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Developing inventory information system using mobile computing with quick response (2d-barcode) and geotagging

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Developing inventory information system using mobile computing with quick response (2d-barcode) and geotagging

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Abstract. Inventory management is the main task of an organization to reach its objective of maintaining the number of stocks precisely and minimizing waste. Web-based inventory management in a university environment is expected to help the employees in keeping up with innovations on the status of tools and equipment. It is only fitting that inventory data management is also capable of accommodating distance. The use of the internet by using mobile computing which automatically can do tagging of inventories including information about the coordinate will broaden the potential of database using mobile computing technology with wireless data communication aided with 2D-barcode decoding automatization makes it possible to synchronize (record and track) on-line to the central database using some computers that work simultaneously and directly from the field. This inventory system can synchronize data directly from the field and the information can simultaneously be accessed by the users. Mobile computing (android Smartphone, computer tablet) is used as a mobile station that is capable of decoding the tags of inventories and buildings (in the 2D-barcode) and associating automatically with the database wireless networks and the internet to eliminate the distance factor and overhead-process (pre-processing of data from the field to the data storing station).

1. Introduction

The development of technology that is increasingly fast requires government or private organizations to get information more quickly, efficiently and effectively. To get such information a subsystem is needed that can handle various data managements using information technology. Inventory data processing at Universitas Pendidikan Ganesha (Undiksha) is done using particular code with some features such as location, year, type, source of fund, etc. It is proper that the inventory data management is capable of accommodating the distance factor. The use of the web through mobile computing can automatically tag the inventory goods including the coordinate information, hence broadening the use of the database potential. So far this tagging of inventory goods has been done

using label system, in which the factor of the width of the area becomes the constraints of distance and time in synchronizing the database through computer system in data management. Currently, the data are stored in the database in the form of catalog of collections and digital data, however, are accessible only offline in the computer (worksheet).

Universitas Pendidikan Ganesha, or Undiksha for short, is a state campus that consists of some faculties and postgraduate spreading in some locations in Buleleng regency and Denpasar. The conventional inventory system cannot cover mobile inventory processing. Such system can record according to its functions, however there are no inter-unit connections in the across working units in Undiksha. The solution recommended is the use of mobile computing technology with wireless data communication aided with decoding automatization with 2D=bardode, which enables synchronizing automatization (record and tracking) on-line to the central database with some computers that work simultaneously and directly from the field. Based on the previous study, web responsive system has been able to be developed to use the internal camera device to read tags and use the reading as the key to synchronize data to the database. Such system is used as the basis for this inventory system.

This inventory system can synchronize data directly from the field, at the same time the information can be accessed by the users. Mobile computing (android Smartphone, tablet computer) is used as a mobile station that can decode tags of goods (in the form of 2D-barcode) and associate it automatically with the database and the internet which eliminates the distance factor and overhead-process (data preprocessing from the field to the data storing station). By using GPS, the position of the users and the collection to be accessed can be directly associated at the digital map.

2. Overview of Inventory Information System

2.1. Inventory information system

Inventory management is the main task of an organization to reach its objective to maintain the number of inventories precisely and minimize waste. The web-based inventory management at the university environment is expected to help the employees in keeping with the innovations on the status of tools and equipment [1]. The inventory manager is faced with the increasing complexity and at the same time is trying to maintain the operation to make it constant, having a good quality and is adequate for the stakeholders and to maintain the number of inventories at an optimal level, thus the manager has to have an appropriate inventory management policy [2]. The development of the inventory information system that uses mobile computing with Quick Response (2d-Barcode) and Geotagging was the research concept of the management of the Department of Informatics Management Undiksha, facilitated by Undiksha Research Institution. This starts from the need of the the university for an inventory system that can be assessed by Wide Area Network supported by the results of relevant previous researches such as the use of mobile devices with multi-tag technologies for overall contextualized vineyard management by C.R. Cunha et al. [3], which had the same orientation with Cheng Lin et. al. [4] on developing facility management developed using 2D-barcode at the level of mobile computing device.

The inventory management system consists of a central control unit and a number of terminal units. The terminal units are spread and are connected and integrated by the central control unit. There are two data managed by the central control unit: master file and transaction (job) file. The file master is used to record unit inventory information while the transaction file to record inventory job information. In addition, there are two types of information stored in the system: job information and updates of inventories. The display of job information is stored to display inventory job information related to the work unit [5].

2.2. Identification by using tags

Tag is a data representation that is capable of being read by the engine that has been widely used that connects physical objects with the digital information. A simple example is the use of barcode in the stores or department stores to facilitate the reading of information on commodities such as price, stock, discount, and other information that is recorded. Basically, barcode is a code of goods that can be easily recognized using an infrared device (barcode reader) so that the casher does not need to type the code of the goods. There are some technologies for identifying things based on tags such as barcode, visual-tags, and radio-frequency identification (RFID) tags, which if combined with on - the-fly decoding system such as the one used by the department store cashier will provide an effective, innovative and contextual information service immediately at the time it is needed [3]. The RFID, Barcode, and 2D- visual tag technologies have their respective strengths l and weaknesses tag as shown in Table 1.

