Increase Effectiveness of Electronic Machine Checklist Development Based on IoT Technology

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Abstract. The research was made to meet the need for online and real-time information. It is necessary to conduct prompt and precise action as needed in determining strategic an important decision. The current application of products based on information technology (IoT) makes it easy to develop the system. The purpose of Electronic Machine Checklist System (EMCS) design is to prevent machine breakdown. The methods used in this study was by collecting machine breakdown data records. The design of development using the Touch screen, Arduino Wemos-D1 and PLC. Those are the tools for development of EMCS which used for monitoring system status of the machine. Communication between devices using wireless. The result of this development can be used to determine action correctly according to the standard. The condition of the machine can be controlled in real-time and online using EMCS.

Keywords: Machine Checklist, IoT, EMCS, PLC, Arduino Wemos-D1

1. Introduction

The purpose of this study is to help accelerate the information regarding the condition of machinery and equipment in real-time. The utilization of computers and applications that can support the work to deliver more value in supporting the improvement process of the machine so that the production process is not impeded. Implementation of an Electronic Machine Checklist System (EMCS) is required to eliminate misinformation, manipulate data from the machine and provide early intervention when the machine will be operated. The study aims to process the information in real-time before the machine operation. This research builds a machine designed with Electronic Machine Checklist System (EMCS) wirelessly with hardware and software that are affordable. The purpose of there search is to help facilitate the process of checking the condition of the machine and prevent machine from sudden breakdown so it can provide more value in supporting the production process. The application of EMCS is needed to reduce operator errors while checking the machine condition before operation (mistake proofing). So, when there is abnormality before running the machine for production can be detected earlier and certainly it can reduce the machine breakdown. This research aims to:

a) Provides initial information about the actual condition of the machine before operation.
b) Build a manual Machine Daily Checklist (MDC) based on check sheets with Touch Screen based technology using the Electronic Machine Checklist System (EMCS).
c) Editing File of MDC to prepare a machine checklist is not effective.
d) Filing Data MDC would be prepared in every end of the month.
e) MDC still using manual method to check machine condition. It is potentially to be missy,
untidy, difficult to control the job, fallen checklist to production floor and missing the document as well as broken machine checklist.

![Machine Checking using MDC Manual System](image)

**Fig.1.** Machine Checking using MDC Manual System

When a machine breakdown occurs suddenly the production process will stop and can become a bottleneck for production. The current process before running the machine for the production process is the operator checks the machine manually at the checkpoint based on the machine daily checklist. Operator checks each machine component which is the point of instruction from MDC. It takes time and accuracy to conduct checking process and the depend on serious ness and understanding of the operator to follow the instruction manual. The obstacles faced when filling in the check points are:

a) Mistake in input and judgement while filling the checklist
b) Some components that are unreachable to check are not checked.
c) Standard checking is still done manually

The sudden damage when the machine is being used for production is fixed by manual machine checking system. It takes time so it can disrupt the production process that has been set. The objective of design and develop Electronic Machine Checklist System (EMCS) is to prevent machine breakdown as a result of not checking machine properly before running the machine. It assures that machine is in best possible condition to prevent injury and defect product. This study is expected to create a system tool checking by EMCS which can be relied. The development design of this research through several methods, processes and stages to produce an accurate design tool to support the analysis for monitoring results.

2. Literature Study

This research using the micro controller. The micro controller is based on ESP8266, which is a wireless (Wi-Fi) 802.11 micro controller module that is compatible with the Arduino IDE. The layout of the micro controller is based on the standard Arduino hardware design with the same proportions as Arduino Uno and Leonardo. This micro controller also includes a set of standard Arduino headers that means it is compatible with various Arduino shields. It also includes a CH340 USB to serial interface like a commonly used USB micro cable.

Research conducted by (Hanif, Prima Rullyanto, et al, 2018) [1] regarding Prototype of Qomatron Prayer Time with the concept of IOT Using Wemos D1 Mini-Based Web where as for the concept of this prototype is to use the IoT as a long-distance communication using a network internet. It can perform remote setting and maintenance. Application settings are made by web-based and can be accessed by a device with a Wi-Fi connection and a browser installed. Research conducted by (Ayu Kusuma, Nurul Aditya, et al, 2018) [2] regarding Design Smart home Using Wemos D1 R2 Arduino Compatible Based ESP8266 ESP-12F, which aims to develop software and hardware for smart home. With the experimental methods and literature, this research has been successfully designed the Smart Home. The results are as the objective to build software with the IP address used 192.168.43.52 (each Wemos has a different IP address) and hardware to simulate Smart Home using LEDs and electronic equipment.

