NOVEL TRENDS IN IMPROVEMENT OF WAREHOUSE MANAGEMENT SYSTEMS FOR MANFACTURING COMPANIES

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ABSTRACT: In real-time situations, operating warehouse management systems (WMS) – which can be purchased for enterprise management 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 paper's possible directions for WMS improvements and possible ways of implementations. One frequently applied improvement method is the development of supplementary applications. These implementation methods are also discussed. Implementation of the process worked out will be also presented by providing a solution for a specific company problem.

1 INTRODUCTION

Nowadays, properly formed warehouse management systems can increase significantly the effectiveness of warehouse process operation by eliminating loss. In the warehouse processes, the long-term goal is the elimination of the 3Mus [1]. 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. Unevenness means a remarkable fluctuation of material handling performance per shift, which causes in many cases overload and/or unexploited use of sources, which is also non-beneficial for the companies. Enterprise management systems (ERP) usually have specific warehouse management system modules (WMS), which are usually frame 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 [2].

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 producer),
- preparation of a supplementary application (preparation of the 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.

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.

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1. More efficient information flow [3]: 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 [4]: 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. Such a case can be for example where material remaining unused by production is located in a multi-step restoring process, or if we place several products from different incoming transports into an adequate stocking place than the determination of which product had arrived when and which production times are connected to it.

3. New analysis possibilities [5]: 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 [6, 7]: Warehouse material handling usually happens based on predetermined principles. Modification of these is not possible within the frame 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 [8], stock in by considering rotational speed, etc.), which might require supplementary software module development.

It can happen that a company would need the implementation of the above-mentioned development possibilities separately or all of them at the same time.

3 IMPLEMENTATION PROCESS OF SUPPLEMENTARY APPLICATION

When a company would like to make its warehouse system operation more efficient by creating a company supplementary application, a multi-step process needs to be implemented, as shown in Figure 1. In the following part, we will describe the most important features of the process steps.

1. Mapping the current process: Individual solutions and also value stream mapping method belonging to the lean philosophy equipment system [9] 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 clearly the requirements towards supplementary applications, which can be the following:

- extra series needed to be provided,
- maximum budget that can be used,
- rate of 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 selection of specialists happens in this step.

5. Getting to know currently applied WMS and revealed interfaces: In supplementary application development, one of most important tasks is to find possible data migration, communication ways 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. Working-out of the conception of the supplementary application: Based on the information based on steps 1-5, the conception of supplementary application can be prepared, in which

- company and/or assigned logistics specialists,
- WMS operating and assigned informatics specialists,

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

need to take part. It is essential to involve the affected people in the conception forming by finding consensus.

7. Application development: Assigned informatics specialists prepare the supplementary application based on the determined conception (if needed, the equipment to be applied later (bar code scanner, smart glasses, etc.) might need to be rented or purchased).

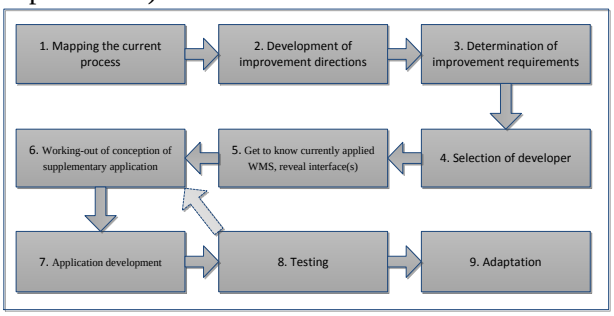


Figure 1. Implementation process of supplementary warehouse management application

8. Testing: After the supplementary application is ready, testing of the modified warehouse management needs to be carried out. As a result of the testing phase, usually the supplementary application and its conception need to be modified because aspects can appear that were not considered during planning (repeating steps 6-8).

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

4 REALIZATION OF 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. The supplementary application screen plans will be not presented because of confidentiality reasons.

1. Exploration of the current process: We revealed the current processes of the stock-in, stock-out and relocation regarding the examined warehousing system. Process of stock-in (Figure 2): The products received are checked on the basis of the delivery note's data upon arrival of the transportation vehicle. Afterwards the delivery note's data will be recorded in the WMS's databases and some stock-in documents will be printed. The stock-in document contains the product's name, its article number, article number's barcode, product quantity to be stocked in and the storage places' identification where the same product type was stored earlier. After the quality control – on the basis of stock in the document's data – the products' stock in took place in the proposed storage places or close to these (if the proposed storage places were full). If the product's stock in was located in a new storage position then the new storage position was recorded in the WMS.