Barcode is designed to minimize errors in inputting data manually. Inputting hundred of item identity numbers manually can waste a lot of time and even can cause entry errors. Using barcode, item codes can be degenerated, printed, and attached to the items in question. The reading of codes can be done using a visual based reader, which automatically translates the codes that are written.

Table 1. Tag comparison between RFID, barcode, and 2D visual tag.

	RFID	Barcode	2D-visual tag
Strengths	Based on radio wave works automatically without visual; can be decoded although from the other side of the object.	Printed; cheap, visual decoding	Printed; cheap; can store more code information visual decoding
Weaknesses	The cost of the tag (electronic); the reading of radio wave; needs special decoding device	Ability to store a small number of data (limited in information line); the reading in a dirty or dark environment	The reading in a dirty or dark environment

The use of barcode (1D barcode) or linear barcode is widely used. This type is capable of storing and representing data through a series of lines with different thickness generally barcode is used in retail sale in which products have Unique Identifying Number (UID), which make automatic tracking and stock taking of the products. With a certain objective, a relational database design can be made to relate UID to the relevant product information.

The development of barcode started from 2d-barcode, which has developed following visual reading technologies. This system can code more alphanumeric data compared to ID-barcode, which is often used to provide URL easily using Smartphone basic features.

Figure 1. 2D-barcode (A) and 1D-barcode (B).

The reading of tags can be done using two approaches. The first approach is by using a special scanner to read tags of their decoding sent to a computer to process the data. The use of a special scanner that is separated from the computer will make it difficult for the application in the field in which practicality is the main factor to consider. The second approach is by using a software that is capable of decoding tags using a tablet computer or a Smartphone equipped with a camera. The camera catches the visual tag (1D or 2D barcode) and then decodes the visual image with a particular software [3].

The performance of table computer/smartphone at this moment is promising and it is equipped with various features that are needed in tagging data in the field. With the development of tablet computer and Smartphone that is equipped with a good processor and camera, it can scan better [4].

The global feature of Global Positioning System (GPS) in the tablet computer/ Smartphone makes it possible to combine the scanner function and geographical location that can be associated directly with the database. Th data on of an object location can be realized directly (rendered) on a digital map which provides visual information on where the object location is. This helps very much in the cases in which the position of an object is important [4].

3. Methodology

This study used software life cycle with waterfall paradigm. Departing from the planning stage of the study, the entire stages in this study can be described using waterfall paradigm [6], as follows: (a). analyzing the condition and doing a field study; (b). designing an architectural system; (c). coding; (d). integrating modules; (e). implementing the system; (f). doing an evaluation of the system implementation viewed from its quality and effectiveness; (g). making some improvement (optional); and (h). conducting a seminar and disseminating research findings to give a broader impact. Stages (f), (g), and (h) are done after the system has been finished. Finally, the software program needs to be selected based on the needs [7].

The job started from the analysis of condition. At this stage an analysis was done toward the existing condition in which the data were obtained from a field study through: library research, to find the philosophy and theories about product development and system implementation as well as tracing needs in the field. After the analysis was completed, a system architecture design was done, including architecture breakdown (detailed design). Then codification was carried out including verification and validation of modules produced. After that, the modules developed were integrated into a functional system. Then, the system was implemented, including in this was doing a system try-out. If at this stage there was an error or a mismatch, this could be corrected by at the stage that needed to be reviewed.

4. Result and discussion

4.1. Data preparation

The instruments used to collect data consisted of some instruments: (1). observation guide; (2). Questionnaire; (3). interview guide; (4). documentation study; and (6). expert judgment. The data used to test the system were mock-up data from the inventory at the Faculty of Engineering and Vocational of Universitas Pendidikan Ganesha. The formal inventory code had not been implemented in this trial without influencing the functions of the features. The faculty data were not automatically copied into the system. It was only done after doing database normalization first. The database was in the form of a ledger recording every record in a table. Some fields such as codes of buildings and codes of units had to be generated (once only). Additional fields such as coordinates were operational fields to display the geographical locations of items in a map.

The data analysis was done at the time of assessment of the proposed system. The data collected in this study were quantitative and qualitative data. Hence, non-statistical and statistical analyses were used. The non-statistical analysis was used to interpret the data descriptions concerning content, inferential logic, process, and product (output). In the mean time, for that quantitative data the descriptive statistical analysis was used to describe the data, so that it could be formulated in a qualitative interpretation to facilitate analysis and revision of the product development done.

