Expert Systems with Applications 36 (2009) 10877–10882

Contents lists available at ScienceDirect

Expert Systems with Applications

journal homepage: www.elsevier.com/locate/eswa

Integrating RFID with quality assurance system – Framework and applications

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ARTICLE INFO

Keywords:
Quality assurance system
Radio frequency identification
Improvement plan

ABSTRACT

A quality assurance system (QAS) is designed and used to inspect product quality, determine causes of abnormal by collecting, analyzing and testing data from the product line, and then determining how an improvement plan should be conducted. By utilizing radio frequency identification (RFID), a QAS may be able to detect, and even prevent, quality problems more effectively than the traditional quality assurance system. The proposed framework provides a structure for an RFID-based QAS that allows on-site staff to monitor complicated variations in production process by handling numerous possible abnormalities simultaneously. Two industry applications are provided to demonstrate using of the proposed framework.

1. Introduction

The primary aim of quality assurance (QA) is to ensure that customers are satisfied with the products produced. A quality assurance system (QAS) enables quality assurance with a framework comprising input, processes, and output over a long period. Therefore, designing and constructing a quality assurance system that prevents poor-quality products from being shipped to customers and has a systemic procedure for controlling damage and dealing with customer complaints is crucial to most companies decision-marking.

One method of constructing a global QAS that can be utilized by international communities and multi-national enterprises is to follow the ISO 9000 quality standard. By following this standard, a QAS can encompass major processes in an organization from product design and production process to the customer service operations that may require many quality control skills to reduce system variation (Turk, 2006). The principles of the Plan, Do, Check, and Action (PDCA) are important parts of the ISO 9000 standard, which requires organizations to improve quality continuously. Since a QAS requires managing process and related document/data, using a technology such as RFID can enhance the effectiveness of the system and ultimately provide a capability for preventing defects via data analysis (Käschel, Teich, & Zacher, 2002).

This work presents a novel framework for integrating RFID technology in a QAS to improve its effectiveness. The QAS framework includes shop floor and customer service (marketing). Within the proposed framework, once an anomaly occurs in the operation process, the RFID technology promptly activates the QAS to respond to customers and suppliers, thereby reducing the bullwhip effect and shortening customers claim response times.

2. Radio frequency identification, RFID

Tags, which contain an integrated circuit chip and antenna, are integrated into objects such that these objects can be identified and their label information can be read. Radio frequency identification involves detecting and identifying a tagged object via radio waves transmitting data from tags to a reader. Fig. 1 shows a typical RF system architecture with, from left to right, RFID tags, an RFID reader antenna (Reader Antenna), RFID reader (Reader) and host application (Host AP) (Goodrum, McLaren, & Durfee, 2006; Kwon & Choi, 2008). One key operation in RFID is data transfer between tag and reader that also known as coupling – through the antennae on either end. The overall radio frequency system is identified from the RF antenna reader information then transmitted to the radio identification reader. The host AP then integrates applications according to different needs.

Compared with barcodes, RFID tags can store vast amounts of information in real-time that cannot be seen directly but can be identified. Additionally, multiple tags can be identified simultaneously, and information can be overwritten. Therefore, RFID is applied to such areas as logistics and supply chain vehicle management, manufacturing and processing production tracking, high-risk security management, animal tracking and identification, waste management, package and aviation baggage tracking, expenditure system management, electronic article surveillance, retail apparel management, and security and asset management.

Barcoding, which is typically utilized to identify objects at the point of sale (POS), has proven to be complex. As the information that can be stored in a barcode is limited and some readers

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0957-4174/$ - see front matter © 2009 Published by Elsevier Ltd.
doi:10.1016/j.eswa.2009.01.082

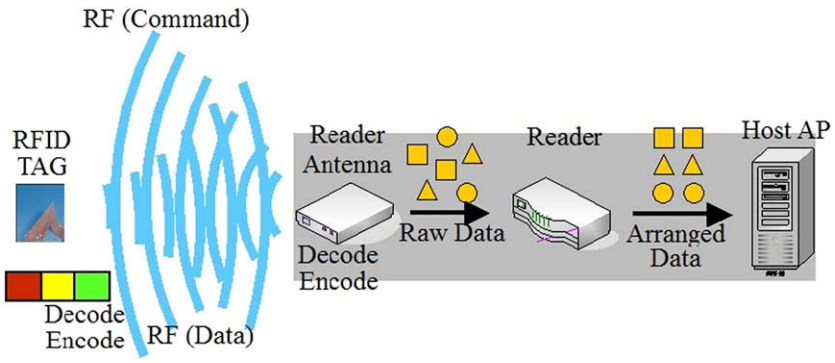

Fig. 1. RF system architecture diagram.

