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Polytechnic University of the Philippines Electronics and Communications Engineering Automated Laboratory (Autolab) System for Transaction and Equipment Monitoring

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Abstract: ***The aim of the study is to implement bar coding system as mechanism for the PUP ECE Laboratory Transaction recording and monitoring. The study was concerned on proper documenting and managing the daily transaction of the ECE Laboratory particularly to automate the existing manual mechanism procedure with the proposed AutoLab System. Results showed that the AutoLab System effectively automated the recording of transactions merging the existing manual method into one recording mechanism. Manual transaction recording cannot provide a 100% effectivity since there were percentages of 9.39% of the 2300 ECE Room Utilization Log Book transactions, 41.38% of the 742 Borrower's Slip transactions and 45.94% of the 603 ECE Transactions Log Book entries that were analyzed. A 100% complete data being filled-out on the ECE Borrower's Slip and the ECE Transactions Log Book permits a more comprehensive study of equipment inventory monitoring which gives detailed room utilization for the ECE Room Utilization Log Book. The Automated Laboratory coined as AutoLab merged the ECE Room Utilization Log Book, ECE Borrower's Slip and the ECE Transaction Log Book into one complete package in terms of transaction recording and equipment inventory monitoring incorporating four databases– the class list, the room utilization, the class schedule and the equipments. As PUP Student Identification Cards have bar codes that embed the student number, the system utilized the information to extract details regarding the identity of the student necessary for transaction and equipment inventory monitoring. Two hundred sixty seven (267) ECE students from the 1142 ECE student population and 19 ECE Faculty Members served as respondents for the study. The respondents assessed the system in three areas – the Graphical User Interface (GUI), the Accuracy of Information Displayed and the Transaction Recording. Respondents rated the GUI in terms of design, user friendliness, minimal amount of time to perform its function and reliability. Overall rating of the system in terms of design was 4.22 (Effective); user friendliness was 4.50 (Effective); minimal amount of time to perform function was 4.51 (Highly Effective) and reliability to be 4.50(Effective). In terms of the Accuracy of Information Displayed, the overall assessment for accuracy of reading of student Identification card was 4.72 (Highly Effective), accuracy of information being displayed was 4.71 (Highly Effective), accuracy of reading for room key to be 4.74 (Highly Effective) and equipment with 4.75 (Highly Effective). Overall rating of the system in terms of recording of borrower's information as 4.72 (Highly Effective), recording of key 4.71(Highly Effective), recording of equipment 4.68(Highly Effective) and updating of record to be 4.70 (Highly Effective). The result from the faculty and student respondents were subjected to T-test analysis to determine whether there is a significant difference between their assessments. Result have shown that there was no significant difference between student and faculty assessment.***

Keywords: laboratory management, automation, equipment inventory monitoring, bar coding

1. Introduction

Engineering is a vital field for economic and technological modernization in a country nowadays. It encompasses the application of scientific and practical knowledge to invent, design, build, maintain and improve structures, systems and processes scattered through the different area of specializations where the Electronics and Communications belong.

In the Philippines, Electronics and Communications is duly empowered through RA 9292 mandate– The Electronics Engineering Law of 2004. The practices of such profession embrace *and consist of any work or activity relating to the application of engineering sciences and/or principles to the investigation, analysis, synthesis, planning, design, specification, research and development … of equipment, systems, networks, operations and processes in the fields of electronics, including communications and/or telecommunications, information and communications technology (ICT), computers and their networking and hardware/firmware/software development and applications* (Section 5, paragraph a).

With vast fields for Electronics Engineering, the ECE *practice relates to the development and application of the electronics engineering science and technology in the field of consultation, design, construction and installation, inspection, appraisal and acceptance, operations, maintenance, research and development, education and manufacturing* (Manual of Professional Practice for Electronics Engineers Section II paragraph 1.1); hence automation through software development in a certain operation form part for the scope and practice.

