PROPOSAL FOR STORAGE APPLICATION IN THE MANUFACTURE USING RFID

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ABSTRACT

The paper focuses on the software part of RFID technology to identify the stored material in manufacture plant. Application of RFID technology for the automatic identification of materials and packaging in the manufacturing company. This will ensure the possibility of tracking the flow of material and locating the stocks with their subsequent inventory.

In the time of solution was to create a database containing information about materials and packaging for the purpose. Part of the application is suggest of usability of RFID. In its practical use and design of databases for the company with the creation of a software application using the AMP middleware, which connects the hardware part needed for the functioning of RFID with the created databases. The result is the automatic recording of information about the material and its placement in transparent databases that will replace the existing localization system. Thanks to the introduction of automatic material flow tracking using RFID, it is possible to reduce the cost of material identification and marking as well as storage.

KEY WORDS: RFID technology, automatic identification, storage systems, process line, middleware.

1. INTRODUCTION

The paper is devoted to the introduction of RFID technology for automatic identification of material and packaging in the manufacturing plant. Through this technology, it is possible to track the flow of material and locate inventories with their subsequent inventory. The intent of introducing RFID technology into a company is to reduce the cost of storing and destroying degraded, long-term stored goods. In our case, the company manufactures corrosion products and the current warehouse system is making losses for this very reason. The problem is that the current system does not take into account the date of production of individual components. Components are stored during manufacture, and if the production date is not tracked, workers choose from the warehouse the materials first found in the warehouse and corrode material stored there for longer. Each year, there are several thousand costs for liquidation and, of course, the costs of material devaluation.

By automatically recording the production date and the place of storage of the individual components, a simpler orientation in the warehouse will be made easier and will prevent unnecessary long-term storage, thus greatly reducing the company's costs.

The work is based on previous research in the field of SCM systems (2009), RFID tagging (2010), middleware support (2013, 2014), storage system (2014), EPC standard (2015), and more within our university's laboratory AIDC LAB.

The main aim of the solution was to create a design of the system, e, g, databases and their linking with control software that combines RFID hardware with other elements. Several variants of the solution have been created so the company can choose which option is best suited to it. At the same time, the databases created three middleware application assemblies that loaded the identifiers and automatically written the data from them to the created databases. After the creation of all software elements, the necessary testing of the system under laboratory conditions took place.

2. THEORETICAL BASIS

In practice, we are constantly meeting the pressure of accelerating and simplifying almost all processes in our lives. One of the most advanced means of speeding, simplifying processes and saving costs is by automatic identification systems where RFID is also included. Unfortunately, this technology is relatively little used mainly because of the high initial costs and general ignorance of the benefits and use of RFID in different spheres of life.

At present, RFID technology is mainly used in industries such as logistics, stock level monitoring, entry control, trade, health, banking, and more,

Within logistics, RFID can be used for each phase of the distribution chain, enabling real-time tracking of the order, tracking the production phase of the product, helping to reduce the number of defective products, reducing the cost of subsequent complaints, and so on.

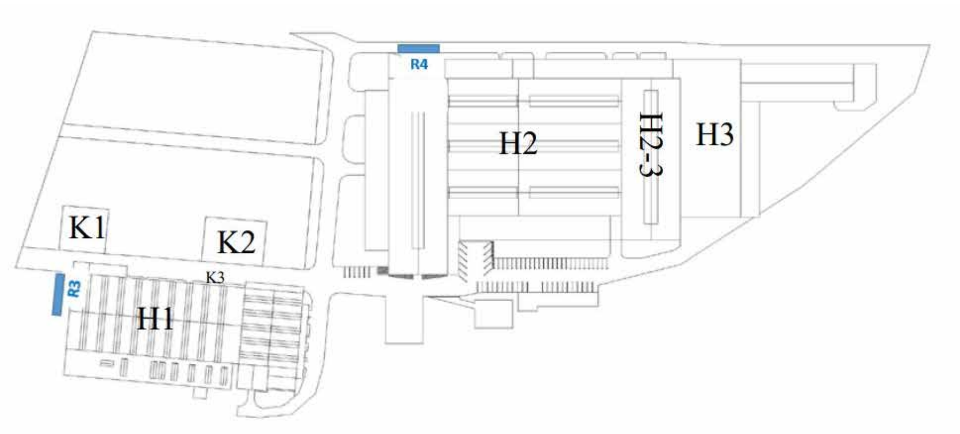
Monitoring inventory level with RFID with a customized data sharing inventory system allows accurate inventory counting within minutes, highlighting the lack of inventory and thus avoiding costs associated with not delivering components to production, and also preventing the purchase or supply of goods that are in stock quantity, which prevents the storage of excess goods.

