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Examination of improvement possibilities in warehouse management systems

Untersuchung zu Verbesserungmöglichkeiten in Warehouse Management Systemen

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In real-time situations, operating warehouse management systems (WMS) – which can be purchased for enterprise resource planning systems (ERP) – are not able to satisfy companies' needs in all cases. In many cases, numerous improvement possibilities remain unused (e.g. optimized material handling, system-evaluation functions, etc.). The subject of this papers are possible directions for WMS improvements and possible ways of their implementation. One frequently applied improvement method is the development of supplementary applications. These implementation methods and processes are also discussed and an exemplary solution for a specific company problem is provided.

[Keywords: WMS, ERP, application-development]

Lagerverwaltungssysteme (WMS) und Enterprise-Resource-Planning-Systeme (ERP) erfüllen nicht in allen Fällen die Wünsche des Anwenders. Häufig bleibt eine Reihe von Optimierungsmöglichkeiten, wie u. a. verbessertes Materialhandling oder Funktionen zur Systemauswertung ungenutzt. Fokus dieser Veröffentlichung sind mögliche Optimierungsansätze eines WMS sowie Möglichkeiten ihrer Implementierung. Eine häufig angewandte Optimierungsmethode ist die Entwicklung ergänzender Applikationen. Auch diese Implementierungsmethode wird in diesem Beitrag behandelt. Die Implementierung eines erarbeiteten Optimierungsprozesses wird präsentiert, indem die Lösung eines konkreten, betrieblichen Problems dargelegt wird.

[Schlüsselwörter: WMS, ERP, Ergänzungsapplikation]

1 INTRODUCTION

Nowadays, properly formed warehouse management systems can significantly increase the effectiveness of warehouse process operation by eliminating loss. In the warehouse processes, the long-term goal is the elimination of the 3Mus [RM03]. Mu stands for Muri (overload), Mura (unevenness) and Muda (loss). Muri and Mura cause Muda in each case. Therefore, we talk about elimination of losses as a goal in many cases. Regarding warehouse activity, the overload can be considered on workers and on material handling machines. In the case of workers, it can increase the risk of health problems, the amount of overtime payment, and also the number of tasks conducted incorrectly, while in the case of material handling machines it can lead to unexpected breakdown and extra maintenance costs. Unevenness means a remarkable fluctuation of material handling performance per shift, which in many cases causes overload and/or unexploited use of sources, which is also non-beneficial for the companies. Enterprise resource planning systems (ERP) usually have specific warehouse management system modules (WMS), which are usually standardized framework systems that can be used by most of the enterprises but do not take into consideration possibilities to increase effectiveness and special tasks appearing in different companies [CSI06]. There are several possibilities to adjust the warehouse management system operation of ERPs:

- purchasing a newer version of WMS (containing the needed function),
- adjustment of the current WMS (program adjustment in present system),
- purchasing a supplementary application (purchasing a system supplied by a different vendor),
- preparation of a supplementary application (preparation of a company's own supplementary warehouse management application).

Based on practical experience, companies make their decision among these versions considering price, lead time of implementation, and quality. On several occasions companies have decided to create their own supplementary software module in order to meet their special requirements and also due to the inflexibility of software versions available on the market and also their developers. In the following part, we will present improvement possibilities of supplementary applications used for warehouse process operation, methods for implementations, and last but not least the implementation process of a company project.

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2 IMPROVEMENT POSSIBILITIES OF WAREHOUSE MANAGEMENT SYSTEMS

Warehouse management systems belonging to enterprise management systems are on different development levels. Due to this, the companies that would like to adapt one might need to develop different applications. This chapter summarizes the important directions and possibilities of improvements based on practical experience.

1. More efficient information flow [THK10]: In many cases, the companies apply enterprise management systems connected to ERP where the issuing and acknowledging of material handling requests are based on paper. This causes significant losses in a warehouse running high material circulation (high cost of paper, long stock-in, stock-out, take stock cycle time and also the notable risk of making mistakes, etc.). By developing a supplementary software module, the same tasks can be carried out – through electrical issuing and acknowledgment – in a more effective way (e.g. by using for issuing, acknowledging mobile data collector scanner, voice control system, interactive glasses, or other solutions).

2. More detailed product follow-up [Fra01]: Warehouse management systems belonging to ERPs enable warehouse stock movements just in a few relations, which means that we do not get a full overview regarding the status of available materials and parts.

