

UHF RFID-based TV Home Shopping Logistics System Design and Implementation

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Abstract— The logistics of TV home shopping is operated by selling products through TV broadcasting after receiving all the products from suppliers. If orders from customers are complete, the products ordered are shipped to customers from the distribution center. However, many problems such as the products being delivered to other people or shortage in quantity occur due to picking errors and receiving/shipping errors. These problems occur due to system errors and human errors. If an error occurs, the cost loss occurs. RFID is the system that recognizes tags by using radio waves. The RFID system of UHF band capable of remote recognition is being used in the logistics sector. If RFID is applied, errors can be immediately found by referring to the data in real time. Therefore, this thesis proposes the system that prevents errors by inquiring about the data during receiving, shipping and picking of products based on the UHF RFID. With the application of this system, real-time receiving and shipping, inventory management and delivery history tracking are also possible.

Keywords— RFID, TV Home Shopping, PDA, Inspection, UHF

I. INTRODUCTION

RFID is the technology that stands out by being developed as a radio frequency identification technology in the mid-20th century and used in the inventory management and supply chain management in the late 1990s. The past systems were not able to recognize individual entities, but all objects are now able to be recognized on the wireless network through RFID. In addition, the RFID technology has the versatility that can be easily applied to various fields and the advantage that can be naturally applied to the infrastructure of the existing industries without great modifications [1][2]. So RFID is rapidly becoming the preferred technology for the Internet of things [3].

TV shopping is a system for selling the product at the customer via the TV. It has been two years since TV home shopping channel for small and medium business was established in order to resolve the small and medium business's distribution difficulties. At this point, we have to assess whether this new entry coincides with its original purposes [4]. Customers can purchase products after checking through the TV without directly going to see them, helping customers easily purchase products. However, the problems that other products are delivered, wrong quantity is delivered or products are delivered to other people are occurring as a lot of orders are received from customers in operating the

logistics. Such problems occur because it is not possible to identify the occurrence of errors between logistics operation processes. Logistics should be operated as quickly as possible because customers want to receive the products they ordered as soon as possible. Therefore, speed and accuracy take are important parts of the logistics sector.

This thesis proposes the system that can promptly find and deal with the problems occurring when operating logistics by acquiring, inquiring about and analyzing data in real time using the UHF RFID technology. The loss due to logistics errors can be reduced in the field through this system. In addition, this thesis proposes the system that complies with the GS1 Standard for the sharing and integration of the system.

II. BACKGROUNDS AND RELATED WORKS

A. RFID system

The RFID system is hardware-reader (Reader or Interrogator), constituted by a tag (Tag or Transponder) and by software consists of RFID middleware, Capturing Application, EPCIS. In general, the passive systems commonly used reader transmits an RF signal to the tag, and the tag received the signal transmits the data stored in the tag by modulating the amplitude or phase of this comes the RF signal to a reader. Modulated signal received from the tag is decoded by the reader demodulation is a basic principle that the tag information is decrypted. The operational leader is connected to the computer.

The purpose of the 21st century new generation of information awareness MIT, UCC, P & G, including 46 partners jointly in the auto-ID Center, founded in 1999, things-to-attach the smart tags on various products intelligent things by, or businesses and consumers with technology was developed for automated supply chain management system via a communication. This standardization is proposed in the EPC Network was established to commercialize EPCglobal. EPCglobal Network is EPC, ID System (RFID Tags and Readers), EPC Middleware, EPC Information Service (EPCIS), consists of a Discovery Services.

The operation of the EPCglobal Network is first attached to the EPC tag items designed to uniquely identify a particular item in the supply chain. EPC tag attached to an article using the RFID technology conveys its own code for the EPC reader. EPC reader and pass the received number to a computer or

local application system known as the Discovery Services, Discovery Services informs whether the information on the network where the location of the object that is attached to the computer system EPC. EPCIS is the gateway of the EPCglobal Network. Receiving events from tags EPC Middleware, and generate information based on a couple of the track & trace events occurring from EPC Middleware, stored in the local data store in preparation for future use. Further, EPCIS is a hub that integrates information for a given EPC.

