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Research Article

Presenting a Framework for Ranking Identification System in the Chain Store: Real Case Study of the Iran *SHAHRVAND* Department Store

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Abstract: The purpose of this research is to specify and rank the appropriate automatic identifying goods system for a real case of a department store (Shahrvand department store). The ideas of the experts about the most appropriate identifying goods system in the department store are evaluated and collected by the brainstorming method, the three types of identification system which are specified by the brainstorming method are: RFID (Radio Frequency IDentification), Barcode and OCR (Optical Character Recognition). In order to ranking the achieved automatic identification systems and helping the management of the department store for decision making, the promethee (Preference Ranking Organization Method for Enrichment Evaluations) method is selected which has the most conformity with this research between the all MCDM (Multi Criteria Decision Making) method. Therefore, by consideration of two approaches: "efficiency of identification systems" and "convenience of customer purchase" eight criteria are extracted for ranking the identification system. Finally, the RFID system is preferred to other automatic identifying good systems by the used method in the research.

Keywords: Barcode, Identification system, Optical Character Recognition (OCR), promethee, Radio Frequency IDentification (RFID), shahrvand department store

INTRODUCTION

In recent years Automatic Identification procedures (Auto-ID) have become very popular in many service industries, purchasing and distribution logistics, manufacturing companies and material flow systems. Automatic identification procedures exist to provide information about people, animals, goods and products in transit. The omnipresent barcode labels that triggered a revolution in identification systems some considerable time ago are being found to be inadequate in an increasing number of cases (Finkenzeller, 2002).There are variety of systems for automatic identifying goods, which are included in the following systems: Barcode, Biometric, Optical Character Recognition (OCR), Radio Frequency IDentification (RFID), Smart cards, the following section gives a brief overview of different automatic ID systems (Fig. 1).

In the next step the useful and operative identification systems for using in the Department store should be collected and ranked, for this purpose the idea of the experts are collected and edited by the Brains Storming method. As it is the case in classic group-based brainstorming techniques (Osborn, 1957), each single idea or solution a person generates to a specific problem situation stimulates new ideas or solutions in others (Fink *et al*., 2010).

Consequently, the 3 identification systems are extracted: OCR, Barcode and RFID. The aim of this study is presenting a Framework for Ranking Identification System in department stores (Shahrv and). According to the circumstances of this problem and the simultaneous use of the qualitative and quantitative criteria in this study, the algorithm of promethee II is preferred to other ranking model. For that reason, after determining the weights of the criteria by collecting the ideas of the experts in the framework of a questionnaire, the alternatives are ranked by software (DECISIONLAB).

Barcode system: Barcodes have successfully held their own against other identification systems over the past 20 years. According to experts, the turnover volume for barcode systems totaled around 3 billion DM in Western Europe at the beginning of the 1990s (Finkenzeller, 2002). Barcodes have been widely used in many industrial products for automatic identification in data collection and inventory control purposes. Barcodes can be read by optical scanners called barcode readers or scanned from an image. Barcodes are widely used to implement Auto Id Identification systems

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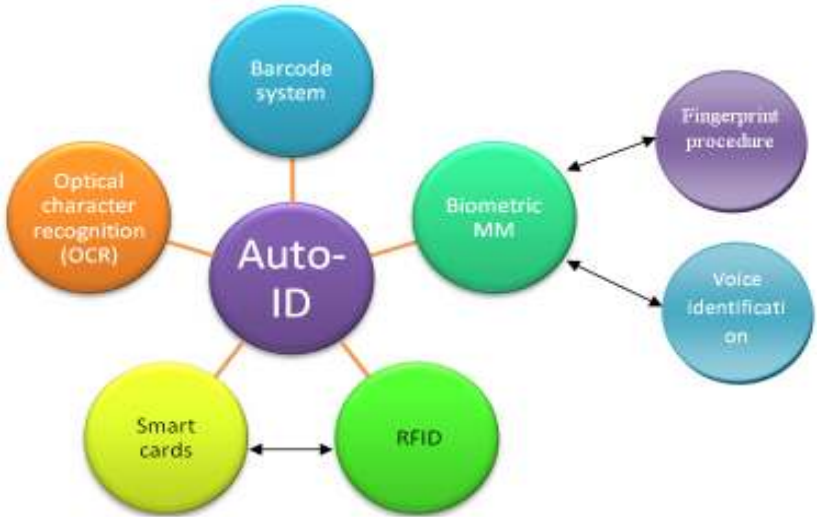

Fig. 1: Overview of the most important auto-ID procedures (Finkenzeller, 2002)

(Sherin and Youssef, 2007). Barcodes are used wherever physical objects need to be tagged with information that is processed by computers. Instead of carefully typing long strings of data into a computer, the operator only has to show the code to a barcode reader. The barcode patterns pasted on commodities in supermarkets are European Article Number Barcodes (EAN-13 barcode), also known as international barcode (Chen, 2008).

