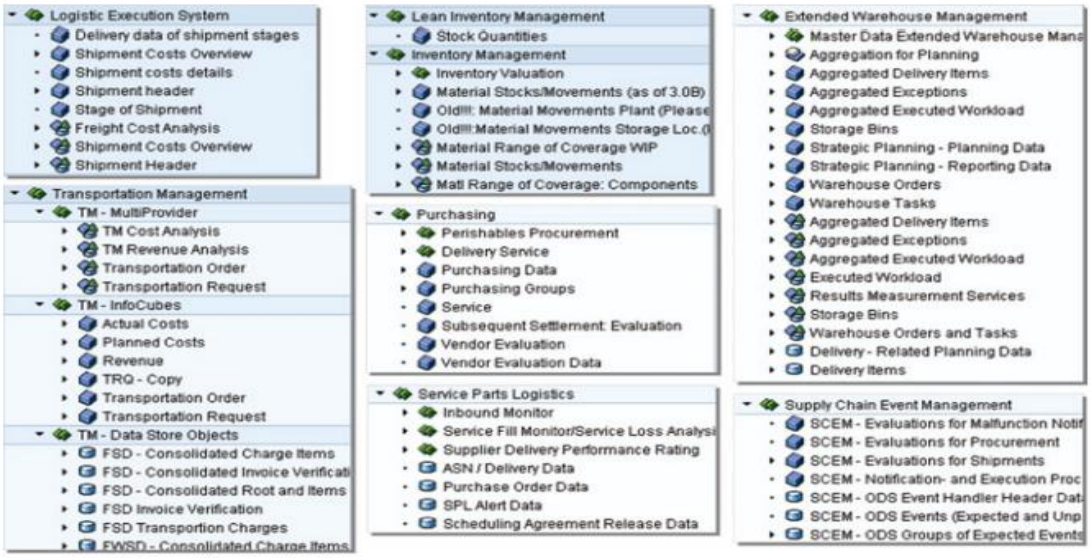


Figure 15. SAP BW content for logistics key indicators provided by InfoProvider (Kappauf, et al., 2012, p. 270).

As shown in Figure 15 above, SAP BW has content for logistics key indicators based on SCOR model (Supply Chain Operations Reference which contains a large number of key performance indicators helping in the assessment of logistics efficiency, from suppliers through production to the customers (APICS, 2017)). SAP BW comes pre-installed with SCOR model's KPIs and many different types of reports are available. For example, Capacity utilization, Order Fulfilment, Procurement Logistics etc. (Kappauf, et al., 2012, p. 271). Therefore, due to the usage of key SCOR indicators, reports done are standardized with important KPIs at cross-company level.

Further, the latest SAP BW has a visual composer feature. This helps in data extraction from different systems and present it in an easy-to-configure user interface. As a result, reporting does not involve programming work, but appears as a simple business process which can be executed by any work personnel.

The reports can be produced as result of integration of logistics processes with SAP BW that involves the following seven steps (Kappauf, et al., 2012, p. 281). The steps for producing reports are shown in Figure 16 below.

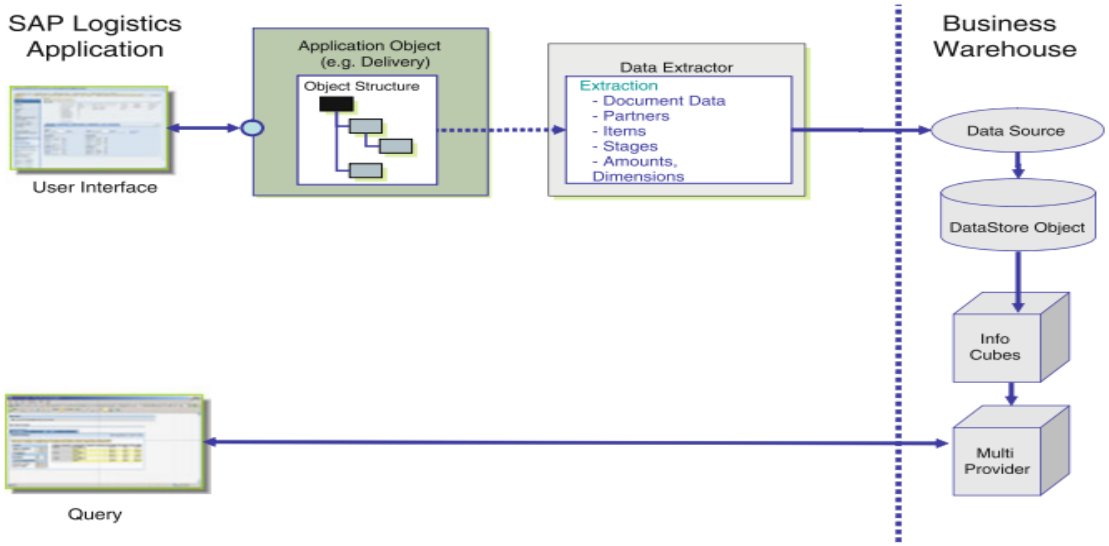


Figure 16. Integration processes between logistics applications and BW to produce reports through 'Query' (Kappauf, et al., 2012, p. 275).

As shown in Figure 16 above, first step, calls for activation of SAP applications, done via user interface. In Second step, the data extraction is done for the KPIs. The method of data extraction can be tailored to a specific application object. Next in the third step, the extraction method places the data in a DataSource to BW. In the fourth step, the DataSource information is further placed in DataStore Objects. In the fifth step, DataStore objects place the information into InfoProviders or InfoCubes. Hence, the InfoProviders save the characteristics and KPIs. Following this in the sixth step, these characteristics and KPIs in turn are used by Multi Providers as a data source. In the seventh step, the information existing in Multi Providers, can be accessed in the BW with several types of 'Queries'. This forms the last step on the way for producing the report. Furthermore, the data for the report can even be combined with other available information to perform targeted analyses. The report can further be displayed in spreadsheets, reports or using dashboards (Kappauf, et al., 2012, p. 274). Therefore, the data from the MultiProvider is pulled for presenting and analysing to Microsoft Power Business Intelligence (Berg, 2010). This is one of the many possibilities of presenting the reports.

Further, SAP Business Objects (SAP BO) can be used with SAP BW for display of reports. This is because SAP BO (Techtarget.com, 2017) provides a new data representation and a query technique which allows information system end users to access (query) relational databases without knowing the relational structure or the structure query language (SQL). It actually forms a semantic layer (Powler, 2011). By

semantic layer, it means that the physical data store and the front-end reporting tool) and ready-written reports can be stored centrally and made selectively available to needed users. Further, business users prefer a common "look and feel" when accessing and analyzing data stored in relational databases and InfoCubes (Wheadon, 2013). This means that in general, managers or business stakeholders prefer that their data is stored in a certain way in the database.

This subsection described the reporting functionality in WMS (related to Measurements and KPIs). The next subsection would describe the conceptual framework of this study.

4.4 Conceptual Framework for Improving the Reporting in the SAP WMS

Summing up, the components of SAP logistics processes in warehouse from SAP WMS generate large amount of data so that it could be used by various stakeholders, such as managers in a company, business partners, freight carriers, official administrations and the customers. Many times, stakeholders in the companies find it difficult to generate conclusions only on the basis of available data. Thus, good reporting from SAP WMS has to be in place in the company. The reporting from SAP WMS should cleverly incorporate measurements in ideally in the form of KPIs. The reporting should be done with tools which has content for logistics KPIs to help in the assessment of warehouse performance, operational logistics efficiency, quality of service offered by the third party logistics and warehousing providers etc. This summarized the content in brief, that was discussed earlier in this section.

Earlier in this study, several challenges were identified in the current state analysis of with the use of SAP WMS reporting by the case company. Out of those, reporting related challenges were selected as the most urgent issues to be investigated further in detail. The two main questions that came out from the challenges in SAP WMS reporting in the case company relevant to this section are: a) “WHAT” KPIs the management want to include in the reports from SAP WMS (which are currently missing), b) “HOW” KPIs should be measured, indicating the exact tools the to be used to produce the correct measurements as part of the reports for the managers. These questions formed the basis for a more detailed investigation of the existing knowledge and KPIs available in multiple business and academic literature.

As a result of this investigation, the findings related to SAP WMS reporting were identified in relation to “WHAT” KPIs the reports from SAP WMS should display, along with

literature for “HOW” to measure the KPIs, indicating the exact tools the to be used to produce the correct measurements from SAP WMS reports for the managers. These are summarized in Table 13 below.

Table 13. Conceptual Framework of this Study.

Processes with weaknesses in reporting found in CSA	KPI advice from literature	SAP WMS Reporting Tool advice from Literature	References
Goods Receipt with Label printing(Inbound)	Receiving time Dock to Stock time	SAP WMS as part of ERP system Logistics Information System and SAP NetWeaver Business Warehouse with SAP Business Objects	(Gu, et al., 2007, p. 4); (Subramanya, et al., 2012, p. 16); (Kappauf, et al., 2012); (Berg, 2010)
Goods Movements	Put away time Order picking time Order lead time Picking productivity Shipping productivity	SAP WMS as part of ERP system Logistics Information System and SAP NetWeaver Business Warehouse with SAP Business Objects	(Koster & Tho Le-Duc, 2007, p. 483); (Staudt, et al., 2015, p. 5532); (Yang, 2000, p. 162); (Subramanya, et al., 2012, p. 16); (Kiefer & Novack, 1999, p. 23); (Kappauf, et al., 2012); (SAP AG, 2005)
Inventory Counting	Physical Inventory accuracy Storage accuracy Inventory Space utilization, Inventory Cost, Hit/Miss Accuracy, Gross Adjustments-Rate	1.SAP WMS as part of ERP system, 2.Logistics Information System and 3.SAP NetWeaver Business Warehouse with SAP Business Objects	(Kiefer & Novack, 1999, p. 23); (Subramanya, et al., 2012, p. 16); (WERC, 2008);(Staudt, et al., 2015, p. 5534-5535);(DashBoardZone, 2017); (Kappauf, et al., 2012); (Stokinger, 2017)
Goods Returns	Scrap rate, Stock out rate, Cargo damage rate, Rate of return	SAP WMS as part of ERP system, Logistics Information Systems and SAP NetWeaver Business Warehouse with SAP Business Objects	(Staudt, et al., 2015, p. 5534-5535);(Kiefer & Novack, 1999, p. 23);(Legacy Supply Chain Services, 2017); (Kappauf, et al., 2012)
Goods Issue (Outbound)	On-time delivery, Throughput, Outbound space utilization, Warehouse Order Cycle Time, Shipping Accuracy, Delivery Accuracy	SAP WMS as part of ERP system, Logistics Information Systems and SAP NetWeaver Business Warehouse with SAP Business Objects	(Staudt, et al., 2015, p. 5534);(Johnson, et al., 2010, p. 228);(Frazelle, 2002, p. 55);(De Koster & Balk, 2008, p. 183); (WERC, 2008);(Kiefer & Novack, 1999, p. 23); (Kappauf, et al., 2012); (Stechies.com, 2008); (Kiefer & Novack, 1999, p. 23); (De Koster & Warffemius, 2005, p. 767)

As shown in Table 13 above, in this framework, *I. Processes with reporting weaknesses found in CSA* includes all the processes which are currently in use in SAP WMS and possess a general lack of reporting utilization. Next, *II. KPI advice from literature* takes into account the best practices from business while generating the measurements in different reports from the SAP WMS. Next, *III. SAP WMS Reporting Tool Advice from Literature* points to "HOW" aspect telling about the tools that could be used by the managers in reporting from SAP WMS and indicating needed KPIs or measurements. Finally, *References* point to the origin of the selected best practice and tool information in different sources from academic and business literature.

This subsection laid the firm foundation for this study by describing the conceptual framework. It would help in for improving the reporting from SAP WMS for the selected processes with reporting weaknesses identified in the current state analysis.

The initial proposal for the study is discussed in the next section.

5 Building Proposal for the Case Company

This section builds the initial proposal for improving the use of SAP WMS reporting practices in the case company. It merges the results of the current state analysis and the conceptual framework towards the building of the proposal. The section ends by generating a proposed draft of the study.

5.1 Overview of the Initial Proposal Stage

In this study, the proposal is built by linking the areas for improvements identified in CSA stage (Section 3) with the knowledge gained from KPIs and tools as part of the conceptual framework (Section 4) expanded with the stakeholder suggestions from Data 2(here, Section 5) for improving the use of SAP WMS reporting practices. The stakeholder suggestions (Data 2) are collected by carefully interviewing the involved stakeholders in this initial proposal building stage. The steps in the proposal building can be described as follows.

First, the reporting challenges related to SAP WMS reporting functionality for five different processes identified in the CSA stage (Section 3) are reviewed. The current state analysis additionally included several other weaknesses in warehousing practices. Out of those, the selected SAP WMS reporting challenges mainly included two points. First, there is a need to identify the reports which the management requires from SAP WMS since those are missing at the moment in the case company. Second, the managers need to know the ways to be able to generate the correct reports needed by the managers.

Second, the same questions mentioned above formed the basis of detailed literature search in terms of the existing knowledge and best practice for SAP WMS reporting. This resulted in a list of specified warehouse management KPIs and the needed tools to be able to improve the current reporting from the SAP WMS. This was done in Section 4.

Third, for generating the stakeholder suggestions and collecting the detailed reporting requirements (Data 2), several stakeholders were interviewed within the case company. These included senior management personnel like Directors from spare parts business to Logistics Managers to day-to-day warehouse Delivery Planners. The reporting requirements were gathered and resulted in the list of needed reports (summarized in Appendix 5).

Fourth, three specific tools would be checked (here, Section 5) in order to produce reports from the current SAP WMS system in the case company. This is done by collaborating with a panel of SAP experts. This includes, a) Running several tests on SAP WMS system as part of SAP ERP to identify the missing entities in reports and check if any reports could be generated without any enhancements, b) Understanding the standard analysis provided by Logistics Information System (LIS) in SAP ERP system for Warehousing Management (WM) reports, c) Understanding the capabilities of SAP BW with SAP BO for generating the same reports.

Last, the costs, time and risk factors of implementation from different tools are compared in order to form an informed opinion for creating the proposed draft.

The next subsection would describe the detailed reporting requirements and stakeholder suggestions.

5.2 SAP WMS Reporting Requirements (Data 2)

The challenges in reporting in warehousing operations (Data 2) were gathered during the interviews in the case company. The interviews additionally helped to gather needed improvements and suggestions in order to improve reporting from the SAP WMS. Hence, the reporting related requirements are divided into two main categories mentioned as follows.

A. SAP WMS Reporting requirements (gathered in Data 2 collection)

The ideas for the SAP WMS reporting requirements are divided in relation to the five processes (with challenges in reporting, as identified in CSA). Next, the KPIs suggested from literature review are discussed to check if they meet the requirements for the KPIs expected from stakeholders (as subset of all KPIs identified in Conceptual Framework). Further, a description of reporting need is mentioned as collected from Data 2. Last, the rationale for the needed report is understood. These requirements and suggestions from the stakeholder are gathered in Table 14 below.

Table 14. Data 2, Stakeholders requirements and inputs for proposal building (Processes 1-5).

Process which lacks reports from SAP WMS(based on CSA)	**List of KPI (from literature, CF)**	**List of KPI needed by the stakeholders (Data 2)**	**Description of WHERE the report is needed (based on CSA, Data 1 + Data 2)**	**Suggestions /Rationale from key stakeholders (Data 2)**
1.Goods Receipt with Label printing	1.Receiving Time 2.Dock to Stock Time	1.- 2.Dock to Stock Relevant for all three stakeholders: Global Transportation and warehouse Manager Logistics Manager Director, Market Unit/Spare &Wear Parts	A. A report is needed to show the connection between supplier way bill number and internal PO number and timestamp (date and time) of goods arrived.	We need a report for indicating timestamps for goods arrived to the warehouse. A weekly and monthly report would act as a tool for measuring the efficiency of the external warehouses. It could be used as one basis for the warehouse operational costs.
			B. A report is needed for ICA (Inter Company Automation) goods receipt to the warehouse to show the timestamp (date and time) of goods arrived.	It could be used as one basis for the warehouse operational costs. A weekly and monthly report would act as a tool for measuring the efficiency of the external warehouses.
			C. A report to show overall goods received to the warehouse as inbound deliveries. The report should show date and time (timestamps) of goods arrival, number of inbound delivery lines, number of items per delivery lines, weight and size of individual items.	The received inbound delivery line acts as rate basis for charging the case company by the Logistics Service Provider (LSP) handling the warehouse. This is the most important monthly report.

