A System for Preventive Maintenance: Machine Maintenance Management System

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Abstract—Preventive maintenance is performed while all parts of the machine are still working. Unfortunately, this activity easily creates some management problems in some of the factories in Malaysia. This is because many factories in Malaysia still use a manual system to store all the date services for each part and component in the machine. Thus, in this project, O-I BJC Glass Malaysia is taken as a subject to build a computerized system for one of its departments which is Machine Maintenance (MM) department. Machine Maintenance Management System (MMMS) is a web-based preventive maintenance management system which helps to remind the user about all the service date that user should be aware whenever the service date is just around the corner. Besides that, agile methodology is used in which the project is divided into several sprints for easy and fast delivery for a better outcome. Then, several user interfaces are created to visualise the actual system environment. In conclusion, MMMS gives many benefits to all employees in O-I BJC as it will improve the efficiency and effectiveness regarding the preventive maintenance activity.

Keywords-component; preventive maintenance; computerized system; reminder; service date;

VI. INTRODUCTION

In the manufacturing field, machine is one of the important thing to be taken care in every factory. Machine that operates every day must undergo service maintenance by the employee. However, there are a lot of flaws when the employees in machine maintenance department does not have any proper service maintenance management in order to make every single maintenance activity to be execute successfully.

A major flaw that most factories in Malaysia owned is the use of the manual system in keeping track of the preventive maintenance schedule. Since factory has a lot of machines and every part of it needs to undergo maintenance, schedule of maintenance is crucial. Data of the maintenance schedule are being kept in pile of files which is sorted according to the date of maintenance that shall be performed. Hence, it will lead to the employee is most likely to overlook the data that eventually leads to some part of the machine not getting serviced for maintenance purpose.

In order to overcome this problem, a web-based preventive maintenance system is developed in order to have a more systematic preventive maintenance service management in the factory. Basically, our subject for this project is come from some of the employees in O-I BJC Glass Malaysia. Hence, the workflow for the preventive maintenance process will follow from their Machine Maintenance (MM) department daily activities.

VII. RELATED WORKS

A. Existing System in O-I BJC Glass Malaysia

Based on the interview with the Manager in Machine Maintenance (MM) department who have a lot of experienced in handling this preventive
maintenance issue, there are several issues that need to be overcome in this project. In last few years, they use Microsoft Excel to record all the service dates for each machine in the factory. Each Excel file will have a name that refer to the which machine data that they saved.

Then, in the Excel file, the first sheet will summarize all the preventive maintenance activity for each component for the machine. In order to alert them with the service date, the cell for that component will change to the red colour. However, this kind of solution just lead to the overlooked if the employee forgets to open another Excel file.

B. ManagerPlus

ManagerPlus is a stand-alone software that provides solutions for companies of all types and sizes [1]. According to [1], ManagerPlus, is one of the best maintenance management system as it has been awarded in The Top 20 Most Popular Maintenance Management System. This is because they offer a function of manage assets and facility of the companies. It also provides a scan and print barcodes function which is quite interesting because most of the company’s asset have their own serial number to differentiate it.

Then, ManagerPlus also has a very important feature which is built-in reporting and analytic in it. This software also includes costs for each order and even check off service items as they are completed. Plus, by having a planning calendar feature, user can easily schedule preventive maintenance tasks and carefully monitor them from it.

C. OneSoft Connect

OneSoft Connect is a simple maintenance management system as it is suitable for any type of business [2]. One of the most important features in this system is planning task. This is because it can easily track the task that they need to do on that day and upcoming days.

OneSoft Connect also has report feature called Risk. This feature is also quite important because all the worker that register under OneSoft Connect will see the condition of the current situation in the company. Then, it also has an employee interface. In employee interface, there is an organization chart for the user to know the person in charge of the respective cases or situations.

D. Comparison between Related Works

Each application or software has its own specialty and weakness although they have a similar idea of the maintenance management program. Different features and different hardware usage make them a different individual web application. Table I shows a comparison between all related works discussed above and MMMS project.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Excel</th>
<th>Manager Plus</th>
<th>OneSoft Connect</th>
<th>MMMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning Calendar</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Preventive Maintenance</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Scheduling</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Service History Tracking</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Work Order Management</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Analysis Report</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>User</td>
<td>M</td>
<td>M</td>
<td>MM</td>
<td>MM</td>
</tr>
</tbody>
</table>

The four systems have the similarity where all of them provide features scheduling, service history tracking and work order management. However, the target user for ManagerPlus is slightly different compared to Microsoft Excel, OneSoft Connect, and MMMS. This is because based on all feature provided by ManagerPlus, it can be seen that their target user just not only for MM department. All department can use ManagerPlus as their management system. For Microsoft Excel, OneSoft Connect and MMMS, all the feature is fully created for MM department.

Lastly, as stated in Table I, Microsoft Excel does not have planning calendar, preventive maintenance, and analysis report feature. This can make a somewhat difference compare to ManagerPlus, OneSoft Connect, and MMMS. Analysis report feature is one of the most important features as it can easily analyse how are the performance on that month. Then, preventive maintenance feature and planning calendar feature can help workers better prepared to face all the possible activity in that month.
VIII. METHODOLOGY

Methodology is a system of broad principles or rules, which specify methods or procedures, may be derived to interpret or solve different problem. In other word, methodology is a guideline to ensure the selected problem can be solved. There are several components in methodology such as phases, tasks, methods, techniques and tools [3].

Hence, the methodology that is used to develop Machine Maintenance Management System (MMMS) is Agile methodology. The reason on why this methodology is being chosen is that the Agile encourages rapid and iterative development of products in small releases. As stated in [4], Agile methodology only focuses on improvement during and after product development.

