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Automatic Data Capturing At Satellite Depots Based On NFC Technology.

Natasha Mwansa¹, Jackson Phiri²

Department of Electrical and Electronic Engineering, University of Zambia, Lusaka, Zambia¹

Department of Computer Science, University of Zambia, Lusaka, Zambia²

ABSTRACT: Small scale farming is a source of income for most villagers in Zambia. Most small scale farmers plant maize during the rainy season and sell it to the national food reserve agency (FRA) during the crop marketing season. Unfortunately the Food Reserve Agency faces many challenges and losses of grain due to its manual counting and recording of inventory that it purchases. In this paper a solution using a mobile application, real time data capture and Near Field Communication (NFC) technology is proposed to aid the agency in the buying of maize from farmers.

KEYWORDS: NFC, Mobile application, real time, FRA

I. INTRODUCTION

Maize is one of the most important staple foods in Zambia, it is consumed on an almost a daily basis by most families. The Zambian government has ensured that there is always a constant supply of this product by having strategic maize reserves around the country. Each year the Zambian government through the Food Reserve Agency purchases this product from small scale farmers throughout the country from satellite depots [1]. Unfortunately the Food Reserve Agency experiences losses of bags of grain because of the manual system of purchasing the maize from the small scale farmers [2].

This paper proposes an automated system which will use real time data capturing technologies, the contactless technology of Near Field Communication and web services.

Part I a thorough literature review based on NFC technologies was done, part II is the related works that have been done concerning Near Filed Communication and mobile applications, part III introduces the methodology which includes the business process mapping and system architecture, part IV shows the results and discussions and lately the conclusion.

II. LITERATURE REVIEW

NFC technology involves a short range wireless communication that is used to exchange data and it is based on Radio Frequency Identification (RFID) standards and protocols [3] [4] [5]. For more recent devices, information can be read or written even by simply bringing the devices within a few centimetres of each other [6]. It operates at a high frequency of 13.56MHz [7]. In our everyday life, NFC enhances the mode of linking virtual information to physical objects that are used for various activities to identify, track and even connected to other network setups [8]. NFC devices utilize reverse technology and backward compatible with other RFID powered devices, setting up a mode for users to handle contactless financial transactions, access digital content, and connect compatible wireless devices [9]. With close proximity being a way in which NFC powered devices communicate, the other technologies of Bluetooth or WLAN connections can be supplemented while still returning the aspect of contactless connections, but with a special advantage of not having the need to configure the devices manually [10].

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There are two types of NFC devices namely, active and passive [3]. The main advantage of NFC systems is the fast detection and setup time, hence it can be used to facilitate other forms of communication such as Bluetooth or WLAN connection without any manual configurations, simply by bringing the two devices in close proximity to each other and the connection is set [11]. NFC devices can receive and transmit data at the same time [12], and have many functions: they can operate, for example, as a passive RFID tag, as a smart contactless card, and as a medium to exchange data between various devices. NFC devices can also be used to exchange data as text and images simply by holding the device near various smart tags [13]. NFC Passive mode devices work in such a way that communication can take place without a need of a power source [14]. However, passive mode devices cannot process any information received from other sources, exchange information nor connect to fellow passive devices [15]. This can be experienced among small transmitters and tags, where the major use is for advertisements i.e. beaming text, signs and symbols on walls [16]. The other class of active devices are powered to exchange information or data, communicate with each other and even connecting with passive devices. This class of NFC devices is used mainly in mobile payments, interactive advertising, ticketing mechanism in transits and so on.

Near Field Communication technology has been propelled by the growing need for users' reliance on hand held devices i.e. smartphones to handle day to day business with ease [17]. NFC technology continues to receive positive feedback from users due to its simplicity and flexible setting in infrastructure surrounding it across the whole world [18]. The three main operating modes of NFC are as follows:

- (1) Card emulation mode: This takes after the native contactless smart card mechanism where the NFC device acts as an external reader [15].
- (2) Reader / writer mode: This is where NFC powered devices are capable of reading NFC Forum-mandated tag types, like ones fused on an NFC encoded poster [15].
- (3) Peer to peer mode: This is where two NFC powered devices exchange data (approximately 424Kbps) as though they have been networked. [15].

