IoT-Based Facility Management for Maintenance Worker

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***Abstract*—Internet of Things (IoT) is relatively a new technology that has received great attention in the recent years. This technology can be applied in many fields in industry including Facility Management (FM). FM is a professional management discipline which focused upon effective and efficiency delivery of the support services for an organisation that is served In this project, IoT-Based Facilities Management is proposed and will be developed. This project is in collaboration with Encorp Bhd. for FELDA Tower which located in Kuala Lumpur. This system is aims to overcome the challenges that they faced which are: providing worker tracking, list of task as a guidance to carry out the maintenance operation, and algorithm to estimate the each and every task to be done by recording the statistic of actual time taken to be updated the task-duration-time. The system will be installed in a handheld which consist of RFID, GPS, camera, list of task, e-mailing and Telegram, which is known as the Things element of IoT. Subsequently, the Cloud element will connect the user to the system via the internet which consists of the server and database. Finally, the Enterprise application software part of IoT will consist of the Graphical User Interface which provide a user-friendly dashboard, where the supervisor can monitor the status, activity as well as the performance of the workers. The developed IoT-based FM consist of Android application, cloud database and web browser will ease to track and monitor the maintenance operation for maintenance worker**

Keywords—Internet of Things (IoT), Facility Management (FM), Graphical User Interface (GUI)

I. INTRODUCTION

Internet of Things (IoT) is a technology where all the things such as devices, appliances, sensors and vehicles and wireless enable system can be controlled by finger tips or remotely due to their connectivity to the internet [1]. The things are implemented by the sensors and small processing power to collect and send data connected to the internet and then become the part of IoT platform. Internet of Things (IoT) is a recent technology that gained enormous attention in the recent years. Today, this technology can address many problems and play an astounding role in daily life by upgrading the conventional system in many field. Besides, it has a impressive prospective which can increase the efficiency and productivity of the system, which enable the user to monitor, record, manage and control the system flexibly. Most of the conventional systems can been transformed into IoT based system, hence become a part of Industrial 4.0. In this work, an IoT framework called IOTWave, will be used to develop the Facility Management (FM) solution, which consists of three essential components, the Things, the Network and the Cloud. The interconnection of all of the three components together will produce a complete IoT system.Presently, the concept of *smart building* was widely known, and FM has become one of the key part of this. FM covered a wide range of activities from monitoring, control as well as maintenance. The facility manager currently has difficulties to ensure all these work are done effectively and efficiently.

In a high-rise building, the facility manager has problem to track and monitor their worker (e.g., the facilities technician), to ensure the assigned tasks at a specific checkpoint is being executed in an appropriate time. Facility managers capability are very limited to monitor and tracking the technician working progress. In this situation, there are no evidence or records whether the technician is really doing the task assigned or checking the equipment in the assigned area.

In addition, during the maintenance routine, the technician need to bring the list of assign tasks which they need to execute, necessitate following the manual in operation maintenance. However, bringing this list is inefficient. Sometimes, the technician miss the list (possibility due to forgetting to bring it out or the list went missing), hence it is a possibility that some assigned task at a particular check point are missed or overlook. At the same time, the facility manager also has difficulties to monitor the duration of time that a maintenance operation at the specific area took to finish by a technician. Suppose, all the tasks could have its typical duration to be done. Some of the worker take advantage of this missing of information or this limited facility-manager

capability, to skip out their work as they know that there is no the higher authorities watching thier work progress.

Internet of Things (IoT) provides benefits in many aspects of FM operation and has become one of the best solution to these concerns. IoT will enable the facility-manager to estimate the time taken for each and every task, provide information on the location of the workers, provide platform for worker to manage their assigned tasks as well as performing reporting (and prove of work). Further, the facility manager could use the information to take a precaution step on maintenance issues earlier. Hence, this has become the reasons that IoT technology is chosen for solution to solve the problems stated.

II. RELATED WORKS

IoT-based FM is proposed to yield the system that can track and monitor the technicians or workers in real time. It provides the list of task as a guidance in order to verify whether they carry out their duty as assigned at each and every checkpoint as instructed and as required in operation maintenance manual. Besides, it also equips the timer in order to estimate the time to finish each and every assigned task as their supervisor can record the statistic the actual time taken to update the task-duration time.