function poorly, the technical constraints of barcoding for large companies such as Wal-Mart or Target are considerable. Nevertheless, RFID technology has the important features such as real time, prompt read/write of remote and no-direction, portability, operating ability of read/write, good penetration, long life time, good environmental resistance, and high-capacity store, thus it may be applied in both automatic production and business management (Curty, Joehl, Dehollain, & Declercq, 2005). RFID technology certainly provides the opportunity to improve those applications currently using bar code as pointed out by Manthou and Vlachopoulou (2001) who indicated the potential of increasing industrial productivity and the accuracy of stock level, providing better customer service, and enhancing communication and coordination between sellers and buyers. That is, for some application systems which could replace bar code with RFID, they might raise the overall management efficiency (Keskilammi, SydÄnheimo, & Kivikoski, 2003).

In a supply chain, RFID technology can simultaneously access data from human resources and facilities, and transmit data to and from computer databases in real time (Ruff & Hession-Kunz, 2001; Strassner & Chang, 2003). Therefore, computer information systems can calculate, analyze, and determine the optimal operational processes or parameters, thereby improving supply chain efficiency (Wagner & Lindemann, 2008). Integrating the RFID system with shop floor and marketing management information systems in the context of supply chain management strategy increases efficiency, profitability, and competitiveness of a company (Abdel-Malek, Kullpattaranirunb, & Nanthavanij, 2005). In summary, the specific primary benefits of RFID include are as follows: reduced errors at the cash register; improved checkout line throughput; enhanced inventory control and management; enhanced buyer–seller communication; automatic auditing of marketing policy; improved availability consumer market research data; and, ability to change distribution mechanism to meet customer requirements (Saygin, 2007).

Notably, RFID applications offer a snapshot of the various ways for reading and distinguishing between tags, which help people, reduce manufacturing costs, improve product quality and serve consumers in real-time. Applications are typically characterized by their primary benefits, which include security and authentication in electronic article surveillance and electronic drug-pedigree applications, and ensuring patient's safety, convenience of a service or application, and process efficiency during monitoring. The RFID technology is currently employed to enhance information accuracy and data transmission speed throughout the business flow, including shop floors management system and customer's (marketing) system and management processes system (Regattieri, Gamberi, & Manzini, 2007). Increasing the readable percentage of a tag and reducing cost, variability in ISO procedures, monitoring and controlling the manufacturing processes can all be used to improve customer service and to increase market share.

This paper proposes a framework to integrate RFID technology in a QAS in order to improve its effectiveness.

3. Framework of RFID-based QAS

Fig. 2 presents the proposed framework, which integrates RFID technology with QAS. Electronic point of sale (EPOS) systems is typically connected to a host computer that receives sales information from Reader Antenna and the host computer can be utilized to automatically record information and track inventory levels to prevent inventory from falling below a predetermined real-time level.

When RFID technologies are incorporated into the supply chain, customers and suppliers provide database information (Cigolini & Rossi, 2008). Incorporating the database and proposed model information for organizing management activities can be provided through the interface. Management activities promote management mechanisms (planning, organizing, staffing, directing, and controlling). Shop floor management functions are via man, machine, material, and method (4M) and where, why, when, who, and how much (4W1H). The information produced by the management mechanism can feedback QAS stratum. The QAS stratum offers suppliers and customers necessary information and can guarantee the result of outputs satisfying the unanimous goal. Marketing management by products, pricing, place, and promotion (4P) has also produced a result. The quality assurance system stratum guarantees that product quality meets consumer criteria.

Shop floor control (SFC) is production activity control (PAC) which includes sending workers and input/output data to control and create master productive scheduling. The productive schedule can utilize rationalization, standardization, automation and e-business technology to manage productive process (Singha & Gilbreath, 2002). One of the productive process mechanism involves Seiri, Seiton, Seiso, Seikety, Shitsoke (5S), and kanban management, productive scheduling, standard operating procedures (SOP), preventive maintenance (PM), stock control, quality control circle (QCC), total quality management (TQM), suggestion systems, etc. (Mukhopadhyay & Shanker, 2005; Tam, Chan, & Price, 2006). Market control (MC) involves customer relative management (CRM) technology, logistics management, electronic data interchange (EDI) and supply chain management (SCM) (Onwubolu & Dube, 2006). Additionally, to improve inventory management, such a system of the economic order quantity (EOQ) must also have considerable potential as a source of marketing data (Schnetzler & Schonsleben, 2007).

The QAS can be based on ISO 9000 quality standard and include the shop flow as well as the customer service (marketing). The RFID tags and readers can be applied in various stages of the QAS including acquisition, analyze, action, and audit phase to reduce the process variation and to enhance products quality (DePuy,