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Process Management in Warehousing Logistics by Means of RFID Automated System

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***Abstract* — To a large extent, build-up of Georgia's economic and investment potential depends on efficient management of the logistical processes. Owing to its geography, the country is a natural hub, which gives it a unique opportunity of becoming a transit location between Europe and Asia and creating favorable cargo handling and servicing conditions. Across the world, multimodal cargo transportation is a rapidly developing industry, whose efficient management largely depends on the build-up a country's economic potential.**

Movement of product flows along the logistical chain is impossible without amassing supplies in certain locations, which have to be stored in warehouses. Warehousing logistics makes the supplies transparent and helps in terms of rapid flow of loads. Material supplies temporarily stored in warehouses subsequently become the product flow. Material supply management is a somewhat complex process requiring compliance with the quantitative and qualitative specifications, product range requirements, definition of the type of products, execution of the relevant documents, loading/unloading etc.

Keywords—(RFID-Radio Frequency Identification, transponder, relative descriptor Warehouse, Stocktaking)

INTRODUCTION

Movement of material supplies through a warehouse calls for considerable labor costs which, understandingly increase the price of goods. Warehouse operation problems affect movement of product flows along the logistical chain, employment of the means of transportation and circulation costs.

Automation of logistical processes by modern IT is important to warehousing logistics. A non-contact data exchange or RFID (Radio Frequency Identification) is a recent innovation, which makes it possible for the user to get identification information and report on whatever item by radio frequencies.

Installment and employment of the IT allows the logistical process managers to duly manage the warehouse, an important part of logistics network.

Employment of the innovative RFID hi-tech in the warehousing logistics holds promise of considerable strategic results. RFID makes it possible to obtain information on any object without a visible contact and thus it is cost- and timesaving.

RFID (Radio Frequency Identification) is used for an automatic identification of object by radiofrequency radiation, reading and recording information in it. As a system, RFID is made up of several components, such as RFID-transponder, i.e. RFID-tag or notch) in which the identification code etc. relevant information on an object is stored. Then there is the RFID Reader, which, by means of radiofrequency radiation makes it possible to read information from the transponder attached to an object without a physical contact and transmit to the software for processing and analysis[1].

On its part, the RFID transponder is a combination of a memory microchip, radiofrequency modulation-demodulation box and an antenna. Fig 1 depicts RFID operation:

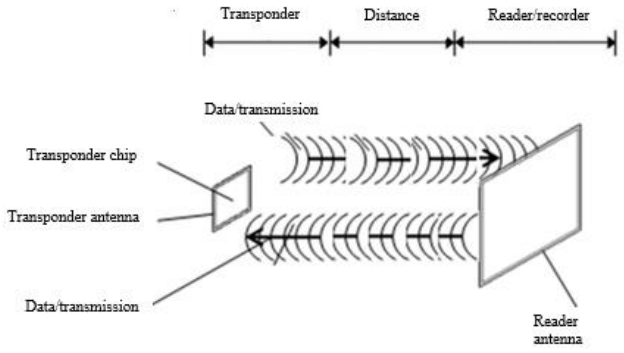

Fig.N1

The information can be read and recorded by means of the electro-magnetic waves between the transponder and the reader.

In terms of information transmission frequency, there are three types of transmitters:

- LF – Frequency (1m) – 1m range low-frequency transmission;
- HF – High Frequency (<=5m) – an up to 5m range high- frequency transmission;
- UHF – Ultra High Frequency (<6-20m) – an up to 20m range ultra-frequency transmission/receipt of information.

