

A Case Study of the Development of PM Software Management System for Biomedical Equipment Used in Srisawan Hospital

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Abstract

The objective of this study is to develop a software-based medical equipment system supporting the hospital officers and biomedical engineers in country hospitals. This system was developed to facilitate the creation of Preventative maintenance and Calibration. Country hospitals don't have Preventative maintenance (PM) and Calibration (CAL) standard. Therefore, many times they have so many troubles with biomedical instruments. In traditional preventative maintenance and calibration data biomedical engineers use paper to record the data for analyzing the instruments. Biomedical equipment in medical has many different forms. It is difficult for biomedical engineers to design and choose the suitable form to use. In this software we create the system to choose and design automatically preventative maintenance and calibration forms. Biomedical engineers add data to this system. Doctors or hospital officers in the hospital can see their preventative maintenance and calibration data in this system. Moreover, they can make report about this software so as to meet Joint Commission International (JCI) international standard and Hospital Accreditation (HA) national standard. We can investigate the efficiency of this software from key performance indicator in standard.

Keywords: preventative maintenance, calibration, software, HA, JCI

บทคัดย่อ

งานวิจัยนี้จะเป็นการศึกษาและพัฒนาโปรแกรมระบบการจัดการสำหรับเครื่องมือแพทย์ เพื่อสนับสนุนการทำงานของเจ้าหน้าที่โรงพยาบาล และวิศวกรชีวการแพทย์ในโรงพยาบาลต่างจังหวัดในประเทศไทย ระบบนี้ถูกพัฒนาขึ้นเพื่ออำนวยความสะดวกในการทำงานในส่วนการเก็บข้อมูลบำรุงรักษาเชิงป้องกันและการสอบเทียบ ในโรงพยาบาลต่างจังหวัดบางโรงพยาบาลจะไม่มีมาตรฐานการบำรุงรักษาเชิงป้องกันและการสอบเทียบ ซึ่งทำให้หลายๆ ครั้งที่เจ้าหน้าที่และวิศวกรชีวการแพทย์เจอปัญหาในการจัดการข้อมูลนี้ในเครื่องมือแพทย์ ที่ผ่านมาข้อมูลการบำรุงรักษาเชิงป้องกันและการสอบเทียบวิศวกรชีวการแพทย์ทำการบันทึกข้อมูลลงกระดาษเพื่อทำการวิเคราะห์ข้อมูลเครื่องมือแพทย์ เครื่องมือทางการแพทย์มีหลาย ๆ เครื่องมือด้วยกัน ซึ่งแต่ละเครื่องมือก็จะมีแบบฟอร์มในการบันทึกข้อมูลที่ต่างกัน ทำให้วิศวกรชีวการแพทย์เกิดความยุ่งยากในการสร้างฟอร์มเพื่อบันทึกข้อมูลและเลือกฟอร์มที่ใช้ในการเก็บข้อมูล ดังนั้นทางทีมงานจึงได้มีการพัฒนาโปรแกรมนี้ขึ้นเพื่อสร้างและเลือกแบบฟอร์มในการจัดเก็บข้อมูลการบำรุงรักษาเชิงป้องกันและการสอบเทียบของเครื่องมือแพทย์ ข้อมูลการบำรุงรักษาเชิงป้องกันและการสอบเทียบสามารถนำไปเป็นหลักฐานในการขอมาตรฐาน JCI และ HA ได้อีกด้วย

คำสำคัญ: การบำรุงรักษาเชิงป้องกัน การสอบเทียบ โปรแกรม เครื่องมือแพทย์

1. Introduction

Biomedical equipment is important in hospitals, but some hospitals don't have the system management for biomedical instruments. Therefore, we need to develop the instrument management for this problem. Biomedical engineers maintain, but they are facing problems with data in paper documents. We develop a software system for recording and making a decision PM form in the path of maintenance for biomedical instruments. In part of the medical instrument on this software consists of 2 parts. The first is preventative maintenance (PM), and the 2nd is calibration.

PM has the following meanings: the care and service of personnel for the purpose of maintaining equipment with satisfactory operating condition providing systematic inspection, detection, and correction of incipient failures before either occurring or before developing into major defects. Preventive maintenance tends to follow planned guidelines from time-to-time to prevent equipment and machinery breakdown (Olakotan, 2015). The work is carried out on equipment in order to avoid its breakdown or malfunction. It is a regular and routine action taken on equipment in order to prevent its breakdown (Bamiro et. al., 2011). Maintenance, including tests, measurements, adjustments, parts replacement, and cleaning, is performed specifically to prevent faults from occurring.