III. RELATED WORK

Marcos J. LópezFernández et al in Control of attendance applied in higher education through mobile NFC technologies presents an improved attendance control system, required for continuous evaluation which has become compulsory following the Bologna Process. It provides a solution based on NFC technology and is based on a real project developed and pilot tested at the Universidad Pontificia de Salamanca, Campus Madrid [7].

Yan-yun Han et al the crop trait information acquisition system for breeding precision management is an effective way for improving the breeding information management level. The wide application of mobile phones provides convenience for real-time and on-field management. Smartphones use NFC and QRC technology to allow the linking of plants and traceability information. RFID-based identification technology and computerized data recording system is economically feasible [8].

In Health Care not only can NFC tags provide medical professionals with information about what treatments a patient should receive, but they can also keep track of when nurses and doctors have checked in with that patient and when. Each time the tag is scanned, the information about who scanned it and when can be transferred to a database. In addition to improving treatment [14].

IV. METHODOLOGY

A. BUSINESS PROCESS MAPPING AND MODELING

Business process mapping was done to understand what a business takes place at the satellite depot by taking into account roles, responsibilities and standards. Business process modelling (BPM) was also done providing a visual way to understand, analyse, and improve upon a current method of working of the business at the satellite depots.

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a) CURRENT BUSINESS PROCESS

Figure 2 below shows the current business processes that take place at the satellite depot when a small scale farmer wants to sell maize .