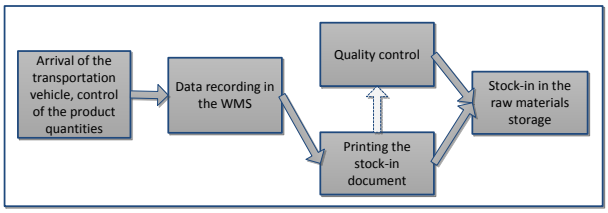


Figure 2. Process of stock in

Process of stock out (Figure 3): The people working in the manufacturing process printed a document for issue of the raw material needs. This document contained a name of the product, its article number's barcode, the quantity to be stocked out, as well as the delivery's destination. The next step was the recording of the stocked-out product's article number and its quantity in the WMS. Afterwards a stock-out document was printed which contained the data recorded in the WMS regarding the stock out. The main objective was the comparison of the stocked-out quantities with the recorded quantities.

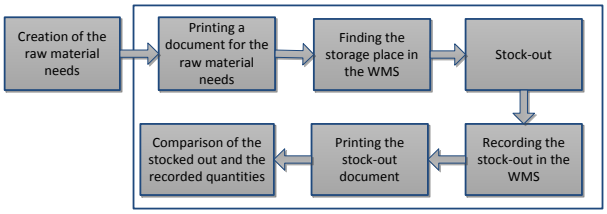


Figure 3. Process of stock-out

Process of relocation and stocktaking: Relocation has two variations, namely between the storage positions and between the production and storage positions (if the production was not process total delivered amount). This process was realized in the WMS with recording of the origin and destination object's identification (e. g. production, raw material warehouse, etc.), as well as the moved product's article number and its quantity. The stocktaking activity was performed in order to compare the effective and the recorded inventory data. The stocktaking activity started with printing the stocktaking document. This document contained the product's article number and name, as well as the storage places and their product data. The next

steps were searching for and counting the products. Afterwards the differences between the effective and recorded quantities were modified 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 had to take into consideration its financial framework. Because of these the company determined its objectives:

- Validation of the FIFO (First In First Out) principle [10] (the WMS was not able to record the product's stock in detail if products from several different deliveries are placed in a storage position).
- Increasing the accuracy of the data recording [11] (the applied WMS was not able accurately track the product).
- Developing the stocktaking process (since this process was carried out with printed forms, the recording of the counted/measured quantities, as well as treatment of the inventory differences was very time consuming).
- Determination of the system evaluation indicators [12] (the WMS did not contain any functions which were able to evaluate the warehousing processes).

3. Determination of the improvement requirements: The examined company determined its requirements on the basis of the objectives and the available financial framework:

- There is a need to record the data exactly and quickly; because of this portable data-collector scanners should be used.
- 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 (if we put several kinds of product in a storage place then we can distinguish these products).
- The stock-in, stock-out, relocation and stocktaking activities should be carried out with portable data collector scanners.
- There is necessary to make supplementary applications for the portable data collectors and personal computer.
- 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: Excellent professional collaboration has existed between institutes of the University of Miskolc and the examined enterprise for a long time. Because of this, the company selected researchers of the University of Miskolc for elaboration and realization of the supplementary application's conception.

5. Knowledge of the currently applied WMS, exploration of the interfaces: The applied WMS contained an interface which enables the bilateral communication between the WMS and the planned system. Further details about this cannot be introduced due to confidentiality.

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

Modified stock in process (Figure 4): From receiving the product up to the quality control there were no changes, and portable data collectors are to be used for the other steps. If a person want to use this data collector for stock in then the first step will be the login in this equipment. The next step will be uploading the data from the PC's database to the portable data collectors (Where can we find the products?, How many products can we find there?, etc.). The data collector scanner will show the storage positions and number of products we can find after reading the raw material article number which can be found 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 person in charge of storage has to put a unique article number on the product after this person has found an adequate storage position.