A. Planning

Planning phase need to be done to identify the problem background and case study for MMMS. Then, the need for the platform and importance will be accessed through a short interview with stakeholder in order to survey the relevance to develop MMMS. Finally, the goal and objectives for MMMS will be defined and stated clearly.

B. Iterate

In iterated phase, there are other process which will be divided into the system feature. Every feature has its own development phase which develop incrementally in short time boxes called sprints. The process involve are analyse, design, develop and test. During analyse process, there are two methods used to elicit requirements for MMMS which are interview and existing system analysis. Interview with the one of manager in O-I BJC Glass Malaysia is conducted to know how the current system works and its problem. A study is also conducted on several existing systems in order to search for an excitement factors in MMMS. At the end of the last iteration, there are two diagrams produced during this process which are Swimlane diagram and use case diagram. Figure 1 is designed in order to show the business workflow for the preventive maintenance activity while Figure 2 shows an use case diagram in order to show the functional requirement needed for this MMMS project.

![Swimlane Diagram for Preventive Maintenance Activity](image)

![Use Case Diagram for MMMS](image)
From Figure 1 and Figure 2, we can conclude that there will be five users which are Admin, employee in Floor Manage Unit (FMU) department, employee in Workshop department, employee in MM department and manager from others department. There are also 10 main functions that need to be applied in this MMMS project.

Admin role for this system is to manage all employee’s details who are related to the system. Then, for employee in MM department can manage all created tasks, component’s details and view schedule in Google Calendar. Next, employee in FMU department can manage all machine’s details and update task received from MM department. Lastly, employee in Workshop department can also update task received from MM department.

Next, in design process, software architecture, database design, and user interface of MMMS is designed and documented in design process. To model and design the diagram, Unified Modelling Language (UML) will be used. Hence, at the end of the last iteration, this process produced several diagrams that will be a guidance to the developer to create the database for the system.
Figure 3 shows a three-tier architecture that is used in this MMMS project while Figure 4 shows an entity relationship diagram used for MMMS project. Basically, an entity-relationship diagram (ERD) is designed in order to decide how many table is needed to create the database. As a result, there is six tables needed in order to save the record from the MMMS project.

With the information displayed in the ERD, a database called MissMachine is produced in the SQL Server Database. In order to connect MissMachine database with the MMMS project, a configuration file is produced. This configuration file is basically used to manage various settings that define a website [6].

After that, classes from three-tier architecture is being developed in stages. In three-tier architecture, there are presentation layer, business layer and data access layer. Presentation layer is where human-computer interaction will exist. According to [7], this layer will provide a graphic user interface for represents the system function in order to user to response to the system.

Then, as [7] said, “Business layer is a controller that acts as a bridge between presentation layer and data access layer”. Function of this layer is to validate all user input and any decision making. Then, it also receives information that comes from the presentation layer and passes it to the data access layer. Lastly, the third layer is a data access layer. Data access layer is a layer that acts as a link between the system and the MissMachine database [7].

Then, there will be a develop process which need to be done before the testing phase. Since MMMS is developed by features, object-oriented programming approach is selected as it will separate program by object and module. In this develop process, the database to store all records needed for MMMS will be created and the development environment will be prepared and configured. After the development process is done, it will release to the user as the increment release to be tested.

Last process in this iteration phase is testing process. There are two methods used in this testing process which are user acceptance testing and black-box testing. In user acceptance testing, stakeholder is needed to test the new feature of the system. All comments from the stakeholder need to be focus as it will help the development team to analyse again the requirement and flow in the analyse process. Then, for black-box testing, MMMS is tested with various inputs and actual output is compared to the expected output. Correction from the testing results will also help development team in the next iteration. Figure 5 shows how sprints is used in this project.

![Figure 5 Overview of Agile methodology](image)

C. Release

In release phase, the MMMS is already a complete system. After some correction from the testing is several iterations, MMMS is ready to be released to the user in order to have a more systematic preventive maintenance service management in the factory.

IX. RESULTS AND DISCUSSION

The development of MMMS project gives benefits and convenience to the users of this system. This can be proved when a user acceptance testing is done among the stakeholders. Figure 6 shows an example on how user acceptance testing is conducted among the users.

![Figure 6: User Acceptance Testing Form](image)

<table>
<thead>
<tr>
<th>No</th>
<th>Action</th>
<th>Expectation Response</th>
<th>Pass / Fail</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fill in username and password</td>
<td>Nothing will display</td>
<td>Pass</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Click “Login” button</td>
<td>a. If user enters valid username and password, system directs user to the admin home page</td>
<td>Pass</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. If user enters invalid username and password, toast message “Please contact administrator”</td>
<td>Pass</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. If system detects empty field, toast message “Please contact administrator”</td>
<td>Pass</td>
<td></td>
</tr>
</tbody>
</table>

Result from the testing, most of the stakeholder achieved at least 95% pass on the testing. Only a few of them has a difficulty to understand some of the words use in the system due to the different
education background for each of the stakeholders. Then, by using this system, users especially employee in MM department saves a lot of time compared to when they are using the manual system. This is because just only a few clicks, they can get notify on what they need to do for the current day. Figure 6 and Figure 7 shows the user interface for this MMMS project.

X. CONCLUSION

In conclusion, MMMS is successfully developed as a web-based application system in order to ease all the daily activities for the employee in MM department, FMU department and in Workshop department. In order to give fully understanding for all the stakeholders, there is an idea to make this system contains dual language which are Malay and English language. This is to ensure different people with different education background has an opportunity to use this system very well.

REFERENCES


