Global Distribution Center Improvement Analysis

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TIIVISTELMÄ

Tämä opinnäytetyö selvittää globaalin jakelukeskuksen nykytilannetta ja tämän hetkisiä ongelmakohtia sekä niiden vaikutusta operatiivisieen toimintaan. Työssä haetaan parannusehdotuksia ja vaihtoehtoja jakelukeskuksen toiminnan parantamiseksi ja tehostamiseksi.

Tämä opinnäytetyö kuuluu logistiikan aluelle ja perustuu varastonhallinnan ja operatiivisen toiminnan ongelmakohtiin. Työ on luonteeltaan konstruktiivinen tutkimus, lähtee liikkeelle käytännön ongelmista ja hakee niihin ratkaisuja. Työssä hyödynnetään myös vertailevan tutkimuksen ja parhaan mahdollisen lopputuloksen tavoitetta.

Tutkimuksen tuloksena tärkeimmiksi kehitysalueiksi nousevat varastonhallintajärjestelmän päivittäminen tälle vuosituhannelle, puheohjauksen käyttöönotto ja logistisen sopimuksen päivittäminen yhteisten kehitysprojektien tehostamiseksi ja nopeuttamiseksi.

Työn tarjoaa selkeitä vaihtoehtoja jakelukeskuksen toiminnan tehostamiseen ja lähtökohdan asioiden parantamiselle yhtiön seuraavien kehitysprojektien osalta. Tätä työtä voidaan käyttää minkä tahansa jakelukeskuksen tai varaston toiminan analysointiin ja samaisia parannusehdotuksia käyttää muuallakin keskustelun pohjana. Työ tarjoaa myös paljon lisätietoa modernista varaston hallinnasta sekä viimeisimmistä työkaluista ja järjestelmistä.

Avainsanat Varasto, jakelukeskus, puheohjaus, logistiikka, maailmanluokan

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Strategic leadership of technology based business

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ABSTRACT

This master thesis is concentrating to analysis of global distribution center current situation and problem areas as well their impact to operational performance. Work is looking for improvement proposals and options for increasing the operational efficiency and way of working.

This study belongs to area of logistics and based on warehousing and problematic of distribution center management. This thesis is constructive by nature, starting from practical problems and finding solutions to them. In this work also benchmarking and operational world-class target has been used for analysis.

This thesis picks up most critical improvement areas for warehouse management system update to this century, use possibility of voice control warehousing and updating current logistics contract to support and motivate for common improvement projects.

This master thesis provides clear options for improving distribution center operational efficiency and gives starting point for company to new development and improvement project. This thesis can be used for analysis and as an improvement basis for any other warehouse or distribution center. Study provides also lot of information for modern warehousing management, software, tools and solutions.

Keywords Warehouse, distribution center, voice control, logistics, world-class

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List of attachments

List of abbreviations

ABC	Activity based calculation/costing
AGV	Automated guided vehicle
ASN	Advance shipping notification
AR	Augmented reality
CLO	Chief Logistics Officer
DC	Distribution center
EAN	European/International Article number
E2E	End-to-end
ECR	Efficient consumer response
EDI	Electronic data interchange
ERP	Enterprise resource planning system
EWM	SAP Extended Warehouse Management module
GDC	Global Distribution Center
GR	Goods receipt
HUB	Logistics consolidation point
HMD	Head-mounted display
IDOC	Intermediate document, SAP data transfer format
KPI	Key performance indicator
LSP	Logistics service provider
PO	Purchase order
RF	Radio frequency
RFID	Radio-frequency identification
RFQ	Request for quotation
RLC	Reverse Logistics Center
SAP	ERP system delivered by SAP AG Company
SKU	Stock keeping unit

SLA	Service level agreement
SO	Sales order
TO	Transfer order, SAP warehouse internal put-away or picking request
VOIP	Voice over IP, general term for phone calls in internet
WM	SAP Warehouse Management
WMS	Warehouse management system
3PL	3rd party logistics service provider
4PL	4th party logistics service provider

1 INTRODUCTION

Target for this Master thesis is to find out and analyze the best possible efficiency improvement for Global Distribution Center (later called GDC). This analysis is done based on one dedicated distribution center but can be used for any similar operations. For every warehouse and distribution center someone may say that they all look the same, but they are still all different. Separate analysis is needed for each operation and hopefully this work makes the reader to think of possible options and gives some ideas about different improvement possibilities. In addition, target is also to give introduction for latest warehousing technologies for future operational and project personnel.

It is expected that this work will be valuable theoretically, process wise and cost wise. Based on this thesis scope, at the minimum, company should have a clear view what to develop and where to concentrate in the future.

This study is done based on company's internal willingness for improving efficiency combined with possible cost reduction and ensure fast and high quality customer deliveries. Depending on final outcome, at the minimum company should have a clear view what to develop and where to concentrate in the future.

This analysis needs to be done to every warehouse and distribution center (later called DC) separate even though there are always similarities, but they are still all different. The thesis should anyway provide information about different options for analysis basis and hopefully makes the reader to think of options and gives some ideas about different improvement possibilities.

1.1 Research framework

This study belongs into the field of warehousing. Theoretically warehousing is part of logistics and supply chain management. The reason for this theoretical selection is based on study concentrating on actual operations improvement in distribution center.

1.2 Business unit introduction

Company is one of the world's largest companies in its business branch. Specific business unit is part of service organization and responsible for spare part sales and delivery, replacement product delivery, repair services and also ensuring long term spare part availability for customers. GDC is key part of the total business and responsible for global after sales business unit deliveries. GDC is only real global distribution center and company has also one region specific distribution center in United States as well multiple smaller country and satellite warehouses around the world.

As business unit is specialized on after sales, this defines very much the nature of the business also. Lot of orders are based on faulty units are the customer and failure reports received. Based on failure report order is created and replacement item delivered to customer. Customer contract defines the lead time for distribution center and currently from GDC fastest service is next day available at the customer and varies up to several weeks. This means in practice that many of orders are only available in system when it is due for picking. Normally order is handled and shipped on the same day after arrival. As orders are based on failure report, there is one item per order and delivery consolidation to customers is mandatory. Largest customers may have lot of orders to same delivery address and to save money on picking, packing, shipping and transportation they are consolidated to bigger deliveries. Many of orders are also very urgent and critical to customer so agreed delivery times can't be missed. Actual spare part sales have bigger quantities on orders and typically have longer lead times also. Typical for this business is also rather slow inventory rotation, inventories must be rather high due to very short customer lead time requirement and also long term inventory reserve is stocked in same place to cover full life cycle of item at the customer. This high level of inventory will bring higher requirements to Warehouse Management System (later called WMS) solution.

1.3 Background and introduction for distribution center

Current distribution center is managed by external logistics service provider. All operations are outsourced to third party logistics partner (later called 3PL or 3rd party).

"3PL, third-party logistics operational model company is outsourcing logistics operations to external service provider. Service provider is managing outsourced services for supply chain, either partly or fully according to contract. Contract may include transportation as well other services like warehousing. Services are usually meant to wide range of customers." (Jalanka, Salmenkari & Winqvist, 2003). Same 3PL partner has been supporting GDC operations since beginning.

The GDC has SAP R/3system solution in use for warehousing operations. Existing operations and highly complicated processes are supported by SAP, but as well the system solution and the operations, they both have room for improvements.

Important years of operations:
1999 Outsourced distribution center operations started
2003 SAP R3 implementation project
2005 SAP enhancement project
2008 GDC consolidation project
2009 GDC recovery project
2011 GDC relocation project
2012-2013 SAP version upgrade project

1.3.1 GDC consolidation

Due to earlier company merger some years ago it was decided that this specific distribution center will be the major distribution center for company's after sales deliveries.

After decision several smaller distribution centers were consolidated to GDC to ensure efficient and consolidated global distribution center operations. Consolidation project was divided to three steps. Step 1 to prepare a system solution and start consolidated deliveries for pilot countries. On step 2 major consolidations from 3 distribution centers was completed and deliveries to all countries started. In step 3 further minor consolidation activities were executed.

As a result of full consolidation project major savings on warehousing operations as well on transportation towards customers were achieved.

1.3.2 GDC recovery project

After heavy merger related consolidation project operational performance started to decline significantly. Consolidation changed the operational processes partly but for part of the merged organization all processes and system solution was completely new as well operation had lack of control and discipline. All kind of workarounds and manual system transactions were executed out of actual correct processes. Separate recovery project was executed with special attention to tough management and discipline. With recovery project actual operational performance was returned to acceptable level.

1.3.3 GDC relocation project

Operations and facility after consolidation was planned to cover full delivery volumes and needed inventory space for minimum 5 years in the future. As things are tend to change, only three years from the consolidation, distribution center was heavily running out of inventory space. Full inventory was shared to several separate buildings in the same geographical area. Customer deliveries were having difficulties as for some of the customer orders items had to be picked from several separate buildings, still despite of heavy pre-planning on the inventory locations. Together with consolidation also delivery volumes have increased to more than double from origin. Additional costs and delays were present for operations.

Together with consolidation project, not only the impact on consolidation from other distribution centers, but also in addition delivery volumes and inventories started to grow significantly. Inventory increased due to additional purchasing as well because of new implemented additional processes. It was clearly seen that current location is not anymore big enough and further activities are needed.

This resulted to relocation project to enable smooth customer deliveries and efficient operations again. Relocation project was finally started mid 2010, and completed by mid 2011. GDC operation has now one large distribution center facility available and is again successfully delivering to customers.

1.3.4 General information

Current GDC is located in the Netherlands, Promised Land of logistics. Current available facility space is 23 000 square meters and with almost 35 000 inventory locations available. Height of the facility is 14 meters and warehousing space is equipped with modern multi-stock-type shelving and modern material handling equipment. One third of building is reserved for reverse logistics center (later called RLC) operations. Both facilities are managed by same 3PL partner and handling same materials for same customer. Difference is that GDC is only handling good units and RLC handling only faulty units, both using same SAP WMS solution.

GDC is delivering products to more than 100 countries globally. Yearly delivery volumes are around 700 000 item pieces. Due to nature of after sales business typically outbound shipments are small with quantity of 1-5 pieces only. Customer orders are with 1-120 days lead-time and heavily focused on urgent short lead-time orders. This high amount of outgoing shipments and short lead-time are setting high requirements for smooth operations.

Picture 1 Global Distribution center

During all these years and after multiple changes in operational environment and consolidation project, all the hassle in the middle, and the successful completion of relocation project, it is now excellent time and excellent basis for further improvement and efficiency increase analysis.

1.4 Content of this research

This thesis consists of five different parts. In chapter theoretical framework relevant theoretical part is explained and concentrating to warehousing and world-class operations. Chapter Research problem and objectives explains what are the key questions and targets for this thesis. In chapter Present state analysis I have analyzed current distribution center status on different ways and comparing to world-class level. Chapter Problem solving and improvement proposal is providing solution proposal to company how to improve the current status. Finally in chapter for conclusion and contribution there is summary of the thesis and improvements.

Constructive research typically includes also solution proposal validation in practice. In this thesis validation is based on general benefits and suitability analysis. Practical validation has not been possible to do due to changes in employment relationship.

1.5 Research exclusions

This improvement study is excluding inventory level calculations, radio-frequency based identification (later called RFID) technology analysis, warehouse layout planning and inventory rotation related analysis.

Inventory level optimization is under responsibility of company's Inventory management team, part of continuous planning and follow-up and now out of scope for this study. RFID usage has been already analyzed in another study for company and pilot project is ongoing. Warehouse layout and racking planning is done completely by logistics service provider (later called LSP) partner and company has only slight possibility to impact on that. Inventory rotation analysis is in hands of same inventory management team as inventory level calculations.

Additionally 3rd partly logistics partner selection has been left out as there is long term contract in place and successful partnership.

In this thesis company name has been left out by request from supervising person and due to possible sensitive and competitive relevant content.'

2 THEORETICAL FRAMEWORK

This study belongs into the fields of supply chain and logistics.

"The term *supply chain* is the process that integrates, coordinates and controls the movement of goods and materials from a supplier to a customer to the final consumer. The essential point with a supply chain is that it links all the activities between suppliers and customers to the consumer in a timely manner. Supply chains therefore involve the activities of buying/sourcing, making, moving and selling. Therefore, *supply chain takes care of business* following from the initial customer/consumer demand. Nothing happens with supply until there is an order; it is the order that drives the whole process. Indeed some people logically argue that the term *supply chain* could be called the demand chain." (Emmett, 2005)

Harrison states that the "current concept of logistics is the integration of time and space" (Francis, 2001). In this thesis I concentrate also very much on time and space. By ensuring fast processing to stock and out of stock to customer, this will save space also. By faster processing less handling areas and inventories are needed. Together with statement from Harrison we should not forget the importance of costs and quality. If any of these four key aspects is failing, operations are far from excellent.

"The term logistics describes the systematic approach towards the comprehensive optimization of flow systems, e.g., material flow systems, beyond single system boundaries. Depending on the alignment there are different definitions; a lot of these definitions just describe the role of logistics in research and teaching, with regard to the planning, organization and control of such system flows. Since this book focuses on the material flow special emphasis is given to the so-called "6Rs" of logistics. The "6Rs" of logistics describe the logistics targets as the delivery of:
-Right goods at the
-Right time in the
-Right quantity and the
-Right quality at the
-Right location at the
-Right costs" (ten Hompel & Schmidt, 2007)

"Despite simplification this principle is widely accepted. In this context right means the fulfillment of customer requirements like ordered, required, expected and minimum costs." (ten Hompel & Schmidt, 2007)

Logistics has multiple descriptions and explanations. One of the common basic approaches is the combination of the material flow, information flow and financial flow. When considering the flow model, 6R description is very meaningful explanation, shortly just doing right things with capital R.

"Essentially, this means organizations create superior value for customers and consumers by managing their core processes better than competitors manage theirs. These core processes encompass such activities as a new product development, supplier development, order fulfillment and cus-

tomer management. By performing these fundamental activities in a more cost-efficient way than competitors, it is argued; organizations will gain the advantage in the marketplace. This principle is powerfully expressed in the words of Jorma Ollila, the chairman and CEO of Nokia: "*Our experienced and unique way of operating is what we see as increasingly putting us ahead of competition. As we move forward in this complex industry, winning will be less what we do and more about the way we do it."* (Christopher, 2005)

Even though logistics can be understood in many ways the fact is that logistics is key part of many companies operations. At the best well managed logistics is bringing significant extra benefits to company and can be the real advantage against competitors. This fact must be understood and supported by company management.

"It is no coincidence that the handfuls of companies who have achieved excellence in logistics have been through a process of change that was driven from the top. Companies like Xerox, Hewlett Packard, Nokia and Philips have experienced, and are still experiencing, often painful change as they transform themselves from functionality based business to market-facing business. Whilst the impetus for change differs from company to company, the engine of change has been the same – the search for superior performance through logistics management." (Christopher, 2005)

The search for superior performance and improvements in one area or process step should never be done without understanding impact to other parts of the process. Lower costs at one step may mean high and increasing costs elsewhere. The relationship between these two should be always considered as part of the review and analysis.

2.1 Warehousing

At the further detailed level this study belongs into the field of warehousing. "The warehouse related actions regarding the outbound and shipping of the material can be considered as a part of customer order management. The integrated order management contains customer specified service for material, status tracking, financial aspects and technical support." (Francis, 2001).

What is warehouse/warehousing? Warehouse is a place where goods are stored. It can be e.g. building, silo, tank or open area. Warehousing can be done for raw materials, semi-finished goods or final products. As an most simply situation with warehouse, goods are coming in, stored for certain time and delivered out on correct time and with correct quantity for example as part of production process. Warehouse in spoken language is often meaning also the same as hub, distribution center or logistics center. They as used as consolidation centers and buffer stocking locations in the middle of complicated logistics chains. Products may come from hundreds of suppliers and delivered to thousands of customer delivery addresses. In written warehouse is typically understood as a location to keep the inventories and distribution/logistics center mainly as a logistics consolidation

point. Nowadays very often companies are outsourcing different parts of operations. Typically both operational parts, warehousing and logistics center, are consolidated and outsourced to one operational partner, like in the case of this thesis target company.

Why warehousing? Some may say that warehousing is not needed, or should be avoided as much as possible. This statement may valid for some business areas and at some level but nature of business and products must be considered for defining correct approach. Another statement is that warehouse is only generating costs. This statement as such is valid, but warehousing should be always considered as part of complete supply chain or logistics chain. When the complete chain is considered, warehousing is balancing material flows from production or suppliers to warehouse and from warehouse to further destination, production, other warehouses, stores or customer. In inbound process balancing is mandatory due to production lots and sensible purchasing quantities (needed quantity/best price quantity/quantity relevant for transportation). In outbound process warehouse is used for consolidating goods from different suppliers and delivering them all to customer together to save on transportation costs. Warehouse may also be used for long term storage like seasonal products, guaranteed spare parts availability after closing of production, or safety factor for natural disasters or other crisis situations.

With the consideration of full supply chain, purpose of warehouse is to improve the complete chain and even save on total costs. Proper inventory levels in warehouse will also enable fast delivery lead times to customer and good level of customer service as available inventory. When warehousing is done correctly it brings clear market benefits to owner.

How to avoid warehousing? Warehousing can be minimized with proper inventory level planning and by having warehouse "on the road" so that physical warehouse location would not be needed. By ordering directly from supplier and delivering directly to customer would not need warehouses at all but this would only apply for certain business types. Instead of avoiding warehousing better approach would be minimizing and optimizing the needed warehousing.

Why to avoid warehousing? Warehousing does not only give the benefits but is also generating costs. The more inventory is stored, higher the costs are. In addition to inventory and interests costs, there are costs also for space, work force, handling equipment, shelving, lights, heating, insurance, IT systems, damaged inventory etc. Too far minimized will again increase the costs as a lack of inventory or even in worst case as lost sales. To avoid unnecessary costs it makes sense to improve and optimize continuously.

Why only warehousing? In addition to basic warehousing operations; receipt, storing and shipping, warehouse/distribution center can also provide different value-add services, like repacking, re-branding, set creation, validating customer returns etc. These kind of value-add services are heavy increasing trend for distribution centers and may include anything from

small improvements for products until full outsources operations including even customer order handling, supplier management etc.

"Although the term warehousing raises negative images like high costs and non-value-adding times, in practice most branches are bound to store their goods for various reasons. A distinctive feature from logistics point of view is the fact that this is planned process to bridge over time and status. Some important reasons to implement and operate warehouse and distribution systems along multi-level supply chains are:
-Optimizing the logistics performance
-Ensuring the productivity
-Providing additional services
-Reducing transportation costs
-Balancing required and delivered quantities
-Using the market position
-Warehousing as a process step"(ten Hompel & Schmidt, 2007)

2.2 Warehouse management

"Warehouse management generally means the control and optimization of complex warehouse and distribution systems. In addition to the elementary functionality of an inventory management like the management of quantities and storage locations, the control and planning of transport means according to this principle of warehouse management also comprises methods and means to control the system status and to choose an operating and optimization strategy. For this reason the system preferably has to be called *internal system for the control and optimization of material flows or system for the control and optimization of the (internal) material flow.* For the reason for simplicity we have chosen the term warehouse management." (ten Hompel & Schmidt, 2007)

The theory of warehouse management is a vital part of warehousing operations. Warehouse management can be divided to two areas; actual managerial part of warehousing operations and warehouse management with systems typically called WMS (warehouse management system).

Warehouse management as operational activity requires significant resource and timely investment on performance, lead times, accuracy, control, safety, quality, resourcing and financial matters.

"The management of warehouse is the main function of a warehouse management system. On the one hand, these systems keep record of the storage capacity, i.e. the specification of the existing storage bins (location management) and on the other hand, of the stored units (inventory management). In addition to this, it should also include several control functions to optimize the storage activities." (ten Hompel & Schmidt, 2007). Any warehouse, bigger that garage size, warehouse management system is mandatory to have.

Warehouse management has two critical and vital parts, discipline and control. Missing discipline will lead missing process steps, products in

wrong locations, delays, not processed orders etc. in short called also as mess; nothing really woks properly at the end. Alternatively also control is as important. With proper level of control these possible flaws on discipline can be easily found and corrected before causing too much trouble for operative business.

2.3 Theory of world-class operations and performance

Theory and meaning of world-class is not that self-evident as can be seen on first sight.

"A prominent characteristic of world-class performers is their reputation or standing in the eyes of their competitors. In other words, does world-class competition pay attention to what they do? Another characteristic would be at what level they choose to compete. Is their arena local, or is the world their stage? In Summary, what makes company world-class is probably a combination of all these factors in varying degrees, depending on the chosen field. If an organization can successfully compete with any other player in the world at whatever it does, it should qualify as world-class." (Dettmer, 1998)

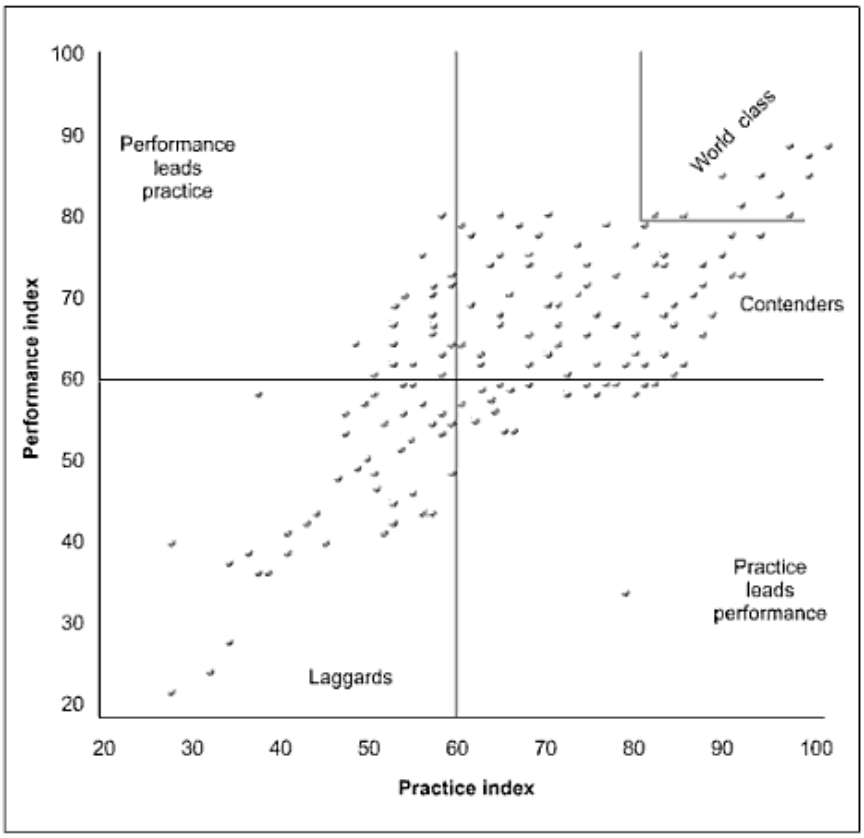
Company may be considered of being in the world-class just due to company size or market share. Other aspect can be the quality of products or services being in world class level. Key of being world-class must be comparable and measurable. Clear view is provided in different market share analysis as well in public comparison e.g. Fortune 500. This aspect clearly drops out all smaller companies from comparison.

On the other hand, also small companies or ever parts of the companies can be in world-class. In these cases world-class means of being in top of the world on something what they are or do. Often this kind of analysis is not publicly share as company is doing its own comparison to others.