3. New analysis possibilities [IGM04]: Companies have different corporate philosophies and determine different goals and targets. In warehouse processes, advancement in reaching the targets happens by building up determining indicators. This is usually not part of the applied warehouse management system. In order to apply these functions, there might be a need to prepare supplementary applications.

4. More efficient material handling [TS10, DIL15]: Warehouse material handling usually happens based on predetermined principles. Modification of these is not possible within the framework of an applied warehouse management system. Regarding warehouse material handling, the professional literature provides different solutions to increase effectiveness (e.g. stock-in to the nearest stock place, stock-in to fixed stock place, optimized stock transfer [CLR11], stock in by considering rotational speed, etc.), which might require supplementary software module development.

A company might need the implementation of the above-mentioned development possibilities separately, or all of them at the same time.

3 IMPLEMENTATION PROCESS OF SUPPLEMENTARY APPLICATIONS

When a company would like to make its warehouse system operation more efficient by creating a supplementary application, it implements the previously described multi-step process. In the following, we will describe the most important steps of the process.

1. Mapping the current process: Individual solutions and also the value stream mapping method belonging to the lean philosophy equipment system [KL04] can be applied in order to map how the current material and information flow system is running. The basic goal is to become familiar with current processes.

2. Determination of development directions: After the current status has been examined, detailed new improvement possibilities are available in the warehouse management system (e.g. more detailed product follow-up due to absence of information parts or changing ordering requests from paper form to electronic.).

3. Determination of improvement requirements: Company specialists need to determine the precise requirements towards supplementary applications, which can include the following:

- extra series that need to be provided,
- maximum budget that can be used,
- rate of expected efficiency increase by certain logistics indicators (loading cycle-time, commissioning cycle-time, etc.).

4. Selection of developer: Based on the information gained during the implementation of steps 1-3, internal or external specialists are selected.

5. Getting to know the currently applied WMS and its revealed interfaces: In supplementary application development, one of most important tasks is to find possible pathways for data migration and communication between the current WMS and the application to be prepared. Conducting this task is the responsibility of the WMS supplier and the specialists assigned to prepare the supplementary application.

6. Preparation of the concept for the supplementary application: Based on the information based on steps 1-5, the concept for the supplementary application can be prepared, in which

- the company and/or assigned logistics specialists,
- the WMS operators and assigned informatics specialists,

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- people participating in the working processes to be modified, and
- the company management

need to take part. It is essential to involve the affected stakeholders during the conception phase to find and establish consensus where conflicts might appear.

7. Application development: The assigned informatics specialists prepare the supplementary application based on the developed concept. If needed, the equipment to be applied later in the production process (bar code scanner, smart glasses, etc.) might need to be rented or purchased for the development phase.

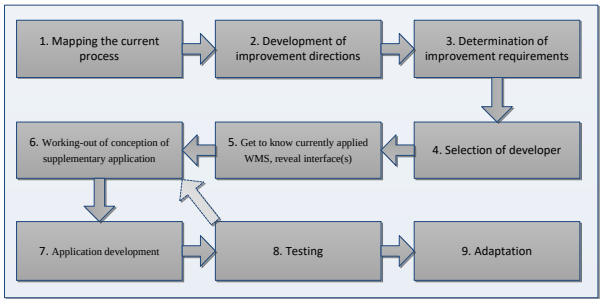

Figure 1. Implementation process of supplementary warehouse management application

8. Testing: After the supplementary application is developed, testing of the modified warehouse management system needs to be carried out. As a result of this testing phase, the supplementary application and its concept might need modification if aspects appear that were not considered during the planning stage (repeating steps 6-8).

9. Adaptation: The final warehouse management system is implemented.

4 REALIZATION OF A SUPPLEMENTARY APPLICATION FOR RAW MATERIAL WAREHOUSING SYSTEMS

In this section, we will outline the details of a research project, which was performed between the Institute of Logistics at the University of Miskolc and a pneumatic products manufacturing company. The steps in the realization process correspond with the steps presented in Section 3. Out of confidentiality reasons, screenshots of the developed supplementary application cannot be presented in this publication.

1. Exploration of the current process: We revealed the current processes of the stock-in, stock-out and relocation regarding the examined warehousing system.

1.1. Process of stock-in (Figure 2): Upon arrival of the transportation vehicle, the products are checked based on the delivery note's data (stock-in process, cp. Figure 2). Afterwards, i the WMS records the delivery note data in its database and prints a stock-in document. The stock-in document contains the products name, its article number, the associated barcode, the to-be-stocked product quantity and the storage place identifications where the same product type was stored before. After quality control – based on the documents data – the products stock-in takes place within the proposed storage places or close to these. If the products stock-in was located in a new storage position then the WMS records the new storage position.