2. Background of the Study

The Polytechnic University of the Philippines College of Engineering is one of the flagship courses of the country's first Polytechnic University. It is continuously producing numerous number of top performing graduates in various licensure examinations and maintained globally competitive graduates in various industries. Hence, the university

officials, the faculty and staff and all benefactors continuously plan and implement programs beneficial towards quality education. Dr. Emanuel C. De Guzman, the current university president, envisions the university to be an epistemic community. He laid down 8 strategic point agenda as which include Strategic Agenda 4 - *Modernizing and Upgrading of Physical Facilities, Equipment, Library and Campus Development.*

Parallel to the implementation of programs to attain the aforementioned objectives, the Electronics and Communications Engineering (ECE) Department through its Laboratory Office made its counterpart in terms of its aim to automate the daily transaction recording and equipment inventory monitoring aligned with the PUP Strategic Objective 4.

The Level 3 Phase 1 Accreditation visit for the Bachelor of Science in Electronics and Communications Engineering Program conducted by the Accrediting Agency of Chartered Colleges and Universities of the Philippines (AACCUP) conducted on November, 2008 presented and recommended for Area IX (Laboratory) that *laboratory operations and management may be enhanced by putting in place a well-monitored supervisory program of the laboratory technician/head/aids* and to *conduct periodic inventory of equipment and instruments and systematic recording of supplies and materials*.

In compliance to the above recommendations, the ECE Laboratory implemented Policies and Guidelines for the operation of the laboratory which includes the recording of transactions through a log book system for room keys under the ECE Laboratory jurisdiction and the borrower's slip for equipments. These had been compiled for analysis and archiving of transaction.

At present, the ECE Laboratory manages its operation with guidelines duly approved and effective since June 2, 2014. The guidelines stated that any class officer is allowed to secure the key for the rooms under the ECE Laboratory jurisdiction within 15 minutes before their class schedule. The student must log in the time the key is borrowed and returned after their utilization. In terms of equipment usage, equipments were borrowed from the ECE Laboratory with a duly filled-up borrower's slips attached to the borrower's ID. In cases that the student intends to do make-up laboratory experiments, the ECE Transaction Log Book would be used to record the transaction.

With the above foregoing guidelines, monitoring is an important aspect to proper laboratory operation management and supervision. As AACCUP recommends well documented transactions and inventory monitoring the daily transaction recording and the equipment inventory monitoring seen viability towards automation and modernization; hence, this study has been conducted.

3. Statement of the Problem

The study focused on the development of AutoLab system that would automate log recording and generate inventory monitoring report. Specifically, it sought to answer the following questions:

1. What is the existing system being used by the ECE Laboratory :
   1.1. transaction recording; and,
   1.2. equipment inventory reports?
2. What are the drawbacks of the existing system being used by the ECE Laboratory:
   2.1. transaction recording; and,
   2.2. equipment inventory reports?
3. What system could be proposed to the ECE Laboratory for the automated:
   3.1. transaction recording; and,
   3.2. equipment inventory reports?
4. How effective is the proposed system of the ECE Laboratory for the automated:
   4.1. transaction recording; and,
   4.2. equipment inventory reports?
5. What is the level of effectiveness of the proposed system of the ECE Laboratory as assessed by the student and faculty users in terms of :
   5.1. Graphical user interface design;
   5.2. Accuracy of User Information Displayed; and,
   5.3. Transaction Recording?

4. Significance of the Study

This study would lessen the use of papers as the logging system and transaction recording could be through the implementation of the bar coding system.

For the ECE Laboratory Office, the development of the system would upgrade the logging and borrowing procedures and served as a method of responding to the strategic objective # 4 of Dr. Emanuel C. De Guzman that is, *Modernizing and Upgrading of Physical Facilities, Equipment, Library and Campus Development*.

There would also be a systematic equipment inventory monitoring. A day to day inventory report could be generated or depending on the option of the laboratory to print a weekly, monthly or annual report of equipment record of transaction pertaining to *who have borrowed the equipment, what subject had been used, how often have been used* and *when it was borrowed*. Moreover, this would also include the compliance to AACCUP requirement that all equipments are coded, listed and inventoried in a periodic manner.

