Decision-making Processes in Introducing RFID Technology in Manufacturing Company

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Summary

The article deals with the application of modern automatic identification systems in manufacturing companies. Automatic identification is nowadays an integral part of any logistics chain, since it enables time and financial savings in managing material flow. In particular, the article focuses on the radiofrequency technology and shows one of the possible standpoints on the decision-making processes in the individual stages of application of the technology. It points to the possible application of exact mathematical methods in solving practical problems. The first part of the article focuses on the possible application and use of the RFID technology in a chosen unnamed company consisting of the automated loading of data on the incoming flow of raw material into the warehouse. The second part of the article deals with a practical application of selected exact methods in the decision-making processes when introducing new technologies in the company. The author of the article points out that the processes and methods described represent only one of the possible solutions.

KEY WORDS

RFID technology
automatic identification
warehouse
decisions

1. INTRODUCTION

In the context of providing logistics services and improving services in industry and commerce it is necessary to come up with new technologies that would put more emphasis on economic efficiency, safety and competitiveness. Nowadays, electronic transmission of data and digitalized retrieving of data from handling units are commonplace in logistics chains. Currently, there are a number of automatic identification technologies based on optic, radio frequency, inductive, magnetic or biometric principle. The technologies use passive or active elements of a logistics chain for transmitting information between the individual elements and operators of the whole logistics chain. They are used to record, identify and seek information, identify and seek objects, identify places, check status, monitor or manage the processes or transact processes [1], [2].

Radio Frequency Identification (RFID) is a non-contact automatic identification system for transmitting and storing data using electromagnetic waves [3]. The storage media have a form of identification labels (so-called transponders) or tags that may vary in the capacity. By means of electromagnetic waves, the data are transmitted to the antenna, from which the data are exported to readers, where they are decoded and exported to readers (or information system). Radio frequency technology is recommended to be used in an unclean environment (frosty, dusty, muddy, with chemically aggressive substances) or in the conditions where there is not possible to ensure visibility (that is, where there is not possible to use bar codes).

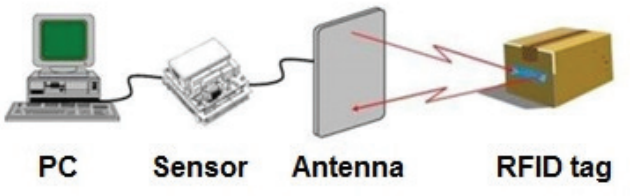
Although radio frequency technology is more expensive than e.g. bar codes, it is able to compete with them, especially in the USA) even in the areas where using bar codes has so far been predominant. The technology is seen as very promising especially for logistics systems. Its further dissemination will depend on the affordability of transponders as well as on the standardisation (at present, the major obstacle is in differing national regulations and legislative standards for allocating frequency the transponders can operate on [4-6].

2. APPLICATION OF RFID TECHNOLOGY IN MANUFACTURING COMPANY

The manufacturing company (unnamed) still uses bar codes (EAN) for recording information and data on incoming material and raw material into the database. Bar codes (most often Code 128 [7]) must be placed on a EUR palette, case or special crate by suppliers. In the company, the material (raw material) is unloaded onto the ramp and subsequently the data are loaded into the warehouse database using a portable EAN reader. By introducing the RFID technology in the company, the transmission of information to the corporate system could be more efficient due to the shorter time necessary for recording material entry into warehouse (bar code scanning will not be carried out), reducing the work of warehousemen and streamlining the storing process itself, since after reading the information from the transponders, the system will automatically store the item and allocate it an appropriate position in the warehouse.

Practical application of the RFID technology in the company consists of the installation of RFID gate (or an antenna), that would automatically read and write the information from the RFID tags without the operator service required. Gates, or antennas, could transmit data of the incoming stock into the central warehouse computer via receiver interface so that it is possible to safely store all the data. The technology can be used with the EDI system that in cooperation with the RFID technology automatically orders goods from suppliers, i.e. the RFID sends the amount of material or raw material to the production process and the EDI writes the sent material off and automatically orders and sends the material from the supplier [8], [9]. The total cost incurred (RFID tags, RFID gates or antennas, software, RFID system and EDI system) is estimated at about 20 million CZK.