Peter Wheatcroft is summarizing world-class definitions to:

- World-class organization as being recognized as the best for at least one critical business process and are held as models for the other organizations.
- World-class being a general term for a high level of competitive performance as defined by benchmarking and use of best practices.
- World-class as ranking amongst the foremost in the world; of an international standard of excellence; of the highest order.

All these definitions support world-class performance as being based on best practices, benchmarking and excellent delivery. (Wheatcroft, 2007)



Picture 2 Charting services against performance and practice indices (Wheatcroft, 2007)

Mark Graham Brown is stating in his book (Keeping score, using the right metrics to drive world-class performance, 1996) that measurement is the key to the world-class performance. By measuring correct things on correct way will give indication of current status. Measurement should always lead to corrective and improving actions. By knowing and understanding current position comparison is lot easier.

Despite of all different definitions, common understanding for world-class operations is being better than most other companies or operational units. Once company has achieved the world-class level, it does not mean automatically having same world-class level later. To become as well to stay on world-class level requires significant focus and investment for ensuring world-class operational performance. Similar to speed and quality on logistics, also world-class operations should not achieved without having a focus on costs.

By combining world-class operations and warehousing, we come to core of this thesis. World-class warehousing means warehousing and distribution center operations which are in top class, comparable to any similar operations and beating them in most areas. To be in world-class it requires top personnel, facility, equipment, tools, processes and operational execution. One of key analysis on this thesis is to understand the current position on distribution center operations and how to achieve the world-class level.

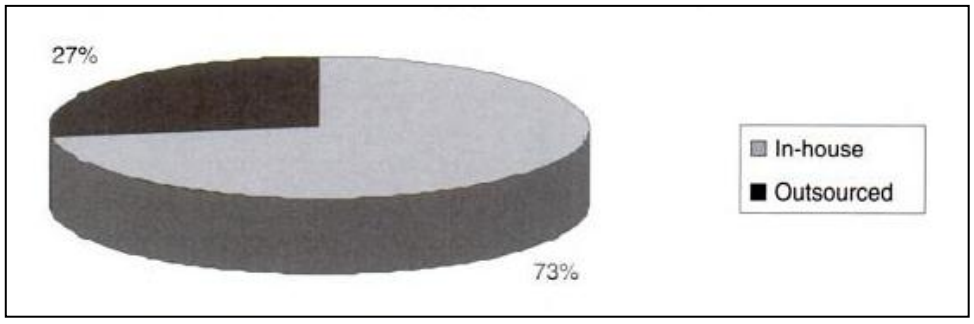
2.4 Logistics outsourcing

As company has outsourced distribution center operations to 3PL partner, discussion for outsourcing theory can't be avoided. "For almost all new outsourcing arrangements, the initial issue after the contract has been successfully negotiated is the successful implementation of the operation." (Rushton & Walker, 2007). Starting point is to have contract in place and then ensure successful deployment. Successful implementation of the operation can be also understood, not only start phase implementation, but in a way continuous implementation and co-operation. Once implemented does not mean it can be forgotten as there is always some additional or new to be done.

"Number of reasons for why outsourcing deals do not succeed:

- Not setting clear or realistic expectations
- Poor implementation
- Relationship focused entirely on cost reduction
- No clear service level agreement (later called SLA) in place
- Over-Promising
- No sufficient competence transfer
- No continuous improvements
- No performance measurement program
- Poor communication" (Rushton & Walker, 2007)

After ensuring successful deployment, business and relationship demands continuous efforts. "Whether you are running a logistics operation as an in-house manager or as a third-party contract manager, the basic reasons for monitoring the operations are very similar: to measure whether the operation is meeting set service levels at an acceptable cost. There are also some special metrics that 3PL may need to provide the client company. The final part of outsourcing process is, therefore, to ensure that the contractor is adequately managed. This is a key consideration that is sadly neglected by some users. The signing of the contract should not be seen as the end of outsourcing process. It is vital to continue to control and monitor 3PL to ensure that overall business and operational objectives are achieved." (Rushton & Walker, 2007)

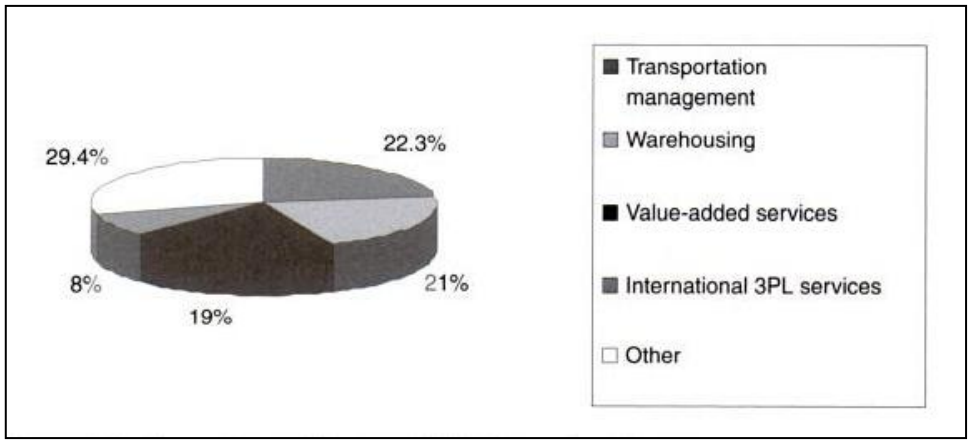


Picture 3 Global logistics in-house spend versus outsourced. Data source: Transport intelligence (2006), from book International logistics and supply chain outsourcing (2007)

The trend for outsourcing is clear and portion for outsourced business is undoubtedly increasing on yearly basis. Same trend is seen also in other business areas than logistics. Alexander de Grahl is writing "For example, a large industry survey by Langley Jr. et al. (2009) indicates that in 2009, of total logistics expenditures in Western Europe 66 percent and in the U.S. 47 percent, respectively, were devoted to logistics outsourcing." (de Grahl, 2011). This survey clearly shows already heavy increase from year 2006.

Warehousing can be part of internal operations or outsourced to external partner. Usually reasons for outsourcing are that warehousing is not seen relevant as part of company core business, company is not able to handle the business properly anymore nor is competent enough or is just looking for cost saving possibilities.

Warehouse and distribution center operations outsourcing is usually done to logistics service providers who are specialized for logistics management. These 3PL companies are executing with their core competence and may enable significant cost savings and improvement on operational performance for outsourcing company.



Picture 4 Percentage of Fortune 500 3PL services by types. Source: Armstrong and Associates (2006b), from book International logistics and supply chain outsourcing (2007)

2.5 Benchmarking

"Benchmarking is defined as measuring your performance against that of best-in-class companies; determining how the best-in-class achieve those performance levels; and using the information as a basis for your own company's targets, strategies, and implementation, or more simply, the search of industry best practices that lead to superior performance." (Evans & Lindsay, 2008)

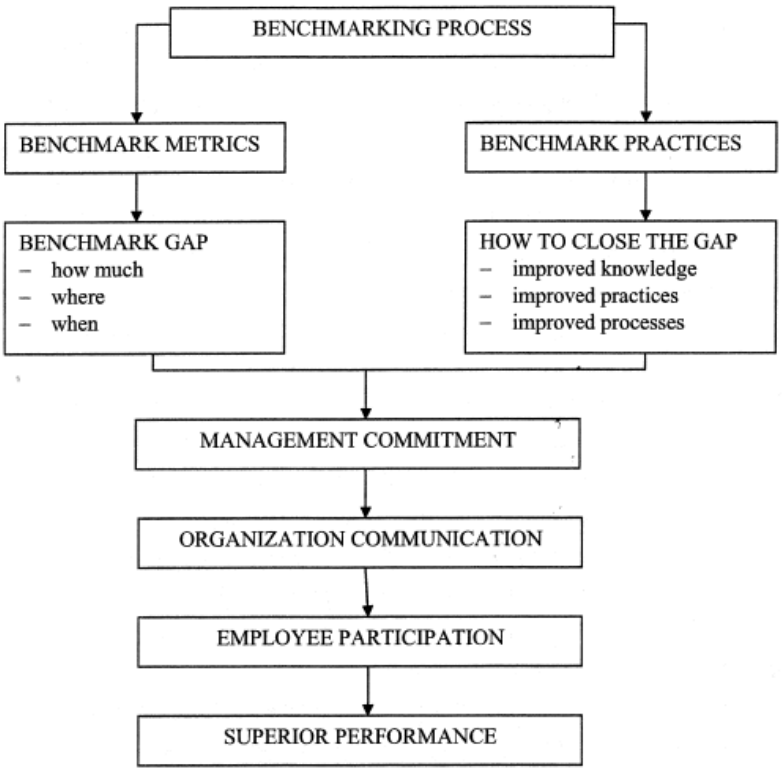
One of benchmarking challenges is to find the best companies or operations to compare for. Comparison to competitors may be very difficult for information and data availability and may not even give expected results. Similarly within the same industry benchmark may give only slight better expectations for operations where target is an industry leader. "However, if benchmarks are adopted from outside the industry, a company may learn ideas and processes as well as new applications that allow it to surpass the best within its own industry and to achieve distinctive superiority" (Evans & Lindsay, 2008)

The idea and concept of benchmarking is not new. "Henry Ford created the assembly line after taking a tour of a Chicago slaughterhouse and watching carcasses, hung, on hooks mounted on a monorail, move from one workstation to another"(Evans & Lindsay, 2008). This example shows very well how you can become an industry leader by utilizing benchmarking information and adapting standard solutions of one industry to another business field.

"Different types of benchmarking
- Competitive benchmarking (seeking winning products, processes, services, pricing etc.)
- Process benchmarking (seeking winning processes, solutions and ways of working)
- Strategic benchmarking (seeking winning strategies that have lead to competitive advantage and market success)" (Evans & Lindsay, 2008)

Different levels of benchmarking
- Benchmarking operations to itself over the time period
- Benchmarking operations to other similar operations within the company
- Benchmarking operations to other companies best-in-class in the similar business
- Benchmarking operations to best-in-class companies in other industry areas

"The basic philosophical steps of benchmarking are fundamental to success: know the own operation (weaknesses and strengths), know the industry leaders or competitors, incorporate the best (learn from industry leaders and competitors) and gain superiority (Camp, 1989). Camp has presented a widely used generic benchmarking process, which describes several important points to help understanding of the process" (Kleemola, 2005)



Picture 5 Generic benchmarking process (Kleemola, 2005 with reference to Camp, 1989)

One time benchmarking will give a competitive advantage to company when executed successfully but only for certain time period. Sooner or later competitors will utilize the same solutions and methods and gained benefit is lost. Benchmarking should be a continuous process to benefit successfully in long term.

Benchmarking on this thesis has been utilized three levels, comparing theoretical world-class level, compared to another distribution center in the same company and two distribution centers in other companies.

3 RESEARCH PROBLEM AND OBJECTIVES

This chapter provides more information for research problem and used research methods.

3.1 Research Problem

Research problem has been given by the company and based on internal needs. Company has clear willingness for continuous development and improvement and desire for market and business leadership.

The research problem is to find out
1) Gained benefits of relocation project
2) What are the biggest issues on current operations
3) How to improve current operations in Global Distribution Center, located in Netherlands, and
4) How achieve world-class operations

Firstly, target for this thesis is to analyze and find out current issues on the operations, and secondly, target is to find out the best possible options for distribution center improvements for the future. Purpose is to analyze different possibilities for operations improvement, including both processes and system related.

Study includes such as a possible improvement for example voice controlled warehouse activities on put-away, picking and controlling, roll track utilization and basic system as well process alignment.

Consequently, the objectives of this study to analyze different improvement proposals for business benefit point of view and compare them to current situation to make proposals for enhancements. Finally the target is to initiate cost saving possibilities, reduce errors and improve the overall efficiency to guarantee world class operations in the future.

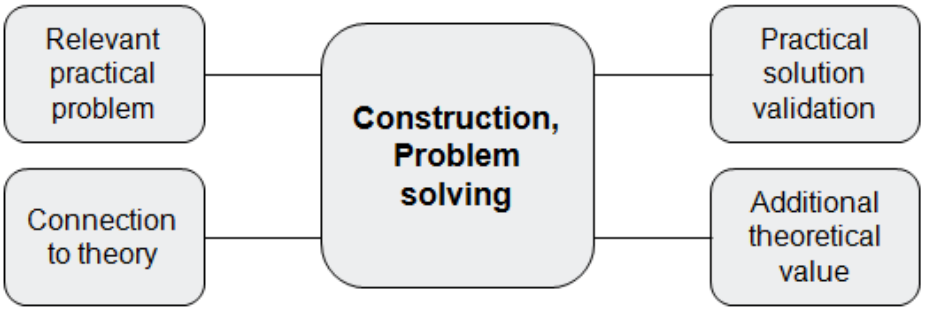
3.2 Research Methods

This study belongs to fields of supply chain and logistics, theoretically in further details for warehousing. The reason for this theoretical choice is the actual need and request for improving the warehousing operations at Global Distribution Center.

This study is constructive research by nature. Constructive research is highlighting innovation, creativity and heuristic approach. Constructive approach is starting from problem without solution, and focusing on problem solving with determined and innovative approach, and proceeding to practical validation of solution, connection to theory and analysis or scientific added value. Constructive research will not bring solution for one problem case only but to complete problem type with adaptations.

"Constructive research can be divided to six phases:
1. Find relevant and study wise interesting research problem
2. Collect information and get understanding on research object
3. Innovation phase, solution model construction
4. Solution model functionality validation, proof of construction correctness
5. Solution model connection to theory and vindication of scientific newness value
6. Solution model" (Olkkonen, 1994)

Simplified approach for constructive research is presented in book Johdatus Teollisuustalouden tutkimustyöhön, 1994. This approach consists of five main parts; finding relevant problems, actual construction and problem solving, connection to theory, validating solution in practice and proving information for new additional theoretical value. This kind of approach I have targeted on this thesis.



Picture 6 Constructive research study model (Olkkonen, 1994)

Additionally in this study benchmarking method has been used. Benchmarking is typically comparing operations and performance to other similar operations inside or outside of company and sometimes even to completely different businesses. Target for benchmarking is to find out how things are done by others and how things can be done better.

Benchmarking for warehouse operations:
"-Benchmarking is a critical step on the way to world-class warehousing
- External benchmarking should be used to set world-class goals for the warehouse operations and process improvement projects.
- The benchmarking process should jointly consider all the major warehouse performance indicators including, productivity, shipping accuracy, inventory accuracy, dock-to-stock time, warehouse order cycle time, and the level of mechanization.
- Benchmarking and warehouse performance gap analysis should be used to set incrementally justify capital expenditures.

Benchmarking and warehouse practices analysis should be users to align the warehouse practices with world-class standards." (Frazelle, 2001)

"Benchmarking process:
1. Define target
2. Find best comparable and similar process
3. Learn own processes
4. Learn best selected comparable process
5. Define differences on performance and reasons, ask why
6. Set the target
7. Adapt and take new process in use
8. Stabilize and develop further" (Tenhunen & Niittymäki, 2011)

Benchmarking typically can be done multiple different ways and in many cases final approach is depending on author itself. In this thesis benchmarking has been done for internal and external operations, as well including benchmarking to theoretical world-class operations. Benchmarking and comparison has been done also for relocation project situation before and after.

For analyzing and improving warehouse operations combination of constructive research method and benchmarking works very well. Methodology selection for this thesis is based on further analysis of assignment for the study.

Theoretical information has been collected from multiple sources; books, earlier similar studies, magazines, internet and companies who are providing different warehousing related solutions.

Author of this thesis has been involved on several different projects for this specific Global Distribution Center. To gain further competence and understanding on processes, I have worked at the selected site as interim distribution center manager for six months. This on site period was arranged due to changes for on-site personnel and based on the need of additional competent site management resource. In addition to latest management position author has worked on site as specialist several years earlier as well worked in multiple earlier projects in different roles with multiple additional site visits. During all these years in depth understanding has been gained for all processes and tools. During all these years and visits there has been huge amount of different meetings, discussions and interviews. In addition also participation observation has been in important role. For further similar studies and improvement projects sufficient time spend at the site is highly recommended; this is the best way to get good understanding on processes, tools and methods.

Benchmarking and comparison data has been collected from specific current distribution center and by visit and interview to other similar operations within same company and other companies.

4 PRESENT STATE ANALYSIS

This chapter is concentrating on finding out current distribution center situation and level of operations. Processes and solutions are analyzed on different ways and targeting to address all main issues for a basis of improvement analysis.

4.1 Present state against world-class analysis

What is world-class warehousing? General understanding for term world-class is just doing things better than most others. For warehousing business one common definition for this is created by Edward H. Frazelle. "Major distinguishing feature of world-class performing warehouses is their practices. The warehouse performs as a function of its practices." (Frazelle, 2001)

He has developed the two analysis models for warehousing,
- Warehouse practices gap analysis
- Warehouse performance gap analysis

Edward H. Frazelle prefers practices gap analysis as a main contributor for analysis. Both of these analyzing models are giving answer to question "how things are done" but with different approach. Warehousing practices is comparing capabilities and technical way of working and the performance analysis is more indicating speed, efficiency and quality.

4.1.1 World-class warehousing practices with Frazelle's gap analysis

Practices in this context have a wider meaning for anything what is happening in the warehouse.

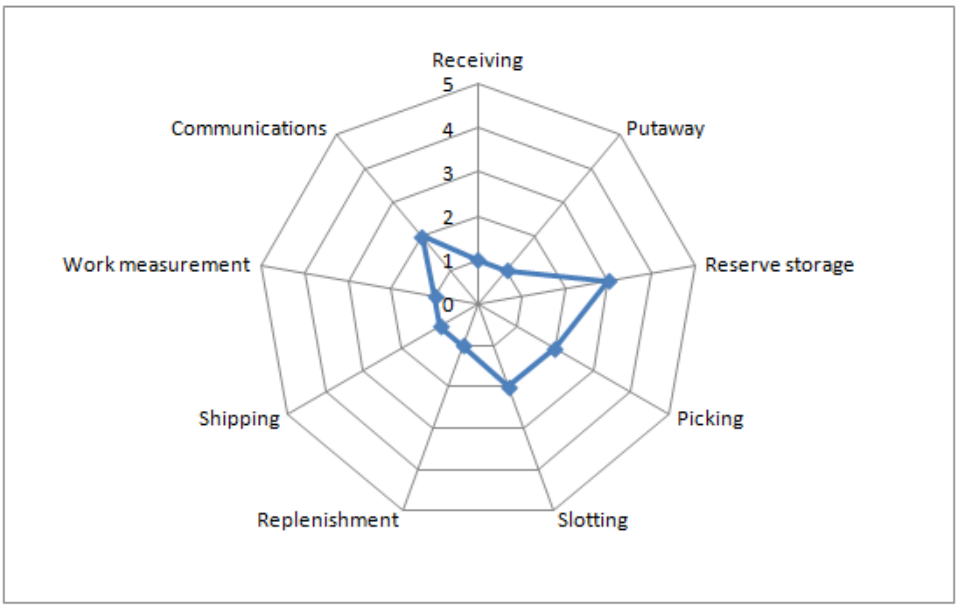
In Edward H. Frazelle's analysis model for practices gap analysis there are classification scores from 1 to 5, stage 5 as world-class, stage 3 as middle-class and stage 1 as no-class practices. In Frazelle's model scores are presented in radar chart model. Each radial represents one of the functional areas in the warehouse and outer ring defines world-class standards.

Frazelle's practices analysis model is covering each functional area in the warehouse. Each functional area will be evaluated with scores from 1 to 5.

Process	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Receiving	**Unload, stage & in-check**	**Immediate put away to reserve**	**Immediate put away to primary**	**Cross-docking**	**Pre-receiving**
Put away	**First-come-first-serve**	**Batched by zone**	**Batched & sequenced**	**Location-to-stocker**	**Automated put away**
Reserve storage	**Floor storage**	**Conventional racking & bins**	**Some double deep storage**	**Some narrow aisle storage**	**Optimal hybrid storage**
Picking	**Pick-to-single-order**	**Batch picking**	**Zone picking – progressive assembly**	**Zone picking – downstream sorting**	**Dynamic picking**
Slotting	**Random**	**Popularity based**	**Popularity and cube based**	**Popularity, cube and correlation based**	**Dynamic slotting**
Replenishment	**As needed – pick face complete**	**As needed – downstream complete**	**Anticipated – by sight**	**Anticipated - automated**	**Pick from reserve storage**
Shipping	**Check, stage & load**	**Stage & load**	**Direct load**	**Automated loading**	**Pick-to-trailer**
Work measurement	**No standards**	**Standards used for planning**	**Standards used for evaluation**	**Standards used for incentive pay**	**Standards used for continuous feedback**
Communications	**Paper**	**Bar code scanning**	**RF terminals**	**Hands free**	**Virtual displays**

Table 1 World-class warehousing practices gap chart (Frazelle, 2001)

After completed analysis and evaluation the end results is shown by E. H. Frazelle as radar chart model. Radar chart is a very visual model to see the current status on world-class point of view.



Picture 7 Example for practices analysis model for warehouse practices gap analysis, (Frazelle, 2001)

Each of practices gap analysis categories should be analyzed separately and evaluation score categories are already give by Frazelle. Based on same model categories can be changed if needed and if not relevant for business. For this distribution center proposed model works quite well and not seen any reason to change it.

Of course in real life each functional area has impact to each other and full chain at the end creates the total picture. It is good to have also certain level of balance between categories as end result is not very good if in-bound works very well but outbound is a bottleneck, or other way around.

4.1.1.1. Receiving analysis

First part of Frazelle's practices analysis is receiving. Current operational model is following:

- Pre-notification
- Agree unloading dock time slot for truck arrival
- Unloading truck to docking area
- Transfer to sorting and goods receipt area
- Sort items to separate pallets and process goods receipt (GR) to system
- Transfer to waiting area for placement
- Transfer to primary stock location

Each phase has different equipment in use and process has separate mainly separate steps. Part of unloading can be done directly to sorting & booking

area but mainly taken to pre-docking only. Actual primary locations are divided to three different areas; narrow isle, high bay locations, fast picking locations and mezzanine locations.

Currently only possibility for doing the goods receipt booking is manual system transaction. Due to business nature and way of purchasing lot of sorting for pallets is needed. Big part of pallets is coming to DC as mixed pallets and must be broken down as one bin location in warehouse can handle only one material code.

Cross-docking and inbound-to-outbound processes are critical to business but currently only possible for special limited item and service portfolio. In addition process is fully manual with special arrangements and without actual system support and is not possible to extend without WMS development. As ordering to specific SO is not possible, available items can be easily taken to wrong order which is causing delays and dissatisfaction to other customers. Other due to special after sales business nature, having next stock batch available may need lot of time and this is why delivery to correct customers and correct orders is critical.

Inbound is often depending on available pre-information. Currently only available information is coming from suppliers or transportation companies and that is very minimal, mainly amount of pallets and timing. Pre-receiving then, is not supported at all by current WMS solution.

Current solution and way of working can reach only level 1. Major challenges are slow throughput time from dock to location, lack of needed processes and system solution as well lack of pre-information availability.

4.1.1.2. Put-away analysis

Process for put-away is done system driven and user controlled but it is quite limited. Sorting in inbound area is done fully manually and items are collected to pallet for put-away. Pallet is taken to waiting area for further processing by fork-lift. Driver will take the pallet and take the reference number for each received batch to WMS, which will then tell destination location for user. Warehouse worker can source list of transfer orders with tablet-PC based on dedicated pallet number and follow the actual put-away process. Put-away order can be done in A-Z or Z-A order based on location list on the user screen. Driver is going to location, placing items to shelf and confirming step in system by scanning the location code barcode and product barcode.