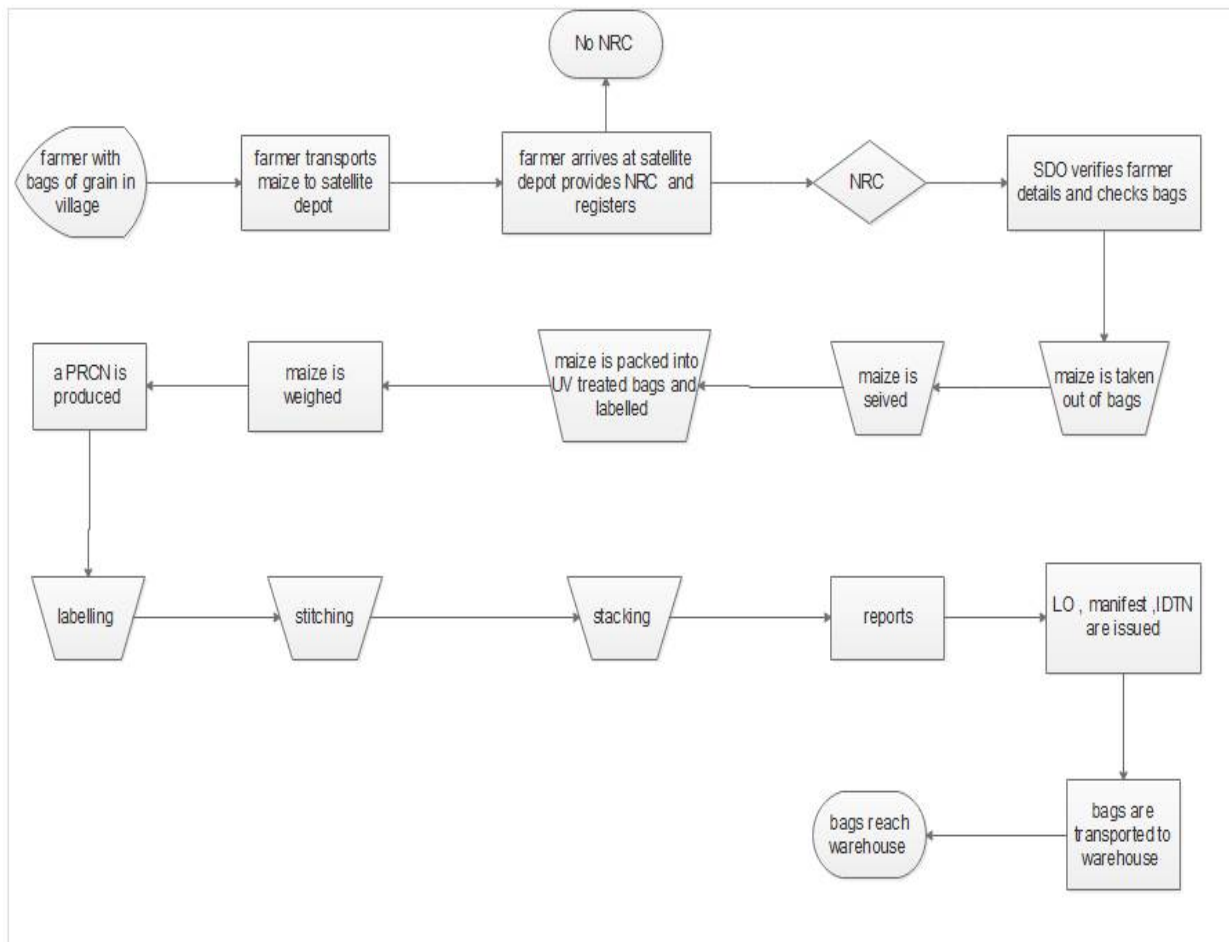


Figure 1 current business process

Farmer harvests maize in village and transports it to the satellite depot. The farmer arrives at the satellite depot and bags of maize are counted and registered in registry book an NRC to satellite depot officer, if not farmer cannot sell maize[20].The maize is then put on grain sieve and cleaned. After this it is placed in FRA standard bags which are UV treated then taken for weighing. A Product Receipt and Certification Note is then issued and the bags are then Labelled with this value . Labelling of the bags enables the FRA to trace back the supplier and source depot in the event of theft or any queries[21].The bags are then stitched manually through the use of bailing twine and locally made needles. The bags are then stacked onto a slab or shed .After closing business at the satellite depot SDO should send the purchase figures for the day to the MA and copy Data entry Clerk. These figures are communicated by short message system (SMS) on mobile phones.

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b) PROPOSED BUSINESS PROCESS

1. The farmers will have to register with FRA before they can sell stock. The information registered includes: first name, last name, gender, marital status, NRC number, Farm Area, camp and block.
2. After the capturing of the information the farmer's photo is then taken and attached to his information on the database. An Identification card is then printed out. This ID is what the farmer will be using each time he or she wants to sell stock to FRA. The ID will also contain an NFC tag. Which when scanned by a mobile phone will bring up the farmer's information.
3. When the farmer reaches the satellite depot he or she produces the identification card. The depot officer will scan the ID to verify the farmer details. Once the ID is scanned the farmer then proceeds to the next process.
4. At this stage the bags of maize are taken out of the bags for cleaning. Cleaning grain means removing all the materials other than the grain.
5. After the cleaning process the bags of grain are then transferred to FRA standard bags. At these point the bags are put on the weighing scale for weight verification, each standard bag should weigh 50kgs.
6. When the weight is verified the bags of maize are tagged with NFC tags. This is done by adding the grain bag into the system and producing a unique identification code for it. The unique number will be 25 digits.
7. At this stage the bags are stitched.
8. The depot officer using the mobile application scans the bags. Once the bags are scanned the officer then uploads the information onto the database for the inventory management system. This information can be viewed by anyone who has authorization to the cloud based database.
9. The system then generates a report or invoice for the farmer.
10. The depot officer then stacks the bags of maize onto the slab or shed.
11. The system will be able to generate the following reports :
Daily, Weekly, Monthly, Annually.

When queried it should be able to generate reports according to: Satellite depot, Camp, Block, District, Province and farmer.