Central RFID system in the company would be set so that the RFID gates, RFID antennas and the central computer mutually communicate on the basis on the radio frequency waves. The system would be interconnected with the EDI technology that in cooperation with the RFID system would record the amount and condition of the goods received to the warehouse. It thus records the amount of the ordered material or raw material that was imported into the warehouse as input stock [10].



Source: http://www.gs1cz.org/ [online]

Figure 1 System of RFID technology

3. DECISION-MAKING PROCESSES IN INTRODUCING RFID TECHNOLOGY

When introducing a new technology it is important to compare the technology proposed with alternative technologies. In the decision-making processes, various exact methods from the decision theory can be used.

The proposed RFID technology can be compared with QR codes or Data Matrix codes. The comparison can be made using the WSA (Weight Sum Approach) method [11].

WSA is one of multi-criteria evaluation of variants. There must be more than 1 criterion, while there is no upper limit for the number of criteria. The rows show the individual variants, while columns contain the criteria. In the centre, there is evaluation of the variant [12], [13].

As the maximization criteria, the company has chosen the cost of acquisition, operating costs, stability and quality of technology. The minimization criterion is the cost of installation and operation of the system. This criterion is converted into maximization criterion. The weights of the individual criteria were chosen according to the Metfessel allocation method (the method of allocating 100 points) [14].

Table 1 WSA method

Variants/ Criteria	K1	K2	K3	K4
V1	0.2	0.822	1	1
V2	0.36	0.811	0.632	0.652
V3	0.51	0.836	0.532	0.131
Weights	0.25	0.2	0.33	0.22
Evaluation	MAX	MIN	MAX	MAX

Source: author, based on [15]

Legend:
K1 – cost of acquisition,
K2 – cost of installation and operation of system,
K3 – operating costs,
K4 – stability and quality of technology,
V1 – RFID technology,
V2 – QR codes,
V3 – Data Matrix.

Subsequently, the minimization criteria are converted into maximization criteria.

Table 2 Converting minimization criteria to maximization

	K1	K2	K3	K4
V1	0.2	0.014	1	1
V2	0.36	0.025	0.632	0.652
V3	0.51	0	0.532	0.131

Source: author, based on [16], [17]

Ideal variant H = {0.51; 0.025; 1; 1}
Basal variant D = {0.2; 0; 0.532; 0.131} [18], [19]

Normalized matrix (see Table 3) is subsequently calculated as follows [20-23]:

$$W_{ij} = \frac{G_{ij} - D_j}{H_j - D_j} \quad (1)$$

Criterion 1:

$$V1 = \frac{0.2-0.2}{0.51-0.2} = 0;\ V2 = \frac{0.36-0.2}{0.51-0.2} = 0.516;\ V3 = \frac{0.51-0.2}{0.51-0.2} = 1.$$

Criterion 2:

$$V1 = \frac{0.014-0}{0.025-0} = 0.56;\ V2 = \frac{0.025-0}{0.025-0} = 1;\ V3 = \frac{0-0}{0.025-0} = 0.$$

Criterion 3:

$$V1 = \frac{1-0.532}{1-0.532} = 1;\ V2 = \frac{0.632-0.532}{1-0.532} = 0.214;\ V3 = \frac{0.532-0.532}{1-0.532} = 0.$$

Criterion 4:

$$V1 = \frac{1-0.131}{1-0.131} = 1;\ V2 = \frac{0.652-0.131}{1-0.131} = 0.599;\ V3 = \frac{0.131-0.131}{1-0.131} = 0.$$

Table 3 Creation and calculation of matrix of the WSA method calculation

Variants/ Criteria	K1	K2	K3	K4
V1	0	0.56	1	1
V2	0.516	1	0.214	0.599
V3	1	0	0	0
Weights	0.25	0.2	0.33	0.22

Source: author, based on [16], [17]

Subsequently, the values in the table are multiplied by the weights:

$$V1 = (0.25 * 0) + (0.2 * 0.56) + (0.33 * 1) + (0.22 * 1) = \mathbf{0.662};$$
$$V2 = (0.25 * 0.516) + (0.2 * 1) + (0.33 * 0.214) + (0.22 * 0.599) = 0.531;$$
$$V3 = (0.25 * 1) + (0.2 * 0) + (0.33 * 0) + (0.22 * 0) = 0.25$$

Based on the WSA method, the most appropriate seems to be the application of the RFID technology.