The 2nd part is calibration. CAL provides the comparison of measurement values delivered by a device under tests with those of a calibration standard of known accuracy. Such a standard could be another measurement device with known accuracy, a device generating the measurement quantity such as a voltage, or a physical artefact, such as a meter ruler.

In Thailand, they never have the management software providing standard in the path of medical equipment. Normally, they use paper-based or SPSS software to collect data and generate reports used for standard. Moreover, this software can reduce the data error from the users. We developed web-based software using PHP language because this method is very flexible for the users when they want to use.

In this system, biomedical engineering can add the data in form of PM and CAL. This system effectively chooses effectively the automatic form in the system. Hospital officers can see their PM and CAL data in this system. They can use this data to request the JCI standard.

2. Objectives

The objective of this study is to develop a software-based biomedical instrumentation management system supporting the hospital officers and biomedical engineers in Srisawan Hospital. Hospital officers have many problems in term of PM and CAL data management because this has a lot of data, and it is difficult for biomedical engineers to design and choose the suitable form to use. This software system can automate to choose and design the form for biomedical engineers using to record PM and CAL data. This management software collects data and generates standard format report for compiling healthcare standards such as Hospital Accreditation (HA) in Thailand and Joint Commission International (JCI) standard. In HA standard this software is in the ENV path and medical equipment management unit. For JCI standard this software is in the path of Facility Management and Safety (FMS) topic 8-8.1 (medical technology).

3. Materials

A. Emergency Care Research Institute (ECRI)


For preventative maintenance and calibration form, we are using the ECRI standard (ECRI, 2001). For over 40 years, ECRI Institute has been dedicated to bring the discipline of applied scientific research to discover which medical procedures, devices, drugs, and processes are best. They pride themselves on having the unique ability to combine practical experience and uncompromising independence with thoroughness and objectivity of the evidence-based research.

B. Preventative maintenance

PM has many data such as Mount, Fitting, etc. You can see in the Figure 1. example of preventative maintenance form, biomedical engineering can add the data in form of PM and CAL. This system chooses the automatic form in the system. Hospital officers can see their PM and CAL data in this system. They can use this data to request the JCI standard.

C. Calibration

Calibration in measurement technology and metrology is the comparison of measurement values delivered by a device under a test with those of a calibration standard of known accuracy. Such a standard could be another measurement device of known accuracy, a device generating the quantity to be measured such as a voltage, or a physical artefact, such as a meter ruler.



ศูนย์วิจัยพัฒนาและบริการวิศวกรรมชีวการแพทย์
มหาวิทยาลัยสุรินทร์

| STATUS | |
|------------------|--|
| PASSED | |
| SERVICE REQUIRED | |
| REMOVED FROM USE | |

Preventive Maintenance Action Report

Device : Flow meter PM CAL ST

Hospital : _____ Deput : _____ Inspector : _____

Mfr : _____ Model : _____ S/N : _____

ID Code : _____ Date : _____ IPM Time : _____

| TEST APPARATUS | |
|------------------|---------|
| Instrument Type | ID Code |
| Safety Analyzer | |
| Manometer Tester | |

| INSPECTION / PREVENTIVE MAINTENANCE | | |
|-------------------------------------|------|---|
| Pass | Fail | Item |
| | | Chassis/Housing (ตัวถัง) |
| | | Mount/Fasteners (ตัวติดยึด) |
| | | Spring Relief (ความดันของสปริง) |
| | | Fitting/Connector (ข้อต่อต่างๆ) |
| | | Control/Switch (ปุ่มควบคุมและสวิทช์) |
| | | Labeling (ฉลากแจ้งเตือนต่างๆ) |
| | | Circuit Breaker/Fuse (ตัวตัด-ปิดและฟิวส์) |
| | | Accessories (อุปกรณ์เสริม) |

| SAFETY TESTING | | | |
|---------------------------------------|------|------|----------|
| Item | Pass | Fail | Measured |
| Maximum Flow Rate (≥ 20 L/min) | | | L/min |
| Minimum Flow Rate (≥ 1 L/min) | | | L/min |

| NOTE |
|------|
| |
| |
| |

Figure 1 Example of Preventative Maintenance form

ID Code _____

| CALIBRATION & PERFORMANCE | | | | | | | | |
|---------------------------|-----------------|----------|----|----|---------|---------------|------|------|
| Accuracy | Set / Indicator | Measured | | | Average | Acceptability | Pass | Fail |
| | | T1 | T2 | T3 | | | | |
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| ENVIRONMENT | | | |
|---------------|----------|------------|------------|
| Temperature : | _____ °C | Humidity : | _____ % RH |

| Item | Pass | Fail | Notes |
|--------------------|------|------|-------|
| Visual Inspection | | | |
| Functional Test | | | |
| Calibration Result | | | |