Confirmation works well and provides the control and quality for the process. What then don’t work are the inbound sorting, batching for put-away and route optimization for destination locations. Sorting is fully manual without any optimization for next steps and batch is the available pallet, smaller inbound batches are just collected to one combination pallet. This combined palled is then kept somewhere in inbound placement holding are but no-one knows where pallet exactly is. Put-away is targeted to be done on first-in first-out bases on pallet level but has no control for outbound

urgency. Destination location placement route is up to forklift driver to do and may take lot longer than as system optimized. In worst case some items are missed on the pallet and driver must return to same isle again.

When system support is not in place it can cause further delays on inbound process and possible errors. Errors are prevented happening by location and material code verification on put-away, but delays on the process can be minimized only with WMS enhancement.

This current very manual approach can reach only level two.

4.1.1.3. Reserve storage analysis

Reserve storage and locations, current facility has:

- Storage isles for wide isle handling
- Storage area for narrow isle handling
- Walk-by picking isles
- Mezzanine storage area for small items and small quantity bins (2 floors)
- Dedicated area for extra wide items with special racking
- storage areas for cross docking materials
- Each area has multiple different bin sizes for different purposes

Based on E.H. Frazelle's definitions on storage location analysis current facility has multiple different stocking locations and options, which would make it as optimal hybrid storage, level 5. This approach is only optimal by definition and may apply for some time. Day by day situation is changing and typically one or more areas are running out of space and others have too many empty locations available. Even worse in current situation it is for detailed location types within one storage type where available locations can be too small or too big, or reserved for wrong kind of material. Lot more flexibility would be needed for actual detailed level locations.

4.1.1.4. Picking analysis

Picking is currently done according to level 3 or 4, based on batch and zone picking and sorting to outbound hold area. Each batch has maximum 40 orders/deliveries included, and then divided to separate warehouse zones for picking. Typical situation is that several small quantity orders are combined to one batch. At the end of picking process partial manual sorting is required which is somehow similar to level 4, zone-picking with down-stream sorting.

Current solution has some issues with multiple picking. Unfortunately WMS is not able to handle these on the most beneficial way, as it requires picking for each order separately even though they would be consolidated to same outbound delivery. E.g. same high volume item requested for picking with 10 pieces for 10 separate sales orders, and all from same location. In this case system is advising picker to pick 10 times one item, and not once 10 pieces of item.

Another issue with current picking is the missing support of zone based picking and consolidation on outbound area for one shipment. In addition to WMS there is additional tool, with manual data transfers both ways, to split picking to different zones and controlling consolidation afterwards. Each zone has different equipment and separate personnel which makes the zone control mandatory. After completing picking in each zone, somehow items must be consolidated back to same customer delivery again without losing location control anywhere in between. With combination of these two tools work can be done surprisingly well but manual data transfer is very risky for errors and delays.

4.1.1.5. Slotting analysis

In today's solution each material has pre-defined storage section indicator information maintained in material master. This storage section indicator is defining preferred shelving type and zone within each shelving type, e.g. A-zone for high moving A-materials. Section indicator is calculated for each material and typically defined when item is received to inventory first time. Calculation is considering delivery volumes and item size. It is possible to update information on the need basis, but typically not done too often. Calculation and data maintenance to material master are done manually.

During goods receipt process, destination location for each material is defined. This destination location is given by system based on following logic: 1. Fill existing locations with same material 2. Choose first available preferred empty location based on storage section indicator 3. If all preferred locations are full, choose first empty location from next non-preferred area.

Current SAP solution is not calculating anything for slotting and not supporting any system driven slotting. Slotting is purely based on pre-defined system values which are causing lot of items stored in completely wrong place or at the minimum in non-preferred low efficient location. When products are in non-preferred locations they tend to have longer pick and put-away distances. It is not only affecting for one item pick from one location but to every single pick and put-away transaction. Current preferred location placement correctness is very low and only temporary manual actions can be done for avoidance.

System is missing the reporting and analysis capabilities for correct master data settings for slotting purposes. Similar, no system driven location optimization is available.

Operations are now only on level 1, random slotting. Somehow level 2, popularity based is utilized as well but is simultaneously continuously incorrect due to onetime definition and occasional changes on material master storage section indicator.

4.1.1.6. Replenishment analysis

Replenishment is triggered according to pre-agreed schedules relevant for picking phases. WMS is used for replenishment proposal generation according picking locations minimum and maximum quantities and replenishment batch quantity. Transaction is executed manually and is dependent on user to run report on timely manner. User is checking the proposal and generating these to transfer requests for warehouse operators. Actual transfer is usually executed during the night or breaks when operations are not that busy.

Replenishment is mainly on level 1, as needed – when pick phase is completed. In some cases by sight is executed as well but this is fully manual activity, picker will need tell inventory controller what is needed and in which location.

Current system solution does not allow fully automated solution for replenishment planning and execution. Similarly it is missing functionality for quick messaging or requesting for replenishments when picker will see that location is getting empty.

4.1.1.7. Shipping analysis

A current operation is heavily driven by on small deliveries and standard or express air freight due to business behavior and demand for fast delivery. Each individual transportation box checked and is taken to staging area to dedicated staging pallet per LSP. Each transportation LSP has dedicated pallet or several waiting for pick-up and wrapped lightly for transport. These pallets are unwrapped in LSP Hub's or Depot's and boxes taken to correct transportation according to destination delivery address. Each pallet may contain dozens of boxes to different delivery addresses.

Current approach is on level 1, check, stage and load.

4.1.1.8. Work measurement analysis

Current warehousing operations is outsourced to 3PL (3rd party logistics service provider). This is limiting the company visibility very heavily on workforce related topics. Business owner is purchasing and getting the service from 3PL, not guiding them how to do their work on details. Part of business details are also considered company confidential and 3PL partner is not willing to give these outside of company as information can be then used against them in e.g. next contract negotiation round.

Based on further discussions, no data has been given, but estimated amount of external personnel is around 50%. For internal personnel clear standards are in place, information is used for planning and evaluation. In addition continuous feedback methodology is used for internal personnel only, and no incentives are paid based on performance.

All outsourced personnel will get training when they arrive. 3PL partner has also standards available what kind of personnel is hired from external employment agency, what is the needed competence level, planning is done regular basis and standards are used for personnel evaluation. Unfortunately no incentive is paid for externals nor is continuous feedback process used.

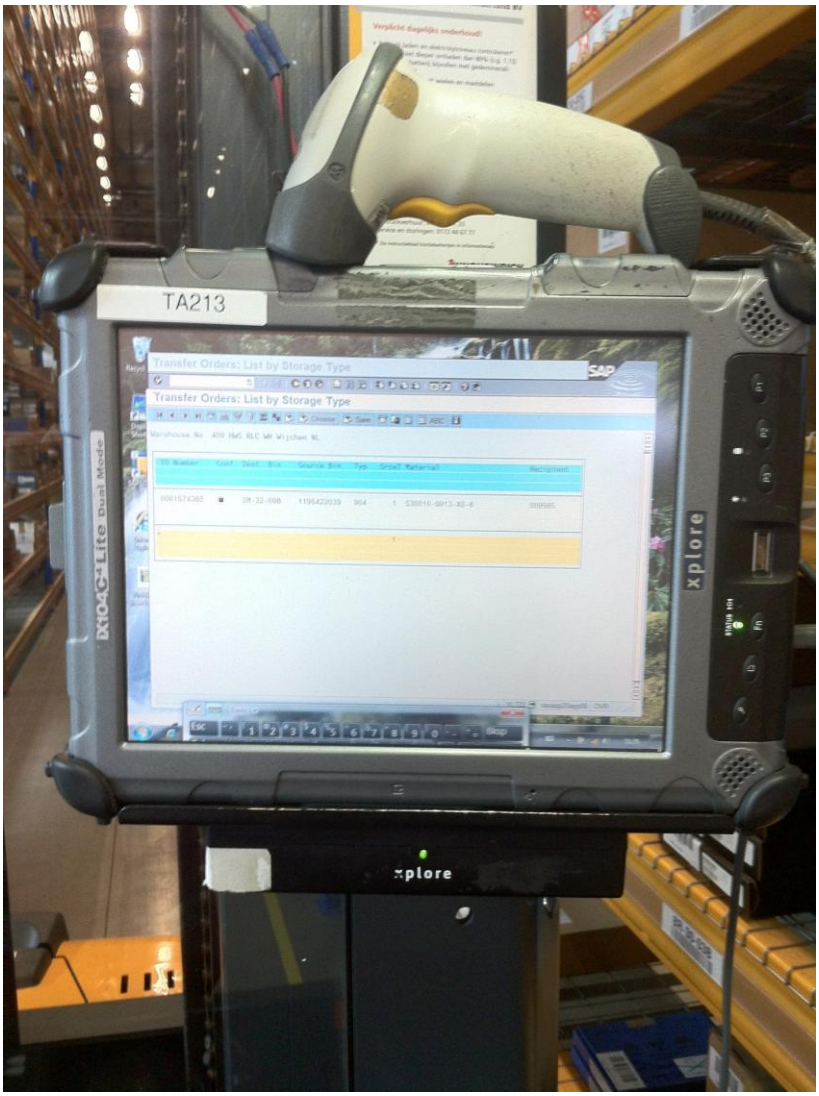
4.1.1.9. Communications analysis

Distribution center has currently RF based touch screen tablet PC's in use and connected over wireless LAN network. Tablet-PC is very useful when there is a need to have longer lists on screen and have more visibility on any transaction in WMS. These tablet PC's are always located in wall stand at forklift or picking trolley as they would be too heavy to just carry around. Picking and put-away operations are all executed with forklift or trolleys, including also barcode scanners. Barcode scanners are used for location and material code verification on picking and put-away.

In addition, transactions executed with tablet-PC's are not touch screen optimized. System is based on standard SAP transactions and calling some RF transactions which both always includes lot of small details and too much information for the user. Due to this almost only way to use the screens is the touchpad pen.

Current tablet-PC's are from the time when SAP was implemented 10 years ago. Without a trolley or forklift it is really heavy to take these anywhere and practically no-one is doing that either. When other supportive operations are needed e.g. inventory counting then tablet-PC has a special movable stand with additional battery and scanner connected to it.

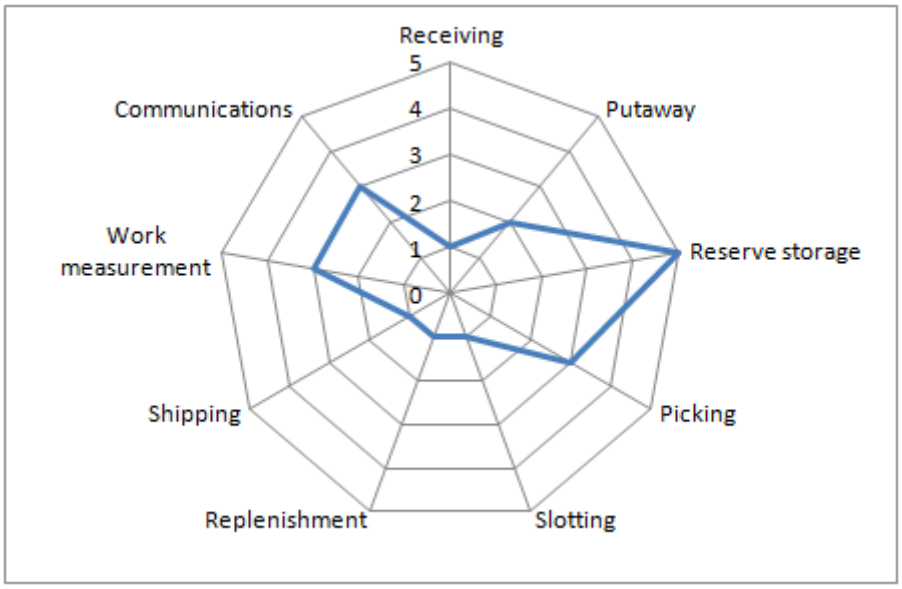
Current operations are in level 3 for world-class analysis.



Picture 8 Current GDC forklift Tablet-PC with barcode scanner

4.1.1.10. Summary for Frazelle's practices gap analysis

According to Edward H. Frazelle's practices analysis current operation is scoring 20 points. This equals average only 2,2 points which is quite far from world-class level 5. By Frazelle's definition 2,2 is even below middle class. This analysis clearly shows that there is still long way to go until world-class warehousing level is reached.

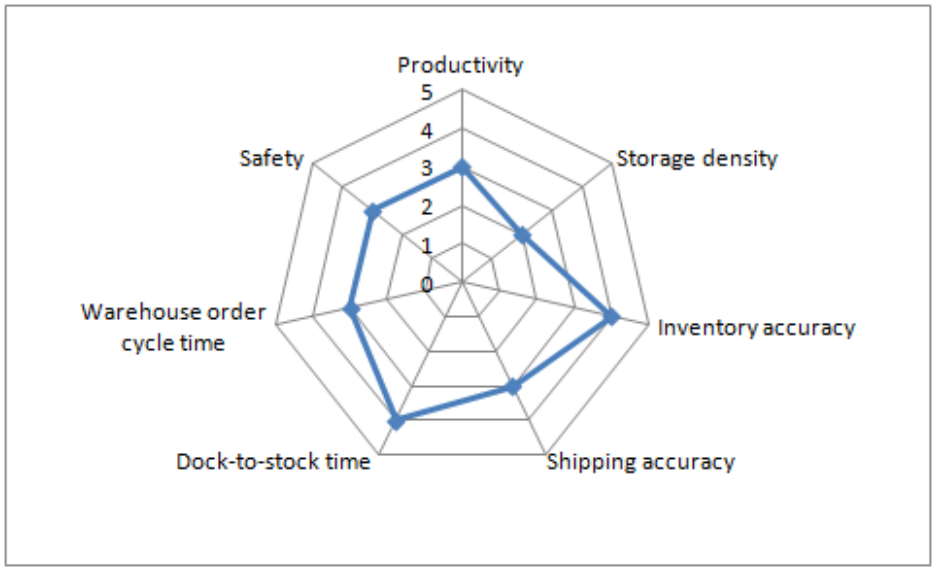


Picture 9 Summary of current GDC status for Frazelle's practices gap analysis

4.1.2 World-class warehousing performance gap with Frazelle's analysis

Similarly as in practices gap analysis, for performance gap analysis Edward H. Frazelle is using classification scoring from 1 to 5, stage 5 as world-class, stage 3 as middle-class and stage 0/1 as no-class practices.

Main practical difference between these two comparison models is that practices gap analysis is easier to compare to other companies or locations as the understanding the terms is more general. Warehousing performance is bit more hard to compare to others. Even in this model shipping accuracy, inventory accuracy and safety are more general and comparable but other factors are very much business dependent. These business dependent categories can be compared to something exactly similar, but what is usually even better, compare to same operations but over the certain time period. Over the time the trend of change can be seen when the measurement criteria's and targets are set in the beginning.



Picture 10 "Example for warehousing performance analysis model, Figure 3-2 Warehouse performance gap analysis" (Frazelle, 2001)

E. H. Frazelle is giving example for world-class level based on following:

- Productivity	6 lines/hour
- Storage density	1 SF/SKU (square foot/stock keeping unit)
- Inventory accuracy	95%
- Shipping accuracy	99,97%
- Dock-to-stock time	24 hours
- Warehouse order cycle time	12 hours
- Safety	max 1 accident/year

Due to outsourced operations productivity information is not available as amount of working hours is not known.

Storage density currently in this distribution center must counted on square meters with following conversion $1ft^2 = 0.092903m^2$.
Current density is approx 3 SF/SKU but this number is very business specific number and highly depending on product size and calculation model. Based on this number it can't be concluded if distribution center is on world-class level or not but over time period this number should be followed and improving trend targeted. Other conclusion related to storage density is that with better warehouse management system storage density can be improved and correct locations controlled better. Currently there is no possibility to get any transfer proposals from WMS just based on improvement activity.

In this distribution center inventory accuracy is constantly above 99% which is definitely excellent level on warehousing. For 95% being as world-class level, I don't agree with Frazelle. 5% gap on inventory accuracy will have impact on operations like put-away, picking and all kind of continuous corrections. All this will increase warehousing costs and de-

crease customer satisfaction. Better number for being in world-class should be 98 or 99% and in some business areas it can be even higher.

For shipping accuracy 99,97% is clearly on world-class level. Current agreement with 3PL partner is target for 99,5% which they are fulfilling with excellent scores. Accuracy may drop below target level only very occasionally.

Dock-to-stock time is also part of agreement with 3PL partner. Target time is 24 hours that everything is received to system. Typically everything is received already during the same business day and not even full 24 hours is needed. Similarly to shipping accuracy the agreed timeline is missed only very occasionally. Question is if this 24 hour limit can really be treated as world-class nowadays? In today's logistics real time visibility is one of key criteria's for successful business and based on this world-class level should be only few hours instead of full 24 hour cycle time.

Warehouse order cycle time world-class level 12 hours can be easily fulfilled. Warehouse orders are created six times per day and processed first-in first-out basis. In normal daily business situation warehouse order is fulfilled during one working shift and operations are completed in time.

Safety as an important category reaches world-class level as no reported accidents during last two years.

Conclusion based on this analysis is that targeted world-class level is already achieved on all categories where information is available. According to results business unit can be happy but this can never be taken as granted. Also set target level for world-class can be discussed but even requirements for level 5 would be increased current distribution center can still fulfill them.

4.2 Outsourcing and logistics contract analysis

Current distribution center operation is fully outsourced to 3rd party logistics service provider. Contract is based on frame agreement and logistics appendixes. Frame agreement is agreed on company level, one with each LSP. Logistics appendixes are done on department level and there are multiple appendixes per each LSP. Each one is created according to different business unit needs for logistics processes and services. Frame contract is renewed 5 year basis. Current distribution center appendix is renewed on 3-year basis.

Contract pricing point of view, this is a mixed contract. Standard operations are paid according to transaction price, special and additional work is paid per hour, warehouse space according to square meters and in addition a payment for fixed costs of operations.

4.2.1 Analysis of current contract

Current contract has a statement in the appendix "The parties agree to establish a gain sharing program on cost savings identified and realized." (LSP contract appendix, 2008). So far, this common gain sharing program for cost savings has not been started.

Contract has also a bonus/penalty statement for KPI metric (key performance indicator) based performance follow-up. Performance follow-up is calculated for four different categories; inbound performance, inventory accuracy, outbound performance and warehouse space fill rate. Bonus/penalty is calculated and paid based on six months period according to outbound performance (OP). OP target is 99,25% and when exceeded, bonus is paid based according to four levels for exceeding the target level. Bonus is paid with certain percentage levels out of invoice value. Similarly, in case OP target is not reached, penalty is paid according to four levels as percentage out of invoice value. So far penalty and bonus payment rules have not been used.

No current contract or appendixes has anything mentioned for performance or process improvement and their impact on payments.

4.2.2 Problem statement

Target for any corporation and as well 3rd party LSP's, is to maximize their business for revenue and profit. When LSP is performing according to contract and even exceeding, they usually can ensure needed level of income. Awkwardness comes out of the ways of maximizing profit level, as the practice may not be beneficial for both parties or not good for long term.

LSP is interested on their revenue and net profit as any other company. This very clear as no-one wants to lose the profit of the business.

Another very typical situation for outsourced operations is that continuous development efforts are done but only to increase the LSP profit. This is very valid scenario on this specific case also. Continuous development may mean some benefits to customer like quality and performance improvement which will bring indirect cost savings, but not done intentionally over the agreed performance levels.

The challenge with outsourced partnership is that when improvement activities are done, this usually affecting negatively on revenue. Company as a business owner provides tools (e.g. SAP in this case) and processes partly given and partly according to LSP. LSP in this case is responsible for executing transactions according to processes. Business owner is developing the processes; motivation for deployment from LSP side can be very low, which is easy to understand. In current situation motivation for improvements only means lower income. This is happening especially on cases like adding steps to the existing process for better control but not considering the negative impact.

4.2.3 LSP status and position

Current LSP is in top 5, but not in top 3, position for global 3PL logistics partners. Benefit of being out of top 3 gives extra push and hunger for success as there is no room for "sleeping". This LSP has been increasing the market share and has target to grow faster than market. This gives customer the extra push and benefit for improvement activities. Question is, how to harness all that power and willingness for being number one and in world-class as this common target for both? Very often, and similarly in this specific case also, common target is only understood as similar target, both targeting best in class operations but doing that separately. How to change "common" that to real common target? How to have real combined target to fight for and act together to achieve the real common target, world-class operations and partnership?

4.2.4 Improvement

Current approach for improving operations is to start a project for system changes and other for operational improvements. These projects are done together as company is the owner of system solution and main processes. In most cases one of the partners will gain the benefit and win-win situation is only happening by accident. There is no common agreement how to enable both benefiting for system or process changes. This missing benefit share agreement is one of the biggest adverse factors for current contract and partnership.

4.3 Analysis of current WMS solution

Company is using currently SAP R/3 version 4.7 in user for both, as general ERP tool as well at warehouse management tool. There are multiple hubs/distribution centers around the world integrated and using same SAP system with similarities on system solution. On this thesis work, analysis is focusing on one particular DC and their way of working with SAP. Current version 4.7 contains the basic warehouse management system but it has already seen that functionalities are not sufficient for neither current nor future operations. WMS is owned and developed by the business owner company and used and executed by 3PL partner. 3PL can give proposals for improvements and planning for coming enhancements is done together.

Analysis of current WMS issues is based on interviews of key business team members and 3PL partner key persons, as well personal observation on site and findings.

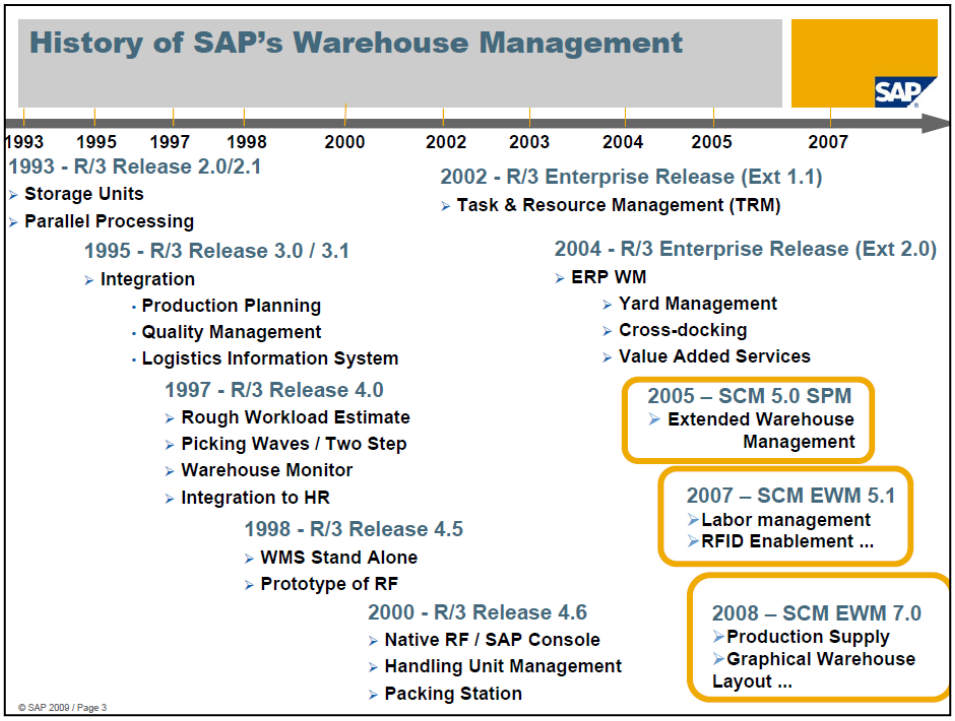
Current issues:

- No performance reporting available
- No resource planning or resource controlling available in WMS
- No slotting optimization for location selection based on delivery volumes or any other criteria's

- No location control for operational interim inbound/outbound locations
- No possibility for inbound and outbound storage type batching
- No possibility for cross docking and fast transfer to outbound
- No serial number control on warehouse management and location level
- No hand held scanner use possibility despite of existing used RF-functionality with tablet PC's
- No touch-screen optimized WMS for tablet-PC's (partly standard SAP and partly SAP RF)
- No pick and put-away route optimization
- No afterwards item location optimization possibility
- No arrival/ASN information available
- No kitting (set creation) possibility
- No dynamic put-away combination with picking in same route
- No inbound sorting guidance and control
- No outbound picking consolidation from separate picking flows, zone bases picking
- No automated goods receipt possible e.g. by RFID gates
- No control for on-hold export location

List of current issues is very long and many of them are business critical. Part of missing functionalities have been over ruled with manual workaround processes, partly with manual data transfer to external controlling tool and partly just nothing done. These manual workaround solutions and manual data transfers are always very weak point and are causing major issues to business.