Process which lacks reports from SAP WMS(based on CSA)	List of KPI (from literature, CF)	List of KPI needed by the stakeholders (Data 2)	Description of WHERE the report is needed (based on CSA, Data 1 + Data 2)	Suggestions /Rationale from key stakeholders (Data 2)
2.Goods movements within the warehouse	1. Put away time 2. Order Picking Time 3. Order Lead Time 4. Picking Productivity 5. Shipping Productivity	1. Put away time 2. - 3. - 4. - 5. - relevant for: Global Transportation and warehouse Manager Logistics Manager	A, B. A report to show the date and time of placement of goods in shelves (timestamps)	It could be used as basis for the warehouse operational costs. A weekly and monthly report is needed to act as a tool for measuring the efficiency of externally operated warehouse.
3. Inventory Counting	1.Physical inventory accuracy 2.Storage accuracy 3.Inventory Space utilization 4.Inventory Cost 5.Hit/Miss Accuracy 6.Gross Adjustments rate	1.Physical inventory accuracy 2.Storage accuracy 3. Inventory Space utilization 4.Inventory Cost 5.- 6.- relevant for: Logistics Manager	A. A report to show the differences between WM and IM for comparing the items from the previous year	This annual report could act as a possible tool for finding problematic items causing inventory discrepancies on a regular basis which could be used for root cause analysis.

Process which lacks reports from SAP WMS(based on CSA)	List of KPI (from literature, CF)	List of KPI needed by the stakeholders (Data 2)	Description of WHERE the report is needed (based on CSA, Data 1 + Data 2)	Suggestions /Rationale from key stakeholders (Data 2)
4.Goods Returns	1.Scrap rate 2.Stock out rate 3.Cargo damage rate 4.Rate of Return	1.- 2.Stock out rate 3.- 4.Rate of Return relevant for: Logistics Manager	A. A report indicating goods received as returns to the warehouse showing the items, date and time of receipt.	This monthly report is needed so that returned inbound delivery lines acts as rate basis for charging the case company by the Logistics Service Provider (LSP) handling the warehouse.
5.Goods Issue	1.On time delivery 2.Throughput 3.Outbound space utilization 4.Warehouse Order cycle time 5.Shipping Accuracy 6.Delivery Accuracy	1.On time delivery 2.- 3.Outbound space utilization 4.- 5.- 6.- relevant for: A. Global Transportation and warehouse Manager B. Director, Market Unit/Spare& Wear Parts	A. A report indicating outbound activity from the warehouse showing timestamp of delivery creation, goods issue and actual time when picking is done. B. A report indicating date and time of goods shipped (outbound timestamps), number of delivery lines, items per delivery line, weight and size of individual items.	This monthly report can act an important, KPI for outsourced warehouse, currently done manually (could include even more steps between picking request creation and goods issue). This monthly report is very important since in the future the intention is to use number of shipped outbound delivery lines as rate basis for charging the case company by the third party logistics service provider handling the warehouse.

B. Miscellaneous requirements gathered in addition to five main processes needed in the warehouse to support SAP WMS reporting

In addition to the requirements mentioned in Table 14, certain facts were mentioned several times which could support reporting practices from the warehouse.

First, there is a genuine lack of proper processes for warehouse reporting at the organization level. There are no clear personnel earmarked to be held responsible for accurate reports from SAP WMS. This includes both at managerial level and from the IT (in terms of SAP WMS expertise). This is evident from the statement below, stating the lack of proper processes for warehouse reporting.

> *"Basically our warehouse has processes in place, but there is no way to monitor it. To me in our warehousing process, the guidelines are in place, but there are no systematic points. Reporting from SAP WMS could help us and the service provider with all the data that is needed." (Director, Market Unit/Spare& Wear Parts)*

Second, there is no barcode scanner integration with the SAP WMS in the warehouse and it causes the following problems: a) High amount of human error due to manually entered incorrect data than that of barcodes. b) Entering data by hand is slow as compared to using barcode scans which are fast and reliable, due to the fact that the information is scanned directly into a computer, instantaneously. c) Third party warehouse employees need be familiar with the entire inventory. This is evident from the statement below, stating the importance of barcode scanners.

> *"Barcode implementation is currently on hold. For a professional warehouse, it is necessary to scan exactly at the place where people are standing. This would help us and the warehouse service provider. I would say that we would save quite a lot of money as well with the fees of the outsourced warehouse if we had the key systems doing things automatically."(Director, Market Unit/Spare& Wear Parts)*

Third, the master data is of very poor quality and has been incorrectly updated. There is lack of proper master data in terms of size and weight of spare parts. Further, the available master data is incorrect so that the configuration of bins is done according to weight and not exact dimensions.

> *"Master data is of low quality and there is lack of it in terms of size, weight of spare parts would genuinely help SAP WMS system. We need, some application improvements, for SAP, master data is clearly number one. Incorrect master data causes more problems than any benefits" (Delivery Planner)*

Fourth, there is a clear lack of knowledge and training as to properly use SAP WMS and not only its reporting feature. The trainings that were provided several years ago

are inadequate in today's business scenario. Additionally, many people who knew the system well have gradually left the organization. This is evident from the statement below, stating the lack of proper training.

> *"We need practical training in SAP WMS. The last time we had a two week long training was in May 2015 by the external SAP WMS provider. Since then, there have been some small updates" (Warehouse Supervisor)*

Fifth, there are multiple tools being used for warehouse reporting in addition to the SAP WMS. This includes the Jakomo tool for reporting damaged items at the warehouse, followed by SAP Business Explorer (a part of SAP Business Information Warehouse) used as a reporting tool for on-time deliveries for end customers. It would be good to remove multiple tools to be replaced by one single tool to do all the reporting. This was evident from the statement below, stating that data needs to be picked from too many systems and still all the facts are not available at the same time.

> *"I often wonder if we could use one tool for the entire reporting. Currently the Jakomo system provides us with data relating to damaged goods at the warehouse but other reports are missing which are then taken either from other places. If SAP WMS could really provide all the functional reports coming out of the warehouse, it could really simplify things for myself for monitoring of the warehouse function."(Logistics Manager, Manager Global Transportation Management)*

Therefore, the suggestions for improvements would be made would clearly require two main elements, a) Evaluating the tools for producing the reports (for each of the processes that lack reporting), b) Recommendations to the Case Company for implementing the proposed tool improvements to aid SAP WMS Reporting based on miscellaneous requirements mentioned here. The current section (Section 5) of this study would only focus on the tool checking part for reporting while the recommendations would be a part in the next section (Section 6) of the study.

This completes the SAP WMS reporting requirements. In the next subsection, the tools are evaluated for the report generation from SAP WMS is done.

5.3 Evaluating the Tools for Producing Reports from SAP WMS

Three tools were mentioned for producing the reports from SAP WMS as part of Conceptual framework (Section 4). In this subsection, the capabilities of each of the individual tools for report generation are evaluated and described as follows:

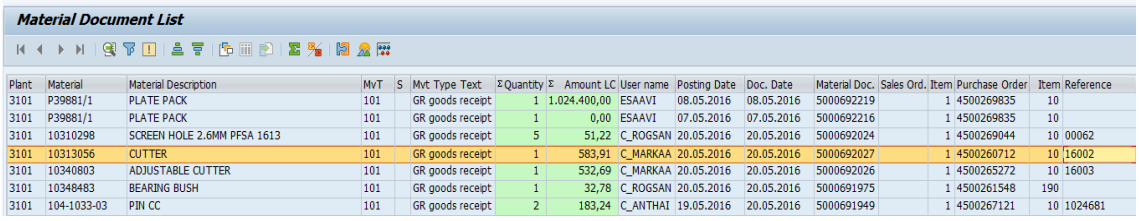
Tool 1: SAP WMS as part of SAP ERP system

The capabilities of SAP WMS as part of SAP ERP system were evaluated by testing the reports that could be generated. For testing, eight “Functional Testing” scripts were created corresponding to reporting requirements for five main processes. These processes are needed in the warehouse using SAP WMS used for reporting. The first three test scripts related to Process1, Goods Receipt with Label printing is shown in shown in Table 15, Table *16 and* Table *17* below.

Table 15. Test Script for generating WMS Report for Process 1, Report A (from Table 14).

Test Script for WMS Report related to Process 1, Report A	
1. Name of the Process	*Goods Receipt with Label printing*
2. Description of the Report	A report is needed to show the connection between supplier way bill number and internal PO number and timestamp (date and time) of goods arrived.
3. Frequency	Weekly and Monthly
4. Needed Fields	Supplier Way bill number
	Internal PO Number
	Date and Time of Goods Arrival (Timestamps)
5. KPI provided	Dock to Stock
6. Steps to generate this report from SAP ERP System	-Login to the SAP system -Go to transaction MB51. -Enter plant, storage location, movement type is 101. -Under header data, enter the start date and end date. -Press Execute

As shown in Table 15 above, the steps were executed to receive the result. The snapshot of the result is as shown in Figure 17 below.



Material Document List

Plant	Material	Material Description	MvT	S	Mvt Type Text	Quantity	Amount LC	User name	Posting Date	Doc. Date	Material Doc.	Sales Ord.	Item	Purchase Order	Item	Reference
3101	P39881/1	PLATE PACK	101		GR goods receipt	1	1.024.400,00	ESAAVI	08.05.2016	08.05.2016	5000692219		1	4500269835	10	
3101	P39881/1	PLATE PACK	101		GR goods receipt	1	0,00	ESAAVI	07.05.2016	07.05.2016	5000692216		1	4500269835	10	
3101	10310298	SCREEN HOLE 2.6MM PFSA 1613	101		GR goods receipt	5	51,22	C_ROGSAN	20.05.2016	20.05.2016	5000692024		1	4500269044	10	00062
3101	10313056	CUTTER	101		GR goods receipt	1	583,91	C_MARKAA	20.05.2016	20.05.2016	5000692027		1	4500260712	10	16002
3101	10340803	ADJUSTABLE CUTTER	101		GR goods receipt	1	532,69	C_MARKAA	20.05.2016	20.05.2016	5000692026		1	4500265272	10	16003
3101	10348483	BEARING BUSH	101		GR goods receipt	1	32,78	C_ROGSAN	20.05.2016	20.05.2016	5000691975		1	4500261548	190	
3101	104-1033-03	PIN CC	101		GR goods receipt	2	183,24	C_ANTHAI	19.05.2016	20.05.2016	5000691949		1	4500267121	10	1024681

Figure 17. Resulting report with no timestamps for Process 1, Report A (from Table 14).

As shown in Figure 17 above, the test steps executed earlier, result in a report which is able to show the posting date but there is no data related to time available at the moment. The posting time could be shown if there was input data available due to enhancements in the SAP WMS in the form of integration with barcode scanners. Hence, it can be said that this report is generated partially.

Table 16. Test Script for generating WMS Report for Process 1, Report B (from Table 14).

Test Script for WMS Report for Process 1, Report B	
1. Name of the Process	*Goods Receipt with Label printing*
2. Description of the Report	A report is needed for ICA (Inter Company Automation) goods receipt to the warehouse to show the timestamp (date and time) of goods arrived.
3. Frequency	Weekly and Monthly
4. Needed Fields	Date and Time of Goods Arrival (Timestamps)
5. KPI provided	Dock to Stock
6. Steps to generate this report from SAP ERP System	-Login to the SAP system -Go to transaction MB51. -Enter plant, storage location, movement type is 101. -Under header data, enter the start date and end date. -Press Execute

As shown in Table 16 above, the steps were executed to receive the result. The snapshot of the result is shown in Figure 18 below.

Material Document List

Plant	Material	Material Description	MvT	S	Mvt Type Text	Σ Quantity	Σ Amount LC	User name	Posting Date	Doc. Date	Material Doc.	Sales Ord.	Item	Purchase Order	Item
7NL0	F623103	CONNECTING LINK FP1516 NON FILTRATE SIDE	101		GR goods receipt	1	61,36	C_CARTHI	20.05.2016	20.05.2016	5000692093		1	4500260188	10
7NL0	F669099/2	CYLINDER COMPLETE	101		GR goods receipt	2	480,31	C_CARTHI	20.05.2016	20.05.2016	5000691963		1	4500263446	10
7NL0	H1113521	SUPPORTING PIPE	101		GR goods receipt	217	3.101,01	C_CARTHI	20.05.2016	20.05.2016	5000691965		1	4500260359	10
7NL0	H1244888	BUSHING	101		GR goods receipt	100	3.175,64	C_CARTHI	20.05.2016	20.05.2016	5000691965		2	4500260359	20
7NL0	H1347582	BUSHING	101		GR goods receipt	100	3.892,72	C_CARTHI	20.05.2016	20.05.2016	5000691965		3	4500260359	30
7NL0	H1519784	BALL VALVE AND ACTUATOR	101		GR goods receipt	2	2.026,26	C_CARTHI	20.05.2016	20.05.2016	5000691960		1	4500265725	10
7NL0	H1903095	NOZZLE Ø1,65 MM, 1.4571,	101		GR goods receipt	5	81,95	C_CARTHI	20.05.2016	20.05.2016	5000692094		1	4500264411	10
7NL0	H2533842	DEFLECTION PLATE DS 2400/1200	101		GR goods receipt	100	932,20	C_CARTHI	20.05.2016	20.05.2016	5000691953		1	4500265859	10
7NL0	H8078	WASHER ø12/6x1,5 EHSN 53606/63409 ST	101		GR goods receipt	498	459,14	C_CARTHI	20.05.2016	20.05.2016	5000691955		1	4500264428	10

Figure 18. Resulting report with no timestamps for Process 1, Report B (from Table 14).

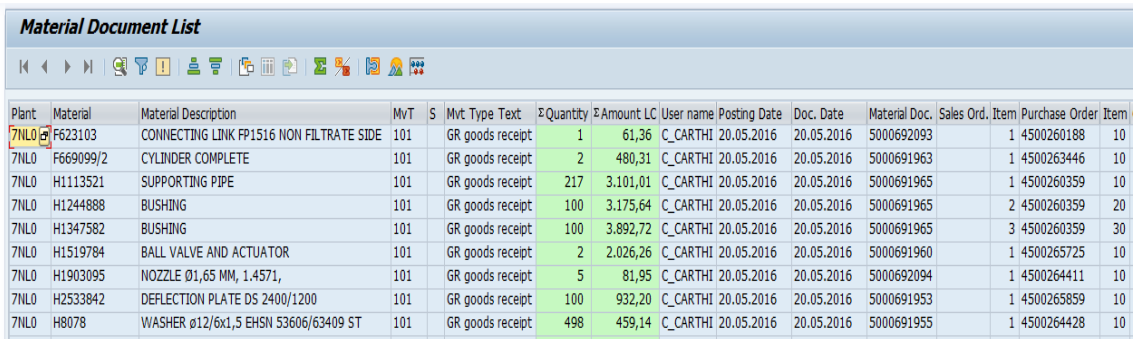
As shown in Figure 18 above, the test steps executed earlier result in a report which is able to show the posting date but there is no data related to time available at the moment. The posting time could be shown if there was input data available due to enhancements in the SAP WMS in the form of integration with barcode scanners. Hence, it can be said that this report is generated partially.

Table 17. Test Script for generating WMS Report for Process 1, Report C (from Table 14).

Test Script for WMS Report for Process 1, Report C	
1. Name of the Process	*Goods Receipt with Label printing*
2. Description of the Report	A report to show overall goods received to the warehouse as inbound deliveries. The report should show date and time (timestamps) of goods arrival, number of inbound delivery lines, number of items per delivery lines, weight and size of individual items.

