

RFID Application in Courier Services

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Abstract— This research paper highlights the efficiency of Radio Frequency Identification (RFID) technology compared to the existing barcode system in the courier services industry. We analyse the RFID impact on inventory accuracy by analysis on error and time taken to read the tags that will apply in the courier warehouse and distribution centre system. These technologies make many companies unsure which technology offers them the best return in this industry. In our study, we examine how RFID will improve the quality of inventory management systems by reducing the time consumed and increasing the number of product accuracy. The research is based on thorough paper and documentation review of the technology related to RFID and barcodes technology.

Keywords— RFID, barcodes, inventory accuracy.

I. INTRODUCTION

Radio frequency identification (RFID) application is a technology that uses radio waves to enable Automatic Identification Technology (AIT) [1] of the RFID tags to read from a distance of several inches using the RFID readers. Scanning is generally faster and can be more accurate with respect to current technologies such as bar codes. RFID does not need physical contact and line of sight to detect items. RFID can improve inventory management by changing the speed and accuracy of related processes [2] in courier services. Recently, most of the courier industry are still using the barcode application to record the customers' details and item information. The barcode application needs to scan items one by one to store the data.

RFID technology uses an automatic data capture system which helps in increasing system efficiency [3] and accuracy. In this paper, we analyse and research the concept of RFID technology to apply in the courier service system. We focus more on the efficiency of RFID in order to help the inventory management system to record the data with high speed and accuracy for a large number of items in a short period. RFID offers a possible alternative to bar code identification systems and it facilitates applications like item tracking and inventory management [1]. The aim of this study is to present the advantages of RFID technology on the courier sector through research related to inventory accuracy. Hence the first objective of the paper is: to study the efficiency of RFID in speed and accuracy to read the data. The last objective of the paper is to investigate if the RFID system can replace the current bar code technology in the courier industry.

II. RELATED WORKS

A paper by Wasim (2016) discusses the advantages and disadvantages of using Barcode, QR Code and RFID technology in order to managing the huge number of resources in the library. The implementation of this kind of software is important to maintain these resources like automation, digitization, content management, e-resource management and much more. Barcode and QR code are quite similar because it turns the information into black and white rectangle or square bars. While RFID is a coded cheap. It is a combined technology between radio-wave and microchip (Yu 2007). Compare of these three technologies, RFID has many advantages such as it is very fast, can get the data less than a second, increase security level, setting up the system in one- is fully automated and easy but it is very costly to implement as well as maintain.

Another paper by Samuel Nyiendo and Silvester Namuye (2015) presents about uses of RFID and Quick Response (QR) technologies to optimize the postal and courier business in Kenya. This research shows the benefits of the RFID and QR coding system in the courier industry includes capturing of detailed electronic signatures through the hand held devices, transmitting the captured recipient signature upon item delivery to sender, generating reports for use for internal package tracking database analysis, automatic feedbacks on updates of delivery date and time for posted online, automatic update of records online upon delivery, instant verification of time from mailroom to the recipient and reduction of time spent locating misplaced packages. There are several factors would affect performance level such as technology appropriateness, consumer's acceptance, barriers, business value and performance impact. The major challenges on RFID technology adoption in Kenya is to

identify what risks were covered in the government ICT policies.

III. Methodology

We apply some of the qualitative research methods (Fig. 1) here due to its nature as a case study of some technology initiative through some high cost modern software. Most of the research, the primary method of data collection will involve a thorough documentation review, which will include books, journals and articles.

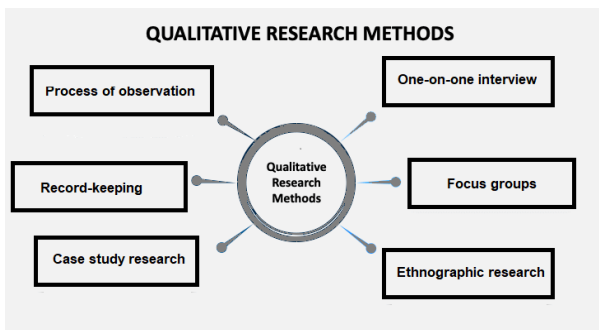


Fig. 1 Qualitative Research Methods

We are researching and reviewing the papers that are related to RFID technology in order to help and give more effective analysis, where the information collected will be categorised and sorted into sections for RFID and barcodes. Since applications of RFID technology are relatively new, literature is less readily available and current in such publications. In addition, there is no industry standard in place so the best way to obtain information relating to standards is through current documentation.

IV. IDENTIFICATION TECHNOLOGY

The identification technology refers to the basic equipment that enables the identifying and capturing of data using such as barcodes, handheld and fixed-position scanners and imagers, radio frequency identification (RFID) [5]. The courier industry which grows with the expansion of e-commerce [3], depends on the efficiency of the devices that captures information of merchandise in each transaction.

Basically, the courier services are using the barcode and QR code system to identify items and store information. With current technology such as RFID, we are trying to implement this into the courier and postal services system for the better improvement on efficiency of operation mechanisms and business value in the company. In this paper, we will identify the value of using RFID instead of barcode technology.