The essence of introducing RFID is to ensure zero variations between the system's registered quantity of goods in the warehouse and the actual amount by ensuring that each shift of material within warehouses and between halls will be recorded by RFID. The material will be automatically logged into the system to prevent hundreds of thousands of euro losses due to material damage due to corrosion when the material is stored in the warehouse. Initially, the RFID system should be applied mainly to the output areas of warehouses or production halls. Later, the system could be applied so that the material can be tracked in the halls as well, so that specific material positions can be determined.

2.1 Analysis of the sole problem

Currently, the site is being renovated and expanded. In most cases, there is no information on possible new storage areas or production halls. For this reason, we must consider the original layout of halls and warehouses, and so it was not possible to test the system under actual operating conditions. The underlying operation is illustrated in FIG. 1

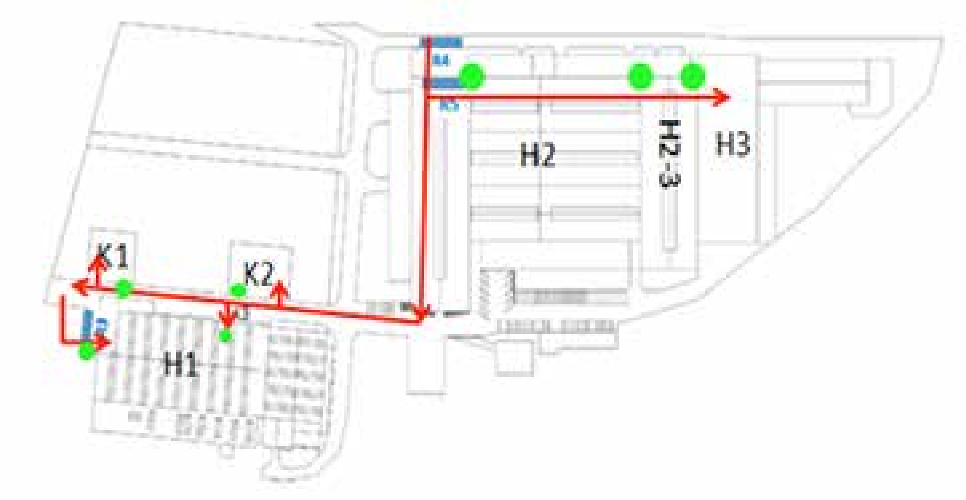
Figure 1. Plant deployment diagram



Source: Authors.

We typed problem spots and recorded them on the site map. These locations represent the passage of material through the "door" of the premises. Each transition between the objects must be recorded due to the location of the material and the boxes in the area. Since localization will be performed automatically, the locations will contain antennas to read the signal received from the identifiers. The rooms K1, K2 and K3 are warehouses and rooms H1, H2, H2-3 and H3 are production halls. The green points show the proposed location of the antennas, and the red lines show the flow of material across the entire production site illustrated in FIG. 2.

Figure 2. Design of antenna placement



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These locations will be used to create databases, application assemblies, and test the functionality of the entire system.