All the workers and technician performance will be recorded and displayed inside the dashboard, where at the same time their supervisor can monitor and track them via displayed location on the dashboard. The dashboard is essential to monitor their duty performance through the web-based application software. The web-based software is a platform-independent platform to provide the Graphical User Interface (GUI) for providing the facility manager to monitor and supervise the workers, as well as getting the updated report easily.

Based on the conventional system that have the same concept as IoT-Based Facility Management for maintenance work such as GUARDEXPERT PRO: Application-Centeric IoT solution for Guard Touring System [2] where the system consists of GPS for tracking the location of the patrolling guards. The system consists of a real time reporting documentation. It uses NFC technology, which the NFC NFC reader is from an NFC-enable smartphone. Guard Touring System administrator monitor the patrolling routine from the monitoring page (dashboard). However, This system doses not have time estimation for each and every task to be done. Secondly, the reporting/documentation is based on general routing routine. Lastly, the NFC is no-go for metal based equipment, because it could not function.

Besides, Patrol Management System Applying RFID to Petrochemical Industry [5] where the system used RFID Tag to represent the checkpoint areas with their own exclusive identity. PDA is used to store data enquire from employee manual, operation rules, task distribution, product introduction and prices stocks. Nevertheless, This system does not have time estimation for each and every task to be done. Besides, the limitation for PDA is it need an extra slot for the GPS and camera.

Last but not least, EZ Facilities Management Software [7], where the system consists of records and track maintenance histories which stores maintenance histories that show completed or closed work orders, the person who approved those work orders and other details. Still, the restrain for this software is it don't provide the estimation time for each and every task to be done. All in all, the conventional system do not have the time estimation to record the time for each checkpoint and every tasks.

III. SYSTEM MODULE

There are several main modulus that are proposed will be presented in the section below.

A. Facility Management System

Facility Management System is basically a system that monitoring and tracking for the maintenance worker during the maintenance operation. With IoT, we can easily track the worker during the operation by using the GPS. The monitoring page is used for the administrator to capture all the data during daily operation that have been recorded for the documentation.

B. Java Integrated Development Environment

An IDE is a programming environment that consist of compiler, debugger, code editor and Graphical user interface (GUI) builder where an application program has been integrated. So, IDE framework is an Android Studio used a comment set of APIs to connect debuggers, code editors, compilers and other compatible tools that were build in Android Studio. Android Studio compatible with other languages such as XML with APIs, although it only optimized for Java languages. This framework is consist of two components: the IDE for functionality platform which provide controls for editing and control version and Android SDK platform, where run-time library provides basic IDE elements such as template coding used by programmers or user interface, an application's data presentation and configuration.

IV. SYSTEM ARCHITECTURE

In this section, will discuss methodology and flowchart for this project of the facilities management based on Internet of Things (IoT) technology.

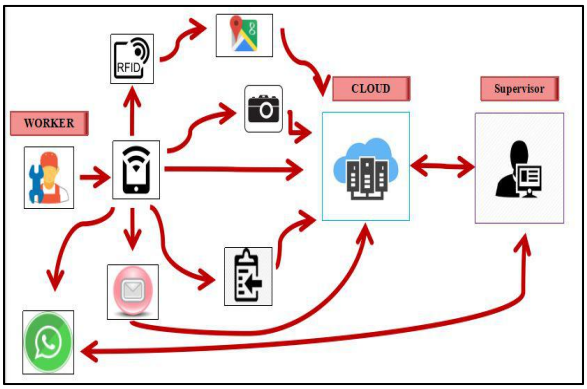

Figure 1 Analysis of the Problem and Technology Selected for the system.

A. Methodology

The system that will develop based on IOTWave IoT framework. IoT framework provides the guideline on how the Things which consists of the sensors and actuators, are connected to the users via the Internet network. The analysis of the problem and technology selected for the proposed solution of IoT-based Facilities Management (FM) is shown in Figure 1.

From the analysis of the problem stated in Chapter 1, the technology selected for the proposed solution consist of handheld which embrace the Radio Frequency Identification (RFID) Tag Reader, Global Positioning System (GPS), camera, list of task, e-mailing services and Telegram. All these Things element combined to formed a complete system to provide the services for the FM. The handheld will also be the gateway to the system, which is the bridge that connect the system to the Cloud. The Things can send information as well as reports through the network via gateway.