Test Script for WMS Report for Process 1, Report C	
3. Frequency	Monthly
4. Needed Fields	Date and Time of Goods Arrival (Timestamps)
	Inbound Delivery Lines
	Items per Delivery Lines
	Weight and Size of Individual Items
5. KPI provided	Dock to Stock
6. Steps to generate this report from SAP ERP System	-Login to the SAP system -Go to transaction MB51. -Enter plant, storage location, movement type is 101. -Under header data, enter the start date and end date. -Press Execute

As shown in Table 17 above, the steps were executed to receive the result. The snapshot of the result is shown in Figure 19 below.



Material Document List

Plant	Material	Material Description	MvT	S	Mvt Type Text	Quantity	Amount LC	User name	Posting Date	Doc. Date	Material Doc.	Sales Ord.	Item	Purchase Order	Item
7NL0	F623103	CONNECTING LINK FP1516 NON FILTRATE SIDE	101		GR goods receipt	1	61,36	C_CARTHI	20.05.2016	20.05.2016	5000692093		1	4500260188	10
7NL0	F669099/2	CYLINDER COMPLETE	101		GR goods receipt	2	480,31	C_CARTHI	20.05.2016	20.05.2016	5000691963		1	4500263446	10
7NL0	H1113521	SUPPORTING PIPE	101		GR goods receipt	217	3.101,01	C_CARTHI	20.05.2016	20.05.2016	5000691965		1	4500260359	10
7NL0	H1244888	BUSHING	101		GR goods receipt	100	3.175,64	C_CARTHI	20.05.2016	20.05.2016	5000691965		2	4500260359	20
7NL0	H1347582	BUSHING	101		GR goods receipt	100	3.892,72	C_CARTHI	20.05.2016	20.05.2016	5000691965		3	4500260359	30
7NL0	H1519784	BALL VALVE AND ACTUATOR	101		GR goods receipt	2	2.026,26	C_CARTHI	20.05.2016	20.05.2016	5000691960		1	4500265725	10
7NL0	H1903095	NOZZLE Ø1,65 MM, 1.4571,	101		GR goods receipt	5	81,95	C_CARTHI	20.05.2016	20.05.2016	5000692094		1	4500264411	10
7NL0	H2533842	DEFLECTION PLATE DS 2400/1200	101		GR goods receipt	100	932,20	C_CARTHI	20.05.2016	20.05.2016	5000691953		1	4500265859	10
7NL0	H8078	WASHER ø12/6x1,5 EHSN 53606/63409 ST	101		GR goods receipt	498	459,14	C_CARTHI	20.05.2016	20.05.2016	5000691955		1	4500264428	10

Figure 19. Resulting report with no timestamps for Process 1, Report C (from Table 14).

As shown in Figure 19 above, the test steps executed earlier result in a report which is able to show number of inbound delivery lines and number of items received per item line. The posting date is shown as well. However, there is no data related to weight, size and time available at the moment. The posting time could be shown if there was input data available due to enhancements in the SAP WMS in the form of integration with barcode scanners. Hence, it can be said that this report is generated partially.

The above descriptions showed only three test scripts for reports identified for the first process, *Goods Receipt with Label printing*. The test scripts for reports related to four other remaining processes identified in the requirements in above Table 14, are placed in the Appendix at the end of this study. For example, the test scripts for reports related to the second process, *Goods Movements within the warehouse* are placed in Appendix 6. This is followed by test scripts for reports related to the third process, *Inventory Counting* placed in Appendix 7. Next, the test scripts for reports related to fourth process, *Goods Returns* are mentioned in Appendix 8. Last, test scripts for reports related to fifth process, *Goods Issue* are mentioned in Appendix 9. Further, some additional test scripts related to reports were needed as part of CSA, but were not related to the five main

processes. Those test scripts are analyzed as part of this study and the results placed in Appendix 10.

This current subsection evaluated the reporting abilities of SAP WMS as part of SAP ERP system. From this evaluation, it is clear that enhancements are needed in terms of data and most of the reports can be generated only partially.

The next subsection would check the second tool, i.e., Logistics Information System (LIS) in SAP ERP system for Warehouse Management (WM) reports.

Tool 2: Logistics Information System (LIS) in SAP ERP system for Warehousing Management (WM)

The Logistics Information System (LIS) in SAP ERP system provides standard analysis feature. This standard analysis helps in utilizing the reports which are present in the system. Before any of the reports for standard analysis for Warehousing Management (WM) can be used, LIS should be activated in the SAP ERP system. LIS is activated by using information structures SO90 and SO91. The reports provided by LIS provides as part of standard analysis are shown in Figure 20 below.

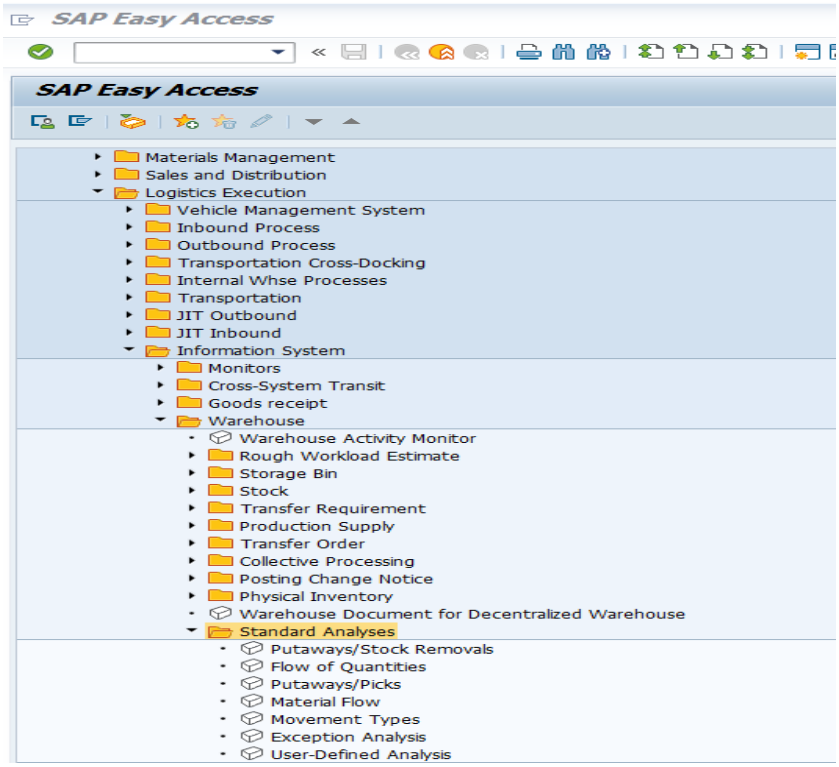


Figure 20. Logical Information Structures providing standard analysis.

As shown in Figure 20 above, there are very few standard reports available which can fully support the needed level of reporting required by the management in the case company. Hence, this tool would not be evaluated any further in the study.

The next subsection evaluates the reporting capabilities of SAP NetWeaver Business Warehouse (SAP BW) with SAP Business Objects (SAP BO).

Tool 3: SAP NetWeaver Business Warehouse with SAP Business Objects

The data from SAP WMS can be used to create needed reports by using SAP NetWeaver Business Warehouse (SAP BW) with SAP Business Objects (SAP BO) as a tool. As compared to the SAP WMS as part of ERP or LIS in SAP ERP being used for reporting, any changes made to SAP WMS system do not impact the reports. This is because the reports reside in SAP BW system and independent of SAP WMS. The quality of reports depends only on the quality of data provided by the SAP WMS. Therefore, if the reports require that data related to timestamps is displayed, then an integration with barcode scanners with SAP WMS is absolutely needed. This has to be already in place before reports could be generated from the SAP BW with SAP BO.

Further, it was clearly understood by collaborating with in-house SAP experts that the creation of reports from SAP BW with SAP BO would require the services of external consultants for the case company. And the needed reports would require implementation as a full time project. During project implementation, the in-house expertise would be used in providing requirements, project management and any other needed support.

In this study, there were challenges in setting up a SAP BW with SAP BO with SAP WMS. Therefore, real reports for all five processes, observed in the current reporting practices (as discussed in the CSA (Section 3), by using the data from the SAP WMS were not generated. However, the knowledge and experience of in-house SAP experts was used and it was concluded that all reports can be fully generated provided there is good quality data available from the SAP WMS. This would mean that data related to timestamps is already present and an integration with barcode scanners exists before reports could be generated from the SAP BW with SAP BO.

This completes the evaluation of all three different tools for report generation from SAP WMS. The summary of the previous subsections after checking all three tools is presented below in Table 18.

Table 18. Summary of Report Generation from SAP WMS by using different tools.

Processes	Needed Report/s	Using SAP WMS as part of ERP	LIS as part of SAP ERP	SAP Business Warehouse with SAP Business Objects
1. Goods Receipt with Label printing	A report which connects the supplier waybill number and the internal PO number.	Partially generated	Cannot be used	Fully generated
	A report which notes the timestamp of goods arrival, goods receipt	Partially generated	Cannot be used	Fully generated
	A report to take care of received inbound deliveries with delivery lines, items received per line along with its weight and dimensions.	Partially generated	Cannot be used	Fully generated
2. Goods movements within the warehouse	A report which tells when inbound goods are put away (placed in shelves).	Partially generated	Cannot be used	Fully generated
3. Inventory counting	A report to to show the differences between WM and IM for comparing the item from previous year.	Fully Generated	Cannot be used	Fully generated
4. Goods returns	A report indicating goods received as returns to the warehouse showing the items, date and time of received.	Partially generated	Cannot be used	Fully generated
5. Goods issues(Outbound)	A report indicating outbound activity from the warehouse showing timestamp of delivery creation, goods issue and actual time when picking is done.	Partially generated	Cannot be used	Fully generated
	A report indicating date and time of goods shipped (outbound timestamps), number of delivery lines, items per delivery line, weight and size of individual items.	Partially generated	Cannot be used	Fully generated

As shown in Table 18 above, it is clear that the features provided by standard reports in SAP ERP are suitable for only one report related to inventory counting. Other needed the reports can be only generated partially without all the needed fields due to lack of data especially while timestamps are needed. Enhancements are needed to receive the

timestamps in the form of barcode scanners integrated with SAP WMS. This would be able to provide input data to assist in reporting. An example of integration of barcode scanners with SAP WMS would be discussed later in the recommendations, subsection 6.4.

Next, standard analysis provided by SAP LIS for WM was found unsuitable for making reports since it does not support business requirements. Hence, LIS as part of SAP ERP cannot be used.

Last, it can be said that SAP WMS reporting using SAP NetWeaver Business Warehouse with Business Objects (SAP BW with SAP BO) would help in providing all the reports as needed in the case company.

In addition to the reports above, there were five additional reports needs identified in CSA. The summary of report generation from different tools for additional reports is summarized in Appendix 10.

This completes the tool evaluation for producing reports from SAP WMS ending in two out the three tools, mentioned previously in Conceptual Framework (Section 4).

The next subsection would compare the costs, implementation times and risks from the remaining two tool options for generating SAP WMS reports.

5.4 Comparison of Tools for Generation of Reports from SAP WMS

In the previous subsection, it became clear that the needed reports could be generated partially or fully from only two tools, a)SAP WMS as part of SAP ERP , b)SAP BW with SAP BO. In the current subsection, a comparison is made of several factors like cost, time of implementation etc. within those two tools to form an opinion to be presented as a draft proposal. This is presented below in Table 19.

Table 19. Comparison of several factors for tool decision.

Factor	Option 1(SAP WMS as part of SAP ERP)	Option 2 (SAP Business Warehouse with SAP Business Objects)
1.Pre-Implementation needed in place before reports	Integration with Barcode Scanners in order to receive missing data in the form of needed timestamps.	Integration with Barcode Scanners in order to receive missing data in the form of needed timestamps.

Factor	Option 1(SAP WMS as part of SAP ERP)	Option 2 (SAP Business Warehouse with SAP Business Objects)
generation can take place		
2.Total time needed for reports implementation	6 months(Approximate)	7 months(Approximate)
3.Total costs for report implementation	€115000(Approximate)	€124000(Approximate)
4.Risks	Reports are not of high quality in a visual sense, however functionally working fine. Does not make sense to enhance SAP standard reports. And there is no sense to create new user defined reports ERP system. Upgrading the SAP ERP system or SAP WMS would require migrating the user defined reports, which is cumbersome.	Reports are of high quality in a visual sense and functionally working fine. Upgrading the SAP ERP system or SAP WMS does not require migrating the user defined reports, so the setup is simple.

As shown above in Table 19 above, in order to generate reports from SAP WMS, both options, a) *Option 1 (SAP WMS as part of SAP ERP)* and b) *Option 2 (SAP Business Warehouse with SAP Business Objects)* would need an integration with Barcode Scanners in order to receive missing data in the form of needed timestamps. This is the only point of similarity between the two options.

However, there are three differences. First, the implementation time difference between *Options 1* and *Option 2* is 1 month. This initially makes *Option 1* slightly attractive than *Option 2.*

Second, the cost difference between *Options 1* and *Option 2* is less than 10% of each other, which makes both the options very comparable. This does not make *Option 1* lucrative than *Option 2* any further.

Third, while the risks are compared, with *Option 1 (SAP WMS as part of SAP ERP),* the reports not of high quality visually and as per the in-house SAP expert, it does not make sense to enhance standard SAP reports or make new user defined reports. Last, but not least, if the SAP ERP system would be upgraded, then the reports would need migrating as well, which is cumbersome if not impossible. *Option 2 (SAP Business Warehouse with SAP Business Objects)* would require that reports reside in SAP BW system and data is received from SAP WMS. So, any upgrades made to SAP WMS does not require

migration of reports from the SAP BW. Therefore, *Option 2 (SAP Business Warehouse with SAP Business Objects)* turns out to be a clear winner.

This subsection summarized the tool that could be used for report generation from SAP WMS keeping in view the pre implementation needs, differences in total implementation costs, differences in total implementation time and risks between the two tool options.

The next subsection would describe a proposal draft for the study.

5.5 Proposal Draft

Summarizing, as a result, in this draft proposal stage, first the SAP WMS Reporting Improvements and Suggestions from Interviews (Data 2) were collected. Next, the focus was to check and compare the reporting abilities of three tools identified from Conceptual Framework (for each of the five processes that lacked reporting (subsection 5.2). This was combined with comparison of total implementation time, total implementation cost, risks among the tools to find the most suitable tool for report generation from SAP WMS.

As an outcome of this comparison, SAP NetWeaver Business Warehouse (SAP BW) with SAP Business Objects (SAP BO) was found to be most suitable for implementing reports which were currently lacking from SAP WMS. This is due to two reasons. First, visual features that are provided are of higher quality than those provided by SAP WMS as part of SAP ERP. Second, due to the fact that upgrading the SAP ERP system or SAP WMS would not require migrating the user defined reports, so the setup would be fairly simple to maintain. Further, it was clarified with the in-house SAP experts that the report generation from SAP BW with SAP BO could be taken as a separate implementation project. The case company could consider using the services of using external consultants for implementation of reports. During the report implementation project, in-house expertise could be used to provide requirements, provide needed inputs and support for user acceptance testing etc.

As a result of this exploration, the findings related to SAP WMS reporting were identified in relation to “WHAT” KPIs the management are looking from reporting to be displayed, along with the tools from literature for “HOW” to do the reporting from SAP WMS in order to have all the needed KPIs reported and relevant parameters properly displayed. These are summarized in Table 20 below.

Table 20. Proposed Draft for this Study.