2.2 Processing of material

The company does not want to be named, so we call it XYZ, it is a leading supplier of innovative automotive parts that has branches around the world. In cooperation with the most important car groups such as BMW, Opel and others strived to permanently reduce fuel consumption and emission levels through lightweight automotive components. The company came up with the requirement to make the storage and identification of the goods of the selected branch more efficient, namely the plant for the production of control stabilizers, MSBS only. The processing procedure is as follows:

- **Order of goods** - input raw material - rods and pipes are ordered by the material owners on the basis of the condition in the internal system. In case of doubt ask for an inventory of the material in the warehouse and in the production. The largest quantity is ordered from the ITSW plant.
- **Packaging and Material Delivery.** In the ITSW stock, in addition to spring springs, rods and tubes for MSBS are processed. The finished parts are fixed in the ITSW plant in bundles with different sizes and pieces of pieces. In one bundle, approximately 50-250 tubes or rods are fixed. Each of the packages is assigned its own IDENT with the label and description of the goods stored in it
- **Income and identification of goods in the plant** is carried out by means of a barcode. Upon entering the warehouse, each parcel scans, recording its acceptance into the internal database. IDENT is a package assigned either to an ITSW plant or to receiving a shipment in a R4 warehouse
- It is not necessary to know the **manufacturing processes** as such, but it is important to know which processes in the production process are being loaded and that the new IDENT is created. Since the production lines are always set for a certain type of operation and the change of setting can take 6 hours, it is necessary to produce a larger quantity of the material currently set, even though the excess material has to be temporarily stored.

