Internet of Things in Overall Equipment Effectiveness Production System Applications

Dina Fitria Murad[1], Bambang Dwi Wijanarko[2], Denny[1] and Alfath Syahrian[1]
[1]*Information Systems Department, BINUS Online Learning, Bina Nusantara University, Jakarta, Indonesia*
[2]*Computer Science Department, BINUS Online Learning, Bina Nusantara University, Jakarta, Indonesia*

Keywords: The internet of thing, industry 4.0, Overall Equipment Effectiveness (OEE), manufacturing, machine services.

Abstract: Utilization of Internet of Thing (IoT) can increase efficiency, and real-time optimization. IoT integration in industrial machines helps the process of monitoring the production processing, thus avoiding single point of failure and easier for resource expansion, so that the machines will be optimal in their use because it can be known at the right time for maintenance. The purpose of this study is to optimize the use of machines in production, especially the process of monitoring production machinery. Using the IoT and Overall Equipment Effectiveness (OEE) approach to the machine, the data is calculated to facilitate the analysis process. The application of the Internet of Things in the field of manufacturing production especially in this company has proven to be effective in making industrial machine services become smarter, more transparent and efficient.

1 INTRODUCTION

PT. Ultra Sakti is a pharmaceutical company that produces OTC (Over The Counter) medicines, which are drugs that can be sold freely on the market. In carrying out these drug production activities, PT. Ultra Sakti always makes efforts to produce quality products by differentiating through quality strategy and value strategy. Quality strategy is to provide products with better quality than competitor products to build satisfaction and loyalty from customers. Strategy value is carried out by submitting more amounts to customers, both through more functional and better services, while always maintaining an affordable price for the products sold.

PT. Ultra Sakti is present in the pharmaceutical industry with the awareness that this industry must be faced with innovation and the creation of high quality and competitive products. To strengthen the company's presence, PT. Ultra Sakti is positioning itself to be a pharmaceutical company that implements standard and modern production standards. Accompanied by firm commitments and innovations that are carried out sustainably, the company's contribution to industry acquisition is expected to increase. To create a quality product, one of the systems development that is carried out is to use internet technology that is implemented on a production machine, its application is carried out in the form of machine and data integration that can be used for the OEE (Overall Equipment Effectiveness) process (see figure 1).

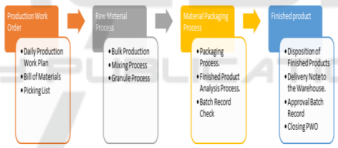

Figure 1: Production Process Flowchart.

To support the implementation and implementation of Industry 4.0 in PT. Ultra Sakti, the process of developing technology and information that can help the means of production activities, must be done automatically and has been integrated with the core ERP system, where data and information processing can be done and generated quickly, easily and precisely. One of the things that can be done to support this process is to optimize the use of machines in production. To find out and monitor the effectiveness of the use of these machines, it can be done by calculating OEE on these machines, so that the device can be known easily.

The application of IoT to manufacturing and supply chain management has become popular in various industries like smart cities (Tanwar et al., 2018), transportation (Murad et al., 2018), bigdata (Hashem et al., 2016). Connected equipment, tracking people and goods or devices, sampling cycle management, and production cycle monitoring are one of the IoT applications in the industry, data acquisition

Murad, D., Wijanarko, B., Denny, . and Syahrian, A.
Internet of Things in Overall Equipment Effectiveness Production System Applications.
DOI: 10.5220/0009090503050310
In *Proceedings of the International Conferences on Information System and Technology (CONRIST 2019)*, pages 305-310
ISBN: 978-989-758-453-4

at the level of PLC (Programmable Logic Control) and supervisor systems, then the data is processed in Computing to connect to MES (Management Exclusion System) and ERP (Enterprise Resource Planning) system. Meanwhile, a system that is interrelated to connect the central system owned by the company (ERP) with production tools can help the process of monitoring the performance of existing production machines and can assist in analyzing and calculating OEE.