The most widely used barcode is the linear barcode, which is composed of vertical lines of varying thickness. A 2D barcode, also known as a matrix code, is another type of barcode, which has much higher capacity compared to the linear barcode. The information encoded in a 2D barcode can be scanned and encoded by mobile phones equipped with built-in cameras and the appropriate software (Ozcelik and Cengiz, 2011). Barcodes may be extremely cheap, but their stumbling block is their low storage capacity and the fact that they cannot be reprogrammed (Finkenzeller, 2002).

Optical character recognition: Text recognition from pictures has been the subject of intensive research for a long time (Goran and Bojan, 2008). Optical Character Recognition (OCR) is a process of automatic computer recognition of characters in optically scanned and digitized pages of text. OCR is one of the most fascinating and challenging areas of pattern recognition with various practical application potentials (Pal and Chaudhuri, 2004). OCR systems have their origins in pattern recognition, artificial intelligence and machine vision research (Goran and Bojan, 2008). Today, OCR is used in production, service and administrative fields and also in banks for the registration of cheques (personal data, such as name and account number, is printed on the bottom line of a cheque in OCR type).

RFID systems: Radio Frequency IDentification (RFID) represents a significant change in information tracking applications. RFID can be used to trace objects and assets worldwide. The recent initiatives of Wal-Mart, Metro and Target, requiring RFID object labeling, may seem trivial to the general public. Information applications industries can reduce the investment in management and improve the high-quality services by attaching smart RFID tags to objects (Jiann-Liang *et al*., 2007). RFID, a kind of contactless automatic identification system, consists of a tag, a reader and a database three elements (Tzu-Chang *et al*., 2010). Radio Frequency Identification (RFID) is a small tag containing an integrated circuit chip and an antenna and has the ability to respond to radio waves transmitted from the RFID reader in order to send, process and store information (Wu *et al*., 2006). The reader accesses the information contained within the tag via radio transmission (Tzu-Chang *et al*., 2010). According to ABI Research's studies (2008, 2009), total RFID revenue will amount to more than $5.6 billion in 2009, the global RFID industry will be valued at $9.7 billion by 2013 and the compound annual growth rate is about 15% (Tzu-Chang *et al*., 2010).

MATERIALS AND METHODS

The PROMETHEE method (Preference Ranking Organization Method for Enrichment Evaluations) is one of the most recent MCDA methods that was developed by Brans *et al*. (1986) and further extended by Vincke and Brans (1985) (Behzadian *et al*., 2009) With PROMETHEE, we are faced with sometimes very large evaluation tables that can include more than seven alternatives and more than seven criteria (Macharis *et al*., 2004). PROMETHEE permits, through sensitivity analysis, to establish the highest allowable deviations from the original weights (Brans *et al*., 1986).

Table 1: Main evaluating criterion of the identification system (Finkenzeller, 2002)

Criteria/alternative	Bar code	OCR	RFID
Data density	Low	Low	Very high
Machine readability	Good	Good	Good
Degradation/wear	Limited	Limited	No influence
Unauthorized copying/modification	Slight	Slight	Impossible
Maximum distance between	0-50 CM	<1 CM Scanner	0-5 M Microwave
Reading speed (including handling of data carrier)	Low	Low	Very fast
Operating costs (e.g. printer)	Low	Low	No influence
Purchase cost/reading electronics	Very low	Medium	Medium

The PROMETHEE I partial ranking provides a ranking of alternatives. In some cases, this ranking may be incomplete. This means that some alternatives cannot be compared and, therefore, cannot be included in a complete ranking. This occurs when the first alternative obtains high scores on particular criteria for which the second alternative obtains low scores and the opposite occurs for other criteria (Macharis *et al*., 2004). PROMETHEE II provides a complete ranking of the alternatives from the best to the worst one. Here, the net flow is used to rank the alternatives. The PROMETHEE II method requires that a generalized criterion be associated to each criterion. A set of six typical generalized criteria is also proposed in this method. Through a group decision process meeting arranged with experts, the effective choice was made interactively by the decision makers according to their feeling of the preference degrees (Albadvi, 2004). PROMETHEE II consists of the complete ranking (equation1). It is often the case that the decision-maker requests a complete ranking. The net outranking flow can then be considered (Brans and Mareschal, 2005):

$$\emptyset(a) = \emptyset^{+}(a) - \emptyset^{-}(a) \quad (1)$$

It is the balance between the positive and the negative outranking flows. The higher the net flow, the better the alternative, so that Eq. (2):

$$a\ P^{II}\ b \text{ if } \emptyset(a) \rangle\ \emptyset(b)$$
$$a\ I^{II}\ b \text{ if } \emptyset(a) = \emptyset(b) \quad (2)$$