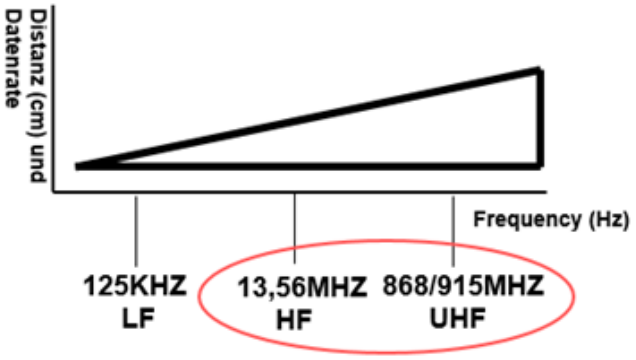

Fig.N2

The figures above show that in terms of radio frequencies, there are several operation modifications of the RFID-transponder, with the distance playing an important part in reading/recording the RFID-transponder information. By radio frequencies, there are three types RFID-transponders: 1) LF (125-135 KHz) range, which is mainly used for subcutaneous chipping of animals and humans. 2) HF (13.56 MHz) range standardized RFID-transponders are chiefly used in the financial systems, namely for payments, card fare payment in the public transport etc. 3) UHF (860-960 MHz) range RFID-transponders standing out for their remote operation and high velocity are mainly used in warehousing, industries etc. logistical registration/management.

A modern warehouse is a kind of living organism calling for permanent care and control. One of the difficulties in the management of the warehouse is that at any time its physical (actual) status may differ from that of the appropriate [2]. Therefore, the warehouse managers take best efforts to keep it in an ideal order, so that each item stored there can be found quickly and easily, is well protected from unsanctioned use and the occupied/unoccupied space can be determined. That is what the RFID hi-tech is for. RFID makes it possible for the manager to:

- take stock as quickly as possible;
- minimize order picking errors;
- exclude errors in loading/unloading;
- upgrade safety.

Stocktaking: while stocktaking, a warehouse employee using a manual reader can receive information on the nomenclature and quantity of products from at least 2m. From the reader, the information is depicted in the Excel tables, where both the ABC analysis and visualization of various data is possible.

The RFID hi-tech depicts the fact of stocktaking and the time spent on individual item and the entire procedure.

Sometimes, in stocktaking due to the barcode damaged during shipment or another technical fault, the reader finds it hard to identify information and an operator has to enter information manually, which is then generated automatically and ends up in the database [1].

Access to the data is important since not infrequently, each datum can be represented by different syntactical patterns. Each identified document contains the index of terms, while the inverse index of each term is associated with the relevant list of documents. So, we get the inverse correspondence, i.e. each term correspondents to a certain list of documents. There are cases when words having the same pronunciation but different meanings (homonyms) and a term that means exactly or nearly the same as another word (synonym) occur repeatedly in the same list, which makes the search difficult.

The task facing us in stocktaking is to determine the right answer in case of the same word or term of different meanings on the list. In tf_{ij}, t – is the term in the text, f – is frequency (fixed last), while ij depicts the frequency of j descriptor in i document. In the same way we can represent Frequency document df_j (the number of documents in which j descriptor occurs repeatedly). The formula [1] below represents the part j descriptor plays in i document.

$$W_{ij} = tf_{ij} * \log(N/df_i)$$

(N – the number of documents). That means that the number in which the used term occurs is proportionate to the one in the inverse document. If we arrange a term used in the text by frequency of its occurrence, then its frequency is proportionate to its serial number [2].

Lets' discuss df_j=N, which means that there is one descriptor in each document; in this case, its recurrence equals 0. Fig. 3 depicts retrieval, i.e. when the desired result cannot be achieved

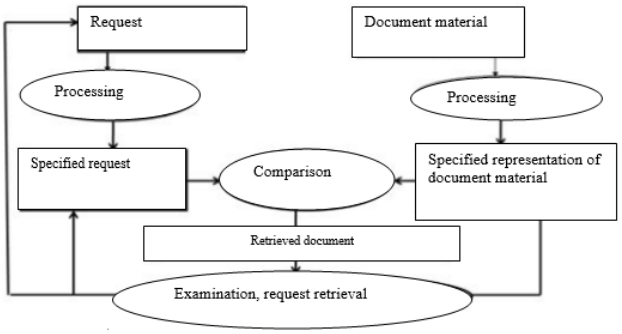

Fig.3

Request retrieval: the presented logical retrieval model is widely employed in commercial systems. Formulation of a request, which is quite complex is crucial to the result.

