Supplies and Equipment Inventory, Monitoring and Tracking Management System using Data Mining Techniques

Mignonette B. Tungcul, Marifel Grace C. Kummer

Abstract: In the present time, there are lot of web and software developer who provides different types of databased and online system to ease the burden of the different supply officer's/inventory officers of different companies and government sectors but Cagayan State University is one of the big universities that remained inventory management in a manual way. This study together with the development of SEIMTMS was conducted to innovate the current system used and to abolish the difficulties and challenges encountered by the Supply Office staffs in inventory management, record keeping, monitoring and tracking, and report generation. Classification and clustering techniques were utilized to produce information and comprehensive decision support reports that aids the Supply Officer and University administration on decision- making and budget allocation. Furthermore, the system used Clustering technique together with MFP algorithm to forecast the frequently purchased supplies and frequently repaired equipment. These decision support reports are essential for Office Heads in identifying items to be purchased for a particular quarter. With the use of ISO/IEC 25010:2011 Software Quality Standards, the system was evaluated by IT Experts with a mean 4.67, qualitatively described as "very graet extent".

Keywords: Classification Techniques, Clustering Techniques, Data Mining, Inventory Management,

I. INTRODUCTION

Traditionally, people use logbooks and pens to input and do the inventory of certain supplies or things in which it consumes all of the employee's time. This inventory also must be balanced with the in and out of the stocks of the supplies. Tracking the inventory and monitoring of the supplies and equipment have been made easy in just a little time and with just one click from the computer. With these different types of system, efficiency and effectiveness of one department is always at its benefits.

Mignonette B. Tungcul*, Instructor, Scholar of Commission on Higher Education, Department College of Hospitality Management, Cagayan State University, Tuguegarao City, Philippines

Marifel Grace Capili-Kummer, Dean, School of Information Technology & Engineering, Doctor in Information Technology Program Coordinator, St. Paul University Philippines

These systems can make the office more organized; the systems likewise give the full details of the different supplies and equipment in an instant; this can create an easy access on tracking down the quantity of the available items.

Inventory management system have been used in Tracking the inventory and monitoring of the supplies and equipment. An inventory management model or system serves many purposes when introduced in an organization by making the work easier and simplified. It makes sure that there is uninterrupted production in the business by ensuring timely and enough supply of the raw materials and gives proper record of all the loss or the consumption of the stock is maintained at all the times which helps in turn to replenish the stock as and when required [1]. Furthermore, it helps in minimizing the capital investment, which gets stuck up due to maintaining the excessive stocks. It makes sure that there is uninterrupted production in the business by ensuring timely and enough supply of the raw materials and gives proper record of all the loss or the consumption of the stock is maintained at all times which helps in turn to replenish the stock as and when required [2]. The goal of inventory management systems is to know where your inventory is at any given time and how much of it you have in order to manage inventory levels correctly [3].

The scope of inventory management concerns the fine lines between replenishment lead time, carrying costs of inventory, asset management, forecasting, inventory valuation, inventory visibility, future inventory price forecasting, physical inventory, available physical space for inventory, quality management, replenishment, returns and defective goods and demand forecasting. Balancing these competing requirements leads to optimal inventory levels, which is an on-going process as the business needs shift and react to the wider environment [4].

Timely identification of newly emerging trends is needed in business process. Data mining techniques are best suited for the classification, useful patterns extractions and predictions which are very important for business support and decision making. Patters from inventory data indicate market trends and can be used in forecasting which has great potential for decision making, strategic planning [5].

Data mining techniques are set of algorithms intended to find the hidden knowledge from the data. Usage of data mining techniques will purely depend on the problem we were going to solve.

Some of the popular data mining techniques are classification algorithms, prediction analysis algorithms, clustering techniques [6]. *It* assigns categories to a collection of data to aid in more accurate predictions and analysis [7].

II. AIM OF THE PAPER

A. Statement of the Problem

Specifically, it seeks to answer the following questions:

1. What are the difficulties and challenges encountered by the participants in the inventory management, monitoring and tracking of equipment and report generations?
2. What data mining techniques can be used to produce decision support reports?
3. What system can be developed to address the difficulties and challenges of the participants in the inventory management, monitoring and tracking of supplies and equipment and report generations?
4. What is the assessment of the participants in the developed Supplies and Equipment Inventory, Monitoring and Tracking System, using the ISO 25010:2011 software Quality Assurance Standards in terms of:
   - 4.1 Functional Suitability
   - 4.2 Performance Efficiency
   - 4.3 Compatibility
   - 4.4 Usability
   - 4.5 Reliability
   - 4.6 Security
   - 4.7 Maintainability
   - 4.8 Portability
5. What enhancements to be done to improve the developed system?
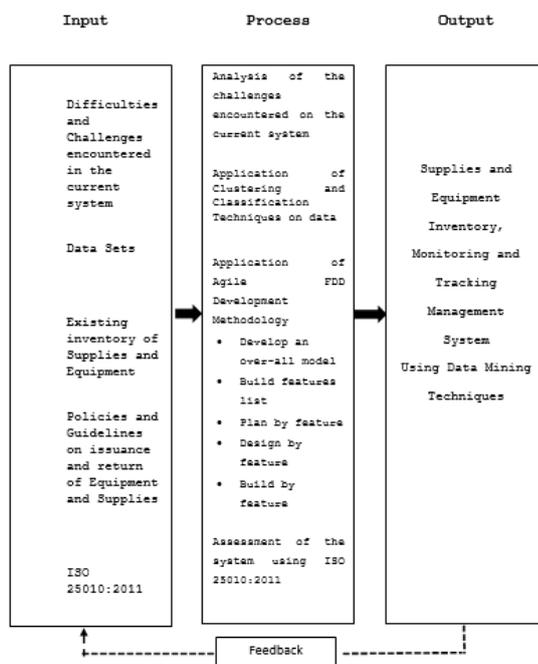
III. PARADIGM OF THE STUDY

Figure 1. IPO model

Figure 1 illustrates the IPO model used as basis in the development of the proposed system. The input include

those that are necessary in the development of system. These are the difficulty and challenges encountered in the current system, Data Sets, Policies and Guidelines on issuance and return of Equipment and Supplies and ISO 25010:2011. Data Sets are the Existing Inventory of Supplies and Equipment, Product Number and Employee Number.

Process involves Analysis on the challenges encountered on the current system which is gathered through interview and investigation, application of data mining techniques such as Clustering, Classification and Forecasting, Also, process involves the application of Feature driven development(with testing and Evaluation using ISO 25010:2011).

Expected output is Supplies and Equipment Inventory, Monitoring and Tracking Management System using Data Mining Techniques.

IV. METHODOLOGIES

A. Research Design

The study utilized descriptive and developmental methodology. Descriptive method was used by the researcher to gather information regarding the status of present system, the difficulties and challenges encountered by the participants with the existing system particularly in inventory, monitoring and tracking management of supplies and equipment of Cagayan State University. The study also adopted Agile Methodology particularly the Feature-driven Development for the development of the system. FDD shows that teams can spend a short amount of time at the beginning of the project to establish a clear understanding of the domain in which they are working and use that understanding to formulate a rough plan without getting stuck in analysis and design paralysis [8].

B. Research Methods

In the conduct of the study, the researcher looked into the ethical considerations for research, especially on the part of the participants. The researcher initially sought the approval of the University President of Cagayan State University through the Vice President for Administration and Finance, since the Supply Office is under its office, for the conduct of the study. Upon approval, the researcher presented the letter to the Supply Officer and discussed the participation of their office in the study.

Before data gathering, the participation of the participants was assured to be voluntary and that the information and data taken from them would be treated with utmost confidentiality as shown in the Informed Consent Form.

After which, the researcher conducted interview on the processes in inventory, monitoring and tracking of supplies and equipment. Essential information regarding the existing system used and the reports generated by the office were gathered. Moreover, difficulties and challenges encountered with the current system were solicited during the interview. The gathered data were essential for the planning and development of the system.

The system was developed by batch or by module. In compliance with the Agile FDD system's development method, once a module was completed, the researcher consulted the University Supply Officer who acts as System Administrator for approval. Suggestions and recommendations were incorporated. The researcher did series of visit with the participants during the development period to make sure that all the requirements and any additional features were met.

After the development of the system, questionnaire for evaluation was given to the IT Experts to test compliance of the system on its compliance to the international software standard which is the ISO 25010.

C. Data Analysis

The responses of the participants during the interview were consolidated and analyzed using qualitative approach called thematic technique. The identified difficulties and challenges encountered with the use of the current system were the basis for the development of the SEIMTMS.

The data collected by the researcher as a result of the questionnaire went through tabulation, analysis, and interpretation. Weighted Mean was used to assess the compliance of the developed system to ISO 25010:2011, which is the international software quality standards.

V. RESULTS AND DISCUSSION

Based on conducted interviews, observations and responses of IT experts to the ISO/IEC 25010 questionnaire the following results were generated:

A. Difficulties and Challenges Encountered By the Participants in the Inventory Management, Monitoring and Tracking of Equipment and Report Generations.

Having gone through series of interview with the participants particularly the Supply Officers and Property Custodians, the Head of Office, the following are the difficulties and challenges that were encountered in inventory management, monitoring, tracking, request for maintenance and report generation.