This research utilizes the Internet of Things (IoT). IoT is a concept where particular objects have the ability to transfer data over a network without requiring interaction from human to human or from human to computer devices. IoT emphasizes the integration of process and management with the system by providing all data on-board (Nasir et al., 2018b) (Nasir et al., 2018a). Utilization of IoT has also been carried out by (Gunasekaran and Periakaruppan, 2017) where IoT is implemented to create a smart home by using Arduino as an I / O signal receiver from the installed device, the working principle of the invention is the same, Arduino is programmed to carry out commands from the received signal, then the system will work as instructed. With recent developments and the IoT application, it has been possible to resolve this problem. It is hoped that the system created can help the parties involved, including production staff, operators & heads of production and management, to monitor production activities and know the results of OEE calculations in real-time so that they can quickly assist in making decisions.

The purpose of this research is to build integrated system automation between machines, technology, and information using IoT. Based on that, the research questions in this study are how the use of IoT can help OEE systems become availability, performance, quality, and achievement in the use of machines.

2 LITERATURE REVIEW

2.1 Hardware

Hardware or hardware is all the physical parts of a computer and is distinguished from the data that is in it or that operates in it and is separated from the software (software) that provides instructions for the hardware in completing its work.

In this study, the authors use the following hardware:

1. Computer
   The computer is used as a web server; the operating system used is Windows 10. The machine is in charge of storing scripts, images, and website page content. Web Servers must be accessible from all areas that have an internet connection.
2. M2M Controller
   M2M Controller is hardware with Modbus / TCP as a tool used to communicate between the signal signaling device and other controller units such as PLC or SCADA. The M2M controller can also function as an input/output unit for long distances in a client server-based communication control system.

Figure 2: CONPROSYS M2M Controller

3. Arduino Uno R3
   Arduino is an open-source single-board microcontroller, derived from the Wiring platform, designed to facilitate the use of electronics in various fields. Arduino also simplifies the process of working with a microcontroller. Here are the reasons for the authors to use Arduino, as a signal sensor to the controller, namely:
   (a) Arduino prices are relatively low, ranging from IDR 100,000, up to the cost of IDR 400,000, - the price is cheaper than other professional microcontroller platforms.
   (b) Arduino libraries are easy to get, available in full on the Arduino website and even on other Arduino community websites.
   (c) Multi-platform, not only for Windows but also suitable for working on Linux.
   (d) Simple and easy programming, Arduino is easy to use for beginners and flexible enough for those who are already advanced. Arduino is based on a processing programming environment, so if students or students are accustomed to using processing, of course it will be easy to use Arduino.

Figure 3: Arduino Uno R3

2.2 Previous Research

Some of the studies that correlate with this study are summarized in Figure 4. There are several uses of IoT in the same field with different methods and approaches.

Specification	Value
1.Title	IoT Based Home Automation Using Arduino (Mahalakshmi, G., & Vigneshwaran, M, 2017).
Method	Home Automation uses Arduino Uno, equipped with a Motor Driver, Wifi Module, PIR Sensor, MQ6 Sensor built with the Android platform
Result	IoT based home automation using Arduino has brought a better quality of life, where users can control the devices or devices that are owned in the house, besides making it more efficient and more cost-effective because everything can be controlled automatically. This research produces a new architecture for low cost and flexible home environment monitoring systems using Android-based smartphones, which are built using micro web servers and Bluetooth communication as an application layer that can be operated to communicate between remote users and home devices. Android-based smartphones with built-in support for Wi-Fi can be used to access and control devices at home. When a Wi-Fi connection is not available, cellular networks such as 3G or 4G can be used thereby eliminating the need for an external voice recognition module
Limitation	When the internet is not available, communication with the smart home cannot be done
2.Title	Internet of Things (IoT): A literature review (Madakam, S., Ramaswamy, R., & Tripathi, S, 2015).
Method	General IoT Method

Figure 4: Previous Research.