Processes with weaknesses in reporting (found in CSA, Data 1)	Name of report	KPI advice (developed outcome based on literature and stakeholder discussions)	SAP WMS reporting TOOL advice for implementation(developed outcome based on literature and stakeholder discussions)	Generic advice for TOOL implementation
1.Goods Receipt with Label printing (Inbound)	A. A report is needed to show the connection between supplier way bill number and internal PO number and timestamp (date and time) of goods arrived.	1.- 2.Dock to Stock time	SAP NetWeaver Business Warehouse with SAP Business Objects	1. Integration of Barcode scanners with SAP WMS, 2. High quality of master data, 3. Availability of UAT testers would reduce the costs of implementation.
	B. A report is needed for ICA (Inter Company automation) goods receipt to the warehouse to show the timestamp (date and time) of goods arrived.		SAP NetWeaver Business Warehouse with SAP Business Objects	
	C. A report to show overall goods received to the warehouse as inbound deliveries. The report should show date and time (timestamps) of goods arrival, number of inbound delivery lines, number of items per delivery lines, weight and size of individual items.		SAP NetWeaver Business Warehouse with SAP Business Objects	
2. Goods movements	A. A report to show the date and time of placement of goods in shelves(timestamps)	1. Put away time, 2.-, 3.-, 4.-, 5.-	SAP NetWeaver Business Warehouse with SAP Business Objects	-Same as above, Process 1
3. Inventory counting	A. A report to show the differences between WM and IM for comparing the items from the previous year	1.Physical Inventory accuracy, 2.Storage accuracy, 3.Inventory Space utilization, 4. Inventory Cost, 5.-6.-	SAP NetWeaver Business Warehouse with SAP Business Objects	-Same as above, Process 1
4. Goods returns	A. A report indicating goods received as returns to the warehouse showing the items, date and time of received.	1.Scrap rate, 2.Stock out rate, 3.Cargo damage rate, 4.Rate of return	SAP NetWeaver Business Warehouse with SAP Business Objects	-Same as above, Process 1
5. Goods Issue (Outbound)	A. A report indicating outbound activity from the warehouse showing timestamp of delivery creation, goods issue and actual time when picking is done.	1.On-time delivery, 2.-, 3.Outbound space utilization, 4.-, 5.-, 6.-	SAP NetWeaver Business Warehouse with SAP Business Objects	-Same as above, Process 1
	B. A report indicating date and time of goods shipped (outbound timestamps), number of delivery lines, items per delivery line, weight and size of individual items.			

As shown in Table 20 above, in this proposal draft, *I. Processes with reporting weaknesses in reporting (found in CSA, Data 1)* includes the processes currently in use in SAP WMS and possess a general lack of reporting utilization. Next, *II. Name of the Report* tells the exact name of the report which would be needed. This is done to make sure that there is higher level of reporting from SAP WMS in the case company. Further, *III. KPI Advice* takes into account the required KPIs as a merger from KPIs found in literature review (Section 4) and stakeholder discussions (Data 2) while generating different reports from the SAP WMS. This would support in answering to "WHAT KPIs" the management from different department want to be reported within the reports that are currently missing. Next, *IV. SAP WMS Reporting Tool Advice for Implementation* points to "HOW" aspect telling about the tool that could be used in order to do the reporting from SAP WMS indicating the needed KPIs as needed by managers in the case company. Finally, *Generic advice for TOOL implementation* points to selected suggestions based on knowledge gained from different academic and business literature dealing with IT implementation.

This completes the initial proposal section. Next, this proposal would be presented to the key stakeholders in the case company for receiving their reviews and feedback collection before the final proposal is created for the study in the next section.

6 Validation of the Proposal

This section presents the proposal validation for improving the current reporting and recommendations to aid reporting using SAP WMS in the case company.

6.1 Overview of the Final Proposal Stage

The initial proposal for improving the current reporting practices using SAP WMS was described in the previous section of the study. In a nutshell, it suggested that SAP NetWeaver Business Warehouse (SAP BW) with SAP Business Objects (SAP BO) would be the ideal tool for generating reports from the SAP WMS. In order to validate this initial proposal, it was presented and review with the key stakeholders in the case company. As a result, the feedback was received from the stakeholders by having discussions and interviews. In the discussion part, the proposal was presented followed by interview questions to gather the feedback. All discussions were held in the Espoo office. This formed the needed Data 3 for the study.

The feedback was collected from four key stakeholders. First, stakeholder was the Delivery Planner who works at the warehouse and regularly uses SAP WMS. Second, stakeholder was the Director, Technical Markets Unit, Spare and Wear Parts. Third, stakeholder was the Logistics Manager. Fourth, stakeholder was the Manager Global Transportation Management. As, a result, the feedback received from the discussions for the initial proposal was utilized for creating the final proposal for the study. The data 3 findings are discussed in the following subsection.

6.2 Findings of Data Collection 3

The initial proposal was presented to the relevant key stakeholders by walking through the proposal for generating reports from the SAP WMS. The detailed feedback is placed in Appendix 11 of this study. Further, it can be summarized as mentioned below in Table 21.

Table 21. Summary of Feedback received for Initial Proposal

Summary of Data 3		
Stakeholders: 1. Delivery Planner 2. Director, Technical Markets Unit, Spare and Wear Parts 3. Logistics Manager 4. Manager Global Transportation Management	Overall feedback regarding the proposal	"I think your suggestions are very good!" "I think this is simple enough. It does have all the ones you have listed, the main reports that we need. Additionally, that can come as our source of KPIs. I think those are good" "I am happy that all needed reports are listed." "It is good that we have now a list of expectations and requirements for the reports."
	Improvement ideas	"None" "None, you have covered all are areas." "None" "None"
	Next Steps	"I do not have any suggestions for those" "I think it is really clear from the proposal on which solution I would take, which is the one slightly more expensive. I would just get the budget and start doing it." "None" "None"
	Other comments	"None" "To keep it simple, as said, the ones you had listed are the ones we need, since sometimes we do not get the budget, we do not get to go forward. I think it is already the deck that the operations and logistics managers can use and monitor the situation" "None" "None"

In general, the initial proposal was well received and overall feedback was very positive.

As shown above in Table 21, no improvements were needed to the initial proposal.

The fact that reporting needs are clearly documented was considered a positive step.

> *"It is good that we have now a list of expectations and requirements for the reports."(Manager Global Transportation Management) &*
> *"I am happy that all needed reports are listed."(Logistics Manager)*

The pre implementation part of the proposal regarding barcode scanner was taken very well.

> *"I am a big fan of barcode topic, talking about it. That has been a talk for two years. That for me is a right way to go, to get proper timestamps instead of somebody doing the work first at the warehouse and then doing all the timestamps when he or she goes back to the computer."(Director, Market Unit/Spare& Wear Parts)*

The use of KPIs to monitor the third party warehouse was found interesting. Next, regarding the use of KPIs and number of reports was found to be good to be retained in the proposal.

> *"I think this proposal has all the main reports that we need. Additionally, that can come as our source of KPIs. I think those are good."(Director, Market Unit/Spare& Wear Parts)*

Utilizing SAP NetWeaver Business Warehouse with SAP BO was accepted choice of the tool for report implementation from the SAP WMS despite the costs to be incurred.

> *"I think it is really clear from the proposal on which solution I would take, which is the one slightly more expensive. So, if we manage with that amount of money, I think that we are able to save many headcounts if we have that information properly from the system."(Director, Market Unit/Spare& Wear Parts)*

In terms of benefits and next steps, for the proposal, there was clear optimism to start the implementation.

> *"With this proposed way of reporting from SAP WMS, it can help to demand a better contract from our outsourced warehouse, when we are able to monitor them and they are able to trust the information from the system. I would just get the budget and start doing it."(Director, Market Unit/Spare& Wear Parts)*

This completes the findings from Data 3. The final proposal would be mentioned in the next subsection.

6.3 Summary of Final Proposal

The key stakeholders validated the initial proposal without any changes to the initial proposal and approved of it. Hence, the final proposal simply repeats the initial proposal. It is shown in Table 22 below.

Table 22. Final Proposal for this Study.

Processes with weaknesses in reporting (found in CSA, Data 1)	Name of report	KPI advice (developed outcome based on literature and stakeholder discussions)	SAP WMS reporting TOOL advice for implementation(developed outcome based on literature and stakeholder discussions)	Generic advice for TOOL implementation
1.Goods Receipt with Label printing (Inbound)	A. A report is needed to show the connection between supplier way bill number and internal PO number and timestamp (date and time) of goods arrived.	1.- 2.Dock to Stock time	SAP NetWeaver Business Warehouse with SAP Business Objects	1. Integration of Barcode scanners with SAP WMS, 2. High quality of master data, 3. Availability of UAT testers would reduce the costs of implementation.
	B. A report is needed for ICA (Inter Company automation) goods receipt to the warehouse to show the timestamp (date and time) of goods arrived.		SAP NetWeaver Business Warehouse with SAP Business Objects	
	C. A report to show overall goods received to the warehouse as inbound deliveries. The report should show date and time (timestamps) of goods arrival, number of inbound delivery lines, number of items per delivery lines, weight and size of individual items.		SAP NetWeaver Business Warehouse with SAP Business Objects	
2. Goods Movements	A. A report to show the date and time of placement of goods in shelves(timestamps)	1. Put away time, 2.-, 3.-, 4.-, 5.-	SAP NetWeaver Business Warehouse with SAP Business Objects	-Same as above, Process 1
3. Inventory Counting	A. A report to show the differences between WM and IM for comparing the items from the previous year	1.Physical Inventory accuracy, 2.Storage accuracy, 3.Inventory Space utilization, 4. Inventory Cost, 5.-6.-	SAP NetWeaver Business Warehouse with SAP Business Objects	-Same as above, Process 1
4. Goods Returns	A. A report indicating goods received as returns to the warehouse showing the items, date and time of received.	1.Scrap rate, 2.Stock out rate, 3.Cargo damage rate, 4.Rate of return	SAP NetWeaver Business Warehouse with SAP Business Objects	-Same as above, Process 1
5. Goods Issue (Outbound)	A. A report indicating outbound activity from the warehouse showing timestamp of delivery creation, goods issue and actual time when picking is done.	1.On-time delivery, 2.-, 3.Outbound space utilization, 4.-, 5.-, 6.-	SAP NetWeaver Business Warehouse with SAP Business Objects	-Same as above, Process 1
	B. A report indicating date and time of goods shipped (outbound timestamps), number of delivery lines, items per delivery line, weight and size of individual items.			

As shown in Table 22 above, in the final proposal, *I. Processes with reporting weaknesses in reporting and II. Name of the Report (found in CSA, Data 1)* support in answering to "WHAT" the stakeholders from different department want to be reported from SAP WMS (which is currently missing). Next, *III. KPI Advice* takes into account the findings from literature review (found in Conceptual Framework) and stakeholder discussions while generating different reports from the SAP WMS. Next, *IV. SAP WMS Reporting Tool Advice for Implementation* points to "HOW" aspect telling about the tool that should be used in order to do the reporting to be able to show the KPIs. Finally, *Generic advice for TOOL implementation* points to basic guidelines for reports implementation for the case company for IT implementation.

This completes the final proposal. A further refinement of the proposal, on a higher level would call for an implementation project. The implementation plan for the same is mentioned in the next subsection.

6.4 Implementation Plan

This study proposed that reports from SAP WMS are to be created using SAP NetWeaver Business Warehouse (SAP BW) with SAP Business Objects (SAP BO). Ideally, this implementation should happen after bar code scanner integration with SAP WMS. The report implementation would ideally require the services of external consultants as a full time project. In order to bring better results for the case company, an "implementation plan" for the same is discussed below in Table 23.

Table 23. Implementation Plan for Report Generation from SAP WMS.

Implementation Plan					
Time frame	1 month	1 month	1 month	6 months	0.5 month
Task	Overall Project Planning	Barcode scanner integration for the products at the warehouse including testing to SAP WMS.	External Consultant/Vendor Evaluation	Report Generation	User Acceptance Testing
Resource	In-house Process Owner(Reporting), Head of Reporting	In-house or third party Warehouse Operator, In-house IT Maintenance, In-house process owner (Reporting)	In-house Process Owner(Reporting), Head of Reporting	External Consultants	In-house User Acceptance Testing team, In-house process owner(Reporting)

As shown above in Table 23, the total implementation time is 9.5 months. Each step is assigned to dedicated resources and allocated a time frame. In order to build reports

from SAP WMS which are needed by the management, the implementation plan is divided into five steps. First, a high level project plan would be built within a month by in-house process owner (reporting) along with the head of reporting. Second, barcode scanner integration including testing the connectivity to SAP WMS is needed and be completed in one month. This step would be done mainly by in-house or third party warehouse operator, IT maintenance and by in-house process owner (reporting). Third, supplier evaluation needs to be done in one month time. This would require that different suppliers would be sent request for quotations (in terms of price and time for creation of needed reports). This step would be done within a month by in-house process owner (reporting) along with the head of reporting. Fourth, reports would be implemented by external consultants in six months. As the final step, the reports would be tested within two weeks by in-house user acceptance team and in-house process owner (reporting).

This completes the implementation plan for the study. The next subsection discusses all the recommendations made through this study needed in the case company in order to aid reporting from the SAP WMS.

6.5 Recommendations to the Case Company

Based on miscellaneous requirements presented in subsection 5.2, part B., here are five recommendations (in the order of priority) needed in the case company. These are need in order to improve the reporting practices while ensuring better reporting from the SAP WMS.

Recommendation 1. Create a process for warehouse reporting from SAP WMS

At the moment in the case company, there is no process for warehouse reporting. This causes a lot of problems since no resources can be clearly identified in terms of roles and responsibilities. The process when created, would comprise of four personnel. First. Warehouse Operator who would act as an information provider. Second, an IT Maintenance person who would help to maintain the SAP WMS. Third, the report owner who would be responsible for maintenance of reports. Fourth, is the report user (ideally someone from the management who would use the reports). This is shown in Figure 21 below.

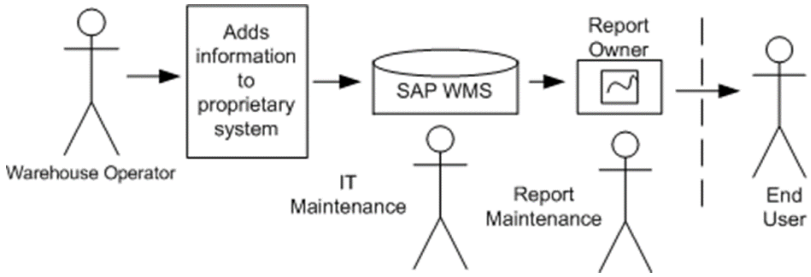


Figure 21. Process for warehouse reporting from SAP WMS in the case company.

As shown in Figure 21 above, the roles and responsibilities could be described in a RACI matrix (Haughey, 2017). In RACI matrix, R stands for Responsible, C stands for Consulted, A stands for Accountable and I stands for Informed. The RACI matrix for SAP WMS reporting activities for the case company for supporting the above mentioned processes shown below in Table 24.

Table 24. RACI Matrix for reporting process in the case company (Haughey, 2017).

RACI Matrix				
Role	Warehouse Operator	SAP WMS Maintenance	Report Owner	End Users
Project Deliverable/Activity				
Information Provision	R/A	C/I	C/I	-
IT Maintenance	C/I	R/A	C/I	I
Report Maintenance	-	C/I	R/A	-
Report Use	-	-	C/I	R/A

As shown above in Table 24, there are four activities tied to four separate roles. For each activity, only one role is Responsible(R) or Accountable (A). The others may be consulted(C) or informed (I). A role may not be used at all in a particular activity depending on the need or the situation.

This subsection described the needed process for SAP WMS reporting along with the RACI matrix for reporting process in the case company. The next subsections would continue to check the other recommendations in order to support SAP WMS reporting.

Recommendation 2. Integrating the barcode scanners with SAP WMS (pre-implementation to any report generation)

Currently, in the case company, the SAP WMS is part of SAP ERP (a standalone system). As a result, the reports generated from SAP WMS lack data in the form of

timestamps about arrival, receipt, picking, delivery and shipping of goods. Ideally, the reports should contain all the needed data. Therefore, in order to generate high quality reports, integration of bar code scanners with SAP WMS forms the pre-implementation step for the case company. An example of barcode scanner integration with SAP WMS is shown in Figure 22 below.