B. RFID System Based GS1 Standard

GS1 Standards support the information needs of end users interacting with each other in supply chains, specifically the information required to support the business processes through which supply chain participants interact. The subjects of such information are the real-world entities that are part of those business processes. Real-world entities include things traded between companies, such as products, parts, raw materials, packaging, and so on. Other real-world entities of relevance to trading partners include the equipment and material needed to carry out the business processes surrounding trade such as containers, transport, machinery; entities corresponding to physical locations in which the business processes are carried out; legal entities such as companies, divisions; service relationships; business transactions and documents; and others. Real-world entities may exist in the tangible world, or may be digital or conceptual. Examples of physical objects include a consumer electronics product, a transport container, and a manufacturing site (location entity). Examples of digital objects include an electronic music download, an eBook, and an electronic coupon. Examples of conceptual entities include a trade item class, a product category, and a legal entity.

GS1 Standards may be divided into the following groups according to their role in supporting information needs related to real-world entities in supply chain business processes:

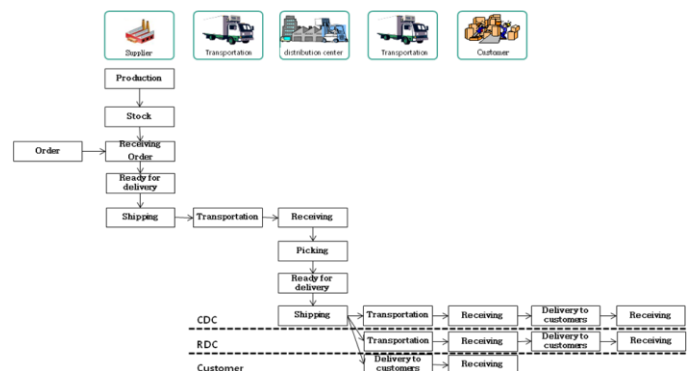
- Standards which provide the means to Identify real-world entities so that they may be the subject of electronic information that is stored and/or communicated by end users. GS1 identification standards include standards that define unique identification codes (called GS1 Identification Keys).
- Standards which provide the means to automatically Capture data that is carried directly on physical objects, bridging the world of physical things and the world of electronic information. GS1 data capture standards include definitions of bar code and radio-frequency identification (RFID) data carriers which allow identifiers to be affixed directly to a physical object, and standards that specify consistent interfaces to readers, printers, and other hardware and software components that connect the data carriers to business applications.
- Standards which provide the means to Share information, both between trading partners and internally, providing the foundation for electronic business transactions, electronic visibility of the physical or digital world, and other information applications. GS1 standards for information sharing

include this EPCIS Standard which is a standard for visibility event data. Other standards in the “Share” group are standards for master data and for business transaction data, as well as discovery standards that help locate where relevant data resides across a supply chain and trust standards that help establish the conditions for sharing data with adequate security.

The EPCIS Standard fits into the “Share” group, providing the data standard for visibility event data and the interface standards for capturing such information from data capture infrastructure (which employs standards from the “Capture” group) and for sharing such information with business applications and with trading partners [5].

C. Logistics Process in TV Home Shopping

The contact with consumers in the home shopping industry through the internet shopping malls and cable broadcasting out of online shopping malls is made in the websites and delivery. The logistics costs can be said to be higher as compared to the ordering costs because products should be delivered directly to customers. Customers’ ordering lead time has a high correlation with the delivery time [6]. The TV home shopping logistics operation process is shown in Figure 1. TV home shopping operators order products from suppliers before broadcasting. Suppliers prepare products according to the orders to ship to the TV home shopping distribution center. The shipped products are warehoused in the TV home shopping distribution center. If the shipping information on the products ordered through the TV home shopping is passed to the distribution center, the products are shipped from the distribution center through picking process. The details process is shown in Fig. 1 below:



- ⑤ Printing waybill and matching it with picked box (Return waybill have no matching box)
- ⑥ Sorting picked box and waybill by delivery vehicles (Depot Shuttles, CDC Delivery, Agent Delivery)
- ⑦ Sorting picked box and waybill by RDC(Regional Distribution Center) truck in the case of moving Inv. to RDC
- ⑧ Inspection & Loading to Vehicles
- ⑨ Delivery

III. PROPOSED SYSTEM MODEL

This thesis proposes the TV home shopping logistics operation system based on UHF RFID. This requires the process of receiving products from suppliers, receiving orders, picking and shipping as shown in the process of Fig. 2. Receiving and shipping are carried out through the RFID system-based kiosk programs, and picking is operated through the PDA RFID reader. The RFID tags are attached to the product boxes when products are delivered by suppliers. The product boxes are pre-mapped with the order numbers before delivery.