B. SYSTEM ARCHITECTURE

In Figure 4, shows the system architecture of the system is shown. It consists of the user application, the cloud which comprises of data storage and web services and the NFC middle which consists of the device manager, the application interface, host controller and the NFC COM service.

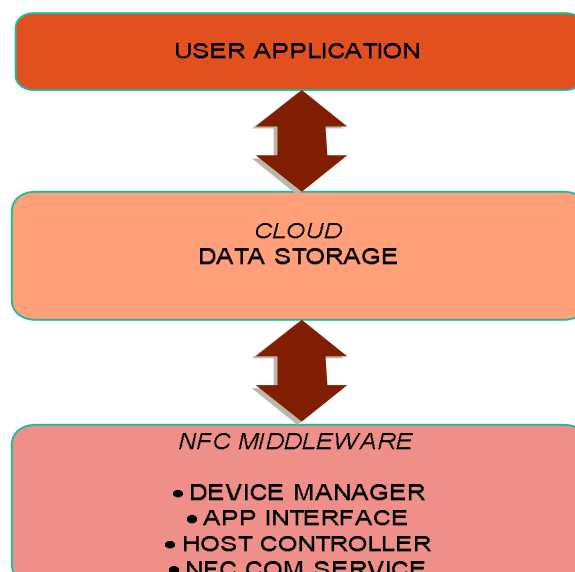


Figure 2 system architecture

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C. USE CASES

As shown in the figure 5 below the main actors of the system are the mobile application; here the user can write / read the NFC tags and once read the information is uploaded to the database , NFC middle wear which consist of the following components ; manage device(control the networking and settings of RFID readers and other similar devices, collect and integrate data by acting as a bridge connecting different systems together enabling the efficient transport of data, structure data by providing users the ability to understand what data they are collecting from each device and structure of where that data goes and when , filter data its able to read the most important and remove redundant or repetitive reads, tag ID association the middleware can keep track of and allocate the tag ID numbers . The user can perform the following functions generate unique ID for NFC tags , add users , add stations , register famers and view captured grain bags from the mobile application.