This study used the Department of Informatics Management, Faculty of Engineering and Vocations of Universitas Pendidikan Ganesha as the location of the pilot study. The pilot study was done purposively, while the sample of the study study for doing an evaluation of the system created used a random sampling technique.

4.2. The inventory information system used mobile computing with quick response (2d-barcode) and geotagging

The system developed based on the result of the need analysis can be seen in the following figure (Figure 2). There are four main features: the first feature is that the inventories (and buildings) designed and implemented to be able to be used not only in the faculty environment, but also at the university by giving the right to access to operators in each unit who are responsible in each faculty as well as the existing technical implementers. The second feature is the recording of the function of the inventories, that is, the recording of assets that are regarded more as functional assets than objects. Some material objects such buildings can have some functions with different uses such as buildings which can be used as classrooms, seminar rooms, toilets, meeting rooms, stationery and office supplies, etc. The third feature is routine caring and lending, done to help in the documenting /operational or logistic staff in relation to the lending and caring of equipment/ inventories. The last feature is the circulation of stationery and office supplies, to record the incoming stationeries and office supplies and is used in the work unit. The inventory system is divided into two levels: user level, that is Administrator and Operator, the second is differentiated based on access right to the feature.

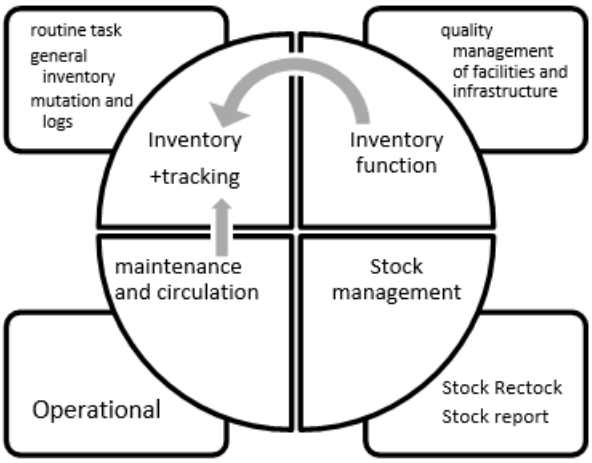

Figure 2. System architecture.

The following are features that are found in the Administrator

1. Mater Unit: This feature consists of CRUDE (Create, Update, Delete) of the master unit. An example is the data of the master unit is a faculty.
2. Unit: this feature consists of CRUDE (Create, Update, Delete) unit. Unit here means each department in a faculty.
3. Inventory Category: this feature consists of CRUDE (Create, Update, Delete) of the inventory category. Every inventory that enters into the system will have its own category.
4. Inventory location: this feature consists of CRUDE (Create, Update, Delete) of the inventory location. This inventory location can take the form of lobby, classroom, etc.
5. Inventory unit: this feature consists of CRUDE (Create, Update, Delete) of the inventory unit an inventory unit is a measurement unit, for example, meter for length, kilogram for weight, etc.
6. Origin of inventory: this feature consists of CRUDE (Create, Update, Delete) of the origin of the inventory. Origin of inventory is related to the source of fund for procurement of the inventory.
7. Account: This feature consists of CRUDE (Create, Update, Delete) of the account. Account here means an account in the form of username and password which are later used to get an access to the system.

The features in the Operator are as follows.

1. Inventory: this feature consists of CRUDE (Create, Update, Delete) of the inventories. Every inventory has a unique qrcode, which will be used at the time of data search for the inventory using a qrcode scan feature.
2. Room: this feature consists of CRUDE (Create, Update, Delete) of the room.
3. Lending: This feature consists of CRUDE (Create, Update, Delete) of the lending of inventories and / or rooms (being developed
4. Scan: This feature functions to a quick and accurate search based on qrcode that will be attached to the inventories.
5. Report: This feature functions to print a report of inventories. For the time being, the report that can be printed is only the report of inventories. Room and report and lending report are still being developed.

5. Conclusion

The use of 2D-barcode (quick-responsecode) and geotagging can give a new interactive experience to every user using a Smartphone/ tablet computer to get accurate and reliable information. Studies of the potential of the use of the digital technology in enhancing the efficiency of resources still need to be developed and the opportunities to do so are widely open. The existence of such a system can become the basis for applications and the next studies.

The strength of this system is that later with the availability of the mobile computing devices with wireless communication connections make it possible for the personnel in the field to directly update to the data center from the field, especially with the support of geotagging technology: GPS and digital map. Even by broadening the data connection with the use of the internet. The location distance factor will no longer become a problem.

Based on the result of the usability testing it was obtained that the system has met the need, 90% of the users could operate and use all the features in the list well (the normal time without instructions). From some of the suggestions given in general the display of this system is simple enough, consistent, and can be used easily, however, from some users it was suggested that training needs to be given and socialization needs to be done on the use of this system. The development study in the future can focus on the ability of synchronization with other information systems in sharing data and information as part of a greater information system integration.

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