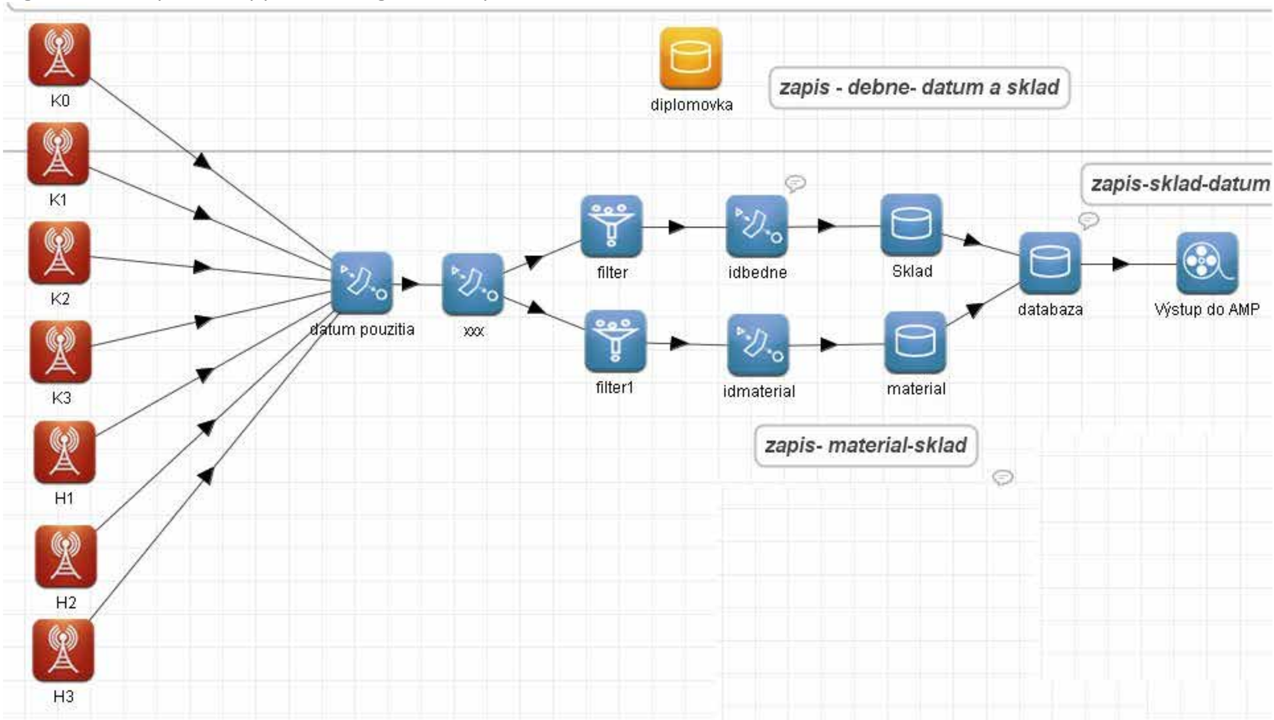
3. SOLUTION DESIGN

Several application modules have been created and integrated into one main module. Their logic involvement, configuration and progress of all application assemblies is as follows:

- the date of loading is recorded,
- the identifiers are filtered according to the start number,
- they are assigned a specific naming - box / material,
- the location of the identifier is recorded,

- according to the filtering, the data are recorded and recorded,
- data is automatically overwritten in the database.

Figure 3. First part of application - general input



Source: Authors.

Input is a processor (K0-H3 in FIG. 3) that modifies reader devices - antennas. As long as we have multiple antennas, we've tagged the inputs with names of warehouses and production halls to know where the identifier was loaded. The practice can be dealt with, for example, IP address, and so on.

As we know, antennas are able to read multiple identifiers at once. In order to be able to write relevant data to individual databases, identifier filters need to be used. Simple filters based on data filtering by the initial character were used. In our case, the identifiers begin with 1 for box 3 for the material. This filtering created a branch in an assembly that ends with entries in the appropriate databases.

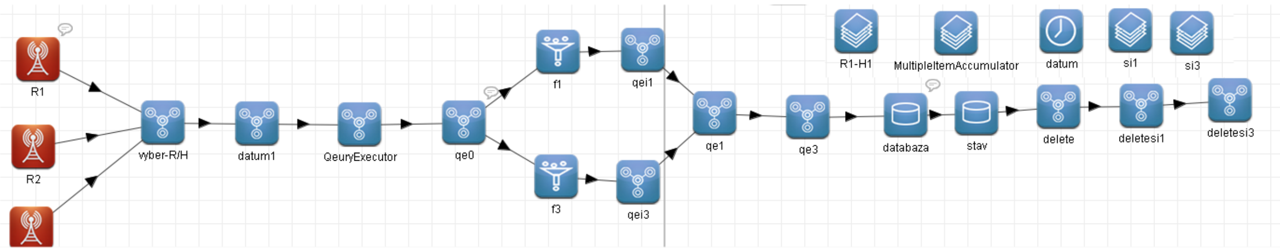
Other processors allow you to write filtered data. When the filter clears an identifier starting with 1, the idbox clearly determines that it is a box and sends the data to the corresponding processor. The second filter then records the identifier of the specified material, and the processor uniquely names the material and moves the next processor.

It is a processor that records all data collected so far and moves them to MySQL where they are embedded in the database. Subsequently, all data is automatically rewritten in the database. At the query.sql command line, the *UPDATE boxes were set to SET Status = 0, Stock = ?, Last_add_post =? Where tag = ?.* This means that we want to update the data in the database boxes by reading the appropriate identifier that passes through the filter and then assigning it the name of the warehouse that is automatically recorded with value of /reading/input. The input is in this case the name of the antenna that reads the identifier and the name is taken from the name of the RFID gateway processor. The same goes for entering the date, but in this case the data is taken from the processor's date of use. When we retrieve the data, we have defined that the state should be automatically 0, because if only the debug identifier itself is loaded and it does not mate with the material it is clear that the box is empty.

The task of this processor is to write data to multiple item accumulator. The processor reads all the data from the input path and moves them to the filters. MERGE means that the processor combines responses to queries from previous messages. The data is collected for the purpose of later linking the material identifier to a single record. (FIG. 4)

Processor *SingleItemAccumulator* stores an item removed from incoming messages in the object's accumulator. SingleAccumulator combine filtered data into individual branches and write them into memory. The following processor draws on it.