A. KIOSK Program for Receiving and Shipping

Kiosk applications provide the kiosk functions that can provide information to help workers significantly reduce the wrong receiving/shipping of products caused by mistakes and ensure prompt and correct receiving/shipping work through the real-time confirmation of the accuracy for the receiving/shipping work occurring at the receiving/shipping base of products and the transmission of the progress status. The main features are as follows:

- Login
- Select Receiving or Shipping Button
- Inquiries about order information on the basis of expected receiving/shipping dates
- Inquiries about the product information and quantity information by order information
- Inquiries about the scheduled receiving/shipping EPC code by order information
- Collection of tag information and updating of the recognized ongoing receiving/shipping quantity information
- Display of misrecognized tag information not included in the scheduled receiving/shipping information
- Transmission and re-transmission of receiving/shipping information
- Inquiries about the transmission records of receiving/shipping information
- Processing of forced shipping

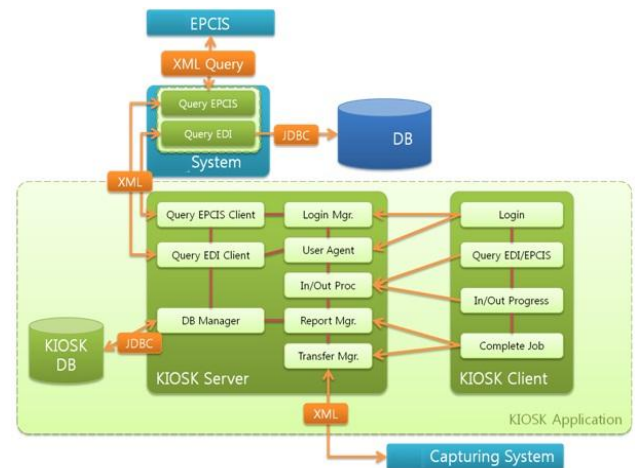


Figure 2. System configuration for Shipping & Receiving of KIOSK

The kiosk applications are widely divided into the query EDI module inquiring about order information and the query EPICS module inquiring about EPICS information, both of which can be used in process by inquiring about order information and EPICS information through these modules from the filed kiosk applications.

In the server part of kiosk applications, there exist the Login Manager module to process the user's login, the User Agent module to manage the logged-in user's process information, the In/Out Proc module to process receiving/shipping progress information, the Report Manager module to create receiving/shipping completion information for delivering to the EPICS capturing application, the Transfer Manager module to deliver data to the EPICS capturing application, and the Query EPCIS Client module and the Query EPICS Client module to process the inquiries about order information and EPICS information, and the DB Manager module to process DB inquiries and storage also exists.

The client part of kiosk applications has the UI screen that is seen by workers, and has only the screen configuration and progress procedure and is configured to bring the information that should be displayed on the screen from the server. The Login module to request the user's login, the query EDI/EPICS module part to bring order information, product information and scheduled receiving/shipping information, the In/Out Progress module to process receiving/shipping, and the Complete Job module to process the completion of receiving/shipping work are configured.

B. PDA Program for Picking

PDA RFID reader applications collect receiving, shipping, returns, inventory and picking information. The receiving and shipping functions are used in the event of system problems and are mainly used for picking. PDA RFID reader applications are driven by being installed on the Windows mobile-based portable RFID reader. In addition, barcode functions are mounted to make the recognition of DO(Delivery Order) value and the data transfer possible through the Wi-Fi or cradle, and they were designed to allow

for working offline as well as online by storing work information in the built-in database if the communication status is not good. Other functions including the filtering of redundant data were designed to reduce the unnecessary use of the network. The main functions are as follows:

- The function that collects the receiving information of products through the RFID tag reading to transmit to the capturing application
- The function that collects the shipping information of products through the RFID tag reading to transmit to the capturing application
- The function that collects the return information of products through the RFID tag reading to transmit to the capturing application based on the previously picked DO value
- The function that creates the scheduled picking process information by inquiring about the scheduled receiving information and that collects and verifies picking information of products through the RFID tag reading to transmit to the capturing application
- The function that displays inventory information to workers by inquiring about previous inventory investigation information and that collects current inventory information to transmit to the capturing application

IV. IMPLEMENTATION

A. Receiving from Supplier

Suppliers produce products after receiving orders from TV home shopping companies, and then deliver the ordered products to the TV home shopping distribution center after attaching tags to the produced products. The distribution center conducts inspection and warehousing if the products shipped by suppliers arrive. The screens of receiving inspection and warehousing are shown in Figures 3 and 4.