The network is essential for the interconnection between the device and the Cloud to store the data, documentation and reports of the maintenance operation. Thus, the Cloud and the dashboard will intercommunicate to display the documentation of the reports and monitor the worker performance. In the IoT system, the Things can be almost anything such as a chair, building, car or even an animal with implemented sensors with the unique ID called based on IP, to enable it to be identified when connecting to the Internet. The existence of IoT technology let the Things communicate among them based on the application. In this project, the Things referred to the handheld which consist of RFID, GPS, camera, e-mailing, list of task and Whatsapp that can help to ease the maintenance operation including to monitor and track the work performance of the workers.

B. System Flowchart

Figure 2 is shown the overall system flowchart of IoT-Based Facility Management System for Maintenance Worker. In this section, the maintenance worker is referred to as the user.

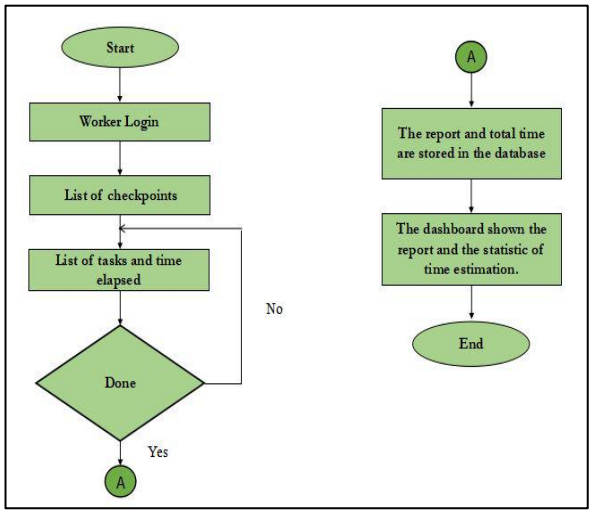

Figure 2 :- Flowchart of IoT-Based Facility Management System

IV. RESULT AND DISCUSSION

In this section result of the work done will be shown and discuss. This includes the design of the user interface for android and dashboard based on the user requirements (FELDA) and expected outcome for the facilities management.

Firstly, the design of the "Work Login" page where the workers or the technicians need to login the apps first by using their work card, as shown in Figure 3. After successfully logged in, the apps will display the list of the checkpoint where the checkpoint they need to carry out their duty. Figure 4 showed that, the technicians need to scan the checkpoint before they want to initiate the maintenance operation.

After scanning the checkpoint, the list of tasks will be displayed on the handheld screen as the guidance for the worker to carry out the operation as shown in Figure 5. Each and every task at specific checkpoint consist of timeline as shown in figure 5, figure 6, figure 7 and figure 8, to record the estimation of duration work need to be done. After record and collecting the data, the data will be saved in database as shown in figure 9 and will be seen on the dashboard by the supervisor.

Figure 3 : Login for the maintenance worker

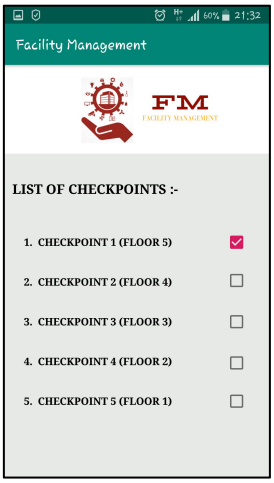

Figure 4 :- List of Checkpoints

Figure 5:- Checklist of tasks that are needed to be done

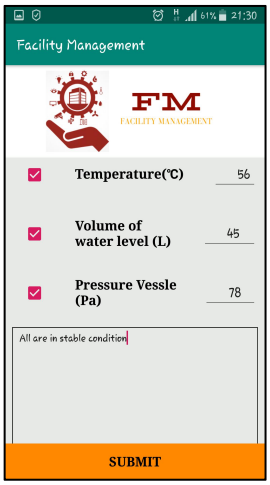

Figure 6:- Checkpoint 1 (Task 1)