Figure 4. Input from mobile readers (R1, R2, R3)



Source: Authors.

After creating the application assemblies, we tested their performance. It turned out that it was possible to link all application sets with databases created in MySQL. The system automatically moves information between the middleware and the database. Database outputs are data in a format defined directly for business needs. At the same time, it would be advisable to link the created databases to the internal ones so that the material data can be populated into the created databases.

3.1 Suggested processing method

When creating a system of automatic material flow identification using RFID, it was necessary to find out how to achieve minimal human intervention in the system with minimal error rate. The biggest problem was how to record or box when entering the production halls and storehouses empty or full. The solution is that the boxes will have their own identifiers and the material will have another. We have defined the H2-3 intermediate as a storage reserved exclusively for empty boxes and named K0. Logically, it is clear that empty boxes should be located only in this space, but that empty boxes are emptied during the production steps. This means that blank boxes can be found anywhere throughout the company. This problem can only be solved by manually loading the identifier and the material identifier in the production halls when the identifier is stuck on the document. Automatically, the state changes from 0 to 1. At the same time, a problem that would otherwise arise from pairing at the crossing points through the main antennas will be solved. If the two identifiers were not handwritten manually and would not be matched, the system would read the X box identifiers and the material at the same time, and would not be able to assign the material in which the transport box is.

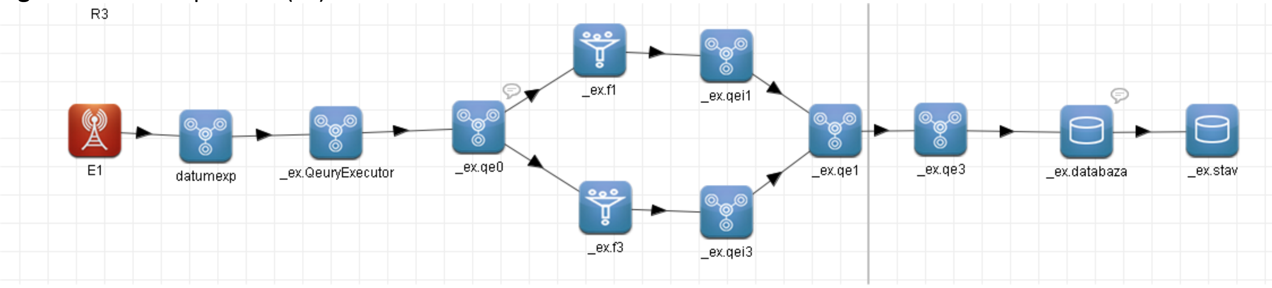
When creating an automatic material flow identification system using RFID it is important to monitor the status of transport boxes, which will be defined in the database as follows:

- Status 0 - Empty,
- Status 1 - Full,
- Status 2 - Shipped,
- Status 3 - Repair,
- Status 4 - Discarded.

Since the number, flow and state of transport boxes are not controlled within the warehouse, the draft is recorded using the status and date of the last use. This will make it possible, in the long run, to correct the costs of storing surplus and repaired boxes. As a result of boxes' flow tracking, it should be that K0 warehouse does not contain boxes whose date of last use was more than one year, it will be more efficient to redistribute the material between less and more of the used boxes, thereby extending their lifetime while recording repairs and with more repairs it will be able to consider whether it would not be more efficient to discard the given bill. At the same time, the output will be an effective tracking of exported debts and their return to the business, which could reduce the cost of purchasing new boxes.

Tracking box status will be performed automatically for status 0 and 1 by tracking the material tags and the box flow itself. Upon switching to the K0 warehouse, the value 0 will automatically be set using the IP address of the given antenna because only empty shipping boxes can be placed in this warehouse. When the box leaves the K0 store and is filled in one of the halls, a material tag will be placed on the box. This ensures that when passing through the antenna of any store or hall, it will be loaded with the respective antenna along with the box tag. As soon as the hand reader retrieves these two identifiers, the status will be overwritten in the status 1-full.