Figure 3. Select Order Number of KIOSK program for Receiving

Receiving procedure is as follows:

- ① Select receiving button.
- ② Select supplier.
- ③ Select receiving date.
- ④ Select order number.

- ⑤ Perform the receiving verification from the RFID reading.
- ⑥ Complete Receiving operation.

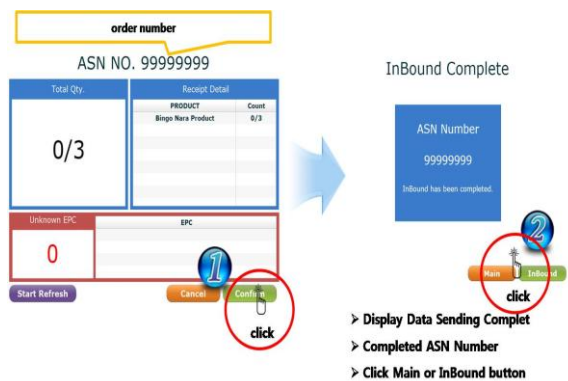


Figure 4. Perform the receiving verification from the RFID reading

B. Picking

Picking is conducted based on shipping and order information. Picking work is completed by moving to the picking place after receipt of orders and then recognizing the RFID tags to determine whether the correct products matching with the order numbers have been picked. The picking process is shown in Figures 5 and 6 follows:

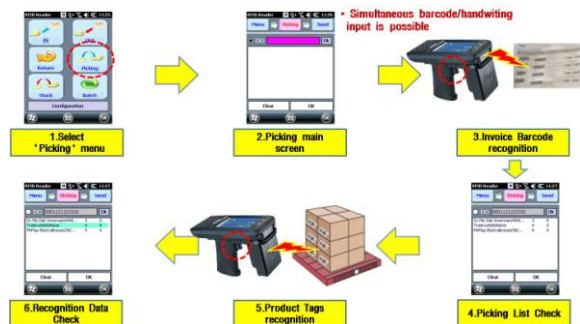


Figure 5. PDA RFID Reader program for picking(1/2)

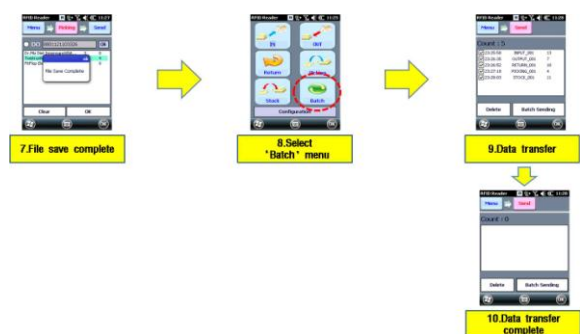


Figure 6. PDA RFID Reader program for picking(2/2)

Detailed procedure is as follows:

- ① Select 'Picking' Menu
- ② Confirm Picking Main Screen
- ③ Invoice Barcode Recognition

- ④ Picking List Check
- ⑤ Product Tags Recognition
- ⑥ Recognition Data Check
- ⑦ File Save Complete
- ⑧ Select 'Batch' Menu
- ⑨ Data Transfer
- ⑩ Data transfer complete

C. Shipping to Depot, Customer, Vendor

There are largely three types of shipping processes based on picking information. While products are shipped to customers after delivering to the depot in case of the remote areas, products are shipped directly from the distribution center in case of the near areas. In addition, the shipping to suppliers also occurs for the returns. The depot buttons are generated according to the number of depots. The shipping selection screen is shown in Figures 7.

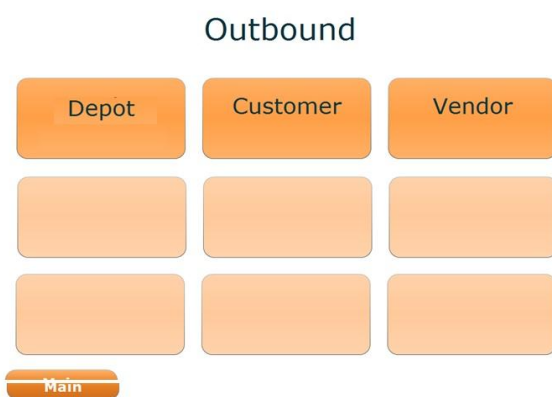


Figure 7. Select destination for shipping

When shipping to a depot, the depot to which products will be shipped should be selected. If inquiries are made based on the desired dates after selecting the depot, the list of the orders for shipping appears. If the order number for shipping is selected, picking information is inquired and scheduled shipping information is on the screen as shown in Figure 8. Scheduled shipping information is shown for the shipping inspection. The shipping errors are shown on the screen if the products and quantity to be shipped do not match with each other.