Company is planning to upgrade current SAP ERP 4.7 to version 6.0 in near future. Unfortunately this will not bring any enhancements to warehouse management related processes, warehouse part is exactly same in both versions. SAP has decided to continue development for warehouse management in a separate module called SAP Extended Warehouse Management (EWM). See picture below for SAP warehouse management evolution.



Picture 11 SAP Extended Warehouse Management – Presentation, World tour 2009

Many of business critical current issues may be such that even present SAP system solution may support those. Difficulty is that partly issue solution proposals are limited due to very complicated system solution for services business and very challenging business processes. Another difficulty for business is very slow and expensive system solution development. Due to large company and world-wide use of same system, even smallest development item may take a year or more when available because of long queue in development list. When development is expensive it is very hard to have reasonable business case and without proper payback time development may not ever be done.

4.4 Distribution center relocation analysis

Current distribution center relocated during 2011 spring and summer to larger facility, during the preparation phase of this master thesis. As relocation was done with rather quick schedule, there were no time and resources available for actual improvements, especially on the processes and warehouse management system.

Then, why to relocate if operations are not improved? The main drivers for the relocation were very limited space availability and cost reduction. Company operations were increasing rapidly and 3PL partner was forced to split inventory to multiple different locations. Due to several inventory locations lot of transfers between locations were needed and accordingly costs were high and operations had really low efficiency. In worst case, customer orders were picked from several locations, which, in addition, caused also significant delays for customer deliveries.

4.4.1 Status before relocation

Due to unexpected growth of operation distribution center was split to four different physical locations; one location handling active inventory, one for less active, third location for handling returns, buy-back inventories etc and fourth for handling export deliveries and holding them until export shipping approval was given.

This multiple location hassle caused high costs for transportation between locations, drop in customer performance, delays on shipping and lot of mistakes in processes. During this mess people started to take short cuts in processes, solving things with quick ad-hoc way and forgetting the importance of control, discipline and quality. The basic reason behind this behavior was the willingness to get thing done as soon as possible, as they were late already for customer. All these actions were only taking the situation worse and worse.

Situation was unsustainable and fast actions were forced to be taken. Most urgent was to get new location ready with modified system solution and then think about possible system improvements later on.

4.4.2 Distribution center relocation improvement impact

In new facility all operations are under one roof and no additional transfers between locations are needed anymore. In addition, increased space availability has improved the situation on the operational areas like inbound and outbound handling areas. With this additional space, operational improvement target was achieved and significant cost savings were gained. Operational performance and customer order processing times are now back on the correct level, and customers are happy again.

Though, as actual process improvement was not the target, there were some improvements achieved. Operations started to use RF based picking again, as since few years back it was stopped temporarily. Picking did change from standard batch based picking to zone based picking. Actual new storage has multiple different racking options available (standard racking, narrow-aisle, mezzanine and fast lane) instead of standard racking only in earlier location.

By comparing the situation before and after relocation with Frazelle's world-class gap analysis for warehouse practices, significant difference on scoring can be seen. Few main categories were improved with the relocation activity, communications, and reserve storage, picking and put-away.

Communications has changed from paper based picking to RF based picking which equals increase from level 1 to level 3. RF picking, and also RF put-away is now done with Tablet-PC terminals. There are still further possibilities with RF use, so perhaps correct score should be 2.5.

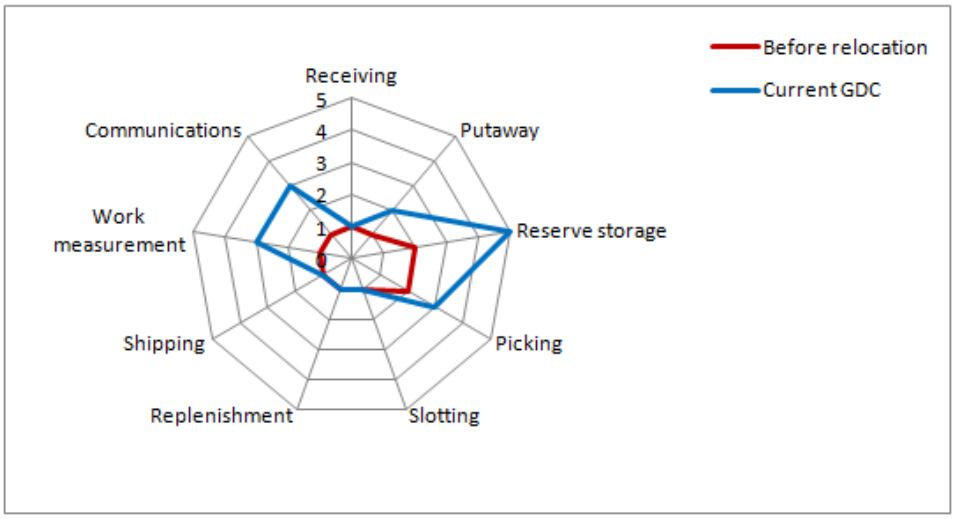
Reserve storage category has improved in new location from level 2 to level 5. Level 2 means conventional racking and bins, and level 5 includes

optimal hybrid storage and means world-class level. Current facility has storage isles for wide isle, narrow isle and walk-by picking isles. In these isles there are multiple different bin sizes for different purposes. In addition to basic isles, there are also mezzanine storage area for small items and small quantity bins, separate area for extra wide items like doors, and additional storage areas reserved for cross docking materials.

Picking is improved from level 2 to level 3. In old location picking was done purely on batch based picking. In current location picking is done as batch based and also with zone based. In new location zone based picking is mandatory as picking is done with multiple different methods: narrow isle picking with special picking equipment, wide isle with standard fork-lift or cherry picker, by foot from picking isles with trolleys and by foot from mezzanine with small trolleys.

Put-away is now done with batching to zones which enables to use correct method for put-away in each zone and reduces the amount of movements within the building. This gives score 2 instead of earlier 1.

All these changes together improved the operations with total scoring increase from 11 to 20.



Picture 12 Benchmarking Frazelle's practices gap analysis for GDC before relocation and in current location.

4.5 Present state analysis based on interview and discussions

Based on the multiple discussions with earlier DC manager and other on-site personnel, following issues have been identified and pointed out as main concerns:

- Inventory management is not possible on serial number level at bin location. Only inbound and outbound bookings are covered on the needed level and any internal transfer or other posting may lose control.

- Country of origin control not available. Company has factories and suppliers in several countries which makes the country of origin control mandatory. Fully manual process at the moment due to lack of system support.
- Lack of RF control, only actual picking and put-away transactions are covered with full RF control and ensured by scanning locations and material code. E.g. internal transfers are not included and missing the needed level of control
- Storage optimization. Current system solution does not provide any support for optimizing and work must be done manually with support of excel sheets.
- Transactions are slow. Part of the transactions is very slow to execute and very complicated in current WMS. Several steps may be required just to conclude one simple transaction e.g. confirm picking
- Lack of interim location control. Current WMS does not have any support or control of locations for inbound sorting and put-away holding area, outbound consolidation area and export delivery holding area.
- Lack of reporting and visibility. Current on-site management does not have proper reports or visibility transactions available to provide real time data access and visibility for ensuring needed level of management and control
- No resource and task management control. Currently all resources are managed fully outside of WMS and task management is only a list of actions needed. There is no possibility for prioritize, arrange, group or control coming or ongoing tasks.
- Lack of dynamic warehousing. WMS does not enable easy change of location types nor master data. This makes the changes very hard and slow and has impact on processing of materials. Solution should also provide more flexibility on checking available locations for put-away
- No Bill Of Material management (BOMs) available. Some items require set or kit creation to provide one complete product to customer but this is not supported at the moment by WMS

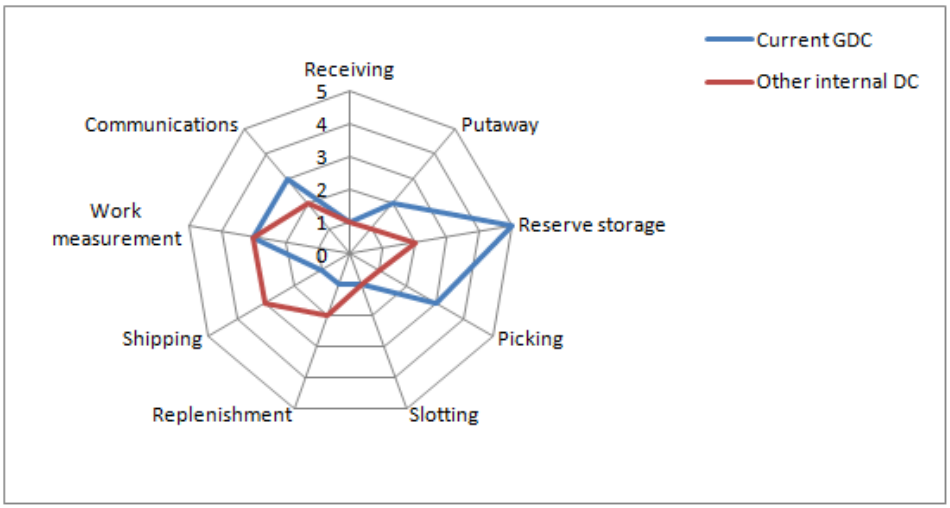
Interviewed persons are happy with 3PL partner way of working, equipment, space and location and competence but biggest concern and disappointment is related to WMS solution. More or less all listed areas are related to system solution missing or insufficient functionalities and limitations.

4.6 Present state analysis based on benchmarking

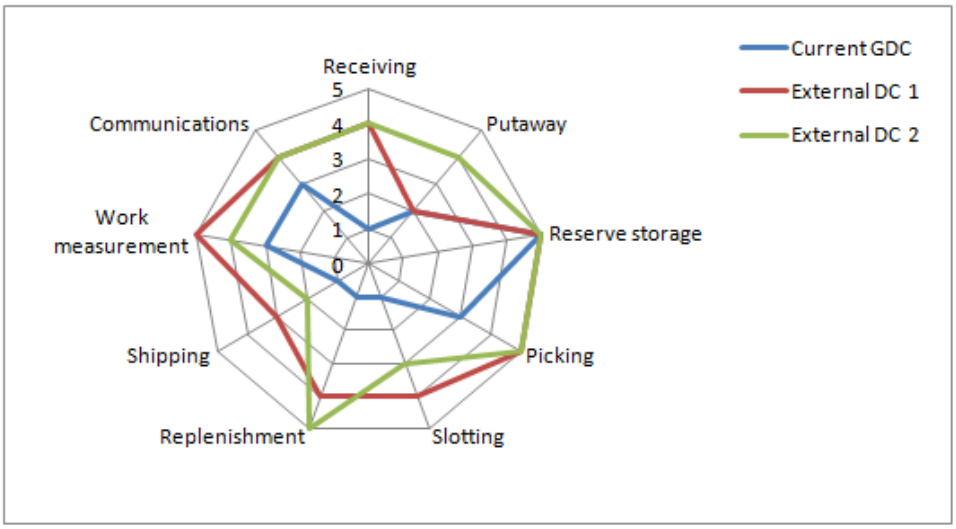
On the earlier chapters current GDC operations have been benchmarked and compared itself over time period before and after relocation as well compared to Edward H. Frazelle's world-class level. This will already give good indication on current situation for warehousing practices.

In addition to this benchmarking is important to do to other distribution centers also. Here the comparison is done against other internal distribu-

tion center in same company and to two external distribution centers. Internal distribution center is used other business unit and is working for bit different business area. External companies have been selected based on visiting possibility and analysis done during site visit. This benchmarking is already giving indication to current status but improvement should not limit for targeting only better that other DC's but really to target for absolute world-class level of operations.



Picture 13 Benchmarking Frazelle's practices gap analysis for GDC with other distribution center in same company



Picture 14 Benchmarking Frazelle's practices gap analysis for GDC and two high-class external distribution centers outside of company

Conclusion on comparison is that situation is bit better than in other internal distribution center. Situation is different as GDC has been working more on improvement actions in the past. Compared to selected external distribution centers gap is bigger and lot actions are required even to achieve this level.

4.7 Other found issues

This chapter provides more information for miscellaneous known and found issues.

4.7.1 Picking with tablet and scanning

Picking with tablet-PC is very good solution but as with current WMS process steps are very slow. Even though quality or process remains high it does not help if slow execution is eating up the operational performance. Tablet-PC based picking equals RF picking on this distribution center. Picking list is shown on screen and used can sort the list or filter based on picking isle or zone as system does not support route optimization. User will open one picking request and see the location information on the screen. Picker will go to location, click the screen to start picking, scan the location bar-code, scan the material code from item box, confirm quantity on screen, and saving. Full process requires pressing buttons and clicking screen several times which makes the overall process very slow. Process seems to be working fine on test or office environment but is absolutely too slow for fast pace operational warehouse.

4.7.2 Picking multi-line deliveries

One of current issues is multi-line picking for one customer. Due to service business nature, in most cases there is one sales order per one defected faulty unit replacement item to customer. For good unit shipping customer orders are consolidated to bigger delivery for saving costs on shipping and transportation. Because of these separate orders picking must be done accordingly in WMS, e.g. in worst case for one delivery from one location with 10 pieces same item code, picking is done 10 times for one piece. Each pick is done by scanning item code and location as well confirming all required steps in system accordingly. This full process will take huge amount of time completely unnecessary and could be avoided by improvement actions.

4.8 Ongoing improvement activities and future plans

One of key initiatives for GDC on development roadmap is automated goods receipt functionality based on RFID label reading. RFID implementation is already ongoing to suppliers. Automated good receiving functionality must consider full dock-to-location processing and not only goods receipt transaction execution in SAP.

Other ongoing activity is SAP enhancement though this will not bring improvements to warehousing area.

WM solution improvement is planned somewhere in the future for roadmap but so far no further actions done for analysis or selection.

4.9 Conclusion on current status

Clear conclusion for current distribution center operation status is that operations are working quite fine and based on current performance level even surprisingly well compared to list of issues. Lot of this current good level of operations is thanks to very competent and professional 3PL partner.

Operations are based on continuous improvement method, but usually any bigger change will require a separate improvement project. Several operational, tool and process related improvement projects are planned to be started in the near future.

Despite of continuous improvement activity several bigger steps are required to achieve targeted world-class level. The gap between current and target level is very high and requires lot of efforts to achieve that.

5 PROBLEM SOLVING AND IMPROVEMENT PROPOSAL

This chapter is providing further analysis for thinkable improvement possibilities in GDC operations.

5.1 World-class warehousing operations target

World-class warehousing operation is a combination multiple aspects. Typically it comes back to practices and performance; how things are done and how well are they executed. In addition to these two above mentioned critical key points, there are other factors impacting to total evaluation for world-class operations:

- WMS, operations must be fully supported by warehouse management system and should even provide further operational improvement possibilities
- Equipment, proper racking, forklifts etc. is a must for world-class operations. There are no room for equipment failures and non-availability, and even safety may become an issue
- Warehouse layout; layout makes big difference on travel distances, usability of racking, picking and put-away speed
- Workforce, well trained competent warehouse personnel is the key to success. With improved technology, simple WMS solution and simple error-free process will minimize significantly training efforts and learning requirements
- Excellent 3PL partner with motivation, operational excellence and proper contract with business owner to enable successful operational future
- Costs of the operations; by following all above, costs should become on correct level, as otherwise there is no future for location

All of these building blocks must be in world-class category, stage 5, to enable full world-class operations. One or few alone does not bring the needed results at the end. Based on this target for operational excellence analysis for improvement possibilities is done.

5.2 Outsourcing and partnership improvement

This chapter is concentrating on logistics outsourcing and improvement possibilities in that. Chapter few key points for outsourcing improvement, how to manage outsourced operations, how to ensure successful productive relationship, what kind of alternatives for outsourcing there are and how to improve current contract.

5.2.1 Outsourcing reasons and background

In the 1990's outsourcing has been a megatrend for large companies. During those years also Distribution center A was outsourced to 3rd party LSP. Managing distribution center was not seen as key or core operations for the company as well expectations were for higher operational efficiency and lower costs.

During same decade there were several studies and surveys done for operations outsourcing. "One of the most significant studies include surveys of over 1200 companies for understanding of the reasons companies outsource various activities and the potential benefits of the be gained. These benefits include following:

1. Improve company focus
2. Gain access to world-class capabilities
3. Accelerate re-engineering benefits
4. Share risks
5. Free resources for other purposes
6. Make capital funds available
7. Create a cash infusion
8. Reduce and control operating costs
9. Gain access to resources not available internally
10. Deal effectively with function that is difficult to manage or out of our control." (Boyson, Corsi etc, 1999)

Reasons 1-5 can be classified as more long range and strategic reasons, and reasons 6-10 as tactical – meaning they affect day-to-day operation of the business." (Boyson, Corsi etc, 1999)

Later studies showed clearly that reasons have been the same all the way. What has been learned on hard way is related to benefit 10: Never outsource an activity which is out of control or no-one has needed level of understanding. This is doomed to failure in most cases and should always be re-considered. When clear operations and clear understanding are missing, outsourced operations will have higher price tag than expected and in some cases benefits of outsourcing can even be negative.

One of additional and significant benefits is the flexibility. Flexibility here is meaning especially personnel, equipment and warehouse space. Large LSP's have personnel available on same site for other operations or other close-by sites. They have good contacts for temp workforce agencies and employees available when needed from those also. Warehouse space is a challenging issue for growing operations and LSP have multiple sites on same country and like space available for flexibility purposes also. In cases of need e.g. non-active inventory can be transferred to another location temporarily or permanently. Additional equipment may be needed on peak days, weeks or months or in some special situations like relocation activity.

Survey showed clearly the benefits of outsourcing. "Following improvements were gained:

- Storage space utilization was improved 20.3 percent
- Inbound receiving costs improved 22.6 percent
- On-time delivery of customer orders shipping timeliness improved 73.9 percent
- Productivity (cartons/hour) improved 16.3 percent
- Costs per carton handled improved 9.2 percent
- Freight costs as a percentage of sales improved 7.7 percent" (Boyson, Corsi etc, 1999)

Surveys showed clear benefits as well common global trends proof the same. Rob O'Byrne is estimating that global logistics outsourcing rate would be already around 85%. He is also listing the main "typical benefits:

- Reduced costs
- Improved service
- A better focus on core activities
- A shift of assets from the balance sheet to the P&L
- Increased flexibility in capacity and costs" (Logistics outsourcing – Trick or treat, internet article)

In same article he is also stating, similar to many other professionals, that far too many companies have got the whole process wrong and with outsourcing they are only ending up to higher cost and worse customer service.

Luckily the case study company has been doing outsourcing with competent persons and always with on-site personnel. These have saved a lot out of possible negative impact and situation is reasonable well.

5.2.2 Outsourcing situation today

By looking and evaluating situation today, the reasoning is the same. There are exact same expectations and benefits. Analyzing bit further few of the benefits:

Benefit 2.Gain access world-class capabilities. This benefit is not as self-evident as the expectations for this are. When outsourcing distribution operations to large LSP, expectation is that they would utilize they full company skills and expertise for continuous improvements, ensure extensive and long-term investment in technology, methodologies and people. Expectations can be even on so high level that LSP would utilize their best competence, equipment and facilities to your specific case. Unfortunately the truth seems to be very different. Operations are local to one specific location and with local personnel. Current LSP operations are very site specific and with minimal intervention to other sites. Further investments are done only in case outsourcing company is willing to cover the costs or LSP is gaining the cost savings by themselves. Long term investment to people is not done and amount of permanent employees is minimized.

Benefit 3.Accelerate reengineering benefits. "Reengineering is a fundamental rethinking of business processes, with the aim of dramatic improvements in critical measures of performance such as cost, quality, service and speed." (Boyson, Corsi etc, 1999)

Expectation is by selecting world-class partner, they would reengineer the processes and solutions "automatically and continuously" back to world class. This may even be part of outsourcing contract with list of proposed improvement activities and can be done as start-up activity. What happens then afterwards? How to ensure continuous improvement? Limitations

will apply as well like the owner of processes and tools will lead many of activities.

Benefit 8.Reduce and control operating costs. Cost savings are achieved as initial start-up activity. Promised cost reductions are usually achieved on outsourcing only when operations are stable and already well managed before outsourcing. In this kind of operations surprises are minimized and outsourcing is a smooth activity. In most of other cases, savings are minimal if any.

5.2.3 Management of outsourced operations

Same above mentioned survey shows very clearly that once contract is in place, new managerial role will appear. Company will need to establish a role for person or group to take the responsibility of 3PL operative management on ongoing basis. When no-one will take the nominated responsibilities, partnership is expected to fail.

"From these results, it would appear that firms perceive that assigning centralized oversight by a single logistics expert is the most effective way to manage the relationship with a third-party provider. The chosen manager must have a clear understanding of the companywide logistics system and decision-making power at the executive level of the organization." (Boyson, Corsi etc, 1999)

In addition to operative management role, contract management responsibility was given in most cases to chief logistics officer (CLO), other executive or cross-functional headquarters team.

In current situation company has a nominated and competent executive manager responsible for daily operative management of 3PL. This nominated manager is working on-site in distribution center. This role and person with competence are the keys to successful partnership.

5.2.4 Productive relationship

"A Logistics specialist from a worldwide manufacturer of computer equipment added: *"We make sure that all of our third party logistics providers increase productivity by at least 5 percent every year. We feel that this is only way to remain competitive. We hold third-party provider forums where we discuss how we can together be more productive. We believe that we should not just beat up the third-party logistics provider every year to provide lower costs. We want them to succeed. We do not want to eliminate their profit margins. We always try to work together toward productivity and encourage the third-party logistics provider to bring ideas to the table."*" (Boyson, Corsi etc, 1999)

This is a good example of constructive and successful relationship. Relationship must be on the real partnership level, not just a contractual relationship. Productive relationship requires good communication and com-

monly agreed goals which are fair to both parties. By forcing results will never be good or successful in long-term. When relationship is on needed level results will be good and business successful for both companies. This kind of relationship has been called as win-win relationship, where both partners are winners.

Current partnership and contract is based on mixed contract with transactional, fixed fee and hourly based fees. With this contract 3PL partner can reasonable well plan and ensure their operations to achieve positive financial results. Just achieving positive results is not enough and profit must be on sufficient level to ensure successful continuation of company and business.