Figure 5. Part of expedition (E1)



Source: Authors.

The last assembly (FIG. 5) is for mobile reader at export point. The assembly was created to automatically rewrite the status in the box database. Significant change compared to assembly 2 is in the processor *_ex_state* only. There we have defined that we want to update the boxes database, automatically change the status to 2 and write the date of this change and the warehouse from where it was shipped. Again, it is necessary that the hand reader is not used for other purposes in order to automatically record the state of the reader.

3.2 Result of solution

By creating databases and linking hardware, automatic identification of the material, its flow, and ultimately the required localization in the warehouse has been achieved. The system worked in the test version, so when the reconstruction in the company ends, it will probably be necessary to adjust the designs according to the new site layout and test them in real conditions. All suggestions, whether hardware or software, have been properly tested and fully functional, so we do not expect the system to be malfunctioning in the real production environment. After testing the technology using the available features, it will be possible to ascertain the effectiveness of the established process

Created suggestions will be provided to the logistics department to assess their benefits. If logistics management has accepted the proposals, it will be necessary to contact the PHP programmer who will create the final user interface and perform the other necessary tasks. It will also be necessary to contact specific hardware vendors in order to create a bid and find out the actual initial costs of implementing the technology into the company. Then, with the offer, the proposal can shift the company's lead.

4. CONCLUSION

In the future, technology could be introduced to a point where it would be possible to locate the material directly in the production hall or in the warehouse. At the same time, a stand-alone shipping database could be created to give the company an overview of shipments and returns.

Statistics on the use of shipping boxes, their service life, and the number of repairs should be created. Likewise, it would be possible to find out how much time the average warehouse stock spends in stores, whether it is necessary to store the volumes at which they are currently in stock or whether it would be more efficient to set up production lines and thus reduce their volume and time spent in stock. It is understandable that it is difficult to obtain the basis for the optimization and sustainability of the horseshoe processes by the slight extensions given by the process and application of machine learning and artificial intelligence technologies. Opportunities for improving the system and detecting its effectiveness are endless, and with every advance in technology, these possibilities multiply.

The direction of further research will be focused on the area of closer digitization in the form of a digital twin and simulation of production and processable lines with a sustainability aspect.

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PREPORUKA ZA PRIMJENU RFID TEHNOLOGIJE PRI SKLADIŠTENJU U PROIZVODNJI

SAŽETAK

Članak je fokusiran na softverski dio RFID tehnologije koji identificira skladišteni materijal u proizvodnom postrojenju. Primjena RFID tehnologije za automatsko identificiranje i lociranje materijala i pakiranja u proizvodnom poduzeću. To će osigurati mogućnost praćenja tijeka materijala u procesu i lociranje robe u inventaru.

Rješenje je tokom vremena kreirati bazu podataka koja uključuje informacije o materijalima i pakiranju u tu svrhu. Primjena i korištenje RFID tehnologije tu može pomoći. Pri primjeni u praksi i kreiranju baze podataka za poduzeće treba kreirati i softversku aplikaciju koristeći AMP middleware koji povezuje hardver potreban za funkcioniranje RFID-a s kreiranim bazama podataka. Rezultat je automatsko bilježenje informacija o materijalu i njegovoj lokaciji u transparentnim bazama podataka koje će zamijeniti postojeći sistem lociranja. Zahvaljujući uvođenju automatskog bilježenja tijeka materijala kroz korištenje RFID tehnologije moguće je smanjiti troškove identifikacije i obilježavanja materijala kao i skladištenje.

KLJUČNE RIJEČI: RFID tehnologija, automatska identifikacija, sistemi skladištenja, linije procesa, middleware.