Research conducted by (Kusuma, Tony & Noble, Muhammad Tirta, 2018) [3] about the Design System Monitoring for Infusion Microcontroller Based Wemos D1 R2 where the study was carried out to overcome the delay to change the empty infusion assisted by using a micro controller. A literature study and exploration of the hardware like Arduino boards, sensors, modules, and software is used. The result of the study is a tool that can provide information about the rest of the fluids in infusion bottle to be replaced soon by the nurse.
Research conducted by (Widya, Adi Rusdi & Syaputra, Hendra Arya, 2018) [4] concerning Development of Machine Monitoring System Application (MMS) Technology-Based IoT Wemos D1 and Raspberry–Pi which are some tools developed and designed machine monitoring system (MMS) is used for monitoring status of the machine (running/stop). Raspberry–Piserves as a Programmable Logic Controller (PLC-master controller) and the Arduino Wemos-D1 as a slave that is integrated with the machine. Communication between the two using wireless. Human Machine Interface (HMI) for a web-based monitoring system can be accessed through a browser. The result can be used to determine abnormalities in the machine in real-time and online so information about machine breakdown can be responded quickly for the main tenance. Research conducted by (Budiono, Totok, 2016) [5] on Remote Monitoring System Based.

IoTU sing MQTT Protocol that implement the system using LM35 temperature sensor, Arduino UNO and Wi-Fi module Esp8266 ver 01. The prototype system successfully realized both at the Sensor Node and Node Monitor. The system can connect to the server MQTT local and global server, capable of sending data (publish) and receive data (subscribe). Based on the few references of these studies, there research will develop using PLC, Wemos-D1 and Touch Screen panel for "Increase Effectiveness of Machine Checklist Development Based on IoT Technology" to help the user prevent damage/breakdown of the machine and increase effectiveness in performing the production process as following Figure 2:

![Machine with Controller Wemos D1](image)

**Fig. 2.** Machine with Controller Wemos D1

### 3. Research Methodology

#### 3.1. Research Stages

This research starts with a literature study, find references, discussion and design of the system to be created. The detail of research flow can be seen at Figure 3:

![Flow of Research](image)

**Fig. 3.** Flow of Research

Explanation:
1. Literature study to find some literature, Journal of monitoring the engine, the use of Wemos-D1 and electronic machine checklist.
2. The design of the system created by the comparison with focus on ease and availability of spare parts. The design of the system, purchase of materials, fabrication, and assembly is made with materials that are already budgeted.
3. Designing and Making Software to be used.
4. Installation, Testing, and Testing of assembly/installation.
5. Improved system design and analysis of results.

Discussion and preparation of research report every step is done based on the data and test results of the electronic machine checklist system (EMCS) will be created and developed, each activity carried out following a predefined schedule.

3.2. Data Collection
Data collection is done by collecting machine checking data records and comparing data before and after using the electronic systems machine checklist (EMCS) for considering and planning information system design. The data collection methods used are as follows:

3.2.1. Literature Study. At this stage collect the data and information is needed to build Electronic Machine Checklist System (EMCS) by reading related reference
3.2.2. Observation method used to obtain data by making observations on the field to determine the actual state of the machine at the moment and to be compared with existing data

3.3. System Requirements
After conduct the analysis, what we required to build the system are:

3.3.1. Hardware; The hardware needed is Wemos D1, PLC, Relay, Power Supply, Router access point, and a Terminal Block.
3.3.2. Software; Software needed is Sublime Text, XAMPP, and Web Developer.

3.4. System Design
The design phase of the system made in this study is as follows:

3.4.1. Design of an Electronic Machine Checklist System(EMCS)
3.4.2. Installation hardware and software configurations.
3.4.3. Implementation system EMCS.
3.4.4. Testing system.
3.4.5. Documentation EMC system.

Software development method in this study using waterfall recommended by Sommerville (2011)[5]. There are five stages in the waterfall model which are requirements analysis and definition, system and software design, implementation and unit testing, integration and system testing, and operation and maintenance. Details of the methods as in Figure 4.

![Waterfall Method](image)

**Fig. 4.** Waterfall Method

The stages of the waterfall method as follows:

1. Requirements Analysis and Definition. In the planning phase of this system we first have to plan on what project we will create or in other words, we have to define the problem to be
solved. This includes the following stages of the determination of features, constraints, and objectives of the system through consultation with users. All these things will be set out in detail and serves as a system specification.