CMO # 24 s. 2008 (Policies and Standards for the Degree of Bachelor of Science in Electronics Engineering) laboratory requirements could be revisited to compare the generated summative report of the equipments commonly utilized for each course subject offering and will be compared to the CHED requirements. The result could give an assessment of what equipment is commonly being used and needed, to purchase additional units or to know what equipment would be lacking.

5. Methodology

The method of research used was a Quasi-Experimental method as it utilized both experimental and descriptive method. Experimental because the system will be subjected to series of experiments to test its accuracy, efficiency, effectiveness and reliability.

The researcher used experimentations to test the proposed system automation through the actual test implementations. Two main experiments have been conducted - the test for accuracy of the system in transaction recording and the equipment inventory monitoring. Test for accuracy was divided into four parts namely (1) Borrowing of Key; (2) Borrowing of Equipments; (3) Returning of Keys; and, (4) Returning of Equipments. On the other hand, the equipment inventory monitoring incorporates the analysis of the equipment utilization in terms of what equipments were usually borrowed, in what subjects a certain equipment was being used and the history of usage for a given equipment.

Aside from the experimentation, intense analysis was used to the existing system being used by the ECE Laboratory through the ECE Room Utilization Log Book, ECE Transactions Log Book and the ECE Borrower's Slip was made. The objective for the analysis was to determine the extent of effectiveness with regards to usage of the mentioned transaction recordings. This included the review and analysis of the entry logs of room utilizations and laboratory equipment transactions from June 9, 2014 to October 11, 2014 with regards to the degree of completeness and incompleteness of data being filled-up.

Having found that the experiments and questionnaires to be valid, the researcher had test the AutoLab system from November 3, 2014 where PUP classes for Second Semester Academic Year 2014- 2015 started until January 14, 2015.

Survey questionnaires were also used to gather information regarding the assessment of the ECE community particularly the ECE students and ECE Faculty members who made transactions to the ECE Laboratory Office.

There were two hundred sixty seven (267) total respondents from the one thousand one hundred forty two (1142) ECE students who had evaluated the system. The minimum requirement from Calmorin (2012) sampling formula was approximately two hundred twenty five (225). Table 4 presents the distribution of respondents per year level. On the faculty respondent counterpart, there were nineteen (19) ECE faculty members who have evaluated the system on November 17, 2014 to January 14, 2015.

6. Results

6.1 Existing System Used by the ECE Laboratory

The existing ECE Laboratory Guidelines and Policies duly approved and effective since June 2, 2014 set the transaction flow for borrowing and returning of key or equipment to the ECE Laboratory Office as shown in Figures 1 to 4.

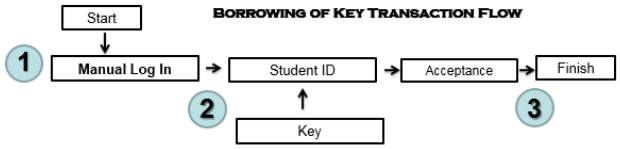

Figure 1: Manual Transaction Flow for Borrowing Room Key

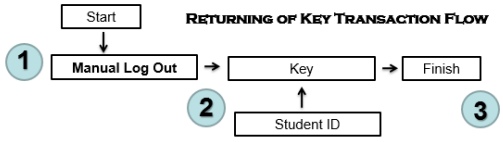

Figure 2: Manual Transaction Flow for Returning Room Key

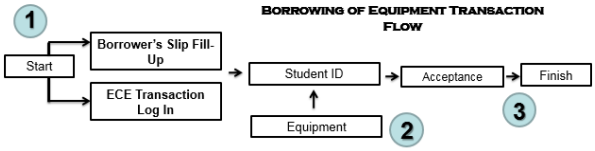

Figure 3: Manual Transaction Flow for Borrowing Equipments

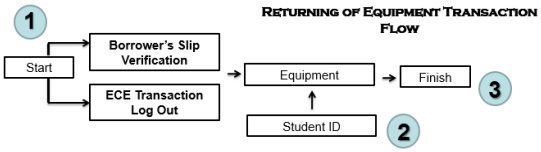

Figure 4: Manual Transaction Flow for Returning of Equipments

6.2 Drawbacks of the existing system used by the ECE Laboratory

Examining the Room Utilization Log Book, ECE Transaction Log Book and the Borrower's Slip, the researcher had found out ineffectiveness of the manual transaction recording as brought out of incomplete data supplemented in the said mechanism of transaction recordings as shown in Figures 5 to 7.