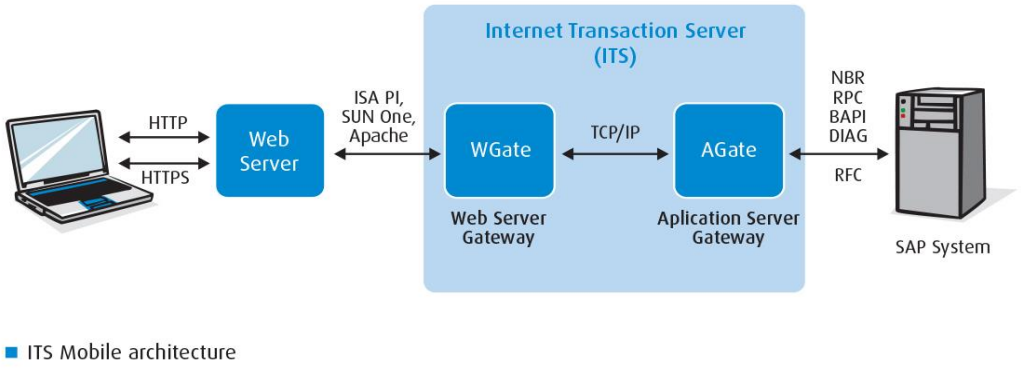


Figure 22. Integrating SAP WMS and barcode scanners (Bartsiewicz, 2016).

As shown in Figure 22 above, the Internet Transaction Server(ITS) Mobile technology enables communication between the scanner and the SAP system by translating the transaction screen from SAP ERP into the mobile device(laptops, mobile phones or barcode scanners) screen. It presents the content of a SAP transaction translating it into HTML for all the above mentioned mobile devices. For bar code scanners, programs are needed to generate an appropriate HTML template for each transaction screen. ITS enhances the client/server architecture by the Internet and it consists of two gateways – Web Server Gateway and Application Server Gateway (Bartsiewicz, 2016). This technology is popular among companies using mobile solutions in warehouses since it provides support with colors and support of multiple devices.

This completes the second recommendation for the case company. The next subsection describes the third recommendation in order to support SAP WMS reporting.

Recommendation 3. Improve the existing Master Data and creation new master data to support SAP WMS functioning including reporting (pre-implementation to any report generation)

Currently, in the case company, there is lack of master data being used by the SAP WMS so that there is less than twenty percent data about spare parts which has both weight and size or dimensions. Further, many stakeholders do not trust the master data and

believe that the master data is inconsistent. As the case company has invested heavily in SAP WMS, it should seriously consider improving and managing the master data. The mechanism used for updating the master data should be consistent so that it can accommodate and manage changes easily.

Improved master data would help in obtaining more benefits in terms of reporting from SAP WMS system. The three most significant benefits would include, a) Reduction of losses in terms of productivity and money from warehouse workers. This is due to the fact that the configuration of bins is according to weight and not size of the spare parts. This leads to the situation that most of the bin allocation suggested by SAP WMS are not followed and spare parts are placed manually. b) Provision of inputs to the senior management in taking decisions with respect to effectively use the services of a third party warehouse provider. c) Increase overall efficiency in operations at the spare parts warehouse for the case company.

This completes the third recommendation for the case company. The next subsection describes the fourth recommendation in order to support SAP WMS reporting.

Recommendation 4. Create proper training documentation material and impart trainings to demonstrate SAP WMS reporting

Currently, the stakeholders in the case company lack training in order to generate reports from the SAP WMS. Since, the in-house changes are timelier and less expensive, SAP WMS expertize within the case company should be utilized to generate adequate training material for SAP WMS reporting. The documentation should include the following a) Good amount of instructions for the managers to be able to use the SAP WMS reporting, b) Limitation of reporting while using SAP WMS, c) Contact persons in case the reporting feature does not work or is insufficient for the business needs. The training material should be stored in a shared drive and should be accessible to be downloaded to all necessary stakeholders.

Next, once the high quality training material is in place, it should be used by SAP WMS experts for giving one-to-one training sessions to few stakeholders (mostly from the management) or over skype sessions if they are at remote locations.

After the first round of trainings, training material could be improvised by receiving adequate feedback from the trainees.

This completes the fourth recommendation for the case company. The next subsection describes the last recommendation in order to support SAP WMS reporting.

Recommendation 5. Reduce the number of tools being utilized in reporting in phases *and replace multiple tools by 1-2 tools*.

Currently, in the case company, different tools are being utilized for different purposes for different aspects of warehouse reporting. This higher level of mechanization and automation causes lack of flexibility in terms of use of information among cross-functional teams. Additionally, it requires a large amount of investment in capital solely for infrastructure, initial trainings. In general, automation has not simplified or resolved complex situations in the case company. Hence, the case company should evaluate the existing multiple reporting systems if those could be phased out slowly and replaced by 1-2 effective systems. During the evaluation, the proposed systems should be tested in a live setting with members from cross-functional teams like IT, business, engineering, warehousing, reports creation and maintenance etc. Until, all members are not fully satisfied of any new improved system in relation to the existing situation, it should not take into use. By simplifying and using smaller number of suitable tools, it would ensure the case company with overall better results from the generated reports.

This completes all the recommendations to aid reporting using SAP WMS in the case company. The next section summarizes the study and checks the final conclusions.

7 Discussion and Conclusions

This section discusses and summarizes the main findings of the study. It evaluates the study by comparing the outcome and the objective. Finally, there is a discussion on reliability and validity.

7.1 Summary

This study concentrated on providing suggestions for improving the use of SAP WMS reporting practices in order to benefit the spare parts organization at the case company. As a concluding result of this study, it was proposed that the reporting from SAP WMS can be improved by using SAP NetWeaver with SAP Business Objects as a reporting tool.

The current state analysis figured out there were many challenges in poor SAP WMS usage. As an outcome, total 55 findings were found clearly divided into categories and prioritized with key stakeholders from the warehouse and management. It became clear that the biggest challenge was due to lack of reports in all five major processes currently using SAP WMS. Hence, the main focus of the study was selected to be improving the use of SAP WMS reporting practices.

The current state analysis ended with two main questions in reporting area. The two main questions were used as a basis of finding solutions from literature and best practice. Based on the current state analysis, two main points were raised. First, there is a lack of clarity in the case company's management about the kind of reports needed from SAP WMS which were non-existent at the time CSA. Second, the managers lack information in order to use SAP WMS effectively to produce reports. As an outcome of literature review, the conceptual framework of this study was generated.

The final results from the current state analysis and conceptual framework were merged in order to build an initial proposal draft. The initial proposal was reviewed and feedback collected on the basis of inputs and comments from the key stakeholders in the form of interviews and discussions. In this study, the initial proposal was validated with no changes needed by the stakeholders and was approved. It then became the final proposal. The final proposal suggested that there was a key pre implementation need in the form of barcode scanner integration with the SAP WMS. This was needed in order to obtain accurate data for report generation in the form of timestamps.

Next, it suggested that SAP NetWeaver Business Warehouse with SAP Business Objects be used as a reporting tool for generating the needed reports from the SAP WMS. This reporting tool was found to be most suitable among the three available options along with a comparison of implementation costs, implementation time and overall risks. It further mentioned that the report implementation be done by group of external consultants as a full time project. An implementation plan for the project was built for the case company in the final proposal. In addition, five recommendations were described as part of the final proposal for the case company in order to improve SAP WMS reporting practices.

The final proposal was found to be value adding for continuous monitoring of the warehouse operations by the managers (main stakeholders for using SAP WMS reports in the case company). Additionally, the final proposal with its implementation related findings were agreed to be followed by the senior management team and relevant process owners in the case company in the times to come. This summarized the study. In the next subsection, an evaluation of the study is discussed.

7.2 Evaluation of the Thesis

This subsection evaluates the outcome in comparison with the objective of the study. It later continues to discuss reliability and validity of the study.

7.2.1 Outcome vs Objective

The objective of this thesis was to suggest improvements for the use of SAP WMS reporting practices in order to benefit the spare parts organization at the case company. The objective was addressed through an outcome in the form of a proposal. The proposal provided with “WHAT” aspect and “HOW” to improve SAP WMS reporting practices being used for spare parts organization at the case company. It was further supplemented by a list of recommendations in order to improve reporting from the SAP WMS.

In terms of the outcome, it appears to be fully relevant for the case company, in generating the list of needed reports from the SAP WMS. The list of reports are relevant for their third party operated Vantaa warehouse. The solution is fully transferable since it contains a set of suggestions which needed to be implemented in the near future. The challenges needed to be overcome in the case company (mentioned in the objective)

was clearly met by improvements suggested (mentioned in the outcome) and stands out to be valid. Most parts of the study went well except that the current state analysis was very lengthy and almost took double the time than was initially planned. It is possible to repeat the same research since all results are properly documented in the case study and hence the research can be said to be reliable. Further, implementing and testing at least one report from SAP NetWeaver Business Warehouse with SAP Business Objects would have given better insights. This would have helped to see the functional capability of the tool and check the results, rather than collaborating and relying on the opinion of in-house SAP experts at the case company.

Summing up, the research has provided an adequate study about improving the use of SAP WMS reporting practices and generated ideas in order to aid reporting from the SAP WMS.

This completes the subsection with the comparison of outcome versus the objective. Next, section describes how reliability and validity has been ensured in the course of the study.

7.2.2 Reliability and Validity

In this type of study, the four criterion needed to ensure the quality of any research included *validity, reliability, relevance* and *logic.*

Validity means if the research truly measures its intended outcome. Or, it may be used to establish the truthfulness of the research results (Golafshani, 2003, p. 599).There are three types of tests which are commonly used for ascertaining validity in research. First, *construct validity* which is used for setting up of correct operational measures for concept being studied in the research. It involves three tactics in the case study. A) Utilization of multiple sources of evidence, B) Establishing a chain of evidence, C) Have a draft case study report reviewed by key informants. Construct validity is used in data collection phase (Yin, 2003, pp. 34-39). Hence, qualitative research is supported by construct validity.

As one type of validity, *internal validity* is used for establishing credibility. It involves the tactics of explanation building and perform pattern matching. Internal validity is used in data analysis phase (Yin, 2003, pp. 34-39). In qualitative research, internal validity is established by triangulation, peer debriefing, member checks, researcher's assumption,

theoretical orientation, researcher's self-monitoring (Riege, 2003, p. 78). Therefore, internal validity helps in doing high quality qualitative research.

As another type of validity, *external validity* establishes an area to which the finding of the study could be utilized or transferable. External validity is used in research design phase (Yin, 2003, pp. 34-39). In qualitative research, external validity is established using predetermined questions, developing the case study data base (Riege, 2003, p. 78). Therefore, external validity helps in increasing the validity of any qualitative research.

In this thesis, *validity* was strengthened by examining the data from different sources. Additionally the research included findings, interpretations and recommendations, triangulations of collected data, researcher's observations, inputs from internal documentation and usage of predetermined questions for interviews and discussions done at the case company headquarters and their third party operated warehouse in Vantaa.

Next, *Reliability* ensures that if another investigator in future follows the same methods and conducts the same case study again, this investigator should obtain the same or similar findings again. Therefore, reliability aims at reducing the errors and biases in research. (Yin, 2003, p. 37). In qualitative research, reliability is achieved by properly documenting any research case study which is undertaken (Yin, 2003, p. 38). It means that in order to establish reliability for any research, the research should be error free, unbiased and well documented.

In this thesis, *reliability* was strengthened by accurately documenting each and every step of the research case study and the data collected before making improvement suggestions. Further, it was strengthened by using different data sources, applying the internal documentation from the case company and collecting data at different points of time.

Relevance means "that research should never be done for frivolous, wasteful, or irrelevant purpose" (Myers, 2013, p. 49). In qualitative research, relevance is ascertained by using interviews as a data collection technique. For example, at the beginning of the each interview, it becomes important to explain the overall purpose of research study. It helps the respondent to understand the relevance of the project. Once the relevance is clear, the responders are able to express their views and experiences more freely (Brennen, 2012, pp. 32-34). It means that relevance in research is highly needed in order to get good quality data from the stakeholders.

In this thesis, *relevance* was strengthened by accurately defining the relevance of the business problem, followed by defining the relevant interview questions. Further, relevance was ascertained by following the best practice for conducting interviews in the beginning and finally while evaluating the relevance of the solution for the case company. The business challenge or the research problem had its relevance due to the fact that the case company had invested heavily in its SAP WMS and was not satisfied with the use of SAP WMS reporting for its spare parts warehouse. The interview questions were additionally made relevant since they were formulated to fit the problem and were the first probed, before asking in-depth questions. The outcome was relevant for the case company since the improvement suggestions would support the use of SAP WMS for reporting. Accurate reporting would help the case company in adding value by continuous monitoring of its warehouse operations.

Logic means that the research is conducted or assessed according to strict principles of validity. There are many ways for establishing logic in qualitative research. First, triangulation (Yin, 2003, pp. 97-101) is used to collect data. In order to counterbalance the errors found in any method of data collection, feedback should be taken from various stakeholders. Thus, stakeholders would help to identify and remove incorrect logic that could easily hamper the correctness of the proposed conclusions (Maxwell, 2013, p. 195). Last, but not least the outcome of the research should explain the logic behind the research (Maxwell, 2013, p. 141). This explains the fact that logic helps to ensure presence of high quality of data and proposed solutions in qualitative research.

In this thesis*, logic* was strengthened by using the technique of triangulation for collection of data. Further, once an initial proposal with improvement practices was created, feedback was taken from various stakeholders.

This completes the subsection on reliability and validity for the study. Next subsection describes the final words from the researcher for this study.

7.3 Final Words

Warehouses are necessary for logistics operations for all kinds of companies in any business area. Currently, businesses stress on global e-commerce, efficient and quick consumer response, just-in-time delivery, the supply chain connecting manufacturing and end customers. These aspects call for the fact that warehouse operations cannot be well coordinated without optimally using IT systems like SAP WMS. High performance

businesses use IT systems like SAP WMS to measure warehouse operational performance by creating reports. Due to highly competitive markets, the need to improvise reporting practices remains high priority for all firms using any kind of warehousing. Initiatives towards improvised reporting could include change of IT reporting tools, new reports implementation to cover previously non-existent reporting needs etc. Good quality, functional and improved IT reports from the warehouse should help to take information backed, business decisions for any company. This in turn would support in monitoring and improving the warehouse performance, reducing unnecessary costs and bring added revenue for company's shareholders.

References

APICS, 2017. *SCOR Framework- The Most Recognized Supply Chain Framework.* [Online] Available at: http://www.apics.org/apics-for-business/products-and-services/apics-scc-frameworks/scor[Accessed 11 04 2017].

Atieh, A. M. et al., 2015. Performance improvement of inventory management system processes by an automated warehouse management system. *48th CIRP Conference on MANUFACTURING SYSTEMS-CIRP CMS 2015,* pp. 568-572.

Bartsiewicz, A., 2016. *Integration of SAP WM with barcode scanners.* [Online] Available at: https://www.bcc.com.pl/en/academy-of-better-business/integration-of-sap-wm-with-barcode-scanners.html[Accessed 24 04 2017].

Berg, D., 2010. *30 technical tips and tricks to speed query, report and dashboard performance.* [Online] Available at:http://www.google.ca/url?sa=t&rct=j&q=30%20technical%20tips%20and%20tricks%20to%20speed%20query%2C%20report%2C%20and%20dashboard%20performance&source=web&cd=2&ved=0CFQQFjAB&url=http%3A%2F%2Fcscstudentweb.lr.edu%2Fswp%2FBerg%2Farticles%2FNW2010%2FBerg_NW2[Accessed 12 04 2017].

Brennen, B. S., 2012. *Qualitative Research Methods for Media Studies.* 2012 ed. New York: Routeledge.

Cagliano, A. C., DeMarco, A., Refele, C. & Volpe, S., 2011. Using system dynamics in warehouse management:A Fast-fashion case study. *Journal of Manufacturing Technology Management,* 22(2), pp. 171-188.

Case company Business Description, 2017. *Case company business description.* [Online] Available at: Case company website[Accessed 11 01 2017].

Case Company Operating Model, 2017. *Case Company Operating model.* [Online] Available at: Case Company Website[Accessed 11 01 2017].

DashBoardZone, 2017. *KPI-Dashboard-Inventory-Management-KPI-Dashboard.* [Online] Available at: http://www.dashboardzone.com/kpi-dashboard-inventory-management-kpi-dashboard[Accessed 03 04 2017].

De Koster, M. & Balk, B. M., 2008. Benchmarking and Monitoring International Warehouse Operations in Europe. *Production and Operations Management,* March-April, 17(2), pp. 175-183.