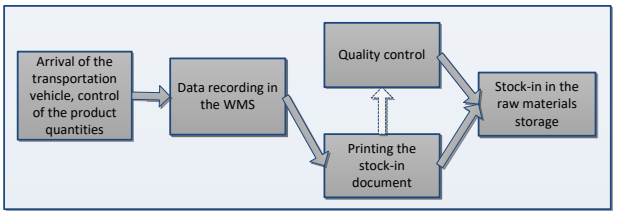

Figure 2. Process of stock in

1.2. Process of stock-out (Figure 3): The workers in the manufacturing process print a document for issue of the raw material needs. This document contains the name of the product, its associated barcode, the stock-out quantity, as well as the delivery destination. IN the nextr step, the WMS records the stocked-out products article number and its quantity and prints a document with this information. During this step, the main objective is the comparison of the stocked-out quantities with the recorded quantities.

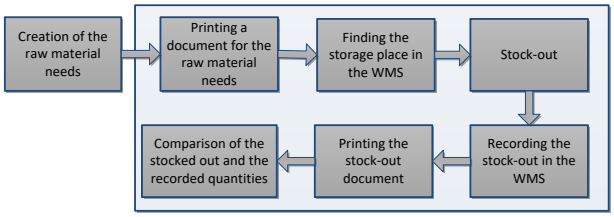

Figure 3. Process of stock-out

1.3. Process of relocation and stocktaking: The product relocation is executed between the storage positions. This process is realized in the WMS with a recording of the origin and destination of the object identification (e.g. production, raw material warehouse, etc.), as well as the article number of the moved product and its quantity. The stocktaking activity is performed in order to compare the effective and the recorded inventory data. The stocktaking activity starts with printing the stocktaking document. This document contains the article number and name of the product, as well as the storage places and their product data. The next steps are the searching for and counting of the products. Afterwards, we modify the differences between the effective and recorded quantities in the WMS.

2. Outline of directions for improvement: The introduced storage processes have numerous improvement possibilities while at the same time the examined company has to take into consideration its financial framework. Because of these the company determines its objectives:

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- Validation of the FIFO (First-In First-Out) principle [GGR04]: the WMS is not able to record the products stock in detail if products from several different deliveries are placed in a storage position.
- Increasing the accuracy of the data recording [Dav94]:the applied WMS is not able to accurately track the product.
- Developing the stocktaking process: since this process is based on printed forms, the recording of the counted/measured quantities, as well as treatment of the inventory differences are very time consuming.
- Determination of the system evaluation indicators [KV11]:the WMS does not contain any functions which are able to evaluate the warehousing processes.

3. Determination of the improvement requirements: The examined company determines its requirements based on the objectives and the available financial environment:

- There is a need to record the data exactly and quickly; because of this, the use of portable data-collector scannersis preferred.
- In the interest of accurate product tracking, labelling storage positions with unique identification is necessary.
- It is necessary to put a unique identification on products arriving from different deliveries to be able to distinguish products that are stored in the same storage place.
- The stock-in, stock-out, relocation and stocktaking activities should be carried out with portable data collector scanners.
- It is therefore necessary to develop supplementary applications for portable data collectors and personal computers.
- For evaluation of warehousing processes, it is necessary to implement the automated creation of evaluation indicators (e. g. stock-in, stock-out, cycle time of the stocktaking, and inventory value).

4. Selection of the developers: Due to the long-standing excellent relationship, the company selected researchers of the University of Miskolc for the elaboration and realization of the concept of the supplementary application.

5. Knowledge of the currently applied WMS, exploration of the interfaces.

6. Elaboration of the supplementary application: This section will present the concept of the modified warehousing processes (stock-in, relocation, stock-out, stocktaking).

Modified stock in process (Figure 4): From the receiving phase to the quality control phase, there are no changes in the process. The subsequent phases use a portable data collector. At first a worker logs into the data collector using his credentials. In the next step the data collector downloads the relevant information from the database of the supplementary application (Where can we find the products?, How many products can we find there?, etc.). The data collector will show the storage positions and number of products after scanning the raw material article number on the stock-in document. If we can place the products in some designated storage place, then we do so; if not (the designated places are full) we put the products into some empty storage place. The worker in charge of storage has to put a unique article number on the product after finding an adequate storage position.