5.2.5 Outsourcing alternatives

After 10+ years of outsourced distribution center operations, possible alternative options are quite limited. In significant partner relationship all heavy changes are always painful, slow on execution and with significant risk to business failure or business interruption.

What is the future of outsourcing? How to continue further? Is outsourcing a one-way street? "*"Once you outsource, you never bring it back"* is no longer true, especially in transportation. About eight years ago, I interviewed the logistics director at Diageo about logistics outsourcing and the changing role of 3PLs, and something he said has always stuck with me: *"A company's outsourcing strategy cannot remain static. As the nature and complexity of supply chains change, so must the nature of outsourcing relationships."*

What your 3PL partners will be doing for you in five years will likely be different than what they are doing for you today. You might bring some functions back in house, maybe because you now believe they should be internal core competencies, and you might outsource other functions that you're currently managing in-house today. This implies that *the nature of how you manage outsourcing relationships* must also change."(Logistics outsourcing vs. in-sourcing, internet article, 2011)

Outsourcing strategy and decisions are done according to current understanding and based on available information. Fact is that all decisions are to be done according to best achievable expected results at the decision making time. Business decisions should never be done according to trends even though they seem to have high impact especially on analysis; should we also outsource as everyone else? Decision making management group must be able and courage to change their earlier decisions when needed.

What options there are then for current situation? Bringing operations back to in-house would be extremely hard. It would be difficult and expensive to ramp up the organization and operations internally. Operations are too complex to bring these in-house without having proper competences available. This would be against company strategy as logistics transportation and distribution centers have not seen as core activity for long time.

This activity would have a significant impact on company cost structure. Not a feasible option and not even recommended.

Second alternative is to outsource operations to another LSP. This option would only be considered in case of significant business savings are available or current operations would be below minimum level of expectations for quality and performance. These significant business case savings should cover also costs of possible transfer project, system changes and set-up, as well ramp-up of operations at new LSP site. In current situation this is not foreseen but in every RFQ round offers are taken also from other LSP's to have comparable evaluation available. Next round will follow in few years from now and may bring different results. Also this option would be expensive and slow exercise to transfer complex operations, and not forgetting needed system changes.

Third alternative would be to outsource operations to 4PL, fourth party logistics service provider. This option requires heavy strategic decision and change on current approach. In this option together with distribution center operations also other significant business areas would be outsourced. Typically 4PL contract contains full end-to-end processes, from sales order management to distribution center operations and purchasing with supply management. This option is seen as very difficult alternative due to very complex service logistics operations. It can be done at the end but it is not an easy way out. With 4PL approach operations are getting even further away from customer, visibility and control are lost; as well further changes will become even more challenging. Typically with these 4PL outsourcing cases system, processes and entire business infrastructure is coming from the partner, only operational results and interfaces in and out would be agreed. Until change in strategy and until expected benefits and savings are clear, this option is out of question. Due to heavy business operations complexity this option is not recommend for the case company.

Fourth alternative is to keep operations "as they are". As they are, here, means that operations are outsources to 3PL partner, but managed internally. This has been seen as the best option in current situation by interviewed persons, at least until next contract re-negotiation round. As they are, still, does not mean that operations would be or stay longer as they are, as the key target and driver for operations is the operations improvement. Improvement and co-operation is the key for future success. On the other hand, there are still lots of improvement possibilities available to assure the successful future.

5.2.6 Improvement possibilities on logistics contract

Logistics contracts have usually three different pricing models, transaction based, cost-plus and open-book. Transaction based is the most common one, based on amount of transactions with fixed price. Transaction can be based on amount of items, sales orders, order lines, pick lines, tons etc. delivered out. Cost-plus is adding an agreed level of profit on top of real costs. Open-book pricing gives full visibility to buyer of cost structure in very detailed level.

Also combination of different methods is used, main part of business with transaction based and e.g. special services with cost-plus pricing. Special services can be executed also with hourly pricing method, but usually not used for normal operational outsourcing logistics contract. Correct and good pricing gives both parties visibility and understanding for the costs. "It is recommended that principles of cost level changes is included as part of the contract. This requires cost structure visibility and agreement for cost level follow-up." (Jalanka, Salmenkari & Winqvist, 2003)

"For Strategic Out-Tasking/outsourcing to succeed, both enterprises and outsourcers need to have a win-win mind-set. The Strategic Out-Tasking model requires enterprises to remain accountable for business outcomes. Enterprises should align what they expect outsourcers to deliver with their overall business goals." (Krisnamurthy, Jegen & Brownell, 2007). On the real, long term partnership very close relationship is a must. Both partners parties needs to be committed to long term development and this can be done only with Win-Win approach. To make this possible some level of unselfishness is needed from both sides. The most common mistake on outsourcing is to think purely selfish way that you are the only one to get the money and forcing 3PL partner only to cut down costs. Both companies have to manage their business on profitable level, and if not, it will be very short sight planning.

To make any improvement happening, partners need to answer to following questions:

- "What do we want to achieve with the co-operation?
- How much we are ready and willing to put efforts on co-operation?
- Are we ready to change our way of working for the common cause?
- Are we ready to improve and develop good practices together and openly?" (Jalanka, Salmenkari & Winqvist, 2003)

By answering these questions, it will show the willingness for the change.

Current contract needs clear agreement and guidelines on the development and improvement related actions. A good contract will encourage for good co-operation and continuous improvement.

Motivation can be gained by participation. In current situation, as tools and processes are owned by the business owner, usually any improvement is done solely by them only. "Good practice is that both parties have a control team. Control teams will meet several times a year according to a need together and separately. Tasks for the control team are development follow-up, identify trends, challenges and possibilities as well anticipation for future volumes. Control team approves investments, establishes development and improvement projects as well resources them."(Jalanka, Salmenkari & Winqvist, 2003). By doing things together and making decisions together, both partners will be committed to the successful goal.

Another motivator is financial benefit. "Financial rewards for service provider for operations development work, where outsourcer gets all the fi-

nancial benefits, sounds very attractive and fair idea. When contract is created, it is very hard to see exactly, what opportunities there are in the future. Usually for this reason, clear contract clauses are very hard to create. Quite often this is left out for separate negotiations in each case." (Jalanka, Salmenkari & Winqvist, 2003). This is very hard topic to agree in advance. Nevertheless, at the minimum, there should be a statement that financial reward can be agreed for each case separately and even better if some indication of the reward value can be given, not only percentage of something unknown. As current contract is mixed price contract, each part of contract needs to be looked at separately.

1. Transaction price. Each improvement can have a certain impact on time and efforts used on transaction. To be able to change the price, full content needs to be understood on very detailed level. Time used for each step needs be known by both parties. If improvement is saving e.g. 5% of the working time, this should then have an impact on the pricing. Unless costs would be down by same 5%, transaction price can't be reduced with same level. As there is no need and will to go for full cost-plus or open-book pricing, there is a lot of trust needed. Based on LSP proposal and with employer approval, transaction price could be reduced during contract validity period. As only way to proceed on this, is to gain benefits on both parties, and level of benefit could be agreed before hand on the contract. One approach could be that savings are valuated with pre-defined split for actual transaction price. Another approach is to use similar method as we have for operational performance; bonus for improving, penalties for not improving anything.
2. Payment per hour. Any improvement for this type of work will reduce the amount of working hours. Price per hour is very hard to change as it is usually based on real costs per person added with agreed profit level for the 3PL company. As the amount of hours is getting less also the revenue is going down. This revenue loss should be discussed and agreed so that will not be impact for 3PL overall situation, at least to ensure that costs will go down on similar level.
3. Warehouse space is paid according to Euro per square meter price. Warehouse costs are quite standard according this pricing method and can't usually be affected. What can be affected is the used amount of space. This can be divided in two parts; actions done by business owner and actions done by 3PL LSP. Owner is responsible of stock level definitions and purchasing execution. By keeping stock levels on correct level and ensuring controlled and on-time ramp-down during end of the lifecycle, this will keep the inventory levels under control. LSP is responsible for ensuring that items are stored in correct locations with correct maximum quantities for enabling full bin locations. In addition, LSP is responsible for optimizing and consolidating the inventory locations. Amount of used square meters is fixed and agreed beforehand for longer term so direct savings are not coming out by improving the inventory utilization but is it still mandatory for enabling smooth operations in putaway, picking and inventory counting. Optimization of bin usage

and consolidation is quite hard and fully manual with current WMS, more information on WMS enhancement chapter. This optimization work can enable for 3PL partner space use for other customers. Most likely space business owner wants to keep the space anyway to ensure sufficient fluctuation possibility for business. Optimization could be compensated by bonus payments but it is extremely hard to measure, usually only visible when it is not done, and even then only as an increased process working time; more locations for picking and for inventory counting.

4. Monthly fixed costs payment. This payment type is used for guarantee certain minimum income for LSP in case of business would stop temporary or reduce very significantly. Payment is intended to cover LSP fixed costs which there is always on certain level. This payment can't really be impacted with improvement actions.

Rewards or additional payments for any improvements of these above mentioned topics should only be done in case they are started or at minimum supported by LSP. This requires clear commitment and driving force for development and implementation. Development may require sometimes very long time and if rewards are wanted, clear follow up on actions are needed. As the basic assumption is the shared benefit, this requires also lot of visibility and trust.

"Contracts are made between the partners, but co-operation is between people. Co-operation is not something you can force into. There must be appropriate conditions created to enable possibilities to learn and accordingly improve operations." (Jalanka, Salmenkari & Winqvist, 2003). At the end, it does not really matter, how good the contract is if there is no correct attitude, no motivation and no willingness to change and improve.

Outcome of new contract version should involve and motivate both parties doing development and improvement actions on long term. New contract should also have possibility for quick changes on agreed pricing. The process for pricing changes should be agreed on frame agreement and have commitment on both parties.

5.2.7 Outsourcing and logistics contract – next steps

When outsourcing is completed successfully and situation is very stable. Question is: What then?

Typical situation is that every time on contract or pricing negotiations 3rd party LSP is showing you a list of various reasons why contract price should be increased. There are topics on the list like increase of personnel costs, electricity, taxes, equipment etc. LSP is interested on their revenue and net profit as any other company. No-one wants to lose the profit of the business. As an opposite outsourcer company is pressing hard and setting targets for cost savings.

Another typical situation is that continuous development efforts are done but only to increase either the LSP profit or business owner profit.

How to ensure that there is real partnership in place? How to ensure operations stay and improve on cost efficiency and operational performance, especially when competitors will not stay on stable level? How to keep same motivation for improvements year after year?

First key target for both parties should be to change to existing contract to really such format which really enable continuous improvement and benefit to both parties. So far only statement in contract for this is related common gain sharing program, which have never even been started or nothing agreed how each party would benefit out of improvements. Contract must enable win-win relationship to keep up the motivation year after year. When both partners are motivated and targeting the improvements, long term co-operation will be successful.

Secondly, common improvement and development targets must be agreed. Target state should bring the co-operation goal roadmap to take the needed improvements step by step. Roadmap can be then split to several smaller projects to make the end result possible via short & long term planning.

Thirdly, improvement does not come for free; needed resources and financing must be ensured, from both companies. Improvement efforts should be considered as investment, not as costs. On the other hand, business case analysis is important, as every development effort should also bring measurable financial benefits.

Earlier in this chapter for outsourcing benefits, was benefit 2 mentioned: "Gain access to world-class capabilities". Current partner LSP is undoubtedly one of world-class companies but how to localize all benefits to partnership operations? With above mentioned three topics all the keys to success and benefits are there.

5.3 Improvement possibilities on warehouse practices with Frazelle's analysis

Warehousing practices are divided to 9 different categories by Edward H Frazelle, as also shown before.

1) Receiving
2) Put-away
3) Reserve storage
4) Picking
5) Slotting
6) Replenishment
7) Shipping
8) Work measurement
9) Communications

When target is a full world-class distribution center, then each of the subcategories needs to be in world class. If this is not done, the chain is as weak as its weakest part. Proposals are done according to these categories and based on Edward H. Frazelle's world-class analysis recommended levels of process categories.

5.3.1 Receiving improvement

Receiving improvement would require technology investments, WMS improvement and operational change. Due to current operational model on inbound heavy changes would be required.

Immediate put-away to reserve or primary location requires very fast and smooth goods receipt process. This would be possible with RFID based goods receipt. RFID, radio-frequency identification, is a technology where item and/or pallet contain small RFID tag. Tag is so called transponder containing needed amount of information like product information or shipment information. Tag information is red by RFID antennas. Typical solution is antenna-gate and receiver is driving through the gate with pallet on forklift. Receiver will get notification on screen when reading is completed and items can be taken to warehouse location.

Further RFID analysis is excluded from this master thesis and is already analyzed and planned as part of another analysis project. Current planning is that RFID based goods receipt will be implemented with automated GR message to SAP during coming years. Until RFID solution is in place, immediate placement strategy can't be utilized and docking in inbound area is needed. Automated GR must also consider following steps, transfer order creation and GR label printing ensuring fast processing from door to destination location.

By enabling good inbound automated GR to SAP would improve the current situation and would make the inbound process faster. Due to business nature in most cases product or pallet can't be taken to primary location immediately but to reserve or sorting area it can be done. Automated GR would require full RFIP implementation to all suppliers and WMS modifications to enable the solution. With this level 2 can be achieved.

Immediate put-away to primary would be really hard or even impossible to arrange due to equipment and warehouse structure but further improvement of receiving, to cross-docking (level 4) and pre-receiving (level 5) would be possible. Currently both are limited due to used WMS system.

Cross-docking is a process solution where materials are received, immediately transferred to waiting area or outbound area for shipping. Solution is saving time and efforts on put-away and picking operations as both can be avoided. It is very useful especially in situation when fast shipping is required after goods receipt or when purchasing is done for specific sales order only and stocking is not even needed. Solution may apply for partial receipts also. Cross-docking system solution would be clearly beneficial as this would make the dock-to-dock process faster, have less steps and no possibility for delivering to wrong sales orders.

Pre-receiving then, is not supported by current WMS solution. Solution typically means that all the needed information is delivered from supplier via EDI (electronic data interchange) or similar before shipment arrives to distribution center door. It may include also location assignment beforehand for improved warehouse location planning. During inbound, ship-

ment is taken to stock with reference barcode, smart card or RFID tag scanning information. After information match, items can be taken directly to destination location. Solution is fully pending on supplier process and data quality, as well transportation. If any item information is wrong or items are lost, solution will give incorrect results and performance is decreased instead of improvement. Pre-receiving or not, only even having sufficient level or pre-information available, this would enable better planning and anticipation for inbound operations. By having pre-information available in WMS, the complete inbound process could be done faster as well information could be used for pre-planning of warehouse locations and planning of sales order deliveries.

With receiving improvement, it would be possible to achieve higher levels with WMS development and RFID implementation.

5.3.2 Put-away improvement

Put-away improvement is partly connected to receiving improvement, and is more challenging to improve in the current environment.

By looking for level 2, batched put-away by zone, or level 3, batched and sequenced put-away, both are, in principle, doable but needs to be controlled outside of current version of SAP WMS. This is currently partly done already but needs further attention to ensure process is followed and benefits gained.

Transfer order creation phase (pick request from inbound area to storage bin) needs to contain information for dedicated pallet number. Each pallet is dedicated for storage isle or combination of several isles, should be ready and waiting for more items to come. When items are manually collected to pallet per isle or zone, then put-away can be done accordingly..

For level 2 and 3 full WMS system support would be needed in addition to current process. System should provide support for sorting out the inbound to correct pallets, enable location, batch and priority control for pallets as well provide support for driver route optimization.

Further improvement to level 4, location-to-stocker or level 5, automated put-away would require warehouse automation implementation. More information provided later on this thesis.

5.3.3 Reserve storage improvement

Reserve storage category was improved during the relocation project already to level 5 together with distribution center relocation project. Level 5, according to Edward H. Frazelle means “Optimal hybrid storage”. Current facility is built to optimal situation with several different storage areas for different purposes.

With this combination current DC operations are on optimal situation. Optimal in this still doesn't mean that it would be perfect. Combination as such is very good in current business situation but correct relationship between different storage area sizes will require continuous follow-up and adjustment. Business is changing rapidly and so are inventory levels and inventory behavior. Current facility height is limited as well space inside the walls, but anything inside can be modified when needed. Similar continuous follow-up is mandatory for correct locations for each material, like for example materials with high delivery volumes have to be stored in fast-picking locations.

Location availability and flexibility within storage type would need the improvement. Each location has fixed definition for material type, though material codes per location can change. This can be enabled with WMS improvements.

5.3.4 Picking improvement

To have full level 4 picking in place, this would require dedicated picking per isle or zone, and with all open picking requests over the batches, not only within one batch. When picking is done all materials from one zone once, this requires further developed WMS solution and outbound handling for holding area location control and consolidation. Outbound area material handling can be manual or automated but must be fully supported with WMS end-to-end.

This down-stream sorting solution is very useful for business where outbound shipments are bigger and consolidation from different zones is mostly needed. Current business behavior is based on high amount of small quantity orders/deliveries and in this kind of situation benefits for full outbound area sorting would turn into disadvantages. This would require huge amount of space available in outbound sorting area as there would be hundreds of orders waiting for consolidation and additional materials to come from picking.

To go further on Frazelle's practices levels, next is level 5, dynamic picking. Dynamic picking is usually understood as different stock-to-picker systems, where inventory is moving instead of picker. There are lot of possible solutions available for this starting from very simple gravity flow racking until fully automated warehouses.

Gravity flow roll racks are very simple and budget level option for dynamic picking. They will get the items to outbound area easy, fast and simple. Gravity flow racking requires always reserved area which needs to be planned before hand.

Picture 15 Gravity track, from downloadable dynamic warehousing presentation from Saar-Lagertechnik, 2012

Second option for dynamic approach could be different type of carousel solutions. Carousel is transferring the inventory to the picker either vertically or horizontally. Carousels are very useful for smaller items and high amount of article numbers. They are also saving space as lot of items can be stored in small amount of cubic meters. Current business has most of materials with 5-15 kg weight which is not very beneficial with carousels. All the smaller materials are stored in mezzanine inventory which is very good on space saving also. Typical is also that smaller size materials have small delivery volumes, and less pick counts, or alternatively high quantity but from one location with one pick only. Due to high investment, major change in warehousing and non-suitability for current products, carousels not recommended at this point.

Third option is different automated warehouse solutions. More information presented later on.

Alternative understanding for dynamic picking is the put-away and picking combination. This solution means that when put-away is completed, picking is done on the way back from the same isle. Highest benefit on this solution is the reduction of travel distances and time. This is beneficial especially in narrow-isle forklift use when travelling is rather slow. In current business solution this kind of dynamic put-away and picking combination is not possible due to WMS limitations. In addition part of narrow isle stocks are dead-end isles, when one way travel without transactions is mandatory.

5.3.5 Slotting improvement

"Some recent research suggests that less than 15 percent of the items in typical warehouse are slotted correctly. Consequently, most warehouses are spending 10 to 30 percent more per year than they should because the warehouse is improperly slotted."(Frazelle, 2001). When slotting is done incorrectly, this has a significant impact on operational costs. Practical impact is seen on longer travel distances for put-away and picking, wrong

size and wrong type locations are used, and they are not pick height optimized for high runners. Assuming, this 10 to 30 percent of additional costs, concludes to high amount of money in large distribution center operations. The bigger the distances are in DC, the bigger are also the costs as error impact is higher. This high amount of extra costs generated because of missing slotting functionalities, brings excellent contribution for WMS system improvement business case calculation.

Classification scoring will remain on level 1 until updated WMS system is available, where target should be on automated system driven dynamic slotting which equals level 5. Proper slotting calculation defines correct shelving type, allocation of needed space and actual location in correct shelving. Calculation is based on delivery volumes, item type, item size and weight, shelf life, popularity, pick density inventory levels etc.

Typically modern advanced warehouse management systems are supporting slotting and defining correct location for each item on put-away. In addition to placements, these WMS's can also give proposal for current inventory situation where items should be located, and needed improvement location transfers can be executed accordingly. This is mandatory functionality for world-class operations as preferred slotting is continuously changing.

5.3.6 Replenishment improvement

Replenishment should be quick, easy and automated system driven functionality. Whenever system will have situation for missing inventory compared to picking requests, replenishment request should be triggered automatically for forklift driver. Solution should ensure fully automatically that picking locations are never running empty. Automated replenishment solution require very accurate location and pick progress control, and high quality master data. Intelligent and modern warehouse management system is able handle this on the correct way.

Edward H. Frazelle is valuating "pick from reserve storage" as highest scores on this category. Actual dedicated picking locations are used for approx top 100 items on delivery volumes. All these high mover locations are picked by walking and by hands to trolley cart. Replenishment is done with forklift by taking pallets down from high stock locations for pickers to floor level. All other locations put-away and picking is done with same method and no replenishment is needed as picking is done directly actual stock location. Current operational solution does not support pick from reserve for high moving items as pickers can't reach the high locations. What would be lot better approach for level 5 is the use of incoming inventory. When system can see that same item is going out there is no sense to first put-away and then pick separately, especially with low inventory levels and large warehouse building. This, again, would require WMS improvement. Full control of each item in current location, and destination is needed when we think about world-class warehousing. By using direct transfers from inbound to outbound, similar to replenishment, lot of efforts and time can be saved.

Excellent replenishment process requires correct timing and correct quantities in correct location, like anything in logistics but this time with fully automated approach.

5.3.7 Shipping improvement

In this kind of operations "check, stage & load", level 1, is very common mode of operations on shipping. Stage & load can be achieved with high quality of operation when no further checking is needed anymore.

Direct load could be considered for one or two LSP's in case delivery volume would be high enough for full or almost full trailer. LSP selection is done based on transportation costs and available routes. Distribution center is delivering to more than hundred countries globally which limits the use of one or few LSP's only. In current business situation delivery volumes are not yet high enough for full trailer loads. As soon as consolidation of transportation can be done more than currently and concentration on fewer LSP's direct loading would be enabled.

On the other hand with this kind of business and with rather small deliveries it may never make sense without "staging". Staging and consolidation is mandatory part of the process as pallets are full of separate deliveries and wrapped.

5.3.8 Work measurement improvement

What is very typical nowadays in warehousing business is the use of outsourced workforce. LSP may have even less than two third of warehouse operators working directly for them and all others joining the operations from subcontractor. Another typical situation nowadays is the change rate of personnel, especially for outsourced personnel. Typical reasons are fluctuation on the warehouse workforce demand and low pay rates. When delivery volumes are going higher, more operators are hired from subcontractor, and when volumes are going down, amount of subcontracted personnel is cut down.

This makes the use of measurement standards even more critical. Performance of each person should be closely monitored and high performing persons rewarded and regular feedback give. This should be always the same despite of whether person is internal or external.

As operations are outsourced to 3PL, business owner has no visibility and no information available but there is still some possibility to impact this. Company can always have discussions and set-up some recommendations. Only real way to impact this is LSP contract. Every time when contract is opened for negotiation, there is room for improvement and discussions. With these kind of small improvements happiness of personnel may increase and this will help and ensure excellent performance for both 3PL and business owner company. Proposal is to ensure relevant clause for personnel in next contract.

5.3.9 Communications improvement

According to Edward H. Frazelle's categories communications is currently in level 3 as RF terminals are in use. Further improvement to level 4, hands free, or to level 5, virtual displays, would all require further investments. More analysis and information is shared on following chapters.