De Koster, M. M. & Warffemius, P. J., 2005. American, Asian and third-party international warehouse operations in Europe-A performance comparison. *International Journal of Operations & Productions Management,* 25(7-8), pp. 762-780.

Eisenhardt, K. M., 1989. Building Theories From Case Study Research. *The Academy of Management Review,* 10, 14(4), pp. 532-544.

Eriksson, P. & Kovalainen, A., 2011. *Qualitative Methods in Business Research.* 2011 ed. London: Sage Publications Ltd.

Frazelle, E. H., 2002. *World Class Warehousing and Material Handling.* s.l.:McGraw Hill.

Golafshani, N., 2003. Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report,* 8(4), pp. 597-607.

Gu, J., Goetschalckx, M. & McGinnis, L., 2007. Research on warehouse operation: A comprehensive review. *European Journal of Operational Research,* 177(1), pp. 1-21.

Gunasekaran, A. & Kobu, B., 2007. Performance measures and metrics in logistics and supply chain management: a review of recent literature(1995-2004) for research and applications. *International Journal of Production Research,* 15 06, 45(12), pp. 2819-2840.

gurufocus.com, 2015. *Revenue of Case Company.* [Online] Available at: http://www.gurufocus.com/term/Revenue/[Accessed 11 01 2017].

Haughey, D., 2017. *RACI MATRIX.* [Online] Available at: https://www.projectsmart.co.uk/raci-matrix.php[Accessed 25 04 2017].

Hompel, t. M. & Schmidt, T., 2007. *Warehouse Management:Automation and Organisation of Warehouse and Order Picking Systems.* 2007 ed. s.l.:Springer.

Johnson, A., Chen, W. C. & McGinnis, L. F., 2010. Large-scale Internet Benchmarking:Technology and Application in Warehousing Operations. *Computers in Industry,* 61(3), pp. 280-286.

Kappauf, J., Lauterbach, B. & Koch, M., 2012. *Logistics Core Operations with SAP: Inventory Management, Warehousing, Transportation, and Compliance.* 2012 ed. Berlin Heidelberg: Springer.

Kiefer, A. W. & Novack, R. A., 1999. An Empirical Analysis of Warehouse Management Systems in context of Supply Chain Implementation. *Transportation Journal,* 38(3), pp. 18-27.

klipfolio.com, 2017. *What is a KPI?.* [Online] Available at: https://www.klipfolio.com/resources/articles/what-is-a-key-performance-indicator[Accessed 12 05 2017].

Koster, R. d. & Tho Le-Duc, K. J. R., 2007. Design and control of warehouse order picking:A literataure review. *European Journal of Operational Research,* 182(2), pp. 481-501.

Legacy Supply Chain Services, 2017. *Warehouse KPIs to measure.* [Online] Available at: https://legacyscs.com/warehouse-kpis-to-measure/[Accessed 08 04 2017].

Marco, A. D. & Mangano, G., 2011. Relationship between logistic service and maintenance costs of warehouses. *Facilities,* 29(9-10), pp. 411-421.

Maxwell, J. A., 2013. *Qualitative Research Design: An interactive approach.* 2013 ed. s.l.:SAGE Publications Inc.

Murray, M., 2017. *Order Picking In The Warehouse,* s.l.: .

Myers, M. D., 2013. *Qualitative Research in Business and Management.* s.l.:Sage Publications.

Powler, T., 2011. *SAP BusinessObjects BI 4.0 The New Semantic Layer – ASUG Webcast Summary,* : s.n.

Richards, G., 2014. *Warehouse Management: A complete guide to improving efficiency and minimizing costs in the modern warehouse.* 2nd ed. London: Kogan Page Limited.

Riege, A. M., 2003. Validity and Reliability in case study research: a literature review wit "hands-on" applications for each research phase. *Qualitative Market Research: An international journal,* 6(2), pp. 75-86.

Rouse, M., 2009. *SAP Definition.* [Online] Available at: http://searchsap.techtarget.com/definition/SAP[Accessed 12 01 2017].

SAP AG, 2005. *Performance Tuning For SAP BW : Business Information Warehouse.* [Online] Available at: https://archive.sap.com/kmuuid2/10fb4502-111c-2a10-3080-df0e41d44bb3/BW%203.x_2.x_%20Performance%20Tuning%20v2.7.E.pdf [Accessed 12 04 2017].

SAP Warehouse Management System, 2017. *Warehouse Management System (WMS).* Online] Available at:http://help.sap.com/saphelp_erp60_sp/helpdata/en/c6/f85c504afa11d182b90000e829fbfe/frameset.htm[Accessed 12 01 2017].

SAP, 2017. *What is ERP?,* Espoo: sap.com.

Stadtler, H., Kilger, C. & Meyr, H., 2015. *Supply Chain Management and Advanced Planning-Concepts, Models,Software and Case Studies.* 5th ed. Berlin: Springer.

Staudt, F. H., Alpan, G., Mascolo, M. D. & Rodriguez, C. M. T., 2015. Warehouse Performance Measurement:a literature review. *International Journal of Production Research,* 53(18), pp. 5524-5544.

Stechies.com, 2008. *What is logistics information system (LIS) in SAP?.* [Online] Available at: https://www.stechies.com/what-is-logistics-information-system-lis-in-sap/[Accessed 13 04 2017].

Stokinger, P., 2017. *SAP NetWeaver Business Warehouse -OLAP.* [Online] Available at: https://wiki.scn.sap.com/wiki/pages/viewpage.action?pageId=304218746[Accessed 12 04 2017].

Subramanya, K. N., Rangaswamy, M. T. & Ramaa, A., 2012. Impact of Warehouse Management System in a Supply Chain. *International Journal of computer applications,* 09, 54(1), p. 6.

Techtarget.com, 2017. *Definition of SAP BusinessObjects,* Espoo: s.n.

WERC, 2., 2008. *Standard Definitions.* [Online] vailable at: http://www.werc.org/assets/1/workflow_staging/Publications/742.pdf[Accessed 08 04 2017].

Wheadon, B., 2013. *SAP Businessobjects,* Espoo: s.n.

Yang, K. K., 2000. Managing a Single Warehouse,Multiple Retailer Distribution Center. *Journal of Business Logistics,* 21(2), pp. 161-172.

Yin, R. Y., 2003. *Case Study Research-Design and Mehods.* Third ed. Thousand Oaks, California: Sage Publications.

Appendix 1. Interview questions for Espoo office for Data 1 round

Name of Informant	
Position of the Informant	
Date of Session	
Recorded	

	Question	***Notes/Answers***
1	Can you describe the current warehousing process?	
2	Does the current warehousing process work?	
3	Does the customer ever return the products?	
4	How is the inventory monitored?	
5	What do you think of the strengths of the warehousing process?	
6	What do you think are the weaknesses of the warehousing process?	
7	What kind of improvements would you suggest to the process?	
8	What do you think of the usage of SAP WMS for reporting versus IM?	
9	Do you know the split between inbound and the outbound?	
10	What do you think are the advantages of using SAP WMS for inbound and outbound reporting as compared to IM?	
11	What do you think are the problems with usage of SAP WMS for inbound and outbound reporting as compared to IM?	
12	Could you describe the 3rd party warehousing concept?	
13	What is your opinion about advantages of 3rd party warehousing?	
14	What is your opinion about disadvantages of 3rd party warehousing?	
15	Do you that there are any challenges in the follow up of rules set for warehousing?	
16	How could the process of using 3rd party warehousing be improved in terms of receiving increased insights and feedback?	
17	What else would you like to discuss to the interview? Or would you like to tell us something…	

Appendix 2.Interview questions for warehouse personnel for Data 1 round.

Name of Informant	
Position of the Informant	
Date of Session	
Recorded	

	Question	Notes/Answers
1	Can you describe the current warehousing process?	
2	Does the current warehousing process work?	
3	Does the customer ever return the products?	
4	How is the inventory monitored?	
5	What do you think of the strengths of the warehousing process?	
6	What do you think are the weaknesses of the warehousing process?	
7	What kind of improvements would you suggest to the process?	
8	Do you utilize the SAP WMS?	
9	What do you see as the benefits of using SAP WMS?	
10	What are the weakness of the SAP WMS?	
11	What improvements would you like to see in utilizing the SAP WMS?	
12	What training needs do you have, which would help you to use the SAP WMS in a better way?	
13	Is there any particular challenges with the usage of SAP WMS?	
14	Why do you not utilize the bins recommended by the SAP system?	
15	What else would you like to discuss to the interview? Or would you like to tell us something….	

Appendix 3.Summary of interview results from for Data 1 round

(A) Spare parts management in the Espoo office

Strengths	
	Very simple setup in terms of configuration. Works and provides dynamic bin allocation as was expected in the first place. Is able to receive data updates from Enovia system. Reliable and stable system
Weaknesses along with their categories	
Configuration	Lack of proper usage of Transactions
Configuration	No suggestions for mixed bins
Configuration	Two ways of printing labels: old way and new way.
Configuration	Bins are not coded
Configuration	Sales Orders and Purchase Orders are heavy for not connected
Configuration	Transport orders are heavy for small warehouse
Configuration	Delivery package, size and weight information
System	System has not been set up correctly to receive all the benefits
System	Non utilization of codes for receiving and check of materials
System	Improper utilization of current features
System	Does not support sales order from the existing stock
System	Only timestamps of receipts of goods
System	Does not update data and cancels every and every document and re-create them
System	Warehouse personnel do not have a list for packaging in terms of light, heavy etc.
System	Mass uploads through Enovia and causes data duplication and errors(forced enrichment of master data)
System	Lack of adequate data to plan daily activities(done manually)
System	Inventory counting is manually corrected
System	No support of automated blocking of adjacent location to accommodate long items.
System	Two deliveries from the same item goes to two separate bins.
System	Update to bin locations are not mentioned while order picking
People	Lack of common visibility, lack of common tracking, lack of clear expectations and responsibility
People	Non utilizations of bins provided(heavy reliance of humans)
People	Non installation of SAP on laptops. Must wait for 1min/transaction.
People	Delivery planners are involved in administrative tasks and printing picking orders
People	Operator has to change bin location line by line and remember where to take them
Reporting	No monitoring in terms of goods issue, goods receipt, and time elapsed, returned products.

(B) Warehouse personnel in Vantaa at third party warehouse.

Strengths	
	The capability to manage warehousing and provide information provide information where the goods are located.
Weaknesses along with their categories	
Configuration	SAP system does not have link to pictures of spare parts and goods.
Configuration	SAP WMS should have descriptions of goods should be more precise and descriptive. Missing information slows down the receiving of goods and could be days or even weeks.
Configuration	SAP system does not have the correct weight information. There is a mixture of units such as kg, g and lbs. Sometimes at warehouse the net weight is checked and corrected to the SAP system manually.
Configuration	In SAP WMS there is often missing information about the goods.
Configuration	SAP system does not have the correct weight information. There is a mixture of units like kg, g and lbs. Sometimes at warehouse the net weight is checked and corrected to the SAP system manually.
Configuration	Some automated update from Enovia obviously overwrites the data in the SAP WMS.
System	SAP does not always tell correctly where the material is located in the warehouse. Therefore the second delivery may end to totally different bin location than the previous one. This seems to be related to one SAP update performed because it used to work better earlier.
System	SAP WMS system suggests big and heavy goods to be placed into small goods area and vice versa. It seems to be that sometimes when collecting pick list for order SAP is suggesting the original suggested place and not the updated bin location.
System	SAP does not always suggest a suitable bin location for the received goods.
System	SAP does not print new stickers if there is a need to change the bin location from the suggested. Then the update to stickers need to be done manually.
System	The SAP user interface should be simpler. Currently one needs to keep open several windows at the same time.
System	SAP does not allow operator to select bin location but directly suggests one. Now the operator needs to change them line by line and remember where to take them.
System	When receiving goods if even one of several lines is missing weight information then all the lines need to be checked one by one to find and complement the missing data. SAP WMS should highlight the line item that misses the information to make it quicker to fix.
System	Bigger font for the paper because it is currently quite small configured in the SAP WMS. Especially for the pickup lists it would be good in conditions when there is limited lightning.
System	The pickup list provided by the WMS should contain information about the bin location. Now it need to be checked separately.
System	Auto logout appears typically after 5 minutes but that seems to vary. It can be 10 minutes on one workstation but another stays logged in for the whole day.
System	SAP is slow because work is done on a remote desktop. For example sometimes need to wait printout to start for a minute. When you print a lot during the day (tens of printouts) it would take a big portion of a day just waiting.
People	Lack of practical training in using WMS. More trainings needed for upgrading the system.

Appendix 4. Interview questions for reporting for Data 2 round.

Name of Informant	
Position of the Informant	
Date of Session	
Recorded	

	Question	Notes/Answers
1	Can you describe the current reporting process?	
2	Does the current reporting process work?	
3	Does the third party warehouse provider send any reports?	
4	How is the reporting done?	
5	What do you think of the strengths of the reporting process?	
6	What do you think are the weaknesses of the reporting process?	
7	What kind of improvements would you suggest to the process?	
8	Do you utilize the SAP WMS?	
9	What do you see as the benefits of using SAP WMS in reporting?	
10	What are the weakness of the SAP WMS in reporting?	
11	What improvements would you like to see in utilizing the SAP WMS for reporting?	
12	What training needs do you have, which would help you to use the SAP WMS in a better way?	
13	Is there any particular challenges with the usage of SAP WMS?	
14	Why do you not utilize the bins recommended by the SAP system?	
15	What else would you like to discuss to the interview? Or would you like to tell us something….	

Appendix 5. Summary of Interview results for Data 2 round

Name of the process that already use the SAP WMS.	Fields Needed	Nature of need(needed/good to have)	Frequency of Report	Benefits to the business	Requested by
Goods receipt with label printing	Supplier waybill number, internal PO number, Date and time of arrival of goods (timestamps)	Needed	Weekly and Monthly	Tool for measuring the efficiency of the external warehouses. Used as one basis for the warehouse operational costs.	Logistics Manager
Goods receipt with label printing	Date and time of receipt of goods (timestamps)	Needed	Weekly and Monthly	Tool for measuring the efficiency of the external warehouses. Used as one basis for the warehouse operational costs.	Global Transportation and Warehouse Manager, Logistics Manager
Goods receipt	For ICA cases, when goods are received in other case company unit	Needed	Weekly and Monthly	Tool for measuring the efficiency of the external warehouses. Used as one basis for the warehouse operational costs.	Logistics Manager
Goods receipt	Received inbound delivery, no of inbound delivery lines, no of items per received line, weight of the items (received no of physical packages per inbound, dimensions and weights and types of the packages)	Needed	Monthly	Very important, intention is to use received inbound delivery line as rate basis for charging the case company by the LSP handling the WH PLS Note: this should additionally include e.g. goods returns as they basically require the same inbound process as the normal receipts	Global Transportation and Warehouse Manager, Director, Market Unit/Spare & Wear Parts
Goods movements with the warehouse	Date and time of when goods are placed in shelfs (timestamps)	Needed	Weekly and Monthly	Tool for measuring the efficiency of the external warehouses. Used as one basis for the warehouse operational costs.	Global Transportation and warehouse Manager, Logistics Manager
Goods movements and Goods issue	Timestamps of when the delivery is created, when picking list is created, when picking is done, when exact PGI is done, when goods	Needed	Weekly and Monthly	Tool for measuring the efficiency of the external warehouses. Used as one basis for the warehouse operational costs.	Logistics Manager, Global Transportation and warehouse Manager, Director, Market Unit/Spare &Wear Parts

	are physically picked up from stock.				
Inventory Counting	Inventory report comparison from the previous year	May be	Yearly	Possible tool for finding problematic items causing inventory discrepancies on a regular basis which could be used for root cause analysis.	Logistics Manager
Goods issue	Time between creating picking request to goods issue	Needed	Monthly	Very important, KPI for outsourced WH, currently done manually (could include even more steps between picking request creation and goods issue)	Global Transportation and warehouse Manager
Goods issue	Shipped outbound delivery, no of outbound delivery lines, no of items per outbound delivery line, weight of the items (shipped no of physical packages per outbound, dimension & weights and types of the packages)	Needed	Monthly	Very important, intention is to use shipped outbound delivery line as rate basis for charging the case company by the LSP handling the WH	Global Transportation and warehouse Manager
Goods Returns	Goods received as returns to the warehouse showing the items, date and time of received.	Needed	Monthly	Returned inbound delivery lines can act as rate basis for charging the case company by the Logistics Service Provider (LSP) handling the warehouse.	Logistics Manager

Reporting needs relevant to additional processes or needs

Name of the process that already use the SAP WMS.	**Fields Needed**	**Nature of need(needed/good to have)**	**Frequency of Report**	**Benefit to the business**	**Requested by**
Forwarding & Invoicing	Invoiced volumes and values for each storage location.	Good to have	Weekly and Monthly	Currently no visibility on the workload of F&I team as the currently available reports are showing the latest invoice	Logistics Manager

				created from an ICA sales order, not the invoice created by the global team. Would be beneficiary for the internal use.	
Bin codes	Total amount of SKUs, which items are located in which Bin location, division to floor, rack and small part shelf bins, items weights, empty space vs. used space per division	Good to have	Monthly	In order to follow up the space used in the WH & develop operations, could additionaly be utilized for m2 based invoicing from Logistics Service Providers	Global Transportation and warehouse Manager
Goods Transfer	A report could be that when we move the free sales stock to sales order stock-> this requires transfer order in the WMS.	Good to have	Monthly	This is needed to be done 50-100 times per month.	Delivery Planner
Goods Transfer	A report that would show many items we have in the blocked stock or quality inspection stock	Good to have	Daily/Weekly	We need to have surveillance that when we put item on QI stock, it should move or not be there more than 2 days. Then we should have an idea. What should we do? Shall we scrap these items or sell them again? Shall we ship those to supplier and get them fixed? Since if the items are in QI stock, no PO can be generated on them. Currently, this is an IM level report.	Delivery Planner
Goods Transfer	A report for the next day's deliveries. So that the guys at the warehouse would know, the number of items to pick up, from which different bin location	Good to have	Daily/Weekly	It would be good that they could see one big list for whole of tomorrow. You need to pick 70 items from bin type 005 and 20 items from a corner. So it would reduce the number of movements they make, better resourcing the people in the warehouse. It would make it easier as to know the number of deliveries we have of small items and which we need from one particular place.	Delivery Planner

Appendix 6. Test Script for Reports related to Process 2

Test Script for Process 2-> Goods movements within the warehouse as shown in Table A below.