A. Barcode Technology

Barcode technology is an automatic identification technology that is produced and developed in computer applications and an efficient means of data collection

designed to achieve automatic information scanning. Originally barcodes systematically represent data by changing the width and spacing of parallel lines, and can be referred to as linear or one-dimensional (Fig. 1). Later they developed into two-dimensional rectangles, dots, hexagons and other geometric shapes (2D) as in Fig. 2. Although 2D systems use a number of symbols, they are commonly referred to as barcodes [4].



Fig. 2 Linear Barcode



Fig. 3 2D Barcode

TABLE I
ADVANTAGES AND DISADVANTAGES OF BARCODE

Advantages	Disadvantages
Accurate data	Costly maintenance
Less human efforts	System fall down problems
Improving workflow	

B. RFID Technology

Radio-frequency Identification (RFID) is practiced through the usage of wireless non-contact devices that apply radio-frequency electromagnetic fields to transmit data from the tag attached to the object for the purpose of tracking and automatic identification [4]. This device predominantly consists of three elements: a tag formed by a chip connected with an antenna; a reader that emits radio signals and receives in return answers from tags; and a middleware that bridges RFID hardware and enterprise applications [7].

C. Types of RFID

1) Active Tags

For the active RFID tags, it contains its own power source where it can be accessed by readers even from far away because of the stronger signal transmitted. Due to its own

on board power source, active RFID tags can operate with higher frequencies such as 455 MHz, 2.45 GHz or 5.8 GHz depending on the reading range and memory requirements of the application. These active tags can be read within the range of 20 to 100 meters [4].

2) Passive tags

On the other hand, passive tags gain power from the signal of an external reader. Passive tags are inexpensive and are small in size. Not just that, the size of memory of the tags is too small to hold complex information. This is because the antenna technology limits the use of the passive tags by about a quarter [4].

TABLE II
ADVANTAGES AND DISADVANTAGES OF RFID

Advantages	Disadvantages
Faster	Costly maintenance
Easier to handle	System down problems
Increase in security	

V. COMPARISON OF BARCODE AND RFID

A. Comparison of barcode and RFID based on efficiency

The efficiency of barcode and RFID will be compared based on two factors which is speed and accuracy. From here it will be determining which one is more efficient to be applied in the courier system.

TABLE III
COMPARISON BETWEEN BARCODE AND RFID

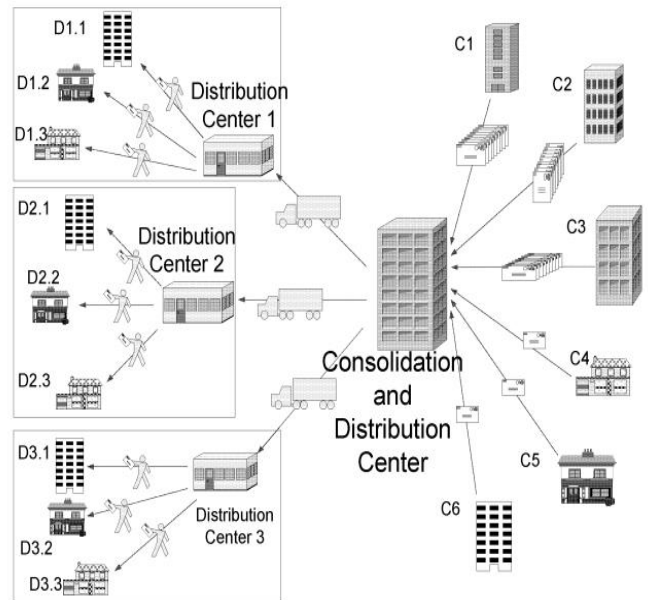
Attribute	Barcode	RFID
Line of sight	Required	Not required
Reading range	Several inches to a feet	Passive tags – up to 30 feet Active tags – up to 100 feet
Technology	Optical (laser)	Radio frequency
Updateability	Cannot be updated	Can be updated
Reliability	Wrinkled and smeared tags cannot be scanned	Nearly flawless
Ruggedness	No	Yes

3) The speed of scanning between barcode and RFID

Based on a major courier firm in Turkey, a simulation is used on the system of consolidation and distribution operations where the system operates on the Barcode system that implements RFID technology through

the simulation to see how this technology can improve the delivery efficiency [5].

In Fig. 4, the distribution and consolidation network of the firm is shown. Immediately after the consolidation and distribution centre receives postal or parcels, all the parcels will be tagged with its own barcode tags and will be sorted according to destinations.



C_i ; i^{th} customer $D_{i,j}$ j^{th} destination at i^{th} region

Fig. 4 Distribution and Consolidation Network

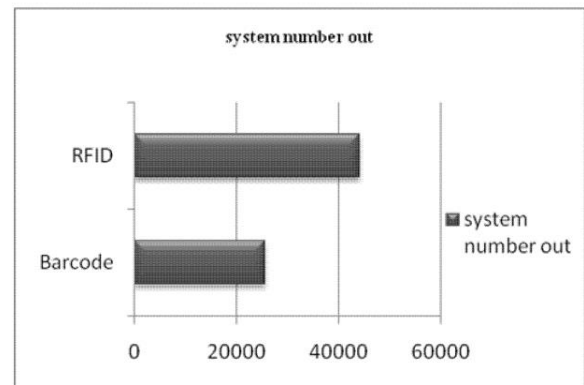


Fig. 5 The system number out

Fig. 5 shows the total number of parcels out for delivery which is one of the variables to validate the simulation. The number of parcels handled by RFID doubled the performance of the barcode system.