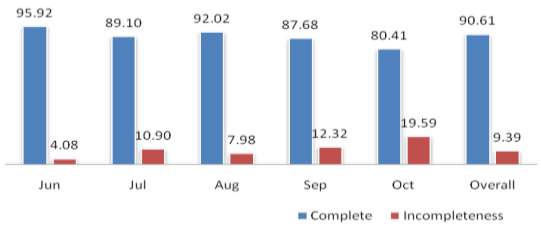

Figure 5: Assessment of Percentage Completeness of Data Record for Key Transaction Based on Room Utilization Log Book

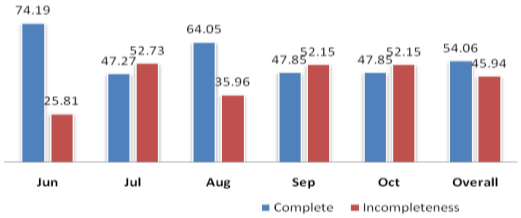

Figure 6: Assessment of Percentage Completeness of Data Record for Equipment Transaction Based on ECE Transaction Log Book

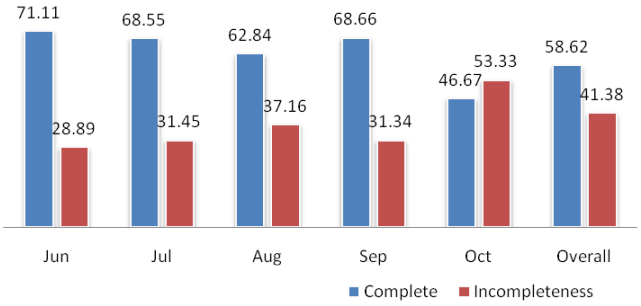

Figure 7. Assessment of Percentage Completeness of the ECE Borrower's Slip

6.3 Proposed AutoLab System for ECE Laboratory

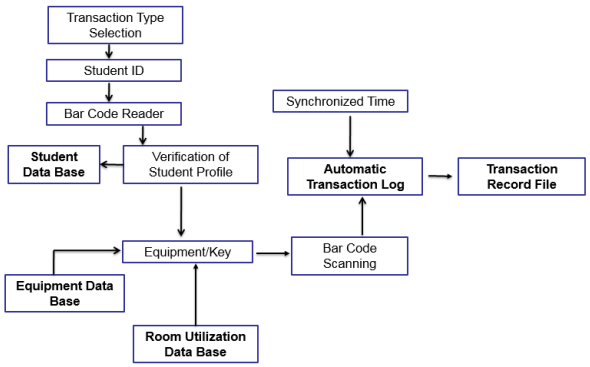

Figure 8: Proposed AutoLab System Transaction Flow

Figure 8 illustrates the process on how the system would work all throughout. The Bar Code in a PUP student identification card is scanned and read through a bar code reader. It sends the scanned code for verification wherein it would automatically presents the student number, student name, year and section. With automatic time updating, the time that the room key bar code is scanned, automatically logs the time borrowed and returned to the transactions recording.

The borrowing of equipment undergoes the same process. The equipment bar code would be scanned and automatically register the equipment borrowed under the name of the borrower. The time of release would be log to the system.
When a key bar code is scanned, the system filters and presents the room utilization schedule. The system is synchronized with the time embedded in the computer unit used - signifying that when transaction is being saved, it automatically log in the time of a key being borrowed and automatically log out when returned.

6.4 Effectiveness of Proposed AutoLab System for ECE Laboratory

From the experimentation done using AutoLab in Borrowing of Keys, record was seen to be complete and accurate in terms of time log during the borrowing process for key while the system records the borrowing of equipment one at a time in a certain user. From the result, the record was seen to be complete and accurate in terms of time log entries.

In the experimentation made in returning keys and equipments, record was seen to be complete and accurate in terms of time log during the returning process. The record was seen to be complete and automatically log the time the key or an equipment had been returned as shown in Figures 9 and 10.