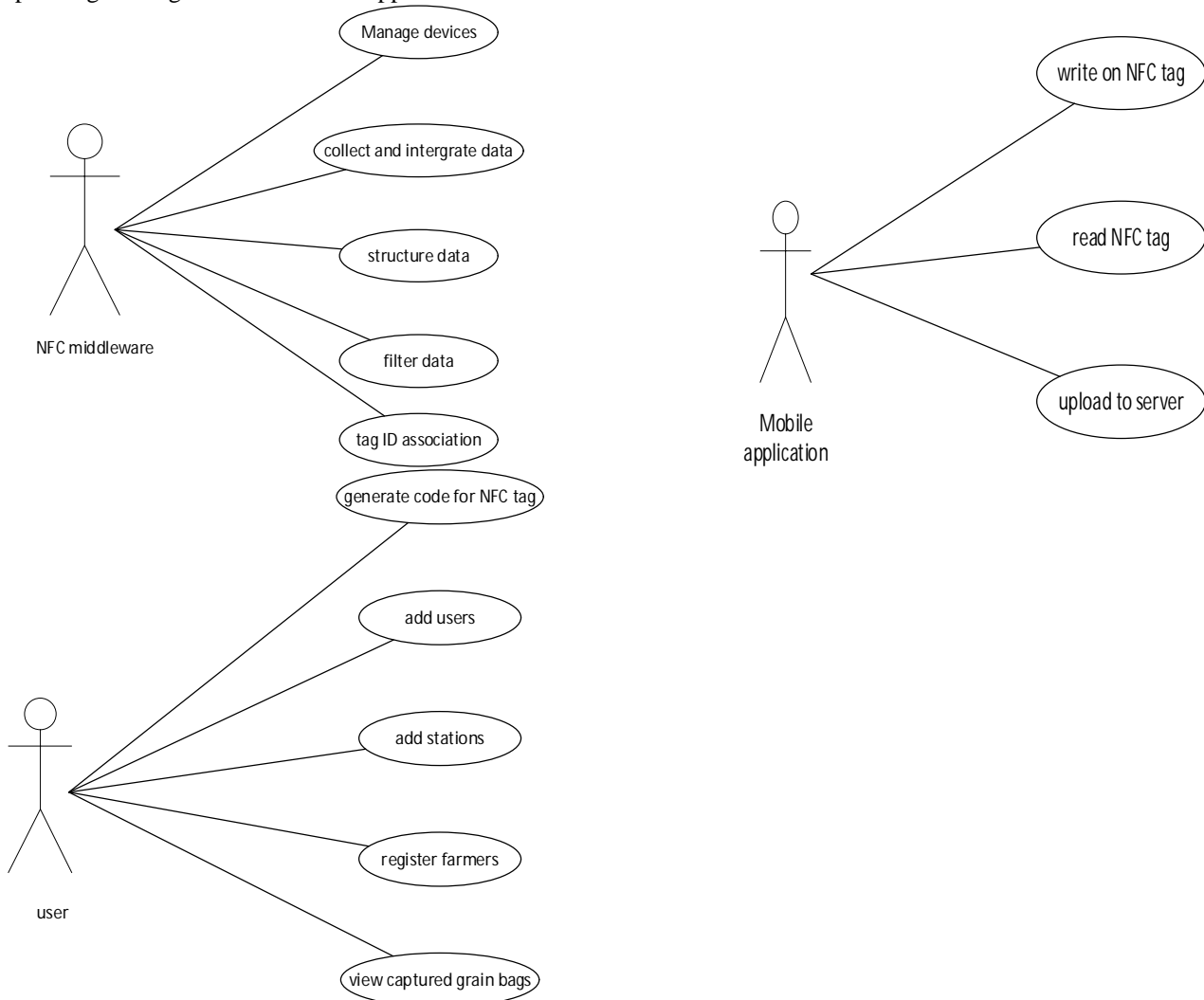


Figure 3 use cases

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D. SEQUENCE DIAGRAM

Figure 6 below is based on an android application. When the application loads the user is given an option to press scan NFC the application the writes bag ID onto the tag and then once rewritten it then reads it and uploads it to the server. The sequence diagram illustrates the writing of the NFC tags, the reading of NFC tags and the uploading to the server.