Figure 8. Select order number and verification from the RFID reading of Shipping for Depot

When shipping products to customers, the Delivery Order of the customer to who the products will be delivered is selected after selecting the Customer button. If the Delivery Order is selected, the shipping inspection is conducted together with the shipping from the depot based on picking information. If the scheduled shipping quantity and RFID recognition information match with each other, shipping is normally conducted. The DO selection screen is shown in Figures 9.



Figure 9. Select order number and verification from the RFID reading of Shipping for Customer

D. Detection of Errors and Confirmation of Proposed System

The error prevention inspection is conducted during all of the receiving, shipping and picking processes through RFID reading. Errors by men and systems do not occur through the verification of each step. The figure below shows the screen detecting errors during receiving products.

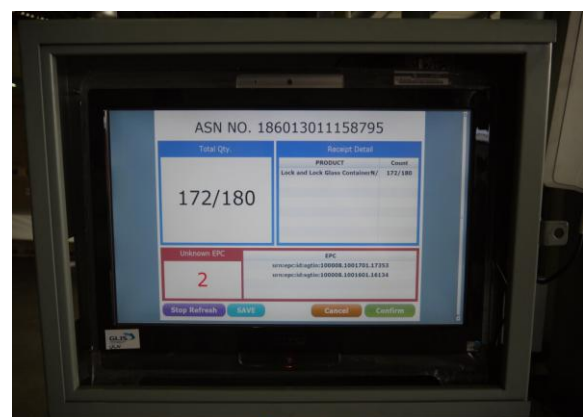


Figure 10. Deployed KIOSK system for Receiving

The scheduled receiving information and other tags are separately displayed at the bottom during reading. In other words, only the products that should be warehoused are processed while other products or tags are filtered. However, the information about the tags that cause errors is separately

displayed at the bottom to allow for removal of errors. Real Receiving screen is shown in Figure 10.

As only the products corresponding to the order numbers can be picked after recognizing the barcodes printed with the order number first as shown in Figure 11, wrong picking can be prevented during picking as well. The details of purchase orders should be checked in terms of the type and quantity of products during picking. By doing so, picking of other products or quantity errors can be removed.



Figure 11. picking operating screen of PDA RFID reader

V. CONCLUSIONS

The proposed system is the logistics loss prevention system where the errors by men or systems such as wrong delivery or wrong picking are removed by applying UHF RFID to TV home shopping logistics sector. As this system will not only protect the loss of distribution costs, but also remove the problems that occurred during conventional manual work, time will also be shortened. This system can be applied to other logistics industries as well as the TV home shopping sector.

REFERENCES

- [1] JD. K. Klair, K. -W. Chin, and R. Raad, "A survey and tutorial of RFID anti-collision protocols," IEEE Commun. Surveys & Tutorials, vol. 12, no. 3, pp. 400-421, 3rd quarter 2010. <http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=5455790>
- [2] Soon-ryang Kwon, Kwang-gon Moon, "Design and Implementation of Intelligent Management System for Retail Stores using RFID Technology," KICS2011-09-427, vol. 36, no. 12, pp. 1659-1669, 2011. http://www.koreascience.or.kr/article/ArticleFullRecord.jsp?cn=GCSH GC_2011_v36n12B_1659
- [3] The Internet of Things. Technical report, Article number: 27441. International Telecommunication Union, Geneva, Switzerland, November, 2005.
- [4] Choi, Jae Seob(2010), Special demand nature of TV homeshopping broadcasting and political implication of it; focused on demand side, Journal of e-Business Research Vol. 11 No.3
- [5] EPC Information Services (EPCIS) Version 1.1 Specification GS1 Standard Version 1.1, May 2014
- [6] Young Hun Jung, Hong Chul Lee, A Study on Returned Product of Reverse Logistics Network in e-Retail Industries, Journal of the Korean Society of Supply Chain Management, Vol. 5, No. 2, pp.29 ~42, December 2005

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