A. Manual Record keeping
B. Difficulty on searching and retrieving of data.
C. Difficulty in monitoring and tracking of equipment
D. Difficulty in tracking insufficient deliveries.
E. Difficulty in monitoring and tracking of equipment from Issuance to Disposal.
  ▪ Challenging request for maintenance
  ▪ Time consuming generation and submission of reports.
  ▪ Unsynchronized data generated by the Supply Office and the Accounting office in terms of Property Number and Classification of Equipment.

B. Data Mining Techniques Used To Produce Decision Support Reports.

Classification technique is a data analysis task [9]. It is one of the methods in data mining for categorizing and determining classes of given objects based on their characteristics, where semantic classes are known beforehand [10]. Also, classification increases the efficiency and ease of use of inventory management [11].

In this study, classification technique was used to classify items in a Purchase Order into Supplies and Equipment. Also, classification technique was used for producing Decision Support Reports such as:

Purchase of equipment - items were categorized based on fund cluster and account code

Report on Physical Count of Property, Plant and Equipment (for PPE)- equipment could be grouped according to Campus, End-User and College/office

Another data mining technique applied in this study is the Clustering technique. Clustering method helps in grouping valuable data into clusters and from that, picks appropriate results based on different techniques [12]. Furthermore, clustering technique is used to extract the useful information from raw [13]. It groups data instances into subsets in such a manner that similar instances are grouped together, while different instances belong to different groups. The instances are thereby organized into an efficient representation that characterizes the population being sampled. Thus, the output of cluster analysis is the number of groups or clusters that form the structure of partitions of the data set [14].

Using the clustering technique, the researcher was able to generate the following reports:
- Disposed Equipment
- Functioning Equipment with 0 Lifespan
- Disposed Equipment with Remaining Lifespan
- Top 10 equipment in terms of amount

The researcher was able to group equipment records, using the clustering technique, the disposed, the functioning but with 0 lifespan and Disposed with remaining lifespan. Analysis and new information extracted from these reports can support the office head in decision-making in terms of purchasing.

Data mining techniques are best suited for the classification, useful patterns extraction and predications which are very important for business support and decision making. Patterns from inventory data indicate market trends and can be used in forecasting which has great potential for decision making, strategic planning [15]. Clustering and Most frequent Pattern (MFP) algorithm can generate more useful pattern from large stock data which is helpful to get item information for inventory [16].

MFP Algorithm: Let we have set X of N items in a Dataset having set Y of attributes. This algorithm counts maximum of each attribute values y_{ij} for each item in the dataset.

SEIMTMS facilitates sending of notification as a reminder to all office heads to submit purchase request for a particular quarter. Along with the notification is a forecast of frequently purchased equipment which could help the latter to decide on which items to order. Clustering Technique together with Most Frequent Algorithm (MFP) extracts the frequently purchased supplies according to the chosen from-to dates. Frequently Repaired equipment are also extracted using these techniques.

C. Supplies And Equipment Inventory, Monitoring and Tracking Management System Using Data Mining Techniques

This developed system is a decision support system that facilitates the submission of Purchase Order, Acceptance and issuance of delivered Supplies and Equipment. Furthermore, it is used for inventory, monitoring and tracking of purchased Supplies and equipment. It uses classification and clustering technique to produce decision support reports that assists the office heads and administration for purchasing and allocating budget.

D. Assessment of the Participants In The Developed Supplies And Equipment Inventory, Monitoring And Tracking System, Using The Iso/Iec 25010 Software Quality Standards

ISO/IEC 25010 Standards	Mean	Qualitative description
1. Functional Suitability	4.87	Very Great Extent
2. Performance Efficiency	4.53	Very Great Extent
3. Compatibility	4.8	Very Great Extent
4. Usability	4.65	Very Great Extent
5. Reliability	4.5	Very Great Extent
6. Security	4.8	Very Great Extent
7. Maintainability	4.64	Very Great Extent
8. Portability	4.57	Very Great Extent
Overall Mean	4.67	Very Great Extent

Table 1. ISO/IEC 25010 Evaluation

Table shows the extent of compliance of the developed system to ISO/IEC 25010 software quality standards as evaluated by IT expert participants in terms of categories Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability and Portability. It reveals that the system is rated highest in terms of its compliance to Functional Suitability and lowest in terms of Reliability. However, all means for all standards are qualitatively described as compliant to a very great extent. The Overall mean of the assessment of the developed system in all categories is 4.67 which is qualitatively described as "Very great extent'.

The key to the improvement process was the use of the ISO/IEC 25010 Standard for Systems and Software Quality Requirements and Evaluation to categorize all issues found. This approach proved beneficial in two important ways: first, it created a clear understanding of the overall ETL processes quality problems; second, it made obvious which issues deserved uttermost attention [17].