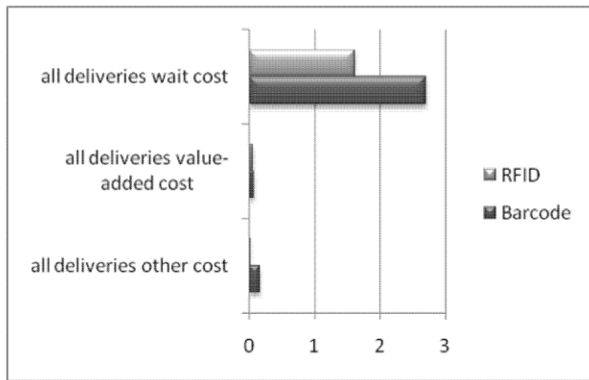


Fig. 6 Main types of delivery cost attributes

In this part, total costs are divided into wait cost, value added and other cost. Wait cost is the amount of cost that deliveries are waiting for processes, it accumulates for every parcel waiting to be tagged, dispatched or in queue for the tag reading process. Whenever a value added operation such as dispatching or tag reading occurs, value added costs are created.

4) The accuracy of scanning between barcode and RFID

In determining the accuracy of the barcode and RFID, error for every system will be analyzed to see which one is the most accurate by the least error. An analysis of the data and findings from the time and motion study showed that there were multiple variables that influenced both RFID and barcode timings that were hard to predict. Table IV shows the problems faced by both systems [6].

TABLE IV
PROBLEMS OBSERVED WITH BARCODE AND RFID

Barcode	RFID
Missing labels	Broken wheels in the stack to move subject
Unreadable labels	Misread tags
Broken scanner	RFID and tag equipment broken
User error in scanning labels	User error due to movement of RFID

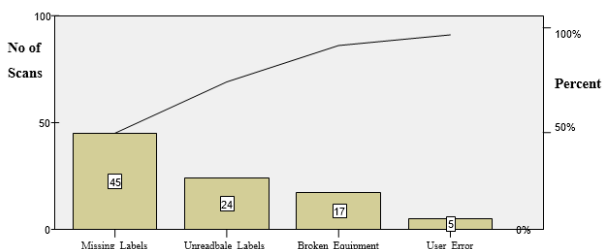


Fig. 7 Error in barcode scanning

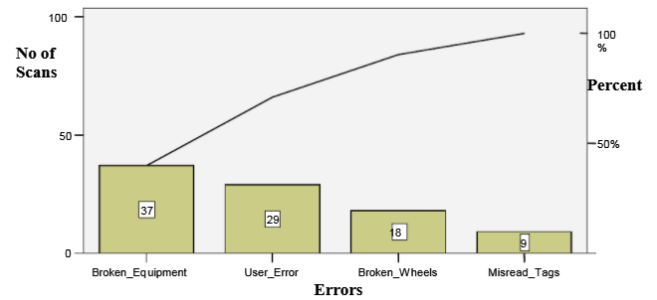


Fig. 8 Error in RFID tagging

VI. FINDINGS

From the comparison of the speed of the scanning, RFID shows the improvement in handling the large number of parcels. Based on the conventional system which is barcode in Fig. 6, it just handles half of the number of parcels that RFID can manage for delivery. As such, RFID have contributed in the improvement in terms of speed of processing.

Additionally, the total deliveries cost also shows a reduction where RFID can save the cost for every parcel that is waiting to be processed. Means the RFID is much efficient because it did not take longer time for being processed and reduced operational cost. Thus, use of RFID apparently is more cost efficient than barcodes in the long run.

For the accuracy of the scanning and tagging, RFID and barcode face almost similar problems during scanning and tagging. So, both of the errors are being compared to see which one has less error. Based on the Fig. 7 and Fig. 8, it shows that the percentage for the error of RFID facing is slightly higher compared to barcode. However, RFID technology is proven to reduce the inefficiency of inventory inaccuracies in the era of IoT [8]. It is because RFID technology is growing and being improved year by year and it is hoped that the discrepancies can be overcome soon.

VII. CONCLUSIONS

The purpose of this study was to analyze and compare radio frequency identification (RFID) and barcode technology in courier practice. It shows that RFID can scan more rapidly and provides a better performance in improving inventory accuracy than a barcode scanning system. The obvious advantages of RFID is the tags can be scanned without using line of sight. This paper has been focused on efficiency of using RFID and barcode by taking speed and accuracy as a benchmark for both technologies. Information was gathered through analysis of past research and documents. However, RFID technology is not always better, it also has its disadvantages in other characteristics.

We believe that further research study is needed to construct efficient models to complement this paper.

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