5.3.9.1. RF Terminals

Current operations are in level 3 for world-class analysis, but even to stay on same level, there is room for improvement. For further use and usability of RF, also hand held scanners would be recommended in addition to existing solution. As current operations are planned and executed with tablet-PC, there will be some WMS system enhancement needed to enable also small screen hand-held RF scanners. In purely standard operations it would be possible to start execution with hand held scanners directly with current SAP WMS solution, but as operations are highly complex and tailored, this requires further enhancement.

Both solutions have their benefits and handheld scanners would be recommended for any current operational transaction which does not require actual use of hands for material execution. Inventory counting would be easier and faster with hand held scanners. Other good possibilities for use would be for example goods receipt and packing transactions. There are multiple options for handheld devices, just best for purpose would need to be chosen. Similarly, on handheld scanner use, WMS must support fully the used equipment and preferably with equipment optimized solution. Recommendation is to use the split solution in process where the benefit is the most for improving current situation

Technology development and evolution for tablets during last ten years has been really significant. Newer versions for touch screen tablets are very light and screen resolution is very high. Typically for warehouse use recommendation is so called rugged pc or rough pad which is meant for heavy duty use. They are very durable and dust proof but disadvantage for these is much heavier weight. Some of very latest light tablets could be excellent office and support personnel which are not actively executing physical warehouse operation. For any other personnel it is still difficult to carry table during the picking or put-away execution so forklift mounted or smaller hand-held RF device is recommended.

In addition, transactions executed with tablet-PC's are not touch screen optimized. There are only standard SAP transactions used which always includes lot of small details and too much information for the user. Just only by optimizing screens for touch screen usage would make the process faster, easier and smoother. Touch screed optimized warehouse system solution is with big enough screen buttons and only very minimal information available to make the use most efficient. By improving current system solution the lifetime and usability of current tablet-PC would improve significantly.

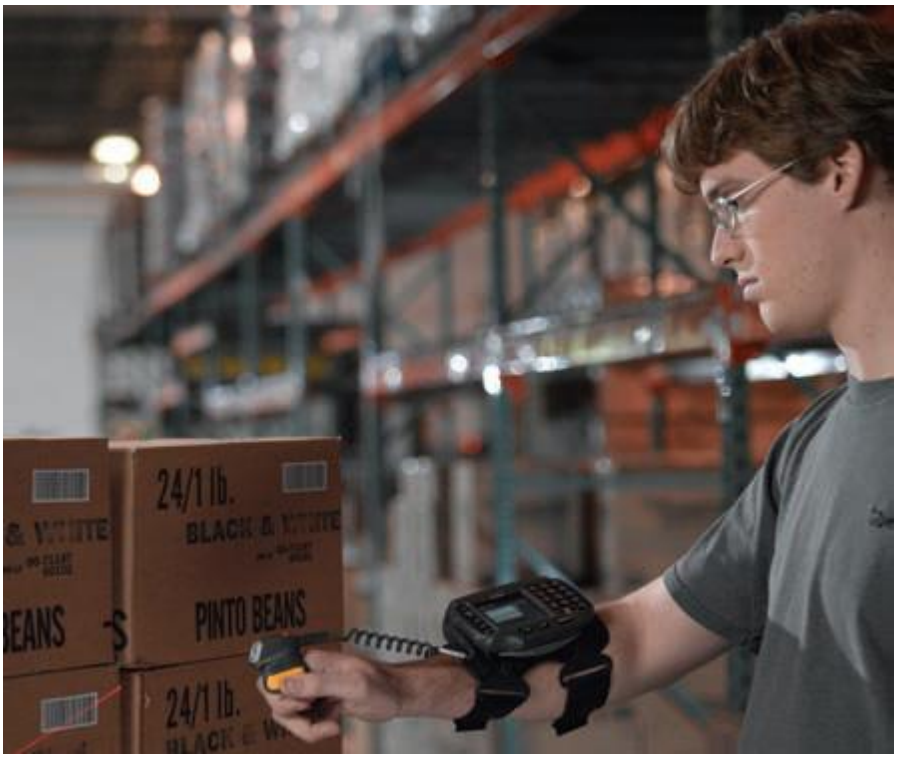
Picture 16 Motorola MC9190-G mobile computer for RF use (Motorola Internet pages, 2012)

Picture 17 Motorola MT2000 series handheld terminal (Motorola Internet pages, 2012)

5.3.9.2. Hands free - RF terminals

One of interesting alternatives for hand-held RF device or tablet-PC is wearable RF terminal. Wearable RF terminals allow the user use both hands continuously which improves warehouse operator work ergonomics. Operator can handle the boxes easier but still he has the computer available all time and immediately for confirmation, information and barcode

scanning. Wearable system is increasing productivity as there is neither need to get back to computer after every picking/put-away transaction nor need to use the separate barcode scanner. User has also full freedom to do confirmations anywhere needed, and not limited to short distance from forklift or trolley. In combination with wearable RF terminal small hand-held or finger tip bar-code reader is recommended. In current operations this kind equipment may not bring significant benefits but still would be worth of testing.



Picture 18 Motorola WT4000 Wearable RF system with finger tip barcode scanner (Motorola Wearables Whitepaper 1208 web, 2012)

5.3.9.3. Hands free - Voice controlled warehousing

Likely the most beneficial hands free device for warehouse environment is the voice operated and voice controlled system. This solution is seen such an important and significant part of performance improvement for current operation that it is explained in separate chapter below.

5.3.9.4. Virtual displays

E. H. Frazelle is defining level 5 for communications as virtual displays. Virtual displays or heads-up displays are the newest invention on ware-housing technology. The warehouse picker is using head-mounted display or glasses, which is showing all relevant information directly available for his view without turning a head. Virtual display can show information like travel paths, indicating location visually, text information for product or location and additional information for the product itself.

Picture 19 Picking with Technische Universität München pick-by-visual solution

The hardware requires in addition to head-mounted display, also small portable computer unit and interaction device, which is connected to server via wireless warehouse network.

Technische Universität München has been working with pick-by-vision solution for long time already and their real solution evaluation was done already in 2007. Analysis was not yet satisfying but user acceptance was very high. Analysis conclusion was: "Our results underline the potentials of Pick-by-Vision. Our evaluations show that the users are faster and make fewer errors. But not only logistics operating figures were considered. The user acceptance is high, resulting in a steep training curve. But there are still some problems. The biggest obstacle for porting such systems from the research stage into practical applications is the hardware components, especially the head-mounted display (HMD) and the tracking system. But there is a continuous further development of these components because the gaming industry slowly discovers augmented reality (AR) and HMD's will soon be a part of the everyday life within mobile multimedia applications. Therefore, HMDs will be used in industrial applications within the next five years." (Reif, 2009)

Augmented reality (AR) is a technology which is supporting human visual sense. It combines real and virtual worlds to one user solution in real time and with 3D visual effect. "AR has many possible fields of application in industrial environments. The first industrial application was the wire bundle assembly project carried out by Boeing in the 1990's." (Reif, 2009).

Presentation video from Technische Universität München for pick-by-voice solution can be found with search from youtube.com with "FAR 09:Pick-by-Vision (Director's Cut)" or use link
http://www.youtube.com/watch?v=FxCLxsf772I

One of the most ready looking solutions at the moment is KiSoft Vision solution from Knapp AG. They are stating in their internet pages that: "The picking solution is already being used in a warehouse setting and is ready for pre-production." Solution looks ready for actual warehouse use

and most likely will start gaining market share soon after actual production is started.

Picture 20 Knapp AG KiSoft Vision head-mounted display unit

KiSoft Vision is also using augmented reality technology. Head mounted display shows exact location to picker and other relevant information like item quantity. KiSoft Vision solution is a combination of control software, a head-mounted display and an integrated camera. Software is connected to the existing WMS, and according to Knapp AG, should be easily achieved. System is optimizing the route for picker in the warehouse and guiding him through the pick route.

One of biggest benefits is so called "License plate tracking" which should ensure completely error-free picking. "All picked articles and target containers can be checked for correctness with a simple look. Tracking lots and serial numbers can be done without any additional steps for the operator." (Knapp AG internet pages for KiSoft Vision, 2011)

Picture 21 Knapp AG KiSoft Vision, verification of picked item and put-away location in trolley.

Benefits according to Knapp AG:
- No training time required for operators
- Navigation within the warehouse
- Visual picking instructions
- Fully automatic tracking of lots and serial numbers error-free picking
- Applicable in every warehouse without structural changes

Presentation video from Knapp for pick-by-vision solution can be found with search from youtube.com with "KNAPP AG - KiSoft Vision in action" or use link
http://www.youtube.com/watch?v=BWY8uFlteIM&feature=endscreen&NR=1

Solution from Knapp AG is combining several warehouse picking techniques to one full solution and combining the benefits out from them:
- User has information for material code, location and qty visible on screen as like on paper based picking
- Pick route is guided to user as in pick-by-voice solution
- Solution is hands-free like pick-by-voice solution
- Location, material code and serial number are verified by vision camera like bar-code scanning

Picture 22 Knapp AG KiSoft Vision, actual user display showing photo for item, location code, route guidance to location and distance to location.

Despite of all these first phase challenges, pick-by-vision is still understood and described as state-of-art order picking solution and will be clearly part of future warehousing solutions.

Solution is called as pick-by-vision but similar solution in warehousing environment and why not for any other as well, can be used for many different purposes. Solution could be used for sorting items on inbound, put-away, packing and inventory counting. Imagine how easy the inventory counting would be when system will check by vision the correct location, material code from box and count the boxes in a second while you are just facing the location.

Conclusion on virtual displays currently is that it is still on prototype phase of development and too early to analyze further. The real commercial solutions are expected to be on market very soon. There are clear benefits possible with working solution for pick-by-vision. Definitely makes sense and is worth of follow-up for any future distribution center development projects.

5.3.9.5. Conclusion on communications improvement

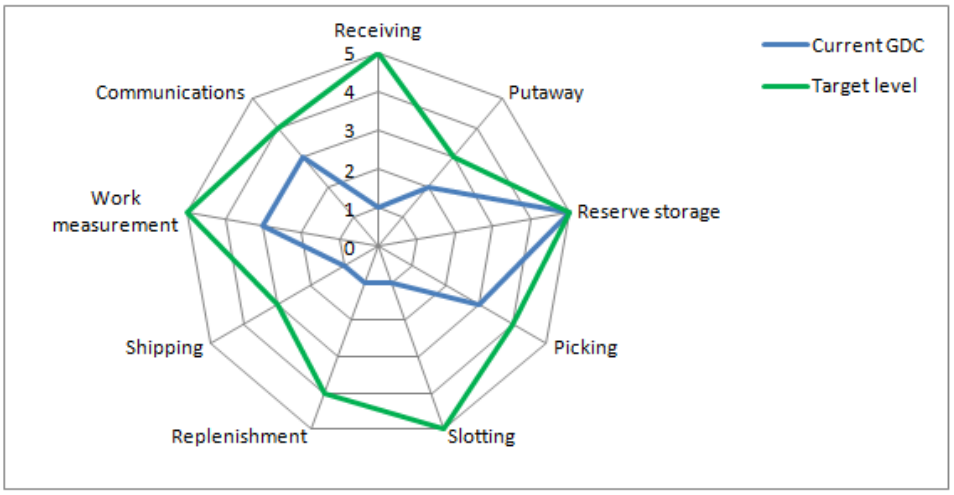
By looking for the available options for improving the communications category the best seen option is the voice control. Smaller improvements can be done by using different type of RF equipment but all these and even current communication solution would require further development on WMS.

For the future virtual display solution sounds extremely promising but not yet on commercial or sufficient level.

5.3.10 Conclusion on Frazelle's practices improvement proposals

Improvement analysis gives potential target level 38 points which equals average of 4,2. This would be an excellent target level and is possible to reach also. By going beyond this scoring it does not support the business or does not make sense with current business situation and delivery volumes. 4,2 can be considered for being in world class level. Target scoring is almost double to original but still realistic and possible to achieve. Target clearly shows how much potential there is for improving operations but also shows for far from world-class operations is at the moment.

In many of improvement areas conclusion comes back to current WMS solution. When current system is changed to another or improved heavily lot more scores can be achieved.



Picture 23 Current GDC scores for E. H. Frazelle's practices gap analysis compared to target level after improvements.

5.4 Improvement possibilities on performance with Frazelle's analysis

World-class technical capabilities and equipments itself will not solve the requirement for world-class operations. Another critical factor is the performance and performance measurement. Old wise saying "What you can't measure, you can't improve" is very true for warehouse performance.

According to Edward H. Frazelle's warehouse performance gap analysis GDC can already reach the world-class level. This still does not mean that they can lay back. Even keeping current level of scores requires lot of follow-up, control and improvement actions as things tend to go down if focus is vague.

"In our surveys of best practices organizations, we found that these organizations use extensive, regular, and systematic performance measurements to improve performance. They also operate according to the philosophy, "Measure what you manage, and manage what you measure"."(Boyson, Corsi etc., 1999)

5.5 Improvement possibilities on warehouse management system

Warehouse management system solution four different improvement possibility scenarios have been identified. One of these four options should be selected:

- Improve current SAP system solution to needed level
- Take SAP Extended warehouse management solution into use
- Select another WMS system and link to SAP ERP with messaging, handle all warehousing operations outside of ERP
- Link current SAP ERP to 3PL partner WMS system with messaging

All options are possible and have their own benefits.

5.5.1 Current SAP solution improvement possibilities

As current SAP development is slow, expensive and done in-house, biggest effort should be used for enabling fast, cheap and agile system development process. This can be done by improving internal resource situation but as company is struggling with financial situation may be easier with outsourced activity by selecting correct partner. There are two key criteria's to my opinion on this; 1) Partner company should not be too big. In many cases big part of agile development is lost when partner is too big and lot of time and money is used for bureaucracy, controlling and other non-development related things. 2) Choose partner with correct competence like in this case competence must be on SAP warehousing, and preferably on after sales business. When correct knowledge is available development is done really fast and no even need to do outsourcing to low-cost countries to have cheap development costs.

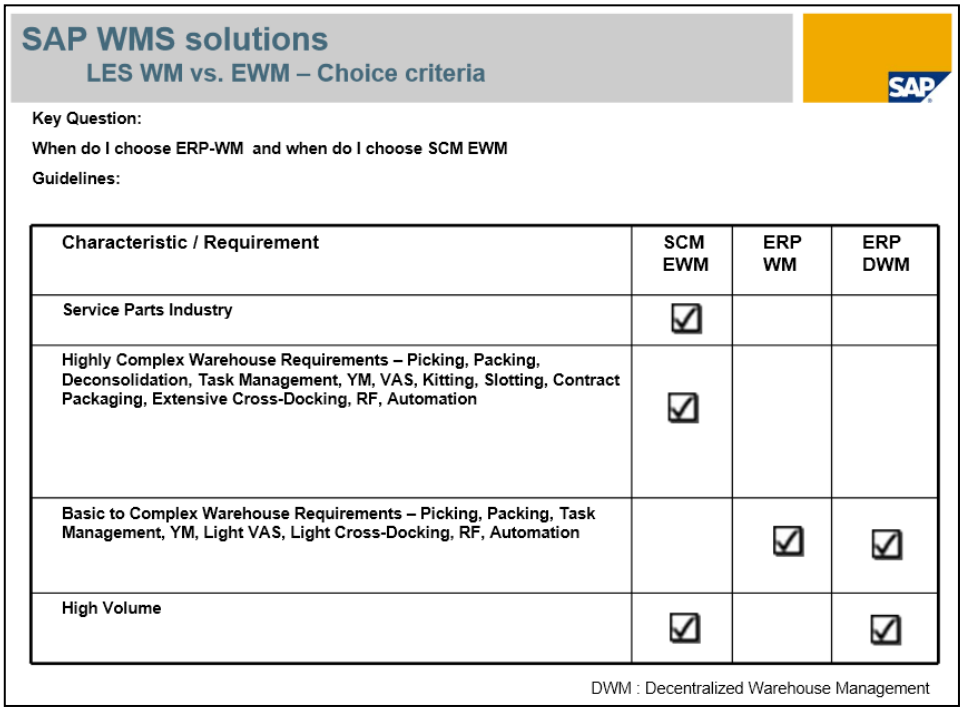
Some of missing functionalities are available in current SAP but will need implementation efforts which are pending for same resources as actual development. Still, even current SAP would used after upgrade to 6.0 it does not bring the situation any better as SAP has stopped the ERP system warehousing development. Many of missing functionalities does not make sense to build fully from scratch. Instead of heavy rebuild of current system other alternatives must be considered and selection of next step on WMS should be based on one of other three options. By building tailor made solution with all needed functionalities fully from scratch would be real stupidity when there are already existing solutions available out-of-box which will fulfill the need.

Behind these issues and multiple other issues or limitations there is already discussions ongoing about changing the current warehouse management system to something more enhanced and improved solution. New solution should bring the company back to state-of-art warehousing level. ERP system will remain in SAP due to company strategy but for warehouse management system there are more possibilities and options available.

5.5.2 Improvement possibilities with SAP – SAP EWM solution

SAP EWM is an extended warehouse management solution and linked to SAP ERP with messaging. SAP has almost 20 years history for warehouse management. Until year 2005 warehouse management has been integrated part of SAP ERP system, and still is but on rather basic level. To have an answer to their customer requests, SAP decided to take the next step. On year 2005, SAP published their SAP Supply Chain Management (SAP SCM) application including extended warehouse management (EWM) module. SAP SCM/EWM is a separate module and connected to SAP ERP 6.0 as a add-on or with full landscape module outside of ERP system. Connectivity to 6.0 is done by using queued remote function call (qRFC) and core interface technology (CIF) for master data. For older SAP ERP versions connection is done with iDoc messaging and core interface technology. Back in time, SAP has been stated to be suitable only for financial ERP back-bone system not as for logistics, but during last 10 years SAP has taken really major steps to improve the warehouse management system solution and is clearly one of market leaders today.

SAP is currently putting all warehouse management related development efforts to EWM solution. ERP WM is left as on basic level and still recommended for many customers and completely sufficient as well. For service parts industry and complex warehouse solutions SAP is recommending EWM solution. Both high level of complexity and service parts business are both valid for this specific distribution center.



SAP WMS solutions

LES WM vs. EWM – Choice criteria

Key Question:

When do I choose ERP-WM and when do I choose SCM EWM

Guidelines:

Characteristic / Requirement	SCM EWM	ERP WM	ERP DWM
Service Parts Industry	☑		
Highly Complex Warehouse Requirements – Picking, Packing, Deconsolidation, Task Management, YM, VAS, Kitting, Slotting, Contract Packaging, Extensive Cross-Docking, RF, Automation	☑		
Basic to Complex Warehouse Requirements – Picking, Packing, Task Management, YM, Light VAS, Light Cross-Docking, RF, Automation		☑	☑
High Volume	☑		☑

DWM : Decentralized Warehouse Management

Picture 24 SAP Extended Warehouse Management – Presentation, World tour 2009

EWM is improving basic SAP WM to really sophisticated warehouse management solution. Basic functionalities have been improved and much new functionality has been added.

EWM has following and currently missing functionalities included:

- Goods receiving with expected items to be received
- Automated goods receiving with RF
- Cross docking functionality, items directly from GR to goods issue
- Pick from goods receiving
- Pick and put-away route optimization
- Transportation cross-docking
- Interim stock location control
- Kitting functionality available (has been the issue for long time) with kitting to order and kitting to stock options
- Possibility to relocate products that are not stored in most optimum locations
- Slotting optimization for location selection based on delivery volumes or any other criteria's
- Dynamic put-away combination with picking in same route
- Warehouse activity monitor, complete and up to date visibility for any ongoing warehouse activity and performance reporting
- Serial number management on document or bin level
- Improved resource management
- Resource planning and controlling
- Tracking of employee performance
- KPI set-up and alerting for KPI's that are not met
- Flow control for put-away and picking
- ASN control and utilization possible e.g. for pre-good receipt
- Proper RF solutions available
- Batch management enhancements

In addition for providing solution to missing functionalities lot more beneficial functions are then available in addition:

- Graphical warehouse layout design
- Warehouse cockpit monitor
- Goods receipt optimization
- Improved returns & reverse logistics solution
- Task interleaving
- Opportunistic cross docking
- Integration to SAP quality system
- Packing specification
- RF support for all executed processes
- Workload simulation
- Real-time work monitoring
- 3PL billing possibility
- Inbound deconsolidation control
- Extensive labor control, ensure correct person in right place at right time, track, measure, alert, simulation of labor impact for process flow and inventory changes as well calculate costs, incentives and efficiency.
- Transportation management

"Plan, source, transport, and deliver better than ever with extended warehouse management software. Acquire the end-to-end execution tools you need to better plan and execute across the supply chain. With an extended

warehouse management (EWM) solution, you can gain control over your warehouse efficiency, transform your operations, and increase your competitiveness. Control warehouse processes and manage movements in the warehouse and your trailers in the yard. Mitigate problems and issues with improved warehouse efficiency. Transform operations into an adaptive fulfillment supply chain that can share its resources. Respond faster to challenges and changes in supply and demand – improving competitiveness" (SAP Extended warehouse management internet page, 2013)

With EWM solution SAP is stating that this brings Execution Excellence to warehouses and distribution centers. This is indeed something what distribution center targeting world-class operations needs. Hundreds of large size companies have already implemented EWM solution for their processes or started the implementation already. There are big customers like Ford, BMW, GlaxoSmithKline, Coca-Cola, Sony, Würth and so on. SAP is also marketing EWM as best-in-class product, for all kind of warehouses, for all industries and complexities, with full scalability and best of breed functionality. This is quite a bit said and easier said than done, but SAP seems to reclaim the promises.

"Maximize responsiveness and improve operations across your supply chain – with the SAP Extended Warehouse Management (SAP EWM) rapid-deployment solution. This preconfigured software and service package can help you quickly set up a modern warehousing system – for enhanced warehouse productivity and efficiency, real-time inventory visibility, improved space utilization, and more." (SAP internet pages, 2013).

SAP has developed and implemented rapid deployment solution also for EWM which enables fast and cost efficient solution implementation. Rapid deployment solution is utilizing experience and best practices from earlier similar implementations and provides a pre-made set-up for system solution. With this fast implementation new system solution implementation can be done in weeks instead of multiple months or years.

Business benefits according to SAP:

- "Automate and streamline your mission-critical warehouse management processes
- Gain real-time visibility and control of warehouse operations
- Proactively mitigate issues to improve warehouse efficiencies
- Quickly respond to changes in supply and demand – for a competitive edge
- Integrate warehousing with transportation and logistics for greater customer satisfaction " (SAP Extended warehouse management internet page, 2013)

SAP EWM would be an excellent replacement of current SAP WM solution. Most of today's issues and missing functionalities are already included in the solution. Additional benefit is the rapid deployment process which enables very fast project and fast return of investment.

5.5.3 Alternative options for current WMS and to SAP

Possible options instead of SAP ERP WM and SAP EWM could be one of any other external warehouse management systems with interface to current ERP SAP. It has been estimated that there are hundreds of different options for WMS systems existing on the market. Few examples for major WMS solutions are:

- RedPrairie
- Microsoft Dynamics NAV and AX
- Infor WMS
- Oracle warehouse management (WMS)
- Epicor WMS
- Manhattan
- HighJump
- Aptean - Catalyst WMS

The main key criteria is the connectivity possibility to SAP ERP. E.g. Manhattan Associates WMS has a SAP certified connectivity possibility to SAP ERP system available. The connection is done by using SAP NetWeaver Exchange Infrastructure (SAP NetWeaver XI) solution and is able to transfer critical data in real-time. (Manufacturing & Logistics IT magazine, 2007). Similarly also RedPrairie has certified integration to ERP and other partner solutions with full support for the integrated solution.