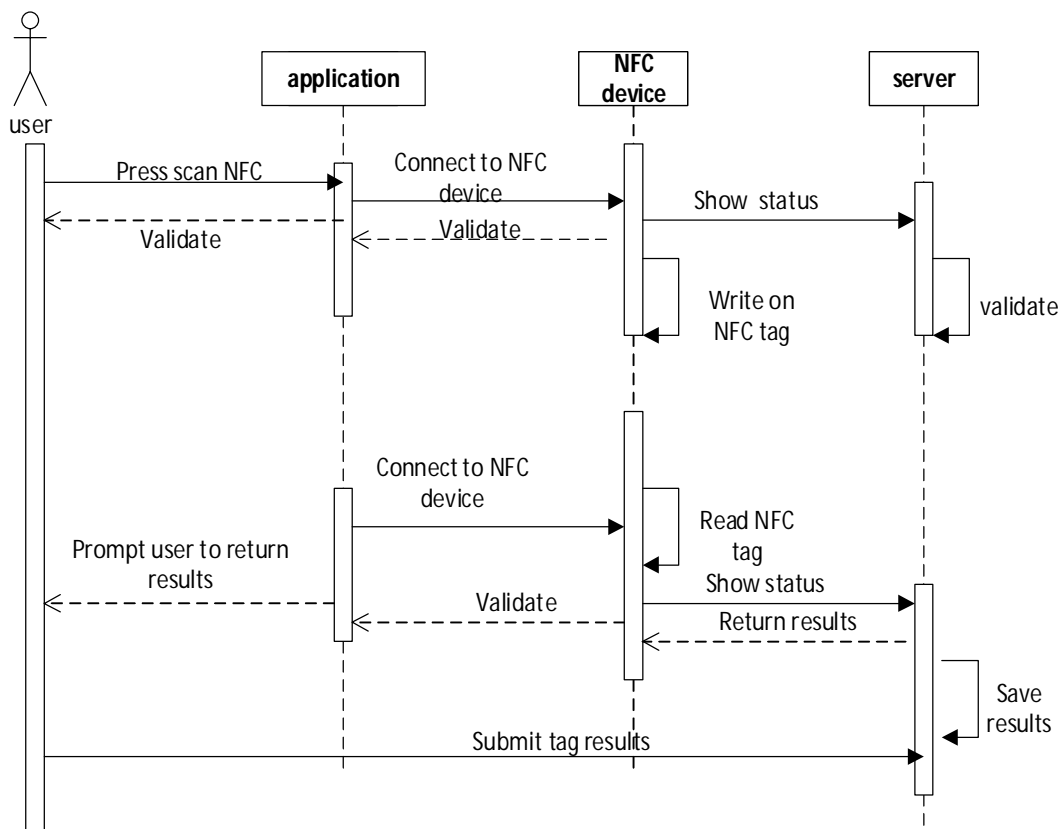


Figure 4 Writing and reading of NFC tags

V. RESULTS

The following sections are the from the business processes and the discussions.

A. BUSINESS PROCESSES

Figure 7 illustrates how most of the business processes have been automated.

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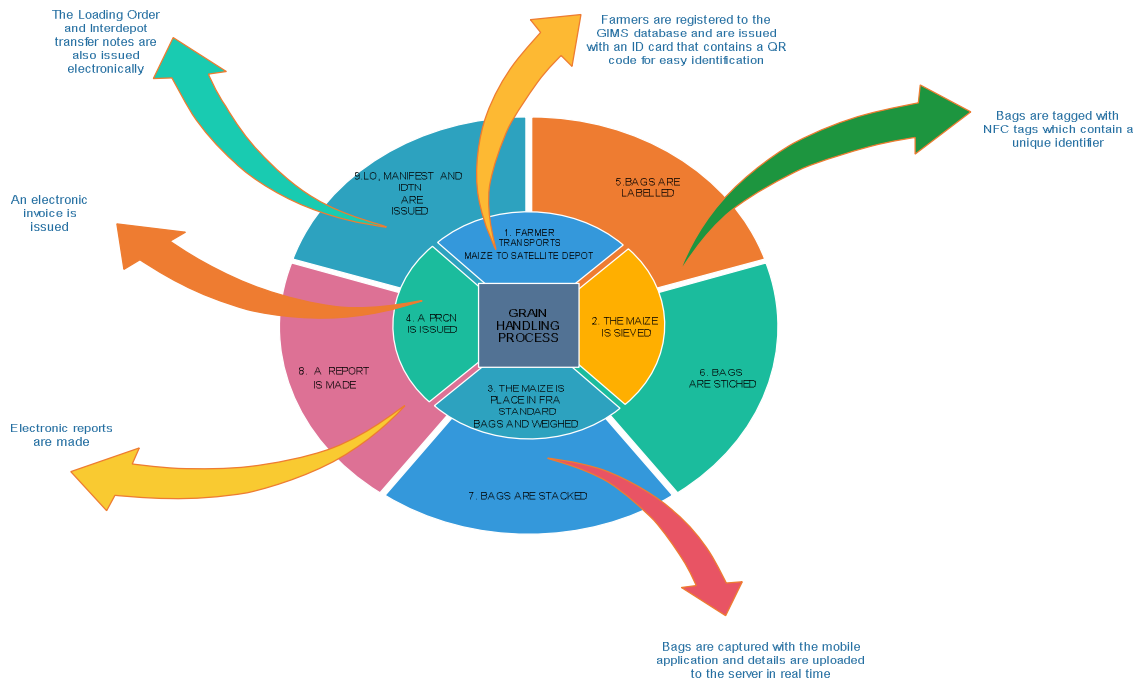


Figure 5

Figure 8 shows how to capture grain bag details that a farmer brings. Basically, all the grain bags that a particular farmer brings, should be linked to them. A unique code is given to each bag of maize.