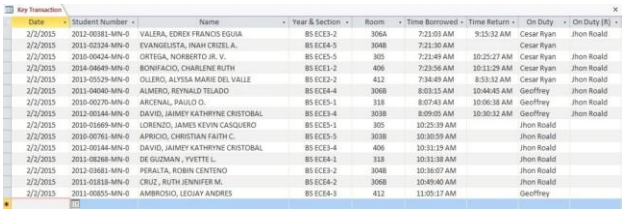

Figure 9: Sample Transaction Recording for the Key Transaction Using the AutoLab System

Figure 10: Sample Transaction Recording for the Equipment Transaction Using the AutoLab System

The breakdown of equipments used by each subject could be generated to address the analysis of equipments needed while the utilization of every equipment can be generated, thus providing necessary information of who borrowed, when it was borrowed and returned and the subject where it was used. This report is necessary for the ECE Laboratory in tracing out who will be liable when the equipment is damaged.

6.5 Level of Effectiveness of the Proposed AutoLab System as Assessed by Students and Faculty

ECE Students and Faculty members had had assessed the AutoLab System in three areas: (1) The Graphical User Interface (2) Accuracy of Information Displayed, and (3) Transaction Recording. The analysis of the data gathered from the survey was through the use of mean score from the total student group and the faculty group respondent as shown in Tables 1 to 3.

Table 1: Respondents Evaluation for Graphical User Interface

Areas of Evaluation	Students	Faculty	Overall	Verbal Interpretation
The GUI provides a good design or format in terms of images and colors	4.07	4.37	4.22	Effective
The GUI provides a user friendly design	4.32	4.68	4.50	Effective
The GUI performs its function in minimal amount of time	4.28	4.74	4.51	Highly Effective
The GUI is reliable	4.37	4.63	4.50	Effective

Table 2: Respondents Evaluation for Accuracy of Information Displayed

Areas of Evaluation	Students	Faculty	Overall	Verbal Interpretation
The System accurately reads student Identification Card	4.64	4.79	4.71	Highly Effective
The System displays accurate information of the user	4.63	4.79	4.71	Highly Effective
The System reads accurately				
a. the room key being borrowed	4.63	4.84	4.74	Highly Effective
b. the equipment being borrowed	4.65	4.84	4.75	Highly Effective

Table 3: Respondents Evaluation for Transaction Recording

Areas of Evaluation	Students	Faculty	Overall	Verbal Interpretation
The System correctly records borrower's information	4.65	4.79	4.72	Highly Effective
The System correctly records the				
a. the room key being borrowed	4.67	4.74	4.71	Highly Effective
b. the equipment being borrowed	4.67	4.68	4.68	Highly Effective
The system updates record of equipment being borrowed	4.61	4.79	4.70	Highly Effective

7. Conclusions

From the given results, this study conclude that:

4. 1. The existing manual transaction recording and equipment inventory monitoring system is being practiced at the ECE Laboratory Office;
4. 2. There is a percentage of ineffectiveness of the current system that results to incomplete filing of transaction record while equipment inventory report does not assure a good monitoring of equipment for the ECE Laboratory in terms of analysis of equipment utilization;
4. 3. AutoLab system as a mechanism for automated transaction recording and equipment inventory monitoring is being proposed for the ECE Laboratory Office;
4. 4. AutoLab system shows high potential and effective method for transaction recording and equipment inventory monitoring as it has seen to be a 100% efficient and could provide a convenient way of analysis for equipment utilization and room transactions as well; and,
4. 5. Users duly transacting for the ECE Laboratory had assessed the system to be acceptable and effective evident by the overall rating from the evaluation survey conducted.

8. Recommendations

For further improvement of the study, the following are hereby recommended:

5. 1. Enhancement of the Graphical User Interface; such as adding a profile picture of the borrower for security purposes in terms of room keys and equipments;
5. 2. Access code for faculty members may be integrated in order to record the permission of the faculty, for the student users to use equipment or room key; and,
5. 3. Further studies regarding the total efficiency of the new system may be conducted.

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