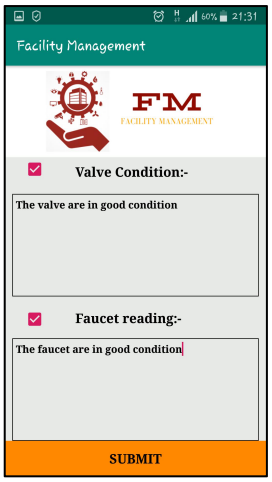

Figure 7:- Checkpoint 1 (Task 2)

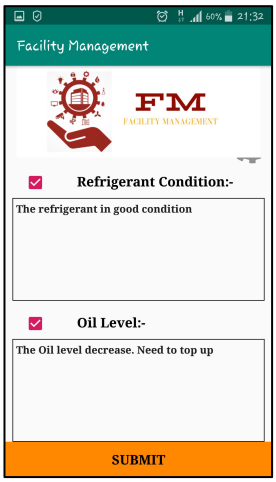

Figure 8:- Checkpoint 1 (Task 3)

id	temperature	volume_of_water	pressure_vessle	report	time_start	time_stop
1	56	45	78	All are stable condition	2019-04-16 07:23:07	2019-04-16 08:06:00

id	valve_condition	faucet_condition	time_start	time_stop
1	The valve are in good condition	The faucet are in good condition	2019-04-16 08:22:00	2019-04-16 09:00:00

id	refrigerant_condition	oil_level	time_start	time_stop
1	The refrigerant in good condition	The oil level decrease. Need to top up.	2019-04-16 09:30:00	2019-04-16 11:00:00

Figure 9:- All the tasks data and reports are stored in database

The movement and the work performance of the workers can be monitored by their supervisor as shown in Figure 10. Hence, the supervisor can monitor them in real-time positioning monitoring at anytime and anywhere. For the compilation reports documentation, will be stored in the Cloud where the data management and storage of data operation held inside the Cloud. Beside the analysis of data for estimation also recorded and stored inside the Cloud and will display in the dashboard for the supervisor do the statistic duration time taken for task to be done and update time maintenance operation.

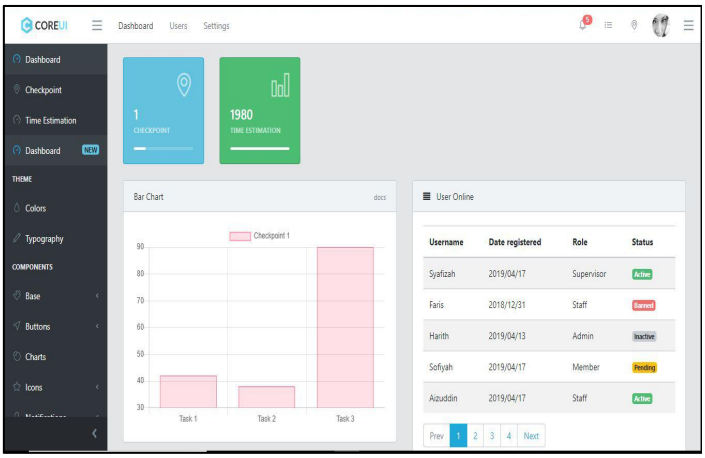

Figure 9 :- Dashboard display

For the dashboard is designed about the overview maintenance operation which can be monitor by their supervisor. The dashboard consists of the features which are Checkpoint, user online and Time-Estimation. Checkpoints features is used to display the checkpoint reports where the data and reports are retrieve from the database. For the Time-Estimation is used to display the statistic of the total time are recorded retrieve also from the database. All these features can notify their supervisor about the real-time report documentation, the technicians use the system online and monitoring the operation.

VI. CONCLUSION

In conclusion, the IoT-based Facility Management system has been successfully developed using an Android Studio. The system provide the user the application during the maintenance operation. The system also provides the monitor and tracking system for the supervisor to monitor their workers during the maintenance operation. All the data for every task recorded in real time and every tasks recorded the estimation time and shown in the dashboard for the documentation.

VII. ACKNOWLEDGMENT

The author wish to express her gratitude to Advanced Telecommunication Technology (ATT) research group and Encorp bhd for FELDA Tower for giving opportunity involved in this project.

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