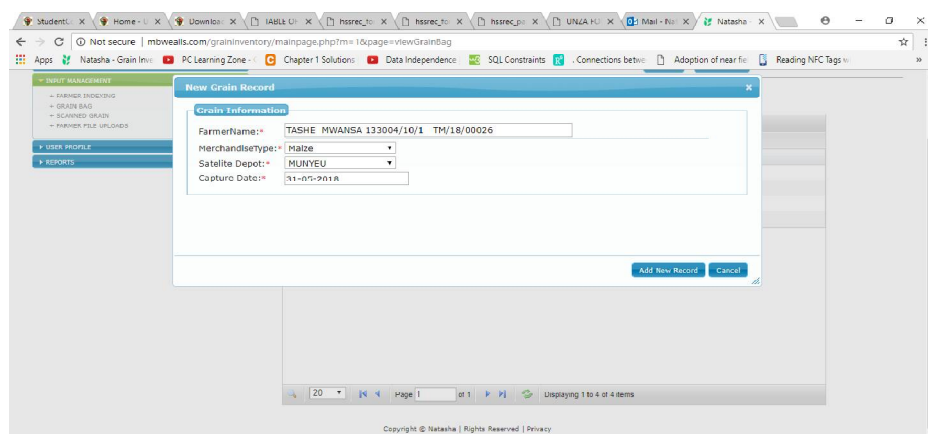


Figure 6 adding a new bag of grain

Figure 10,11 and 12 shows the mobile application value of the unique code that has to be written on the NFC tag, once complete the authorized user presses the ok button the figure 12 shows the value of the tag once read.

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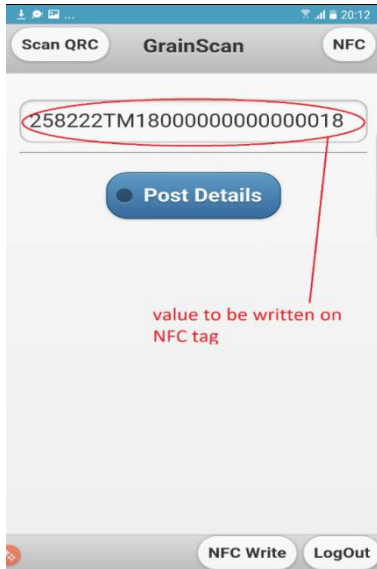