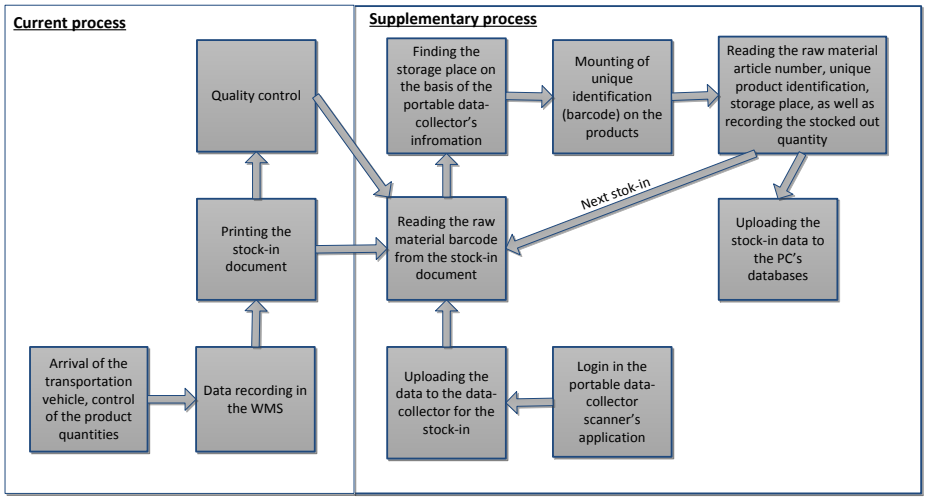
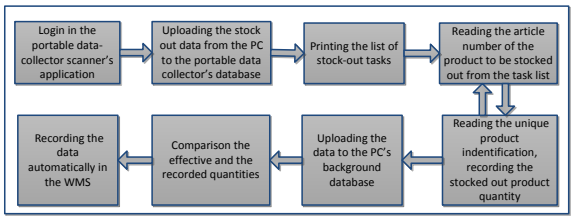


Figure 4. Modified stock-in process

Afterwards the person has to record some very important information to this unique article number via the portable data collector scanner (e. g. quantity, storage place's identification, etc.). The storage person has to upload the stock-in data from the data collector scanner to the personal computer's background database (we had to use docking stations because of the financial framework).

Modified stock-out process (Figure 5): The storage person has to log into the portable data collector's application and has to upload the data necessary for the stock-out activities. After uploading the data a list is printed containing the product name to be stocked out, the article number and its barcode, quantity to be stocked out, as well as the delivery's destination. If the storage person reads an article number's barcode from this list then the data collector's application will show the stock-out information according to the FIFO principle (article number and its storage place). Once the storage person finds the stock-out place then he/she has to read the product's unique identification with the data collector and has to record the stocked-out quantity in the data collector's application. This data will be saved in the portable data collector's background database after the stock-out activities. These data will then be uploaded to the background database of PC's application. After uploading the stocked-out material data, the data will be given (S) status in the database. The storage person has to modify this status to (D) if the product has been delivered to the destination. A list is printed in order to compare the quantities of stocked out products and the recorded products in database. If the storage person experiences difference on the basis of the comparison then he/she has to modify the database's data. The controlled data will get (QD) status and will be uploaded automatically to the WMS's background database (origin and destination places, article number, quantity data).



Modified stocktaking process (Figure 6): The first step is that the leader of the warehouse has to approve the stocktaking process on the PC's application. Afterwards the other warehousing activities (stock-in, stock-out, relocation) will be denied. This is very important in order for the storage person to examine a fixed storage status. Afterwards the storage people have to upload to the background database of the portable data collectors the data that are necessary for the stocktaking activity (e.g. article number, name of products). The storage person has to read the products' unique identification and has to record the inventoried quantities in the portable data collector's background database. The storage people have to upload these data to the PC's background database after the stocktaking activity. The PC's application will compare the stocktaking data and the WMS data. If the storage person approves a modification of the differences then the application will carry this

out automatically in the application's and the WMS's background database.

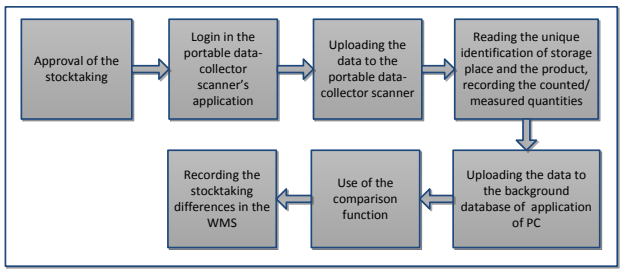


Figure 6. Modified stocktaking process

7-9. Application development, testing, adaptation: Application development for the PC and portable data collectors took place on the basis of the elaborated conception. 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, then the new system was phased in completely.

5 SUMMARY

The subject of the paper is to present possible imperfections regarding warehouse management system (WMS) operation, possibilities for improvement, and also the alternatives of development implementations. Preparing supplementary applications is a frequently applied solution to eliminate the imperfections of previously purchased WMSs. The implementation process steps are also described in the thesis. To demonstrate the presented method implementation, the solution of a specific company problem is also reviewed. Generally, we can state that there are endless numbers of research possibilities to improve WMSs, and by doing this companies' competiveness can be increased significantly.

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