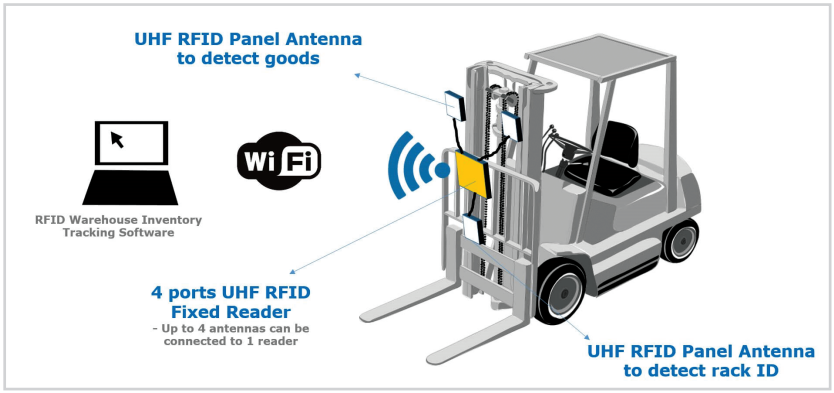
The company thus plans to introduce the RFID technology. However, it is necessary to decide whether to apply RFID tags during the coming/ transporting of the material by rail, that is to attach them to the wagons that belong to the rail carrier, or whether the RFID tags will be attached only to the transport units with material. In the first case, the information on the material flow would be loaded by means of RFID gate placed at the railway siding gate, in the second case the information would be loaded during the process of unloading wagons by means of antenna attached to the forklift trucks that transport the material to the warehouse. Another possibility is to place the RFID tags on the received palette units that would be automatically recorded into the database of the company systems by means of RFID antenna or warehouse RFID gate.

The question is whether the company should place the RFID gates (antennas) at the railway siding gate or later on the forklift trucks, or whether to place the RFID tags on the palette units after transporting the material to the warehouse and record them in the warehouse after transporting the material using various handling equipment, which is not a solution to the material reception optimization problem (only its next flow).

This problem can be solved by using the method of planning and forecasting assessment [24-27]. The company determined the score (1-10) and weights according to the following criteria (see Table 4).

Source: http://geotekbs.com [online]

Figure 2 Application of RFID tags on wagons



Source: https://ja-si.com/rfid-forklift-rack-management/ [online]

Figure 3 Application of RFID antenna on forklift trucks

Table 4 Calculation of method of planning and forecasting assessment

Individual factors:	Weight (%)	Score (1-10 points)			Weighted score		
		ŽV	VV	PJ	V	V	PJ
Cost of acquiring RFID technology (tags)	0.12	7	6	4	0.84	0.72	0.48
Costs of equipping wagons with RFID tags	0.28	9	7	5	2.52	1.96	1.4
Costs of equipping forklift trucks with RFID antennas	0.10	7	6	4	0.7	0.6	0.4
Costs of equipping palettes with RFID tags	0.06	6	5	4	0.36	0.3	0.24
Personnel costs	0.13	8	8	8	1.04	1.04	1.04
Specialization of workers	0.10	7	5	5	0.7	0.5	0.5
Usability of RFID tags	0.20	8	8	7	1.6	1.6	1.4
In total:					7.76	6.72	5.46

Source: author

The calculation is as follows [28-30]:

- Score * weight = weighted score;
- Total weighted score = Σ of weighted score of all factors.

Based on the results showed in Table 4, the best solution for the company is to equip railway wagons with RFID tags and place RFID gates (or antenna) at railway siding gate that would automatically record the data from the individual tags placed on each railway wagon [31-33].

4. CONCLUSION

Radiofrequency automatic identification enables companies to get a perfect real time overview of reception of the material in the warehouse, production and dispatch of consignments from the warehouse. Basic advantages of the system are improving the security / safety of the stock and eliminating repeated handling, which results in saving time and error elimination.

Despite all benefits of RFID technology, its application has not been fully used so far. The main obstacle is in missing/ non-existing standardization of RFID bands from the global point of view. RFID systems operating in the UHF band are already in use and in the future they will be more and more used in logistics, identification and control of packaged products. It is the area where products are often transported all over the world, where it is necessary to ensure that it is possible to read the RFID tags produced and placed in Europe even in the USA, China or Australia. Unfortunately, very frequently used UHF communication frequency band varies from country to country and thereforeother frequencies have been allocated to the RFID. And this is the sticking point – different frequencies and incompatibility of the individual systems.

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