Figure 7 value to be written on tag

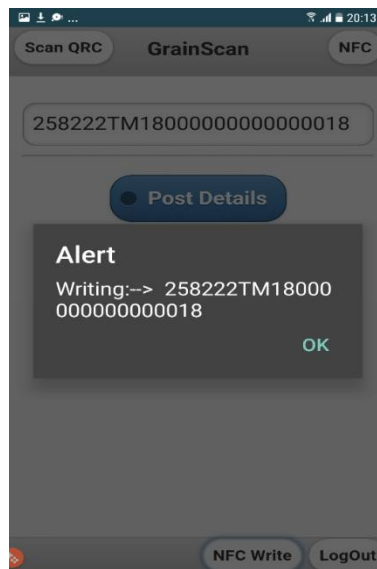


Figure 8 tag being written

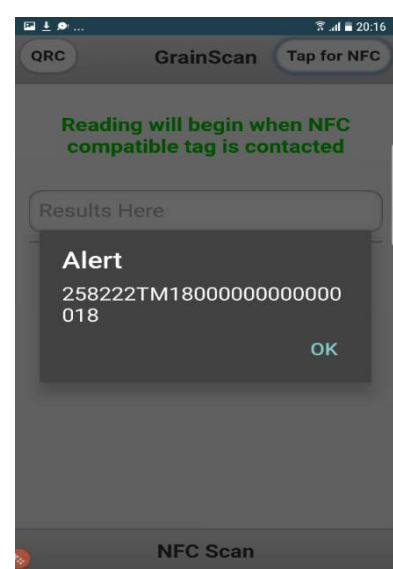


Figure 12 value of NFC tag

Figure 13 shows part of the captured grain bag details. The highlight information is shown such as grain number, farmer name, merchandise type and depot. This shows how to add, edit and delete a record. The mechanism is such that, when a row is selected, we navigate to the tabs to process that record. The records can further be sorted in a desired order, searching and navigating across pages.

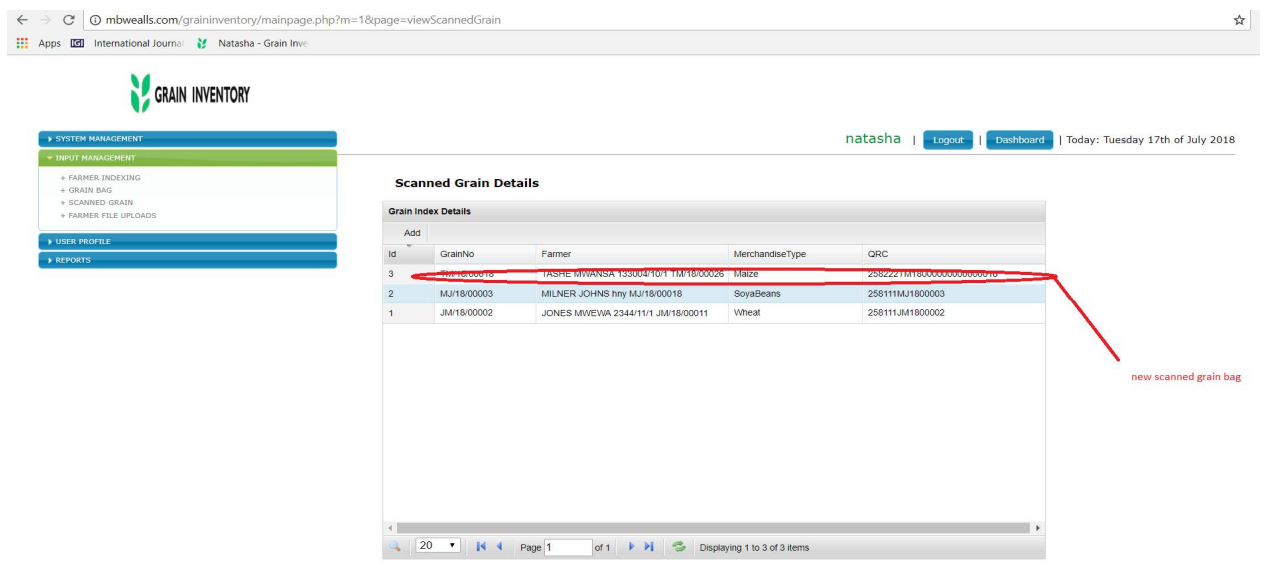


Figure 13 scanned grain bag successfully uploaded onto the database

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B. DISCUSSION

The main objectives of this study were to determine and map all the business processes at the FRA satellite depot, Design a model for real time data capturing based on the business process in using NFC technologies and to develop a prototype based on model, this automated system was implemented and it was noticed that the rate of errors which were caused by manual counting and invoicing had reduced. It also helped in the fast processing of farmer payments.

VI. CONCLUSION

In this paper, a study was done to establish the challenges faced by the FRA concerning grain accounting. From the results, we can gather that the FRA has been using a manual paper and excel spreadsheet based inventory system. Thefts would occur simply because of bad accounting of the bags of grain and farmers would have to wait several months before they could get payments for the stock that was sold. An automated system was a good solution to aid the FRA in easy counting and tracking of the bags of maize.

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