Acknowledged By _____ Approved By _____
 (___ / ___ / ___) (___ / ___ / ___)

Figure 2 Example of Calibration form

System Design

This management software is designed and based on web application using PHP language and MySQL database because they are the open source. The advantages in this software are flexible for users because they can use this software when they have the Internet. We use this programming language to analyze data for the result report.

This management software consists of 3 users: an admin, engineer, and hospital officer. According to this system, they must authenticate before using. They can use a computer, laptop and mobile phone to connect it to this software by the Internet as you can see in the Figure 3. The admin's responsibility is to manage the configuration data such as a hospital, device, etc. and to set authentication for the users. The engineer's responsibility is to add, and update the PM and CAL data that they did. The hospital officer's responsibility is to check the PM and CAL data in the system.

This program is web based using responsive web design (RWD) which is an approach to web design aimed at allowing desktop webpages to be viewed in response to the size of the screen or web browser that is viewing with. (Marcotte, 2010; Ben, 2012). A site designed with RWD adapts the layout to the viewing environment by using fluid, proportion-based grids, flexible images and CSS3 media queries. Responsive web design has become more important as the amount of mobile traffic now accounts for more than half of the total Internet traffic.

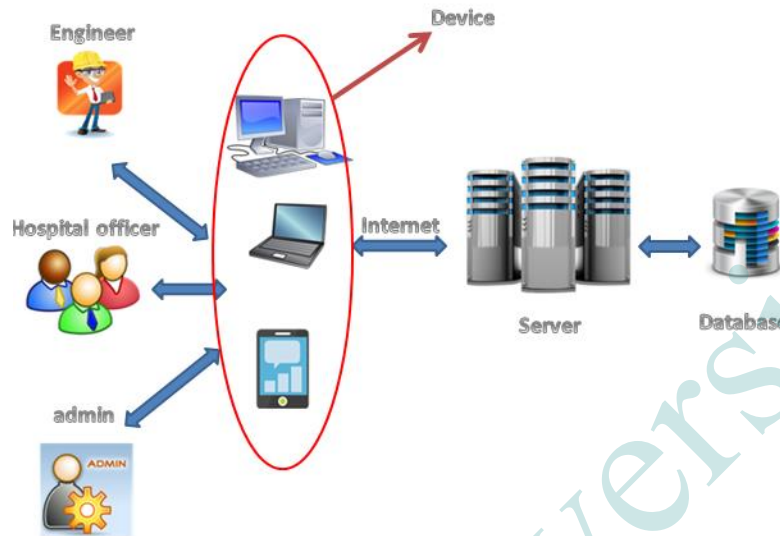


Figure 3 System architecture

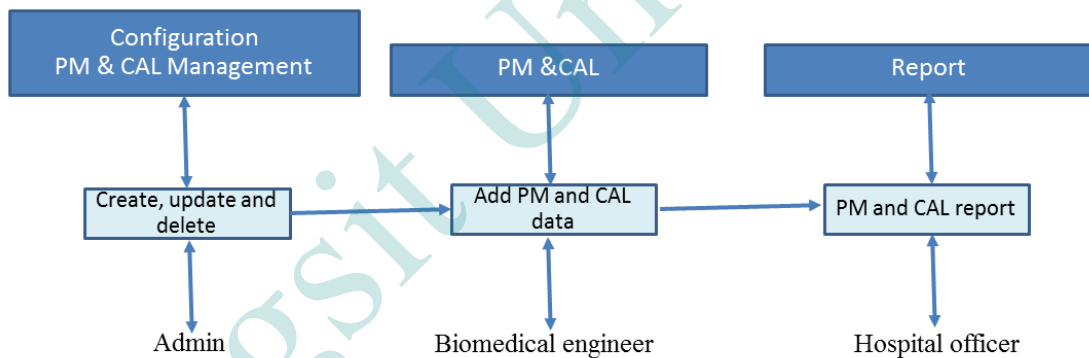


Figure 4 Data flow Diagram

In the Figure 4 shows the data flow diagram. Admin creates configuration and PM&CAL management. When a biomedical engineer maintains equipment and adds PM&CAL data with selected and automated form. The admin, biomedical engineer and hospital officer see PM&CAL report from software created. The hospital officer cannot add PM&CAL data and create configuration because this module requires a specialist in biomedical engineering for doing that.