E. Enhancement to Be Done To Improve the Developed System.

To enhance the developed system, the researcher recommends the development of a module that will link and extract data from the system used by the Budget Office and Accounting Office, the National Government Accounting System (NGAS). Development of a module that will link and extract data from the future system of Bids and Award Committee(BAC) office will be necessary.

Also, the use of barcode reader in identifying equipment is recommended.

VI. CONCLUSION

Introduction of web-based SEIMTMS to Supply Office of Cagayan State University is of big help to revolutionize the way processes are executed in the office. It solves the difficulties experienced by the staff in performing inventory management, monitoring and tracking of equipment and supplies from purchasing to inspection and from acceptance and issuance to disposal. Using data mining techniques, specifically the classification and clustering, the system solves challenges on generation reports. Also it was generate decision support reports that aids the Supply Officer and University Administration in decision making, planning and budget allocation. Moreover, the system forecast the frequently purchased supplies and frequently repaired equipment which helps the Office Head in purchasing. Using of decision support reports that help administration in planning and decision-making. With the use of ISO/IEC 25010:2011 Software Quality Standards, the system is compliant with a "Very Great Extent" rating in all criteria. Furthermore, the development of a module that extracts data from the system used in the Accounting office and Bids and Awards Committee Office and also the use of bar code reader in identifying equipment are recommended.

REFERENCES

1. Reddy, C. (2016). Inventory Management: Features, Objectives, Pros and Cons - WiseStep.
2. Walts, A. (2020). Inventory Management 101: Helpful Techniques + Methods (2020).
3. Rouse, M. (2020). What is Big Data and Why is it Important?.
4. Singha, D., & Verma, A. (2017). Inventory Management in Supply Chain. Retrieved 23 October 2020, from https://isiarticles.com/bundles/Article/pre/pdf/83432.pdf
5. Ware, V.S. (2014). Decision Support System for Inventory Management using Data Mining Techniques.
6. Polamuri, S. (2014). Introduction to data mining techniques.
7. Chapple, M. (2020). How Classification Helps Make Big Data Understandable.
8. Gajjar, N. (2018). Feature Driven Development (FDD).
9. Gangwar, A. (2019). Basic Concept of Classification (Data Mining) - GeeksforGeeks.
10. Oluwaseun, Adelaja & Chaubey, Mani. (2019). DATA MINING CLASSIFICATION TECHNIQUES ON THE ANALYSIS OF STUDENT'S PERFORMANCE. 7. 17. 10.11216/gsj.2019.04.19671.
11. Aktepe, S. Ersoz, A.K. Turker, N. Barisci, & A. Dalgic. (2018). AN INVENTORY CLASSIFICATION APPROACH COMBINING EXPERT SYSTEMS, CLUSTERING, AND FUZZY LOGIC WITH THE ABC METHOD, AND AN APPLICATION. SAJIE Vol 29(1), pp 49-62
12. Pedamkar, P. (2020). Clustering Methods | Importance and Techniques of Clustering Methods.
13. Saroj et al, 2015, / (IJCSIT) International Journal of Computer Science and Information Technologies
14. Popat, S. et al, 2014 / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (1) , 805-812
15. Thinaharan, N., & Chitradevi, B. (2015). Role of Decision Making in Data Mining Systems.
16. Ware V., Bharathi H. N, 2014. *Decision Support System for Inventory Management using Data Mining Techniques*.
17. Alves, T., Dias, M., & Silva, P. (2014). Applying ISO/IEC 25010 Standard to prioritize and solve quality issues of automatic ETL processes.

AUTHORS' PROFILE

Prof. Mignonette B. Tungcul, obtained her Bachelor of Science in Computer at St. Paul University Philippines. She Pursued and finished her Masters in Information Technology at Cagayan State University. She is currently taking her Doctor in Information technology at St. Paul University Philippines, Tuguegarao City. At present, she is Instructor III at Cagayan State University teaching Information Technology subjects. Prof. Tungcul is an active member Philippine Society of IT Educators Foundation, Inc. (PSITE).

Dr. Marifel Grace Capili-Kummer, took her Bachelor of Science in Computer and Information Technology at Saint Paul University, Tuguegarao and later took her Masters in Information Technology at University of La Salette, Santiago City, Isabela. She obtained her Doctor in Information Technology at St. Paul University Philippines. She is the current Dean of the School of Information Technology & Engineering and the Doctor in Information Technology Program Coordinator at St. Paul University Philippines, Tuguegarao. She was a Lecturer of Computer Science in Jubail University College, Kingdom of Saudi Arabia. Dr. Kummer has organized seminars, attended speaking engagements and presented relative to her profession.

85