SAP pre-requisites for connectivity to SAP ERP system are:

- SAP 6.0 with needed support pack and software component installations
- SAP XI with minimum version based on SAP NetWeaver 7.0.

Other key criteria's are the needed functionalities for complicated after sales business, global tool solution, global presence for solution provides and scalability. Nearly every WMS supplier provides all sufficient functionalities according to their marketing information. To have full understanding on provided solution you need to dig vey far on to further details, as some may say "Devil hides in details". Tool fit to business on functionalities is extremely critical. Best situation would be to find WMS customers with similar business; both satisfied and dissatisfied, to analyze further what is good and what is not that good. Tools may work reasonable in all circumstances but when target is the real world-class operations selection process must be even more careful.

Finding new WMS solution for DC or warehouse is heavy exercise and needs lot of competence and understanding on requirement specifications. On possibility for reducing amount of possible solutions are online selections tools. Three of these were checked to get more information about possible options:

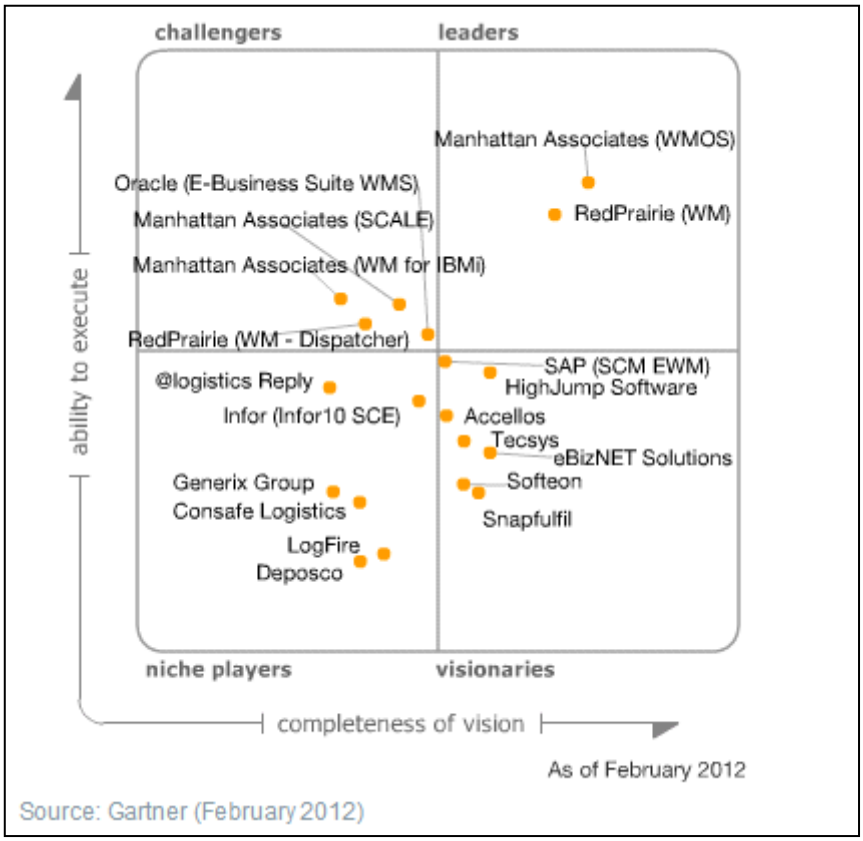
Software Advice pages, 4 options available
http://www.softwareadvice.com/scm/warehouse-management-system-comparison/

Warehouse Logistics, WMS online selection tool
Free version checked, knock-out selection gives 38 fulfilled WMS solution providers with 31 different system solutions and 51 solution providers where criteria's were not fulfilled
http://www.warehouse-logistics.com/1/3/home.html

Online WMS finder (WOLF), 23 options available with selected options
http://wmsfinder.com/index.aspx

What is common for all these online selection tools is that they don't have enough selection options and criteria's available to get to enough detailed level with current complex DC solution. SAP EWM is only solution common for all these three online selection tools. WMS online selection tool from Warehouse Logistics provides lot more information and options with non-free analyzer but for this thesis only free version was checked. Other business situations they may be useful but not for this DC.

In addition to all above it is very advisable to check neutral market analysis. One of recent is Gartner analysis for warehouse management systems, called Magic Quadrant for Warehouse Management Systems from 27 February 2012. Gartner provides very in-depth analysis for current WMS situation.



Picture 25 Magic Quadrant for Warehouse Management Systems, 27 February 2012, ID:G00219755, Analyst: C. Dwight Klappich

Based on Gartner analysis there are two clear market leaders, Manhattan WMOS and RedPrairie WM. They both have also lower level solutions but due to complexity likely the most extended version suites the best for this DC. If alternative WMS is selected, one of these two is recommended.

By selecting alternative WMS to current solution this must be company-wide strategic decision. In large companies it makes the most sense and is the most cost efficient to have similar solution in every distribution center.

5.5.4 ERP interfacing with 3PL WMS

When decision is done that 3PL partner would take the full ownership of WMS and DC this will have significant impact on partnership. Connectivity to business owner ERP system can be done the same way as for company internal WMS other than SAP, with XI solution but limitations are different. Only mandatory information would be transferred to and from 3PL system to be able to execute the transactions. This will limit very heavily company visibility to actual warehouse situation and will limit the possibility for improvements and enhancements. In addition to lack of visibility also 3PL changes will get extremely difficult. In this situation business owner would have neither visibility nor competence about actual processes and warehouse details anymore, how do you transfer something like to another partner? Inevitably this approach is leading to increased transaction costs as full package is purchased from 3PL.

At the same time company internal resources are not needed anymore for actual system development, deployment and support. Only area is to take care of is correctness and smooth operations of interface.

Similarly to external WMS also this will need clear strategic decision from company management and currently not seen visible but is possible.

5.5.5 Conclusion on WMS

Besides staying with current SAP solution, every other option means change for operations and has companywide strategic impact. The easiest solution is to stay with current SAP but this will never solve the existing issues nor will provide future proof WMS solution. And even more, this will guarantee never getting on world-class warehouse level. Even Gartner decided to drop out SAP ERP WM out of their recent WMS comparison analysis as it is not SAP's go-forward WMS platform. ”If the system will only support stage 1, no-class processes, you can expect similar processes and performance in your warehouse – no matter how great the technology is.” (Frazelle, 2001)

When final selection of to-be WMS system is done, following needs to be taken into consideration

- Connectivity to SAP ERP system; connection must be reliable, real-time and easy to set-up and maintain

- Best of breed functionality and technology support e.g. support for RF hand-held terminals and voice control solution available
- Future proof WMS solution. When system solution supplier is putting efforts to improve solution this will guarantee needed upgrades and improvements
- Full company support available, selection not only for one DC

There are three good WMS options but none of these will be easy to execute for implementation. All of these will need new additional development, implementation and support resources as they are all new solutions for company. Out of these three, SAP EWM would be the best option due to following:

- Will keep business harmonized on global SAP template
- SAP has taken significant steps forward during past 10 years for warehouse management solution development
- Lot of competence, experience and resources available in-house even though EWM would be a new module
- Clear and reliable linking to SAP ERP
- Less risk for "trying something new"
- "The Best-Run Businesses Run SAP" (SAP internet page, 2013)

WMS situation on market is changing very rapidly, tools are developing very fast and mergers and acquisitions are done for companies. Due to this decision should be done fast and stay with it as there is always something better behind the corner.

Despite of final decision on WMS key to success is fast, cheap and agile system development process. This will take a big step upwards on world-class stairs.

5.6 Improvement with voice controlled warehouse solution

Voice controlled warehouse operations was already mentioned above on Frazelle's practices gap analysis and here are more details and additional information for that.

Voice control implementation is currently one of major trends and improvement initiatives in warehousing and distribution centers, and for good reasons. The biggest business area using voice control currently are the wholesale grocery distribution centers and proceeding rapidly to other business areas and smaller warehouses and distribution centers also.

5.6.1 Background of voice control in warehouse

"First warehouses in United States have taken voice control warehousing applications into use already 20 years ago. In years 1996-97 Vocollect sales started to increase and since then amount of delivered Talkman-terminals has almost doubled on yearly basis" (Lehtinen, Hinkka etc., 2005). Despite of 20 years of existence voice control is still rather new technology in warehouses. Use of voice started from large grocery whole-

sale distribution centers that have huge delivery volumes, high amount of different titles and very short lead times.

"Yet voice recognition has been used in Japanese warehouses for at least 20 years." (Ackerman, Warehousing forum, 2002). Ackerman is referring to Japanese companies, who have been the first known users of voice recognition already in 1980's. In Europe, the use of voice technology has really been started only ten years ago at start of 00-decade. Main countries using the solution are UK, Germany, France, Netherlands and Belgium.

Marketing in Nordic countries was started 2002 and in Finland 2004. First solution in the whole Nordic area was delivered to Tuko Logistics Oy at 2005. Solution was delivered by Optiscan Oy and is based on Vocollect system solution.

Only now, more than 20 years after starting in US, it starts to become more common and widely known technology. Situation is still very similar to starting point, main users are grocery wholesalers, but fast spreading to other business areas also.

Nowadays as internet and VoIP calls are quite common, people are getting used to use headsets and even TV's start to have voice control possibility, all this makes the path easier for voice control implementations in warehouses.

5.6.2 Introduction of voice control

"Voice control technology can be divided in five different parts:

1. Speech recognition; in speech recognition system is recognizing the given word or word series samples based on given information
2. Voice recognition; Equipment has a pre-programmed voice profile for each user. Voice recognition system is recognizing and finding the word which is closest to given one compared to voice profile. Voice needs to be on needed decibel level as well similar to the accent in profile, but not exactly same.
3. Text to speech translation, text or data information in WMS is translated for user speech synthesizer to spoken language
4. Speaker authentication; In speaker authentication system is recognizing and securing user correctness based on unique user profile
5. Audio scanning; Voice files and e.g. video files can be checked with audio scanning. Scanning is looking for certain key words or other information, and linking them to other information or giving alerts. This is working on the same way as internet search engines are looking for key information from written text." (Lehtinen, Hinkka etc., 2005).

Voice recognition is used in many different business areas, but could still be used lot further. Email can be written by voice, automated phone services are available, call recipient name can be give with voice, navigation address and other information can be given by voice. Even special phone calls are planned to be introduced soon where two persons are both speak-

ing with their own language and call system is recognizing the voice, and translating to another language to receiver, e.g. from English to Spanish.

5.6.3 Use of voice in warehouse

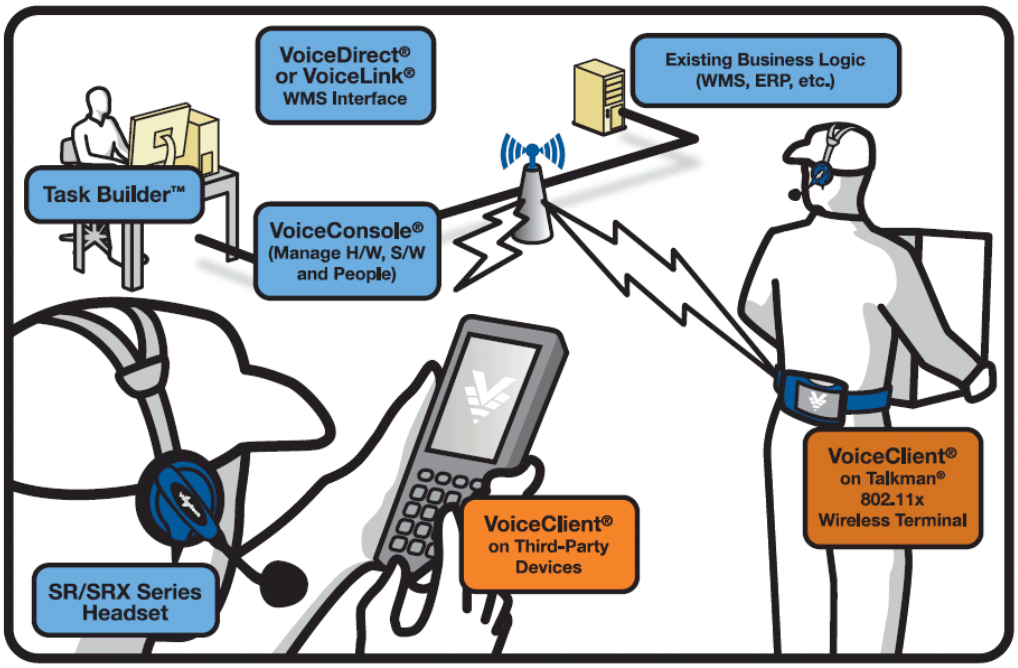
Voice control is one of the possibilities to transfer information between WMS system and warehouse worker on both ways.

There are two main global solution providers in voice control business that are Vocollect and Voxware. They are both US based and origin companies. This study is concentrating Vocollect solution with support of Optiscan Oy, Espoo. When actual solution is selected, all main solutions available should be verified.

"Vocollect has turnover of more than 100 MUSD on each of last four years. There are more than 300 000 users in 60 countries with 35 languages using Vocollect equipment (November 2010). Customer base of over 1500 customers and solution deployed in 4000 warehouses or distribution centers. Remarkable share, over 15% out of sales is invested in research and development. Serving diverse industries, including automotive, clothing & apparel, food & beverage, grocery, pharmaceutical, retail and wholesale distribution" (Vocollect company fact sheet, 2010).

Optiscan is the leading voice solution provider in Nordics, Baltic countries and Russia. Optiscan customers are handling already 5 000 000 order lines every single day with their systems. Turnover is 17 MEur, personnel 60 and offices in 5 countries.

Voice control solution in warehouse is based on four main parts, warehouse management system (WMS), voice control system (e.g. Voice console), user terminal with headset and wireless network. User has a personally coded headset which is used by one person only for sanity reasons. Headset is connected to Talkman T5 terminal which is held on the belt during the use. Terminals are not personal and multiple terminals can be available in warehouse. They are battery operated so another set can be charging while others are in use. Talkman T5 has a Voice client firmware installed. Voice client is recognizing the voice and changing that to data format. T5 contains also the needed process logic information what to speak, and what to expect as an answer. With VoiceConsole ongoing warehouse tasks can be assigned and monitored. It contains also all users' personal voice profiles, user configuration and can be used for voice terminal firmware updates. All users are connected wireless network to VoiceConsole and to WMS system. All tasks can be completed and monitored in real time.



Picture 26 Vocollect/Voicelink voice control solution principal picture

Picture 27 Vocollect SR-20 headset

Picture 28 Vocollect Talkman T5 mobile terminal

Picture 29 Warehouse user with Vocollect headset and Talkman T5 terminal

Some WMS systems are supporting voice control with direct connectivity e.g. Manhattan, CDC, Infor and Exceed. In case direct support is not available, additional VoiceLink server can be used for transferring and converting the data. VoiceLink data transfers is based on WMS standard messages and done in real time.

For SAP ERP system, there is a SAP certified solution available, VoiceLink WCS for SAP. This is using SAP NetWeaver platform and provides configurable basis for standard real time messaging. Solution is working together with SAP WM (versions 4.7, 5.0 and 6.0) and SAP EWM all versions.

"Clearly most common voice controlled warehousing process is picking. Other possibilities and existing solutions are receiving, cross-docking, put-away, packing, sorting, replenishment, inventory counting, checking and returns." (Lehtinen, Hinkka etc., 2005). Voice control can be utilized in any process where controlling and progress confirmation is needed, even outside of warehousing and logistics.

5.6.4 Achieved benefits of using voice in warehouse

Significant benefits are possible to achieve by using voice. As processes may vary a lot, used tools, way of working and current situation different, exact benefit calculation is rather hard to do. Benefit analysis can be done based on average values and achievements in warehousing business in general. Still even if on benefit calculation, lower saving values would be used, benefits are still very significant.

Based on VTT pilot case "voice control benefits can be achieved at least in package and pallet based environments where working is mainly manual done by individuals. This means that voice control enables especially in terminals and warehouses very easy operations with data collection, information sharing and using further." (Lehtinen, Hinkka etc., 2005).

Vocollect voice customers have achieved (Vocollect VoiceDirect, 2010):
- 25% increase in productivity
- 35% decrease in overtime
- 99.995% order accuracy
- 50% reduction in training time
- 50% decrease in returns management time
- Greatly reduced service level performance penalties
- Reduced accidents and worker compensation claims
- Payback is generally realized in less than 12 months

5.6.5 Voice, general benefits

Benefit information collected from multiple sources:
- Safety, ergonomic and comfort
    - Both hands available for picking all the time
    - Balanced lifting position
    - Easier picking for heavy items
    - Eye contact to see anything around improves safety as there is no need to look at papers or screens
    - No need carry RF-scanners or papers by hand
    - Increased user happiness
    - Voice commands to and from user can be done with users own language, dozens of languages available and more is easy to create
    - Durable equipment and easy to carry with
- Increased accuracy
    - Eye contact to see items and locations all the time as there is no need to look at papers or screens. Continuous eye contact is reducing process mistakes.
    - Further confirmations with scanning or coding can used if needed
- Process improvement
    - Multi-customer picking enabled even this would not be supported by ERP system
    - Correct process must be followed without shortcuts. Usually ERP and WMS systems can enable multiple options to do tasks and user may not always follow processes correctly. Voice guided process steps must be followed.
    - Processes can be simplified compared current WMS or ERP+WMS system guided processes → Only mandatory tasks required by user
    - Accurate and real time visibility available for any voice controlled process steps improves warehouse management and reporting possibilities

    - Workload planning is easier and balancing possible with immediate effect.
    - Change data or other control data can be transferred to user without any extra efforts or movements
- Performance improvement
    - Self-motivating speed increase on the processes. Users usually in a week turn the voice speed up to maximum and as voice speaks fast, user acts fast also
    - Faster processing of requested steps than with traditional equipment like paper, RF or tablet-PC. → Increase throughput and velocity
    - Many of the activities can still be continued in warehouse even though connection to ERP system would be down or to any servers outside of the building
    - Special warehouse environment requirements, typically very hard for any other picking methods, voice works and can be used as well as in any standard warehouses
        - Cold/freezing
        - Hot/heated
        - Extra clean spaces
        - Rough/dirty/humid/dust
        - Poor lighting
        - Noisy
    - Special information entry to WMS as first time entry or confirmation and no need to type on terminal on get to computer
        - Weight
        - Measures
        - Color
        - Shapes
        - Conditions
    - Faster training and learning as only very simple commands and basic process needs to be trained for new users. New users will reach good performance level faster than with other methods
    - Personnel performance follow-up is easier and workload for each person can be easily balanced according to personal working capacity and speed.
    - Immediate replenishment requests can be given during the picking process
    - Change of user responsibilities is easier and faster with voice, and can even be done in the middle of the process as voice control system can transfer work to other persons or remember the current step for later processing.
    - Easy method available for performance based pay as activity and speed for each person can be monitored.
    - Reduced costs due to all above

5.6.6 Voice control compared to other options

	Paper and Labels	RF Scanning	Pick-to-Light
Productivity	Vocollect 10 – 15+% faster	Vocollect 15 – 25+% faster	Same
Accuracy	Vocollect 10 - 20 less errors per 1,000	Vocollect 2 - 4 less errors per 1,000	Vocollect 2 - 4 less errors per 1,000
Training	Vocollect reduced time by 50%	Vocollect reduced time by 50%-65%	Similar training effort
Issues	▪ Lack of real-time associate visibility and accountability ▪ Lack of real-time inventory, people, system update ▪ Difficult to batch-pick ▪ Data entry errors ▪ Labor and materials cost to handle paper ▪ Not hands-/eyes-free	▪ Average two weeks of training for associate to be self-sufficient ▪ Operator is distracted: data entry, read, scan ▪ Safety issues (Heads-down) ▪ Not ergonomic ▪ Not hands-/eyes-free ▪ Battery issues ▪ Many points of failure (need to have back-up inventory of equipment)	▪ Inflexible ▪ Expensive to add SKUs ▪ Can't efficiently manage two order selectors in one zone ▪ Difficult to batch-pick ▪ Sized based on SKUs vs. people ▪ Thousands of points of failure (we are talking about lights…)

Picture 30 Vocollect white paper comparison Voice controlled operations versus traditional systems

Vocollect analysis shows clear benefits compared to paper/label based picking, RF picking and pick-to-light solution. Of course it can be mentioned that Vocollect is not neutral party for giving numbers on differences as they are one the main suppliers for voice control systems. Similarly VTT has done the study for voice control. VTT is neutral research institute and got following results; Reductions achieved after voice implementation vs. scanning (Lehtinen, Hinkka etc., 2005):

- 11% reduction on shortages
- 25% reduction on miss picks
- 50% reduction on customer returns

Similarly any other research or comparison is ending up to similar level of difference. Voice control is clearly better solution in all ways when implemented on correct way.

Additional video clip for speed comparison:
http://www.youtube.com/watch?v=KkADR5P37Is

5.6.7 Voice use possibilities

Voice control solution is not limited to picking only. It can be used in warehouse environment for multiple different purposes:

- Goods receiving
- Put-away
- Inventory counting
- Picking
- Warehouse internal transfers
- Packing
- Shipping
- Sorting
- Consolidation
- Placements to interim stock locations

Voice control can be used as a separate solution for its purpose but at the best voice control is combined to any other warehouse tools and processes. Processes, methods, tools and systems should be always defined according to real need, and to make the process most optimized. The key driver is the co-operation and connection between each method. Voice can be easily combined with bar-code readers, printers, RF scanners (see picture), RFID solutions, computer screens, pick-to-light systems, paternoster systems, tornado systems, carousels and mobile shelving. Hybrid solution is possible and usually also the best option for warehousing. Likely voice control will never replace other solutions completely, but supports other systems very well and for correct situations it is very powerful solution.

Picture 31 Psion, Intermec and Motorola terminals with Vocollect headset

5.6.8 Voice control benefits to GDC

VTT stated in PULO report and based on their pilot case "voice control benefits can be achieved at least in package and pallet based environments where working is mainly manual done by individuals. This means that voice control enables especially in terminals and warehouses very easy operations with data collection, information sharing and using further." (Lehtinen, Hinkka etc., 2005). This statement applies exactly for current GDC operations, different types of forklifts are used but picking is always done by individuals.

Significant benefit is related to 3PL way of working with employees; there is in-house employment agency taking care of sufficient amount external workforce. Amount of workers is changing almost on daily basis depending on delivery volumes. Also 3PL operation has certain level of changes on personnel. Together with this way of working with personnel, voice controlled operations will make the training and start of effective work much faster. Many of workers are other than Dutch origin and with voice they can easily do picking with their own language. Persons working with voice may not even need to learn how to use WMS system which brings very fast payback time for training.

Compared to very slow operations with current tablet-PC, material handling will become must faster, there is no need to follow the screen and system will tell user where to go next.

One disadvantage aspect which is making picking and put-away slower currently is the scanning of location and material code barcodes. This

scanning was forced to be taken into use due to lot of errors in process and location inaccuracy. Typically voice control brings such accuracy that this scanning is not even needed anymore, and if wanted, it still can be used together with voice.

Voice picking will make the picking safer and faster due to both hands available and vision on item to be picked. This is especially important when working in high floor with cherry pickers. Together with voice control system it is very easy to manage the workload and control ongoing activities. For example if stock isle is too busy with pickers he can be advised to start from another picking isle first. Similarly if inbound is getting too busy, picker can be instructed to stop the picking and help at inbound area. System will assign this stopped picking to another picker or keep track on picking status to be continued later on. Faster picking speed is also coming from having dialog with voice system before and after picking actions during walking phase instead of stopping in the location for checking the screen for location, code, quantity etc. as well actions with tablet-PC for confirming the picking afterwards and looking for next location.