In the report, the module showed the data report. That design report form uses the JCI standard. The JCI accreditation is considered the golden standard in global health care. JCI consultants are the most skilled and experienced ones in the industry to join the global JCI movement. For this standard, they must know the biomedical instrument management in the hospital. This system provides that. In this software, there are 21 PM forms and 21 CAL forms. The forms are automatic selection when the biomedical engineer adds the types of medical equipment.

Moreover, in the past it was difficult for the hospital officer to analyze PM&CAL data because these data are in the paper, while they were using this system. The instrument data were in the server that was easy to analyze.

4. Result

The user must log in when wanting to use this system. The Figure 5 shows you the log in page. The user must type a username and password. The username and password are created by the admin. When the user logs in correctly, software will show the home page for this user. Menu for each user is different by the types of users.

That the user sees the different page design depends on what device the user uses to open the system. The Figure 6 shows the home page for the admin using a computer or laptop. The Figure 7 shows the home page for the admin using a mobile phone.



Figure 5 Log in page

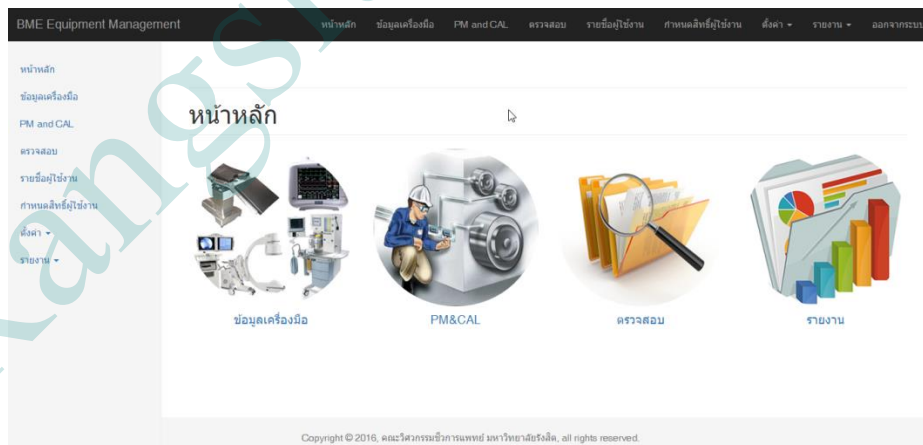


Figure 6 Home page for the admin using a computer or laptop



Figure 7 Home page for the admin using a mobile

This system is compatible, when the user uses different devices. The Figure 6 and 7 show systems in different devices. The resolution of the systems depends on the resolution device which is used. For this software, the hospital officer and biomedical engineer can see the report everywhere when they want to use it if they have the internet connection.

The result for this software evaluation in term of concept design is 4.5 point, work flow is 4.8, auto decision is 4.43, and result report is 4.11. For the future work, we will develop the function used for purchasing medical equipment, planning to purchase, planning to maintain medical equipment. Moreover, we will develop the result report such as the graph report for biomedical engineers.

5. Discussion

As our discussion of our software we had developed is very important and very useful for medical equipment management. In the future our team will develop this software is more user friendly and more modules such as maintained plan, replacement plan. When this software has many data our will know budget and equipment they will use for PM, replacement use for discussion.

6. Conclusion

Currently, the government have talked about Thailand 4.0 many times. Biomedical engineers must move forward with this. We made this worked for that. It is easy for biomedical engineers to provide data for hospital officers. The hospital officers can see their PM&CAL data in this system when they use it. They use PM&CAL data in this system to require the JCI and HA standard. This system is more flexible to collect and generate the standard format report, for they use to meet Joint Commission International (JCI) standard and Hospital Accreditation (HA). Moreover, the users can use it in the computer, laptop and mobile phone. The resolution of system depends on the resolution device which is used. They can use this system software every time whenever they want to use. This software achieves success and is applied to the JCI standard and HA. Srisawan Hospital is passing accreditation for JCI standard in 2016.

7. Acknowledgements

The authors would like to thank the Faculty of Biomedical Engineering, Rangsit University, and Director of Srisawan Hospital. This work was supported by the Faculty of Biomedical Engineering, Rangsit University. We thank Srisawan Hospital, JCI and HA for the information provided regarding the PM&CAL data.

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