Table A. Test Script for Process 2, Report A (from Table 14)

Test Script for WMS Report related to Process 2, Report A	
1. Name of the Process	Goods movements within the warehouse
2. Description of the Report	A report to show the date and time of placement of goods in shelves (timestamps)
3. Frequency	Weekly and Monthly
4. Needed Fields	Date and time of placement of goods in shelves (timestamps)
5. KPI provided	Put away time
6. Steps to generate this report from SAP WMS using Logical Information Systems (LIS)	-Login to the SAP system -Go to transaction LX12 -Enter warehouse number, select Confirmation status as “Only Confirmed TO items”, and Place the dates for Program Parameters and IM movement type is 101. -Press Execute

As shown in Table A. above, the steps were executed to receive the results. The snapshot of the result as shown in Figure A below.

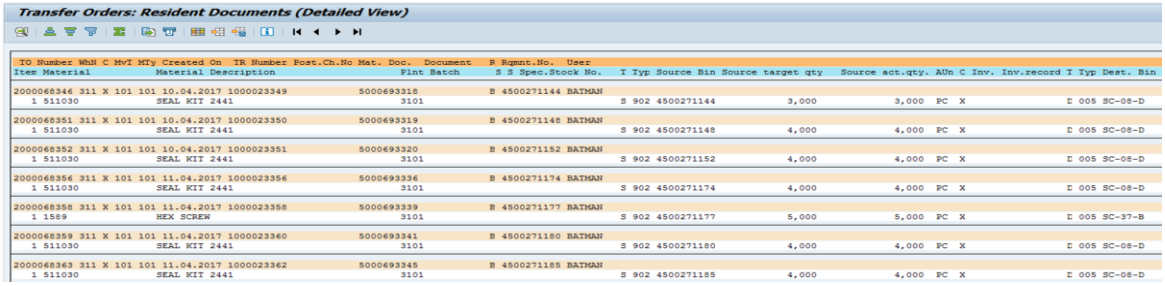


Figure A. Results of Test Script for Process 2, Report A (from Table 14)

As shown in *Figure* A above, the Transfer Order, Warehouse number, movement type, transfer number, material document, source bin and destination bin. This clearly shows the date of creation. However, the timestamp is not shown. Hence, the report is partially generated. The posting time could be shown if there was input data available due to enhancements in the SAP WMS in the form of integration with barcode scanners.

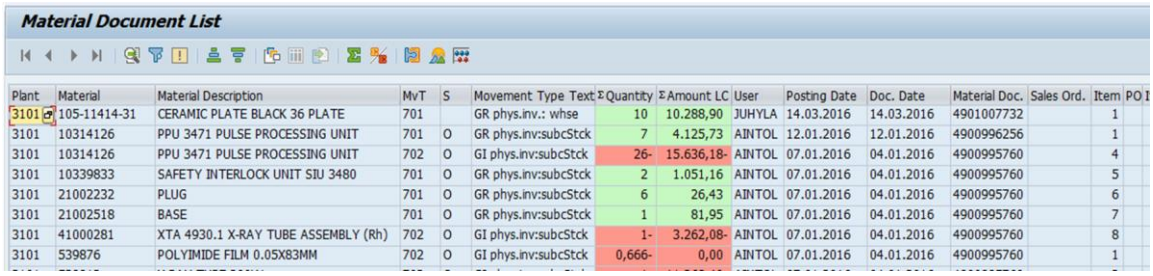
Appendix 7. Test Script for Report related to Process 3

Test Script for Process 3, Report A (from Table 14) Inventory Counting as shown in Table B below.

Table B. Test Script for Process 3, Report A(from Table 14)

Test Script for WMS Report related to Process 3, Report A	
1. Name of the Process	Inventory Counting
2. Description of the Report	A report to show the differences between WM and IM for comparing the items from the previous year
3. Frequency	Annually
4. Needed Fields	Inventory Count from Last year
	Inventory Count from the Current year
	Difference between the above two fields
5. KPI provided	Physical inventory accuracy, Storage accuracy, Inventory Space utilization, Inventory Cost
6. Steps to generate this report from SAP WMS using Logical Information Systems (LIS)	-Login to the SAP system -Go to transaction MB51 -Enter plant and movement type as 701. -Enter posting date say for one year, 01.07.2015 and 30.06.2016. -Press Execute

As shown in *Table B.* above, the steps were executed to receive the results. The snapshot of the result is shown in *Figure B* below.



Material Document List

Plant	Material	Material Description	MvT	S	Movement Type Text	Quantity	Amount LC	User	Posting Date	Doc. Date	Material Doc.	Sales Ord.	Item	PO I
3101	105-11414-31	CERAMIC PLATE BLACK 36 PLATE	701		GR phys.inv.: whse	10	10.288,90	JUHYLA	14.03.2016	14.03.2016	4901007732		1	
3101	10314126	PPU 3471 PULSE PROCESSING UNIT	701	O	GR phys.inv:subcStck	7	4.125,73	AINTOL	12.01.2016	12.01.2016	4900996256		1	
3101	10314126	PPU 3471 PULSE PROCESSING UNIT	702	O	GI phys.inv:subcStck	26-	15.636,18-	AINTOL	07.01.2016	04.01.2016	4900995760		4	
3101	10339833	SAFETY INTERLOCK UNIT SIU 3480	701	O	GR phys.inv:subcStck	2	1.051,16	AINTOL	07.01.2016	04.01.2016	4900995760		5	
3101	21002232	PLUG	701	O	GR phys.inv:subcStck	6	26,43	AINTOL	07.01.2016	04.01.2016	4900995760		6	
3101	21002518	BASE	701	O	GR phys.inv:subcStck	1	81,95	AINTOL	07.01.2016	04.01.2016	4900995760		7	
3101	41000281	XTA 4930.1 X-RAY TUBE ASSEMBLY (Rh)	702	O	GI phys.inv:subcStck	1-	3.262,08-	AINTOL	07.01.2016	04.01.2016	4900995760		8	
3101	539876	POLYIMIDE FILM 0.05X83MM	702	O	GI phys.inv:subcStck	0,666-	0,00	AINTOL	07.01.2016	04.01.2016	4900995760		1	

Figure B. Results of Test Script for Process 3, Report A (from Table 14)

As shown in *Figure B* above, Quantity and Amount are shown for each material. Hence, this report can be generated fully from the SAP WMS as part of SAP ERP system.

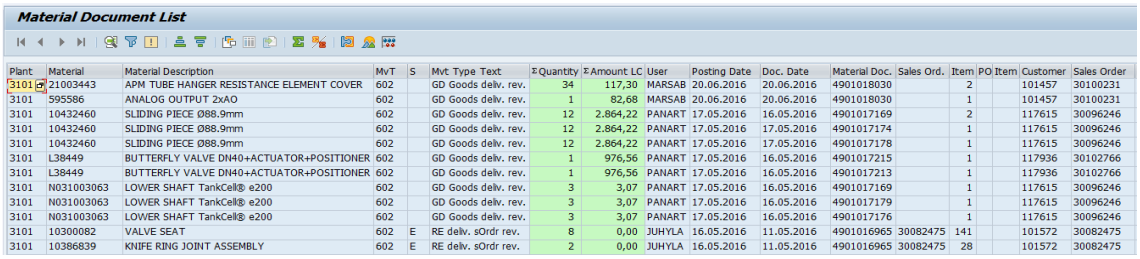
Appendix 8. Test Script for Report related to Process 4

Test Script related to Process 4, Report A (from Table 14) *Goods Returns* as shown in *Table C* below.

Table C. Test Script related to Process 4, Report A (from Table 14)

Test Script for WMS Report related to Process 4, Report A	
1. Name of the Process	Goods Returns
2. Description of the Report	A report indicating goods received as returns to the warehouse showing the items, date and time of received.
3. Frequency	Monthly
4. Needed Fields	Items received as returns
	Date and time of received goods
5. KPI provided	Stock out rate, Rate of Return
6. Steps to generate this report from SAP WMS using Logical Information Systems (LIS)	-Login to the SAP system -Go to transaction MB51 -Enter plant and movement type as 602. -Enter posting dates say for one month. -Press Execute

As shown in *Table C.* above, the steps were executed to receive the results. The snapshot of the result is shown in *Figure C* below.



Material Document List

Plant	Material	Material Description	MvT	S	Mvt Type Text	Quantity	Amount LC	User	Posting Date	Doc. Date	Material Doc.	Sales Ord.	Item	PO Item	Customer	Sales Order
3101	21003443	APM TUBE HANGER RESISTANCE ELEMENT COVER	602		GD Goods deliv. rev.	34	117,30	MARSAB	20.06.2016	20.06.2016	4901018030		2		101457	30100231
3101	595586	ANALOG OUTPUT 2xAO	602		GD Goods deliv. rev.	1	82,68	MARSAB	20.06.2016	20.06.2016	4901018030		1		101457	30100231
3101	10432460	SLIDING PIECE Ø88.9mm	602		GD Goods deliv. rev.	12	2.864,22	PANART	17.05.2016	16.05.2016	4901017169		2		117615	30096246
3101	10432460	SLIDING PIECE Ø88.9mm	602		GD Goods deliv. rev.	12	2.864,22	PANART	17.05.2016	17.05.2016	4901017174		1		117615	30096246
3101	10432460	SLIDING PIECE Ø88.9mm	602		GD Goods deliv. rev.	12	2.864,22	PANART	17.05.2016	17.05.2016	4901017178		1		117615	30096246
3101	L38449	BUTTERFLY VALVE DN40+ACTUATOR+POSITIONER	602		GD Goods deliv. rev.	1	976,56	PANART	17.05.2016	16.05.2016	4901017215		1		117936	30102766
3101	L38449	BUTTERFLY VALVE DN40+ACTUATOR+POSITIONER	602		GD Goods deliv. rev.	1	976,56	PANART	17.05.2016	16.05.2016	4901017213		1		117936	30102766
3101	N031003063	LOWER SHAFT TankCell® e200	602		GD Goods deliv. rev.	3	3,07	PANART	17.05.2016	16.05.2016	4901017169		1		117615	30096246
3101	N031003063	LOWER SHAFT TankCell® e200	602		GD Goods deliv. rev.	3	3,07	PANART	17.05.2016	16.05.2016	4901017179		1		117615	30096246
3101	N031003063	LOWER SHAFT TankCell® e200	602		GD Goods deliv. rev.	3	3,07	PANART	17.05.2016	16.05.2016	4901017176		1		117615	30096246
3101	10300082	VALVE SEAT	602	E	RE deliv. sOrdr rev.	8	0,00	JUHYLA	16.05.2016	11.05.2016	4901016965	30082475	141		101572	30082475
3101	10386839	KNIFE RING JOINT ASSEMBLY	602	E	RE deliv. sOrdr rev.	2	0,00	JUHYLA	16.05.2016	11.05.2016	4901016965	30082475	28		101572	30082475

Figure C. Test results of Process 4, Report A (from Table 14)

As shown in *Figure C* above, Quantity and Amount are shown for each material. Posting Date is displayed, however time is not displayed. However, the timestamp is not shown. Hence, the report is partially generated. The posting time could be shown if there was input data available due to enhancements in the SAP WMS in the form of integration with barcode scanners.

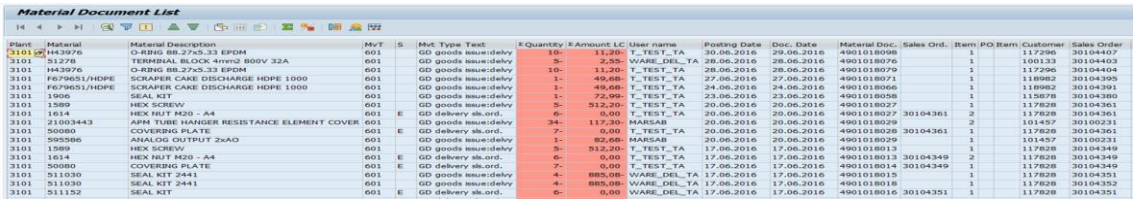
Appendix 9. Test Scripts for Reports related to Process 5

Test Scripts related for reports related to Process 5, Report A and Report B for *Goods Issue* as shown in *Table D* and *Table E* below.

Table D. Test Script related to Process 5, Report A (from Table 14)

Test Script for WMS Report related to Process 5, Report A	
1. Name of the Process	Goods Issue
2. Description of the Report	A report indicating outbound activity from the warehouse showing timestamp of delivery creation, goods issue and actual time when picking is done.
3. Frequency	Monthly
4. Needed Fields	Timestamp of delivery creation
	Goods issue
	Actual time when picking is done.
5. KPI provided	On time delivery, Outbound space utilization
6. Steps to generate this report from SAP WMS using Logical Information Systems (LIS)	-Login to the SAP system -Go to transaction MB51 -Enter plant and movement type as 601(for delivery creation). -Enter posting dates say for one month. -Press Execute

As shown in *Table D.* above, the steps were executed to receive the result. The snapshot of the result is shown in *Figure D* below.