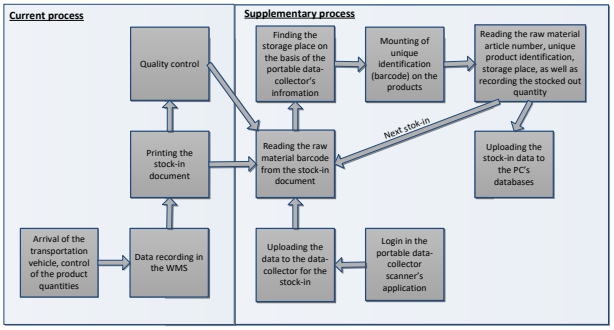

Figure 4. Modified stock-in process

Afterwards, the worker records additional information to this unique article number via the portable data collector (e.g. quantity, storage place identification, etc.). The worker has to upload the stock-in data from the data collector to the supplementary application database (due to financial concerns, we had to use docking stations in the described project).

Modified stock-out process (Figure 5): The worker logs into the data collector application and uploads the data necessary for the stock-out activities. The system prints a list containing the product name, the article number and its barcode, the stock-out quantity, as well as the delivery destination. If the worker reads a barcode from this list, the data collector application will show the relevant stock-out information according to the FIFO principle (article number and its storage place). Once the worker locates the stock-out place then he/she has to read the unique identification of the product with the data collector scanner and records the stocked-out quantity in the data collector application. It saves the information in the background database after the stock-out activities are finished. The system assigns the status “S” to the uploaded stock-out data.

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The worker has to modify this status manually to ”D” when the product reaches its delivery destination. The system then prints a list in order to compare the quantities of stocked-out products and the recorded products in database. If the worker finds a difference based on this comparison then he/she has to modify manually the entry in the database. The supplementary application assigns the status “QD” to the controlled data and uploads it automatically to the background database of the original WMS (origin and destination places, article number, quantity data).

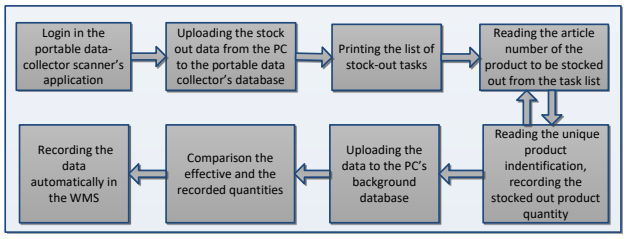

Figure 5. Modified stock-out process

Modified stocktaking process (Figure 6): In a first step, the administrator of the warehouse approves the stocktaking process on the supplementary application. This results in a general lock-down of warehousing activities (stock-in, stock-out, relocation). This ensures a fixed storage status while the stocktaking is undertaken. Afterwards, the workers upload the initial stocktaking data to the background database (e.g. article number, name of products). The worker has to read the unique identification of the product and records the inventoried quantities in the background database of the data collector. The worker upload this data to the supplementary database after the stocktaking activity. The supplementary application will compare the stocktaking data and the WMS data. If the worker approves a modification of the differences then the application will carry this out automatically in the application and in the WMS background database.

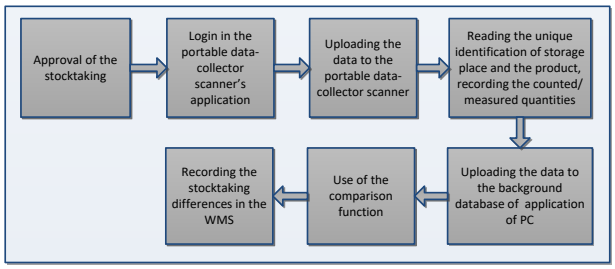

Figure 6. Modified stocktaking process

7-9. Application development, testing, adaptation: Application development for the PC and portable data collectors take place based on the described concept. During the testing process, some problems were revealed (e. g. legibility of the data collectors display, adaptation of new data columns, etc.). Firstly, the elaborated system was used with the former system simultaneously, and then the new system was phased in completely.

5 SUMMARY

The subject of the paper was to present possible imperfections regarding a warehouse management system (WMS) operation, possibilities for improvement, and the alternatives of development implementations. Preparing supplementary applications is a frequently applied solution to eliminate the imperfections of a previously purchased WMS. We describe the implementation process steps and demonstrate an exemplary implementation as well as a solution for a specific company problem. The examined company realized our proposals which result in the FIFO principle was fully applied, accuracy of the product tracking was increased. The supplementary application enabled to determine some more important logistics indicators as well (stock-in-, stock-out, relocation lead time, etc.). We can state that the implemented system has resulted in relevant advantages for the examined company.

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