2. System and Software Design. System architecture will be established based on determined criteria and to identify and describe the basic abstraction of software systems and relationships. This phase carried out before coding. This stage aims to give an overview of what to do and how it looks helps in specifying the hardware, system requirements and defining the overall system architecture.

3. Implementation and Unit Testing. The results of the software design will be realized as a set program or a program unit. The software is broken down into small modules will be tested, which will be incorporated in the next phase.

4. Integration and System Testing. Each unit of the program will be integrated and tested as a complete system to ensure the system meets the requirement so existing and tested to determine whether the software created following the design and still has an error or not. After that, the system will be sent to user.

5. Operation and Maintenance. In the maintenance phase the software that has been executed and performed maintenance if needed. Maintenance included in correcting errors that are not found on the application before. Stage of development in this research only to integration and testing phase only.

The concept and design of EMC System Topology concept of electronic machine checklist (EMCS) by using the Web Application Development can be seen in Figure 5, below:

![Fig.5](image)

**Fig.5.** Topology System of EMCS with Web Application Development.

Here is a system topology that will be built as shown in Figure 6.

![Fig.6](image)

**Fig.6.** Topology System EMCS

**Figure 6** shows that Wemos installed on the machine. When the activity machine checklist is happening, the controller will send the machine status to Wemos and that status will be forwarded to the database and PLC through an intermediary access point. After that, the existing data in the PLC
The manual machine checklist needs to be improved using EMCS. Based on the data collection and interview, there are some problems experienced in the Machine Checklist:

1. The editing process of the machine checklist every end of the month takes 2 days.
2. Spend 1020 sheets/month of paper to print a machine checklist.
3. Late to return the machine checklist from production area to manufacturing office
4. Difficult to get Machine Checklist summary few months or several years before.
5. The checklist paper is often dirty, torn.
6. Some locations are difficult to reach.
7. Forgot and wrong in filling out the Machine Checklist
8. Fill in the Machine Checklist is still with manual handwriting

Target is to reduce those current eight problems condition that arise from manual checklist become zero problems as seen in figure 7:

![Fig. 7. Target Reducing Problems](image)

**Planning System**

1. Make an EMC system that inputs checklist data not from the user, but from the Machine itself.
2. Make an EMC system using the wireless system and real-time.

Making and discussing for improvement: EMCS would be integrated with machine foolproof to prevent mistaken operation. Selected using wireless system integrated. **Figure 8** shown an integrated system using wireless network to support high mobility and productivity, easy installation and flexibility against layout.

![Fig. 8. Planning Concept of EMCS](image)

4. **Result and Discussion**

The following are the results of the design of the EMCS:

a) Point of checking installed on Touch Screen as detail in **Figure 9**:
b) Judgment decision condition of machine decided by the machine itself or by user as Figure 10.

![Figure 10](image10.jpg)

**Fig. 10.** Judgment machine condition by the machine itself

In Figure 11, EMCS has been installed in the machine to reduce manual machine checklist and make accurate and real time machine condition and support to increase productivity.

**In figure 11,** EMCS has been installed in the machine to reduce manual machine checklist and make accurate and real time machine condition and support to increase productivity.

![Figure 12](image12.jpg)

**Fig. 12.** Devices for Monitoring EMCS
In Figure 12, all devices for monitoring and reporting machine condition will be controlled by user and maintenance officer who is responsible to handle and check the machine condition and all devices such as smartphones, computers, and notebooks. The supervision and control of the machine can be further improved and always get updated information.

5. Conclusion

Based on the research that has been done, it can be concluded that the application of the Electronic Machine Condition System (EMCS) can speed up information about the state of a machine. It also facilitates the user in carrying out self-maintenance so can guarantee the safety and reliability of the machine when running for the production process. Further explanation of the results of the development of the EMCS is follows:

a) Reduced MDC check time before: 30 minutes, after development to 10 minutes, so there are time savings of 20 minutes = 67% compared to the previous manual MDC system.

b) Reducing eight problems to zero by implement EMCS in the machine or equipment. Based on the results of design and application of EMCS using HMI technology, there is an increase in performance for Autonomous Maintenance. This design can be deployed on another production machines so it can help the production process and reduce workload by eliminate manual process checking and reporting by operator and/or user. Application of machine self-checking activities with EMCS not only simplify the work method but also an effective way to prevent errors caused by all manual sequence process.

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