The known retrieval or recurrent model is the vector space-retrieval model. The number of descriptors in a document is defined by the formula below[2]:

$D_i = (T_{i1,} T_{i2,} \ldots, T_{ik,} \ldots, T_{iN})$, where T_{ik} is the descriptor volume in i document and N is the serial number of all the descriptors. The request is similar to:

$$Q_i = (Q_{j1,} Q_{j2,} \ldots, Q_{jk,} \ldots, Q_{jN}),$$

In $Q_{jk,}$ K is the descriptor volume in j request. In this case volume is a binary value (0 or 1) as calculated above for $W_{ij,}$. Therefore, D_i and Q_i are similar values represented by the formula below:

$$S(D_{i,} Q_j) = \sum_{k=1}^{N} T_{ik} * Q_{jk}$$

In case of modification of requests, descriptors are associated with the documents and vice versa as depicted in the formula below:

$$Q^{(i+1)} = Q^{(i)} + \alpha * \sum_{Di \in Rel} D_i - \beta * \sum_{Di \in NonRel} D_{i,}$$

where Q is the initial request, $Q^{(i+1)}$ is the new one, which depends on the result of the previous request. α and β shows the degree to which the request was fulfilled and accuracy of the result. Generally, for the purpose of definition of document modification, the rules below are to be observed:

- the relative descriptor of requests not classified in the presented document initializes it;
- the relative descriptor of requests classified in the presented document gives it a certain status whereupon it is presented in line with the request;
- the descriptors not found in the request diminish importance of the document and no search for it takes place.

This kind of modification is right when the request corresponds to the presented retrieval model of four parameters:

1. $P(rel)$ - probability of the fact that the document is relative;
2. $P(nonrel)$ - probability of the fact that the document is not relative;
3. $a1$the cost corresponds to the retrieved non-relative document;
4. $a2$ the cost corresponds to the found relative document.

Subject to these parameters, we can derive the formula below:

$$a2 * P(rel) \geq a1 * P(nonrel),$$

which shows that when the document is relative, its value is lower than that of the non-relative document as a result of which cost of storing products in a warehouse goes up.

Automotive Management of Traffic Stream in the Warehouse. The RFID hi-tech allows the operator to automatically, in real time define storage places in the warehouse. After marking pallets at the entrance of the warehouse, the loading operator sees the number of the vacant site on the screen. After that appropriateness of the storage site is automatically controlled, with the result appearing on the screen in the monitoring room [1].

Each shelf is marked with an identification notch. When an operator approaches one to place a pallet, the reader scans its notch and the system automatically defines the information on the pallet and the capacity of the site, so that an erroneous action can be eliminated.

Order Picking Control. In picking the orders, the operator inspects the product notches on the pallet, while the system automatically compares them to the list. Before the ordered batch is fully picked, the operator continuously receives information on missing, extra products (in terms quantity and nomenclature) or errors.

Taking Products out of the Warehouse. Loading goods into vehicles is a complex procedure calling for special control since not infrequently, the wrong kinds and number of goods is loaded. The portal RFID reader in the exit of a warehouse identifies both the pallets and individual products on the grounds of which the system automatically compares consignment notes with the products taken from the warehouse [3].

On the screen, the operator sees the list of the loaded products and the ones to be loaded. If the products taken out of the warehouse have not been identified by the RFID portal reader, an error signal appears on the screen. After loading, the system automatically creates documents to be sent to the accounting office. The same procedure takes place at the delivery of products to the warehouse.

The advantages of the RFID hi-tech compared to the other identification technologies are as follows:

- multiple change of information in the RFID transponders, which is impossible in barcodes;
- the RFID readers do not require direct vision of the transponders;
- as against the barcodes, the RFID makes it possible to receive information from 20m;

- compared to another hi-tech, much more information can be stored in the database;
- the user can read information from several transponders (150 pcs/sec) simultaneously;
- in the stocktaking, the presented mathematical model makes precise initialization of erroneously entered products possible;
- the discussed technology is environment-tolerant;
- high safety.

Conclusion: Application of the RFID hi-tech in the warehouse logistics cuts costs, rapidly provides accurate information on the supplies and secures high-degree safety. Also the study depicts information-relative system and secures indexation of stocktaking. The study determines relativity of documents, while the presented mathematical model makes it possible to precisely determine access to the relevant documents and shows that the frequency of the used term is proportionate to that in the inverse document.

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