Material Document List

Plant	Material	Material Description	MvT	S	Mvt Type Text	Quantity	Amount LC	User name	Posting Date	Doc. Date	Material Doc.	Sales Ord.	Item	PO Item	Customer	Sales Order
3101	H43976	O-RING 88.27x5.33 EPDM	601		GD goods issue:delvy	10-	11,20-	T_TEST_TA	30.06.2016	29.06.2016	4901018098		1		117296	30104407
3101	51278	TERMINAL BLOCK 4mm2 800V 32A	601		GD goods issue:delvy	5-	2,55-	WARE_DEL_TA	28.06.2016	28.06.2016	4901018076		1		100133	30104403
3101	H43976	O-RING 88.27x5.33 EPDM	601		GD goods issue:delvy	10-	11,20-	T_TEST_TA	28.06.2016	28.06.2016	4901018079		1		117296	30104404
3101	F679651/HDPE	SCRAPER CAKE DISCHARGE HDPE 1000	601		GD goods issue:delvy	1-	49,68-	T_TEST_TA	27.06.2016	27.06.2016	4901018071		1		118982	30104395
3101	F679651/HDPE	SCRAPER CAKE DISCHARGE HDPE 1000	601		GD goods issue:delvy	1-	49,68-	T_TEST_TA	24.06.2016	24.06.2016	4901018066		1		118982	30104391
3101	1906	SEAL KIT	601		GD goods issue:delvy	1-	72,99-	T_TEST_TA	23.06.2016	23.06.2016	4901018058		1		115878	30104380
3101	1589	HEX SCREW	601		GD goods issue:delvy	5-	512,20-	T_TEST_TA	20.06.2016	20.06.2016	4901018027		1		117828	30104361
3101	1614	HEX NUT M20 - A4	601	E	GD delivery sls.ord.	6-	0,00	T_TEST_TA	20.06.2016	20.06.2016	4901018027	30104361	2		117828	30104361
3101	21003443	APH TUBE HANGER RESISTANCE ELEMENT COVER	601		GD goods issue:delvy	34-	117,30-	MARSAB	20.06.2016	20.06.2016	4901018029		2		101457	30100231
3101	50080	COVERING PLATE	601	E	GD delivery sls.ord.	7-	0,00	T_TEST_TA	20.06.2016	20.06.2016	4901018028	30104361	1		117828	30104361
3101	595586	ANALOG OUTPUT 2xAO	601		GD goods issue:delvy	1-	82,68-	MARSAB	20.06.2016	20.06.2016	4901018029		1		101457	30100231
3101	1589	HEX SCREW	601		GD goods issue:delvy	5-	512,20-	T_TEST_TA	17.06.2016	17.06.2016	4901018013		1		117828	30104349
3101	1614	HEX NUT M20 - A4	601	E	GD delivery sls.ord.	6-	0,00	T_TEST_TA	17.06.2016	17.06.2016	4901018013	30104349	2		117828	30104349
3101	50080	COVERING PLATE	601	E	GD delivery sls.ord.	7-	0,00	T_TEST_TA	17.06.2016	17.06.2016	4901018014	30104349	1		117828	30104349
3101	511030	SEAL KIT 2441	601		GD goods issue:delvy	4-	885,08-	WARE_DEL_TA	17.06.2016	17.06.2016	4901018015		1		117828	30104351
3101	511030	SEAL KIT 2441	601		GD goods issue:delvy	4-	885,08-	WARE_DEL_TA	17.06.2016	17.06.2016	4901018016		1		117828	30104352
3101	511152	SEAL KIT	601	E	GD delivery sls.ord.	6-	0,00	WARE_DEL_TA	17.06.2016	17.06.2016	4901018016	30104351	1		117828	30104351

Figure D. Results of Test Script related to Process 5, Report A (from Table 14)

As shown in *Figure D* above, Quantity, Posting Date, customer id and sales order are clearly shown. However, the timestamp is not shown. Hence, the report is partially generated. The posting time could be shown if there was input data available due to enhancements in the SAP WMS in the form of integration with barcode scanners.

Table E. Test Script related to Process 5, Report B (from Table 14)

Test Script for WMS Report related to Process 5, Report B	
1. Name of the Process	Goods Issue
2. Description of the Report	A report indicating date and time of goods shipped (outbound timestamps), number of delivery lines, items per delivery line, weight and size of individual items.

3. Frequency	Monthly
4. Needed Fields	Date and time of goods shipped (outbound timestamps)
	Number of delivery lines
	Items per delivery line
	Weight and size of individual items.
5. KPI provided	On time delivery, Outbound space utilization
6. Steps to generate this report from SAP WMS using Logical Information Systems (LIS)	-Login to the SAP system -Go to transaction MB51 -Enter plant and movement type as 601 -Enter posting dates say for one month. -Press Execute

As shown in *Table E.* above, the steps were executed to receive the result. The snapshot of the result is shown in *Figure E* below.

Material Document List

Plant	Material	Material Description	MvT	S	Mvt Type Text	Quantity	Amount in LC	User name	Posting Date	Doc. Date	Material Doc.	Sales Ord.	Item	PO Item	Customer	Sales Order
3101	L58381	PROGRAMMABLE TOUCH SCREEN 12.1"	601		GD goods issue:delvy	1-	1.538,30-	C_MARKAA	02.05.2016	02.05.2016	4901014741		3		403100	30100869
3101	L600891	INTERMEDIATE PLATE SANDWICH	601		GD goods issue:delvy	1-	324,82-	C_MARKAA	02.05.2016	02.05.2016	4901014742		1		118713	30097948
3101	L601937	HEX SOCKET SCREW	601		GD goods issue:delvy	4-	57,69-	C_MARKAA	02.05.2016	02.05.2016	4901014742		3		118713	30097948
3101	L601939	NUT M5	601		GD goods issue:delvy	4-	11,56-	C_MARKAA	02.05.2016	02.05.2016	4901014742		4		118713	30097948
3101	L601940	PRESSURE RELIEF VALVE UNADJUSTED	601		GD goods issue:delvy	1-	135,45-	C_MARKAA	02.05.2016	02.05.2016	4901014742		6		118713	30097948
3101	M106309	CHAIN	601		GD goods issue:delvy	2-	4.121,09-	C_MARKAA	02.05.2016	02.05.2016	4901014735		1		116959	30096446
3101	M948910101	TILT FRAME, CS	601		GD goods issue:delvy	2-	3.789,46-	C_TUOHUH	02.05.2016	28.04.2016	4901014634		4		120376	30088620
3101	M948910103	SHAFT SS	601		GD goods issue:delvy	4-	694,80-	C_TUOHUH	02.05.2016	28.04.2016	4901014634		9		120376	30088620
3101	M948910104	TUBE SS	601		GD goods issue:delvy	8-	1.768,98-	C_TUOHUH	02.05.2016	28.04.2016	4901014634		2		120376	30088620
3101	M948910106	CAM CS	601		GD goods issue:delvy	8-	442,03-	C_TUOHUH	02.05.2016	28.04.2016	4901014634		1		120376	30088620
3101	M948910110	CAM DISC, CS	601		GD goods issue:delvy	2-	284,54-	C_TUOHUH	02.05.2016	28.04.2016	4901014634		5		120376	30088620
3101	N048004280	HEX HEAD SCREW M8x35mm	601		GD goods issue:delvy	8-	1,60-	C_ROGSAN	02.05.2016	02.05.2016	4901014759		1		403960	30100156
3101	N048069901	SEALING KIT Ø32mm	601		GD goods issue:delvy	3-	85,25-	C_TUOHUH	02.05.2016	28.04.2016	4901014634		6		120376	30088620
3101	N048278369	LOCK WASHER NL8	601		GD goods issue:delvy	8-	5,55-	C_ROGSAN	02.05.2016	02.05.2016	4901014759		2		403960	30100156
3101	N048391336	TRANSFER DEVICE LEFT DWG 806222-2	601		GD goods issue:delvy	1-	9.117,16-	C_JARMAT	02.05.2016	02.05.2016	4901014719		1		101462	30091795
3101	N048418363	SPARE PART SET FOR BEARING UNIT BC-200	601	E	GD delivery sls.ord.	1-	0,00	C_LARNII	02.05.2016	02.05.2016	4901014698	30098291	1		120567	30098291
3101	OU600032954	CIA 4200 CELL INSERT ASSEMBLY	601		GD goods issue:delvy	1-	633,93-	C_ANTHAI	02.05.2016	02.05.2016	4901014752		2		115330	30102586
3101	P27059/2	CLOTH SCRAPER PPF 1.4436-PU	601		GD goods issue:delvy	7-	772,34-	C_JARMAT	02.05.2016	02.05.2016	4901014723		1		114101	30101142
3101	P27059/2	CLOTH SCRAPER PPF 1.4436-PU	601		GD goods issue:delvy	12-	1.324,01-	C_ANTHAI	02.05.2016	28.04.2016	4901014642		1		116664	30101959
3101	P318484	BELLOWS PF 30-60 AND 60-144	601		GD goods issue:delvy	4-	2.674,41-	C_ANTHAI	02.05.2016	02.05.2016	4901014712		1		119247	30099783
3101	P410716	SLIDE PIECE PPF, ETRACETA	601		GD goods issue:delvy	20-	522,44-	C_ANTHAI	02.05.2016	02.05.2016	4901014692		2		105288	30096347
3101	P410716	SLIDE PIECE PPF, ETRACETA	601		GD goods issue:delvy	50-	1.306,11-	C_ANTHAI	02.05.2016	02.05.2016	4901014692		7		105288	30096347
3101	P412202	SEALING FRAME MM, WITHOUT STRENGTHENER	601		GD goods issue:delvy	20-	705,72-	C_ANTHAI	02.05.2016	28.04.2016	4901014641		2		118757	30102323
3101	P414151	SEAL PPF	601		GD goods issue:delvy	92-	556,04-	C_ANTHAI	02.05.2016	02.05.2016	4901014692		4		105288	30096347
3101	P414151	SEAL PPF	601		GD goods issue:delvy	92-	556,04-	C_ANTHAI	02.05.2016	02.05.2016	4901014692		5		105288	30096347
3101	P41715	SEALING FRAME PFH	601		GD goods issue:delvy	80-	1.942,26-	C_ANTHAI	02.05.2016	28.04.2016	4901014641		1		118757	30102323
3101	P44864	SLEEVE PFH BEARING SLEEVE	601		GD goods issue:delvy	4-	98,34-	C_ANTHAI	02.05.2016	02.05.2016	4901014687		1		114101	30098183
3101	P49229	SLIDE PIECE PPF, ETRACETA	601		GD goods issue:delvy	40-	268,07-	C_ANTHAI	02.05.2016	02.05.2016	4901014692		8		105288	30096347
3101	P49229	SLIDE PIECE PPF, ETRACETA	601		GD goods issue:delvy	40-	268,06-	C_ANTHAI	02.05.2016	02.05.2016	4901014692		3		105288	30096347
3101	RRR561274	DIRECTIONAL VALVE 4WE6	601		GD goods issue:delvy	1-	58,98-	C_MARKAA	02.05.2016	02.05.2016	4901014742		5		118713	30097948
3101	SF0070	AIR BLEED VALVE	601		GD goods issue:delvy	1-	879,96-	C_LARNII	02.05.2016	02.05.2016	4901014750		1		117307	30097645
						914-	114.758,01-									

Figure E. Results of Test Script related to Process 5, Report B (from Table 14)

As shown in *Figure E* above, Quantity and Amount are shown for each material. Posting Date is displayed, however time is not displayed. However, the timestamp is not shown. Hence, the report is partially generated. The posting time could be shown if there was input data available due to enhancements in the SAP WMS in the form of integration with barcode scanners.

Appendix 10. Summary of Report Generation from SAP WMS for additional processes

The report generation possibilities of needed additional processes with reporting needs identified in CSA are shown below in *Table F*.

ADDITIONAL PROCESSES	NEEDED REPORT/S	USING SAP WMS	ACTIVATING LIS in SAP ERP SYSTEM	Using SAP BW/BO
Forwarding & Invoicing	A report which connects invoiced volumes and values for each storage location.	Cannot be used	Cannot be used	Fully generated
Bin Codes	A bin utilization report which would show the total number total number of SKUs, which items are located in which Bin location, division to the floor, rack and small part shelf bins, item weights, empty space versus used space per division.	Partially generated	Cannot be used	Fully generated
Goods Transfer	A report to show the number of items in blocked stock or quality inspection stock.	Fully generated	Cannot be used	Fully generated
	A report to indicate movement from the free sales stock to the sales order stock.	Partially generated	Cannot be used	Fully generated
	A report to plan the next day's deliveries. It would tell the warehouse workers how many items to pick up, from which bin location etc.	Fully Generated	Cannot be used	Fully generated

Table F. Summary of Report Generation for additional processes identified in CSA.

As shown in *Table F* above, a report for *Forwarding and Invoicing* process would require full ABAP Coding and hence it would be better if that is implemented using SAP BW/BO. Next, the report for *Bin Utilization* cannot be implemented in SAP WMS. This is due to the fact that data about individual weights does not fully exist. All reports from *Goods Transfer* could be done using SAP WMS and SAP BW with BO except for “Report to indicate movement from the free sales stock to the sales order stock”. ´This is due to lack of data available in the SAP WMS. It can be said that all reports can be generated from SAP BW with SAP BO.

Appendix 11. Interview questions and responses at the Espoo office for Data 3 round.

Name of Informant		
Position of the Informant		
Date of Session		
Recorded		
	Question	**Notes/Answers**
1	What is your feedback regarding the proposal suggested by me in order to improve the SAP WMS reporting?	
2	What would be your suggestions in order to improve the proposal?	
3	What should be the next steps?	
4	Any other comments that you have…	

Interview responses in the Espoo office for Data 3 round.

Name of Informant	Informant 1	
Position of the Informant	Delivery Planner	
Date of Session	5.5.2017	
Recorded	Yes	
	Question	**Notes/Answers**
1	What is your feedback regarding the proposal suggested by me in order to improve the SAP WMS reporting?	“I think your suggestions are very good!”
2	What would be your suggestions in order to improve the proposal?	Well, I do not have any suggestions since you kind a have covered the whole field there.
3	What should be the next steps?	None
4	Any other comments that you have…	None

Name of Informant	Informant 2	
Position of the Informant	Director, Technical Markets Unit, Spare and Wear Parts	
Date of Session	8.5.2017	
Recorded	Yes	
	Question	**Notes/Answers**
1	What is your feedback regarding the proposal suggested by me in order to improve the SAP WMS reporting?	"I think this is simple enough". It does have all the ones you have listed, the main reports that we need. That can additionally come as our source of KPIs. I think those are good. I am a big fan of barcode topic, talking about it. That has been a talk for two years. That for me is a right way to go, to receive proper timestamps instead of somebody doing the work first at the warehouse and then doing all the timestamps when he or she goes back to the computer. How, they do it now is that, they do all the system stuff in a go, so we have no idea when actually they have been doing the work.
2	What would be your suggestions in order to improve the proposal?	None.
3	What should be the next steps?	I think it is really clear from the proposal on which solution I would take, which is the one slightly more expensive. That would be now on our process and owner execution side to review the budget that we could use for this. I think if the budget is €124K, is quite a small number seeing the fact, how much efficiency people obtain from the operations side. So, if we manage to do that with that amount of money, I think that we are able to save many headcounts. We are able to save a lot of operational headcounts, if we have that information properly from the system. And, then we can demand a better contract from our outsourced warehouse, when we are able to monitor them and they are able to trust the information from the system. I would just get the budget and start doing it.
4	Any other comments that you have	To keep it simple, as said, the ones you had listed are the ones we need, since sometimes we do not get the budget, we do not get to go forward. I think it is already the deck that the operations and logistics managers can use and monitor the situation.

Name of Informant	Informant 3	
Position of the Informant	Manager Global Transportation Management	
Date of session	9.5.2017	
Recorded	Yes	
	Question	**Notes/Answers**
1	What is your feedback regarding the proposal suggested by me in order to improve the SAP WMS reporting?	It is good that we have now a list of expectations and requirements for the reports.
2	What would be your suggestions in order to improve the proposal?	-
3	What should be the next steps?	This could be done outside the thesis. Somehow take into consideration integration costs possibility. If I understood correctly, if we need bar code scanners, we need some kind of integration and then like it would be really interesting to know the difference in the costs. So we would have two options. One would to use 100, 000 plus for making the reports. But if we give the same amount of money, we get the integration and the reports from other 3rd party providers. Warehouse providers have given me this option since some of them do not use the SAP.
4	Any other comments that you have	-

Name of Informant	Informant 4	
Position of the Informant	Logistics Manager	
Date of session	9.5.2017	
Recorded	Yes	
	Question	**Notes/Answers**
1	What is your feedback regarding the proposal suggested by me in order to improve the SAP WMS reporting?	I am happy with the list. All the requirements and needs are known.
2	What would be your suggestions in order to improve the proposal?	-
3	What should be the next steps?	-
4	Any other comments that you have…	-