In the follow, the criteria should be weighted. PROMETHEE does not provide specific guidelines for determining these weights, but assumes that the decision-maker is able to weigh the criteria appropriately, at least when the number of criteria is not too large (Macharis *et al*., 2004). For this purpose, in this step for considering all of the expert votes, "Group Method" (Abbas *et al*., 2011), based on geometric mean Eq. (3) is used:

$$wj = \sqrt[n]{\sum_{j=1}^{n} wj} \quad (3)$$

By using this equation the weight of each criterion is gained, then for obtaining a constant percent for each criterion all of the weights should be normalized by Eq. (4):

$$wj = aij / \sum_{k=1}^{n} akj\ , \forall i = 1,2, \dots , n \quad (4)$$

Verifying the criteria and evaluating the ability level of the identification system: After studying the literature of the application and capability of the three mentioned type of identification system, 8 criteria are extracted and are shown in the Table 1.

The mentioned criteria should consider 2 approaches for ranking: "efficiency of Identification systems" and "convenience of customer purchase".

Ranking of identification systems based on promethee II: A threshold value is determined for every criterion in the decision matrix, by using Eq. (5):

Threshold Value = max I = 1rij – min i = 1rij /2 (5)

Calculation of the difference between the elements of the decision matrix to the threshold: The difference between the values of both elements of the decision matrix to the related threshold is calculated in this step.

Applying preference function with 0: According to the status of criteria being positive or negative, one of Preference Functions 6 or 7 is used for all elements of the matrix:

$$\text{If } \pi(i,j) < 0\ 0 \text{ For positive Criteria} \quad (6)$$

$$\text{Else } \pi(i,j) \text{If } \pi(1,j) < 0 - \pi(1,j)$$
$$\text{For negative Criteria} \quad (7)$$
$$\text{Else } 0$$

Applying preference function with 1: Preference function with 1 is applied on this step Eq. (8):

$$\text{If } \pi(1,j) > 0\ \ 1 \quad (8)$$
$$\text{Else } \pi(i,j)$$

Creating weighted matrix: Now the weighted matrix must be shaped by using the weighting vector from criteria weighting step. So that, each column of the matrix is weighted by the weight of its related criterion.

Table 2: The result of ranking the operative identification systems in the department store

$\rho = \sum_{j=1}^{n} \pi(i,j) - \sum_{j=1}^{n} \pi(i,j)$	$\sum_{i=1}^{n} \pi(j,i)$	$\sum_{j=1}^{n} \pi(i,j)$	Rank of identification system
0.59	0.09	0.68	RFID
-0.2	0.34	0.13	Barcode
-0.38	0.41	0.03	OCR

Formation of collective utility function: In this step, the collective Utility function is calculated by the Eq. (9):

$$\rho = \sum_{j=1}^{n} \pi(i,j) - \sum_{j=1}^{n} \pi(i,j) \quad (9)$$

In fact, the collective Utility function will have created for every option (Abbas *et al*., 2011).

RESULTS AND DISCUSSION

In the last step, after calculating the related parameters such as threshold value and the weight of the criteria, alternatives (three Identification systems which are operative in the department store) are ranked based on the different parameters of the Identification Systems, by using the algorithm of PROMETHEE II. According to Table 2, the best operative system for using in a department store is the RFID.

CONCLUSION

Nowadays, technologies are inevitable in every sphere of life today; it has always made things easier. This study tried to realize the suitable technology according to the needs of a department store based on identifying goods. After studying and evaluating the automatic identifying goods systems and whole aspects of shahrvand department store as a real case, the findings of this study, as shown in the Table 2, is declaring the result of ranking between 3 automatic identifying goods in a department store: RFID (Radio Frequency IDentification) systems, Barcode systems and OCR (Optical Character Recognition), the RFID has the most efficiency in the department store according to the described criteria by the expert based on the efficiency in the department store.

The result of this study shows that the useful and suitable automatic identifying good system for using in the department store is RFID which has some advantages rather than the other systems, such as, low cost of operating and operating in large distance of the department store. In addition, implementing the RFID systems in a department store improve supply chain efficiency. Enterprises employing RFID technologies include retailer Wall Mart, cell phone company Nokia and a number of large pharmaceuticals companies (Chia-Chen *et al*., 2007).

By expansion of the activities of financial transactions and security in the large stores like hypermarket and department store which have considerable affects on each other in the network structure, it is suggested to focused on the ANP (Analytical Network Process) method for the future study. Due to this, some sub-criteria and criteria are needed to describe the mentioned concepts (security and financial transactions).

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