Barcodes vs. RFID and Its Continued Success in Manufacturing and Services

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INTRODUCTION

Versatile Nature of the Ubiquitous Barcode

A barcode is a machine-readable code in the form of numbers and a pattern of parallel lines of varying widths, printed on a product (Sirico, 2010). Barcodes are essentially a type of symbolic language that uses printed horizontal strips of vertical bars used for identifying specifications. An accompanying scanning device reads the barcode by moving a beam across the symbol (McCathie, 2004). Barcodes can come in one-dimension (1D), 2-dimension (2D), or three-dimension (3D). Barcode systems are used in routine business from the manufacturing and ordering process to the parking lot after purchased. Joseph Woodland and Bernard Silver invented the barcode in 1949. Silver overheard a conversation of a supermarket executive from a food chain called Food Fair. The general rationale was to have an automatic system for capturing product information (Seideman, 2015).

Barcode technologies have had a relatively long history with almost every type of business that keeps track of goods and services. Point-of-sale (POS) is probably the most common use for the barcode (Chen & Dubinsky, 2003). Customers typical view barcodes on almost every item that is available for purchase within a retail environment. The cashier uses the barcode to scan the items into the computer system and retrieve the amount the customer will owe for that particular item. Barcodes in manufacturing help in inventory control, quality control, and help measure productivity throughout the manufacturing process. Barcodes are used for packaging, tracking time and attendance of employees, and measurement of proficiency (Jain, Benyoucef, & Deshmukh, 2008; Kamhawi, 2008; Kay, 2007; Kearney, 2005; Kennedy & Widener, 2008; Koong & Lin, 2007). Evaluating the efficiency of barcode systems routinely reduce costs while improving quality, on-time performance, and reducing errors.

BACKGROUND

The future need for barcodes will probably be increasing due to its universal acceptance and easy-to-use with low costs of producing barcodes (e.g., it is usually included in the cost of printing labels or packaging materials on products) (Cowles, Kiecker, & Little, 2002; Davis, 1989; Devaraj, Fan, & Kohli, 2002). As the population grows, so does the need to make workplaces and their environments more efficient and safer. Barcodes are employed in supply chain management (SCM) applications in the healthcare industry. The use of barcodes in healthcare facilities allows hospitals to save space and reduce overstock by ordering the supplies needed daily (Harrop, Das, & Holland, 2016). In the retail setting, barcodes are becoming a part of smartphones with apps. The consumer can shop and scan items through the convenience of their phone. This easily enables

DOI: 10.4018/978-1-5225-2255-3.ch458

the retailer to track consumers' spending. A majority of manufacturing companies are turning to the barcode system as well. The use of barcodes in manufacturing facilities assists in making the manufacturing process faster and more efficient. However, with barcodes, as with all IT-intensive technologies, have important advantages and disadvantages to consider, as illustrated in Table 1.

Barcodes are extremely easy-to-use and generally require little to no training for users. The time saved by scanning a barcode is substantial to the amount of time that would be spent manually entering product information for one or one's entire inventory. Two-dimensional (2D) barcodes reduce error and read accurately when scanned. Linear or one-dimensional barcodes are limited in their accuracy since the scanner and barcode must be properly aligned for the information to be captured. Barcodes are generally the most cost efficient method of technology for coding information, but associated equipment such as POS or inventory tracking software and scanners, etc., can quickly increase the initial costs, including replacement costs. Security on barcodes is not good, as most information coded in barcodes readily found.

Undoubtedly, there are other issues that need to be generally discussed [e.g., total quality management (TQM), lean manufacturing, just-in-time (JIT) manufacturing, waste management, change management as well as numerous other practices that are comparable to the strategy of adopting AIDC] and how the results of this can effect whether or not the AIDC-based technologies would be successful. As evident from recent headlines, the need to maintain the privacy and ethics of personally identifiable identifiers (PII), and some companies have been accused of prying and collecting data that were always consented. In a recent study, experts believe that the use of RFID will increase from 12 million in 2011 to billions by 2021 applications Irani, Gunasekaran, & Dwivedi, 2010; Smith & Rupp, 2013; Ustundag, 2010; Visich, Li, Khumawala, & Reyes, 2009). Even if the pros outnumber the cons, it still does not answer the question if management with take the long-term and choose to take advantage of the opportunity. Such technologies have been improving at an exponential rate and many studies (Bhat, 2008; Baxter & Hirschhauser, 2004; Biswas & Sarker, 2008; Browning & Heath, 2009; Cavaleri, 2008; Chan & Kumar, 2009; Devaraj, et al., 2002; Drejer & Riis, 2000; Gaukler, Özer, & Hausman, 2008; Grewal, 2008) have suggested that result of implementing AIDC with lean technologies will have positive outcomes. This is especially associated with the expectation that costs will drop for both the manufacturers and subsequently the consumer.

Table 1. Selected advantages and disadvantages of barcoding as a part of identification technologies

Advantages	Disadvantages
Inventory Control (through tracking and essentially error-free readings)	Costs (associated equipment and replacement costs)
Accuracy (2D, 3D Barcodes), Error reduction	Accuracy (especially with linear barcode)
Time savings	Limitations by line of sight scanning
Easy-to-use	Security issues, as they are easily read

Advantages of RFID over Barcodes

The general advantages of RFID-related technology only make sense where it provides advantages over barcodes (Green & Khermouch, 2005). Some of the important advantages that RFID has over barcodes include the following (Harrop, 2010; Smith, 2005a, 2008):

1. Speed, since a RFID reader can read tags faster than a typically barcode scanner can scan barcodes. For example, RFID readers designed for supply chain operations can perform up to 1,500 read operations per second;
2. Read distance, as it is common to read RFID tags at distance of at least three meters between the tag and the antenna and the read field is three-dimensional;