In the VTT PULO report (2005), there is payback calculation done with four alternative scenario calculations for two different companies, 8 or 25 pickers. Productivity increase has been estimated for 15% which is very realistic expectation with voice control implementation. Investment payback time calculation showed anything between 3,2 and 10,6 months. After this payback time achieved savings will be significant.

One of non-written benefits seems to be, and confirmed by several interviewed warehouse managers, is that people tend to work with faster pace together with voice. Voice system is fully controlled by picker and next command only given after request or confirmation of previous action. Speed of voice speech is fully adjustable and as confirmed by managers most persons will turn speed to maximum to get faster return for their command and get information for next action faster. When speed of speaking voice is getting higher, people tend to behave automatically faster, walk faster and do actions faster. Not because of someone is requesting them to do so but self driven. So, not only gaining all benefits for new solution but also people will start working faster. Some of best benefits of using voice is that by gaining more speed this will not reduce the accuracy like any other system.

Additional saving to self-evident voice control operational savings is coming from proper implementation of voice solution. Voice control system has intelligent system software included and instructing workers based on pre-defined processes. When voice implementation is done at the best all processes should be re-evaluated and renewed, never just to be implemented to as-is process. Though, even with as-is processes savings can be achieved but they should be always maximized. In GDC complete creation of picking waves, manual data transfer to supportive control system, split to zones etc. could be completely avoided and let voice control system generate the needed picking actions at the most optimum way. Operation managers or controllers can follow the progress clearly and real-time and

easily change priorities when needed. One of current issues is multi-line picking for one customer. Due to service business, in most cases there is one sales order per one defected faulty unit failure reporting from customer. For good unit shipping customer orders are consolidated to bigger delivery for saving costs on shipping and transportation. Because of these separate orders picking must be done accordingly, for one delivery from one location with 10 pieces same item code, picking is done 10 times one piece. By scanning item code and location as well confirming steps in system this full process will take huge amount of time. By realigning this with voice control system solution, picking can easily be done with 10 pieces at once.

Compared to current, dual system use solution, with voice control real and accurate status reporting is available and better control can be achieved.

Voice control solution should not be limited only for picking. In GDC voice can support for example at inbound sorting and goods receipt and it can be done much better and faster, the key is improved system control. It would work very well and bring the benefits also together with put-away, warehouse internal transfers, picking consolidation and packing. Same 3PL partner in same facility is providing service also for other operations for company, handling and checking faulty unit returns from customers which could also be done very easy and fast with voice control support.

In addition to above mentioned examples voice control implementation will give full range of improvements with reasonable price and pay-back time. With all these benefits voice control is without a doubt one of most beneficial improvement action for GDC and to be implemented as soon as possible.

5.6.9 Conclusion on voice

"Based on VTT study there has not been found any factors which would be significant adverse factors. Especially as voice recognition technology has been improving fast and equipments have become very reliable." (Lehtinen, Hinkka etc., 2005).

Voice controlled warehousing is today's way of working, not something for the future. During voice implementation achieved benefits can be really significant, especially when work processes and routines are evaluated very openly and innovatively and solution implemented according to best processes.

Voice control solution is to be taken very seriously in almost all warehouses and distribution centers nowadays. When solution is bringing improved safety, ergonomic and comfort, improve accuracy, improve difficult processes even with less optimum WMS, improve performance, improve management and control, increase quality and reduce errors as well cutting down costs, who can anymore object this? Especially now when also voice control system solution and equipment prices are coming down on very achievable level.

5.7 Additional improvement possibilities

In addition to above mentioned bigger improvement topics also several smaller individual improvement possibilities can be done and has been here analyzed.

5.7.1 Fully or partially automated warehouse

There are three commonly used wrong statements for warhousing automation:

- Losing flexibility; Flexibilitity limitations are different to standard warehouses but typically modern automation systems are possible to change and adjust due to modular structures and mandatory changes can be done
- Investment too expensive; During past years prices have come down and automation is profitable for smaller distribution centers also.
- Warehouse is too complex for automation; Almost any solution is possible to automate when proper end-to-end solution is built.

Despite of possibilities or limitations, the main question is if it makes sense financially and business wise. Typically payback time becomes rather long and business continuity must be guaranteed in same location. Best solution is to build automated warehouse completely from scratch so that complete building measurements and layout is made for automated solution.

Automated warehouse is at the best when locations can be stored as pallets or plastic boxes. Warehouse automation will transfer pallet to picker who will pack and ship the pallet out. When less-than-pallet quantities are handled usually plastic crate or box is the best. Distribution center is supporting replacement and spare parts business. Typicaln for this business is that inbound except top 20 high movers is coming in with less than pallet and for outbound never full pallet same item code going out to one customer

In current premises full automation would require complete rebuild for racking and still the building would remain rather low height for automation.

Another challenge is big variation of item box size. Items can be anything between one per pallet up to 200 per pallet. As picking quantities are very small and always less than pallet, only way forward would be to use some kind of crates. As most common items are between 6 to 25 kg and size is rather high this would make the crates very big. Items have also very high variation on delivery volumes and high moving items are handled by taking full pallet down for picking area from whre the picking is done by hand.

Automation is very suitable for distribution center running for long operational days but burrent delivery volumes does not support more that 12 hour working day with current resourcing. Delivery quantity is rather

high at the moment but trend is downgoing due to technological evolution of equipment, products are getting bigger and much better so less quantity is needed in the future.

Part of inventory is used for long term customer support and may be stored for next 15 years due to customer contract oblication.

Automated warehousing solution not recommended due to downgoing trend on delivery volumes and high investment compared to current costs. Also current facility, high variation on box sizes and high inventory levels compared to picked quantities do not support further automation analysis.

5.7.2 Mobile printer

In addition to current and possible to be equipment, one of best supportive equipment would be portable printer. Printer is kept at the belt holder and is capable of printing the needed labels for the operations. This kind of printer works excellent together with any other portable or hand-held device. In principle printer can be used also together with current solution but better for current would be fixed mounted printer.

One of examples is the portable wearable RFID printer from Zebra which can be used in heavy duty environment indoor and outside in manufacturing, transportation, warehousing and in all moving jobs. Printer is producing high quality stickers anywhere needed.

For current operations this kind of printer could be used instead of preprinted labels and label scanning to system, in inbound sorting and consolidating for put-away, outbound consolidation and export holding area controlling; highly recommended.

Picture 32 Zebra P4T portable sticker printer

5.7.3 Pick their minds

”Pick their minds is a phrase that describes what is done on a visit to another company’s warehouse.” (Reduce your warehouse expenses, 2009).

The idea behind this phrase is to learn by visiting to other warehouses. It is really a lot easier to learn best practices when you see operations in real compared to reading a book for example. This is valid as well for bigger overall topics and down to smallest details. Sometimes small things can make a big difference. During the visit it is good to take photos, if allowed, collect the documentation and ask as many questions as possible.

This same approach can be used also inside the larger companies, applied by visiting warehouses from other departments, other countries or different operations.
Target on pick their mind approach is to find the best in class or world-class warehouse or distribution center, go there for a visit and learn and feel how it to be one of the best is. When people see in practice how things can be done better they usually learn much better than someone just telling them how to do things. This would be recommended for all DC personnel.

5.7.4 ABC analysis

ABC analysis and classification means that items in the warehouse will be divided to three or sometimes even more categories. Category A item is the high moving item and will need significant amount of picking activity. These A items should be located close to outbound area to minimize the picking distance and have all high moving items located together. B category is for medium moving items, C for slow moving and D for very slow moving items. Amount of different categories is based on the need for each solution; can be from two up to as many needed. Most common type is deviation to three, ABC, by dividing according to delivery volume percentage 80-15-5.

On warehousing perspective ABC classification is affected by two causes; item lifecycle status and item rotation/delivery volumes. Based on these two factors, correct classification can be given. Classification will define the best possible location, A being closest to outbound and C/D with the lowest picking rate, located at the farthest distance from outbound.

When item is in starting phase of life cycle, classification can be done based on forecasted sales. During normal delivery cycle, actual delivery volumes can be used. On final ramp down phase, accurate follow-up and forecasting is becoming more critical.

ABC review is needed on regular basis. Target is to have items located in optimal locations but not to have continuous changes on locations. By consolidating one category to one isle, zone or section, it will “enhance the space utilization, provide a good picking hit density & concentration that improves employee productivity” (Reduce your warehouse expenses, 2009).

Improved version of classification is ABC+ analysis model. “Life cycle based ABC+ classification increases power on warehouse optimization” (Logistiikka - magazine, 3-2010). In this article analysis model is related to purchasing and inventory level optimization but as well can be used for many other purposes like product location optimization inside the warehouse. Classification is based on ABC for delivery volumes and +, = and – for defining status in delivery volumes; + for increasing delivery volumes, = for stable situation and – for down going delivery volume trend. Author of this article, Jyrki Salmivuori has written a book “Vaihto-omaisuuden hallinta pk-yrityksessä käytännönläheisesti” where is lot more information provided for this topic.

ABC analysis is done fully manually with Excel sheets at the moment. Location analysis is one of missing key elements on current WMS and must be available in improved version on next system solution. Target is that WMS is calculating relevant category automatically, ensuring continuous improvement for locations and using locations on dynamic way. When improved solution is in place put-away and picking distances in warehouse will become shorter and performance is improving. Currently each additional minute makes driving or walking time longer and money is lost.

5.7.5 Outbound quality

”What goes out bad comes back is a pack activity term that refers to a customer order pack quality to minimize damage sku’s.” (Mulchany & Ritchey, 2009) Incorrect and insufficient packing will clearly lead on increase with customer return rate. When packing is not done on correct way items will easily damage and end up to customer return or claim. Absolute critical is to have packing instructions available.

Another aspect is the actual content for the delivery and the documentation included.

Customer return reasons
- Shortage delivery
- Overage delivery
- Incorrect delivery
- Damaged delivery

Shortage delivery means that customer has received all materials compared to packing documentation. Packing documents with SAP are based on items which have been packed system wise. When packing is done simultaneously in system and in real, this will ensure correct delivery. However, there is still always room for errors e.g. when items are packed to multiple cartons and missed or printed packing documents attached to incorrect delivery. Part of the items may be lost during the transportation also.

Overage delivery means that customer has received an extra item. Usually this is resulted out of packing in system has missed item.

Incorrect delivery can have multiple issues; items are not the same as on packing list, items are not what customer ordered, items delivered to incorrect address etc.

Damaged delivery is usually caused by insufficient or incorrect packing either mishandling during the transportation. Due to one or more of these reasons, item(s) or shipment is damaged so badly that item can't be used anymore. For these cases customer will not have the items available and additional costs will occur.

Possible options for outbound quality control are 100% check accuracy, random check and packing lane based on any other special check. Some additional checks have been already implemented but challenge is to have check done full proof. On packing phase serial numbers are scanned from all boxes and material codes scanned once per delivery line. In addition visual check and comparison is done.

On outbound and packing possible improved can be done together with voice control. By utilizing voice and handheld barcode scanner when putting items to transportation boxes and pallets, packer can keep the control better by looking products continuously instead of travelling between pallet and computer, he will have both hands available for packing, quality and speed for packing are improving and additional checking may not be needed anymore.

5.7.6 New equipment

One of very interesting innovative new equipment is new F5t Tablet PC from Motion Computing. This Tablet PC is designed for warehousing use with rugged design, built in camera and barcode scanner with combination of powerful processor and good battery life and all combined in very light package.

This product gives great flexibility for working and is an excellent tool for all warehouse controllers and other similar personnel who are moving around in warehouse and concentrating on safety, stock controlling, inventory counting etc.

Picture 33 Motion Computing F5t Tablet PC

5.7.7 Other improvement options

Here are some additional improvement possibilities listed for warehousing environment which can't be fully skipped during the analysis but not seen useful for current distribution center.

1. Pick-to-light solution. Very good solution for carousels and for example picking isles where picker is proceeding fast through the isle to one direction and picking from every location where light is on. This is not recommended as lot of picking is done with cherry picking narrow isle forklifts and by walking on fast moving picking area. There are several pickers in the isle same time and benefit in this case is not received.
2. Pick'n go solution. Pick-g-go is a new product from Optiscan. Estimated productivity increase is even as high as 70-100%. This is enabled by very creative way of combining Voice controlled picking and automated guided vehicle, AGV. Basic principle is to minimize picker's time for any additional and unnecessary move-

ments. When looking for warehouse cost structure, it is showing that pick-n-go is the best way to reduce the costs after voice control start-up. Usually half of total costs are for personnel, and out of these picking is clearly the biggest. When picker is doing manual picking, he is using half of the time for transfers. By reducing this unnecessary moving, he can really concentrate for what he is supposed to do, picking. This is excellent for warehouses which have most or all picking by walking with partial pallets and very long walking distances but does not apply to GDC situation.

3. Conveyors and rolling tracks. Conveyor and rolling tracks are simple solutions to transfer items horizontally or for example feed products directly to picking or outbound area. Some rolling tracks are used at GDC for packing lane and for this situation no benefit seen to increase the amount of them.

6 CONCLUSION AND CONTRIBUTION

Analysis for this master thesis led to several improvement proposals which are important to take as next step. When operation efficiency and improvement is targeted biggest and most urgent improvement area is the warehouse management system. Current WMS does not support the business anymore on the needed level and lot of extra manual work is required for running business, meaning that it fails to deliver the complete needed business process. Despite of additional work proper level of operational efficiency is not reached, errors are done and costs are higher than it should. Today's WMS tools are not only providing solutions for current issues but bringing lot more. They are also having graphical views and newest functionalities which can even improve operations further when these are taken into use. Updating or changing WMS must be on the highest priority.

Second big step on improvement roadmap should be voice control solution implementation. Voice is bringing significant amount of benefits to GDC, faster and more reliable processing in safer working environment. Voice control is making training faster and workers will be productive much faster than with any traditional system in this multi national distribution center.

Third important point is the logistics contract with current third party LSP. Contract should enable and motivate to closer co-operation and common improvement initiatives with win-win approach. When both partners are motivated and willing to execute improvements lot of miracles will happen. Logistics partnership is recommended to keep as is but continue co-operation and development together. Current contract has a statement in the appendix "The parties agree to establish a gain sharing program on cost savings identified and realized." (LSP contract appendix, 2008). So far, this common gain sharing program for cost savings has not been started. It is highly recommended to start this as soon as possible.

Usually constructive study approach includes also solution validation in practice. In this thesis only relocation related impact is analyzed. Any other improvement is waiting for SAP upgrade completion first and only then other improvement project can be started. Operational and development organization is rather limited for resourcing and not many projects can be executed together. In addition WMS has very long implementation timeline due to quite complicated business processes and likely some solution adjustment is required. WMS update is already taken to development roadmap by company but nothing else done besides this thesis so far.

Finding and collecting all the relevant information had been challenging due to very fragmented information. Most books related to warehousing and distribution centers are rather old and not up-to-date anymore but some positive surprises have been found also. Warehouses and distribution centers have been changing quite a lot during last decade and similar change trend is still valid; new technologies are coming available and implemented to even smaller warehouses. Very typical approach on this

business branch for improvement projects and initiatives is that companies are contacting consultants who then "will take care of improvement and fix things". This kind of approach is good only for short term but warehousing and distribution business should work for continuous improvement, not only for short term fix.

This analysis has been done for one specific distribution center only. Despite of this approach thesis can be used for any warehouse or distribution center improvement analysis as a supportive tool. This work also has latest solutions documented and analyzed and is very good information package for any person working related warehousing and DC's. Thesis is giving very wide scale of information and not only concentrating one or few single issues. The analysis work is increasing common knowledge and understanding on today's warehousing technologies and improvement possibilities, very much applicable for any alike operations.

"Developing a world-class logistics operation that provides competitive advantage and supports corporate goals may require radical rethinking and redesign of logistic activities, which in turn requires commitment, resources, and time to implement. It is also likely to accompany or provoke change in other activities or other parts of company – and possibly in the organization as whole. For example, and integrated, centrally managed supply chain could not operate as effectively in a functionally organized firm.

In addition, adopting logistics best practices cannot be done in isolation. It will involve at a minimum the support of top leadership and managers or related units and the help of non-logistics experts, such as financial specialists, those skilled in developing performance metrics, and those with experience in managing change, including the human resources effects of new approaches and norms." (Boyson, Corsi etc., 1999)

Target for this distribution center should be, not more and not less, to achieve the world-class level operations. Similar target should be in every warehouse and distribution center, does not make sense to target only for slight improvement. To enable and keep operations on world class level requires hard and continuous work. There is no room for slipping out from the continuous improvement trend. Just to keep in mind, once in world class does not mean always world class. Outsourcing partners have often been compared to long time marriage. Key to success is hard work and strong will from both partners.

"Completely reorganizing a warehouse for superior performance is not a short term project. Although some major overhauls may be accomplished in one or two years, even then the process of continuous improvement should proceed not only in warehouse but also in the operations of the rest of the network, including supplier factories. Thus, achieving near-optimum results will usually require years. This does not mean, however, that radical improvements cannot be started tomorrow or even today! Every warehouse needs a short-term improvement strategy."(Harmon, 1993). In addition to setting up target for world-class, company should also have

improvement strategy. Improvement and development strategy helps to focus on correct things and have correct priorities in short and long term.

For current operations taking needed steps for improvements is mandatory to save money and fight against continuous increasing costs. Costs are the key, otherwise there is no future. It is reasonable to expect easily at least 10% savings on total costs by comprehensive operational improvement, starting from WMS renewal and voice control solution implementation.

It’s time to make it all happen, starting today!

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Attachment 1

Voice controlled warehousing operations examples for voice command dialog work flow:

Voice controlled picking
User: Start picking
Voice control: Isle 02
User: 02 (confirmation for correct isle)
Voice control: Section 3A
User: 3A (confirmation for correct section)
Voice control: A7 (location)
User: 47 (e.g. confirmation from location check number
Voice control: Pick 5
User: 5 (user confirms picked quantity)
Voice control: Give number
User: 028 (e.g. last 3 numbers from EAN code)
Voice control: Isle 03
→Continues until picking completed
Voice control: Pick complete

Voice controlled goods receiving:
User: Start receive
Voice control: Scan PO number
User: scan
Voice control: Scan despatch note number
User: scan
Voice control: Scan item code
User: scan
Voice control: Verify item quantity
User: 5 (confirmation of quantity)
V-system: item code and quantity comparison
Voice control: Scan serial number
User: scanning all serial numbers
(Verification for not scanning item code as serial and comparison if advanced shipping information available)
V-system: create unique goods receiving ID and send idoc message to SAP for goods receiving posting.
SAP: Create goods receiving posting in SAP
SAP: Create transfer order
SAP: send idoc message back to V-System
V-system: print receiving label (ID, transfer order number etc.)
User: Ready

If any issues at any point, user is asked to start manual process.

Attachment 2

Optiscan deployment case studies with achieved confirmed benefits:

Case Nanso Oy (Optiscan deployment)
"Optimum news 1-2008"
Target was to consolidate 5 warehouses to one new distribution center, improve customer service and improve efficiency. Nanso decided to go for completely new approach and take the latest technology into use. Optiscan was involved from beginning as selected supplier. Optiscan delivered a full package: new WMS system, voice controlled picking equipment, wireless network, hand-held scanners, forklift-PC's, barcode scanners and printers. With very wide co-operation all operations were tested centralized and all equipment related problems were minimized. Hand-held scanners are used in goods receiving and picking locations replacement. Voice equipments are used in picking with route optimized to shortest one. Target is to improve work safety and make picking process more straight forward.

Case Finnfrost Oy (Optiscan deployment)
"Optimum news 4-2008"
Target was to reduce mistakes and improve productivity
- Frozen warehouse with 100+ employees
- Cost efficiency is important
- Meaning of comptetent employees is significant as special skills are required
- World's first SAP certified voice controlled VoiceLink picking system (VoiceLink WCS for SAP)
- Voice control improved work safety and ergonomic
- Training time for new employees is shorter
- Both hands are available for picking
- In frozen environment, voice is a lot easier as there is no need to use papers or stickers and glows can stay on
- Competitive advantage for productivity and employee happiness

Case H.I. Giortz Sonner AS, Norway (Optiscan deployment)
"Optimum news 1-2009"
HIGS is part of Norgesgruppen, Norway's biggest supermarket chain. Project target was to improve quality by reducing picking mistakes as well improve productivity and work ergonomy. All steps in picking process are voice controlled including multicustomer picking.
- Productivity has increased 10-15%
- Error reduction from 1,6% to 0,2%
- Customers not doing inbound verifications anymore
- Procutivity based salary payment implemented
- Pickers have both hands always available
- Quality improved

Case Heinon Tukku Oy (Optiscan deployment)
"Optimum news 2-2009"
- Picking accuracy and quality have improved
- Voice control is focusing pickers to do actions in correct order
- Training and start-up for new employees is faster
- Accidents have reduced several percentages
- Less waste and more environmental friendly due to less printing

Case DHL for voice controlled warehousing (Optiscan deployment).
"Optimum news 3-2009"
Target for project was to simplify and lean warehouse activities in central warehouses. Project had two main targets; improve inventory level accuracy and reduce the time used for time consuming goods receiving inspection. Results achieved:
- Reduction for customer delivery errors up to 90% (picking accuracy improved 99,7%)
- Productivity increase 5%
- Work environment has improved
- Training time and training costs for new pickers has significantly reduced
- Temporary employee productivity has increased and amount of picking errors reduced also during holiday periods
- After voice control deployment one of main customers (100+ delivery addresses) for this warehouse stopped goods receiving checking completely due to extremely minimal amount of delivery errors

Case Itella Logistics Oy, Voutila warehouse (Optiscan deployment).
"Optimum news 3-2009"
- Voice controlled picking done for multi-customer delivery picking
- Makes picking easier
- Environmental friendly, no paper printing needed
- Warehouse is multi-customer warehouse. As voice controlled picking is used for all of them, it is very easy to transfer people to different parts of warehouse according to need. Every picking is done with same basic principle and any difference on rules and instructions is instructed via voice
- Productivity has increased 10-30 %
- Error rate is down to half
- Process become more visible, better on control and tracking
- Pickers prefer voice picking so much that they don't want to go back to normal picking
- All ages in warehouse (16-64) feel very comfortable
- People from different countries can partly communicate with their own language as all replies can be with persons own language

Case Meira Nova (Optiscan deployment)
"Optimum news 1-2010"
Project target was to improve quality, work safety, ergonomy, cost efficiency, productivity and reduce picking mistakes. All targets were achieved together with proper planning and testing as well doing start-up's in phases according to warehouse structure.

- Immediate benefits
- Picking errors reduces significantly
- Productivity improved according to expectations
- Employees with very positive attitude, users prefer voice picking
- Multi-customer picking was enabled and started with voice picking
- Pick location replacement process improved
- Voice is very handy and easy to use

Case Bergendahls (Optiscan deployment)
"Optimum news 1-2010"
One of biggest supermarket chains in Sweden. Warehouse with 30 000 m2, 200 emplyees and 70 000 picking lines on daily basis. Bergendahls is trying improve work environment, productivity and efficiency continously. Main target was to improve processes in the central warehouse and increase picking accuracy and picking productivity. Bergendahl decided to go for voice controlled warehouse.

- Picking errors reduced over 70% out of very low starting point
- Improved working environment
- Increased productivity 10-20%
- Better ergonomy, always 2 hands available
- Easier to have temporary employees joining the team when needed due to very easy training.
- Works very well in frozen warehouse