Result	IoT describes everything that can be connected and communicate intelligently. Ambient Intelligence from IoT is a developing technology that will increasingly change lives at large, which unites the real and virtual worlds. IoT has gradually brought technological changes to our daily lives, which makes life simpler and more comfortable. IoT can be implemented in all domains, including medical, manufacturing, industrial, transportation, education, governance, mining, and others.
Limitation	The observation still made in the literature is that IoT does not have a standard definition, requires universal standardization at the architectural level, requires interoperability because it uses different technologies, requires better global governance, protocol standards need to be built.
3.Title	Improving Overall Equipment Effectiveness (OEE) Through the Six Sigma Methodology in a Semiconductor firm: A Case Study (Ng, K. C., Chong, K. E., & Goh, G. G. G, 2014
Method	DMAIC (Define, Measure, Analysis, Improve and Control) Approach & Six Sigma Approach
Result	The DMAIC approach helps to identify and clearly define the problem at the specified stage. It provides a systematic methodology by giving step by step analysis to the micro level to get the root cause of why OEE is low.
Limitation	To be able to know OEE, it is not only done by DMAIC and Sig Sixma Approach, but this is also because the needs and conditions in each company are different.
4.Title	Developing Performance Measurement System for the Internet of Things and Smart Factory Environment (Hwang, G., Lee, J., Park, J., & Chang, T. W, 2017).
Method	The IoT-based performance model is consistent with the ISA-95 and ISO-22400 standards
Result	Implement the proposed performance measurement model using ISA-95 and ISO-22400 where the IoT device can be used to calculate OEE. Besides, for the configuration of the IoT-based performance measurement system architecture, ERD was created to enable modelling of complex relationships between various data entities. The study was conducted by combining performance measurement models with ERD architecture outputs to develop BPM models, accuracy validated by virtual factory simulations. The virtual factory used, which consists of the set of machines obtained and the production process, is developed to enhance realism
Limitation/ Next	There is a time gap between the

Figure 5: Previous Research(cont.).

Future	planned time stamp and the actual timestamp, which is caused by a combination of arrangements and time delays that are not included in the plan. Further research is needed to analysis the effects of this hidden time loss and develop an anomaly algorithm that triggers an alarm when the difference between planned and actual time exceeds a certain level. Some IoT devices can show some anomalies; in this case, the performance appraisal will be wrong or cannot be used to calculate KPIs. Further studies are needed to consider such situations and compare the results with typical conditions.
5.Title	The Internet of Things for Smart Manufacturing: A Review (Yang, H., Kumara, S., Bukkapatnam, S. T., & Tsung, F, 2019)
Method	Cyber-physical Manufacturing Networks and data-driven innovations in smart manufacturing
Result	This study presents an overview of the development of IoT technology and applications in manufacturing companies. As well as providing preliminary studies to utilize IoT and cloud computing to build virtual machine networks, thereby enhancing manufacturing decision-making capabilities through cyber-physical integration of manufacturing companies
Limitation	IoT is still under development and facing technical problems for cyber-physical integration in manufacturing systems such as communication, big data, and control.

Figure 6: Previous Research(cont.).

Based on the literature review, the Internet of things can be used to help make the whole process automatic, where devices can be controlled by programs that can be run from various places, according to the needs that are expected. The results of the research review can also be used by the writer in understanding the use of the Internet of Things in the manufacturing and smart factory world where these influences to provide support in real-time in the world of production and improve OEE.

From study 1, the method used is the same, namely by utilizing Arduino Uno and acting as an automation system, the difference lies in its use where this thesis is used to support OEE applications at PT Ultra Sakti. Study 3 also deals with improving OEE, but the difference is that study 3 uses DMAIC & Sig Sixma Approach. In Research 2, 4, and 5, the similarities are discussed concerning the use of IoT in the manufacturing and smart factory world.

3 RESULT AND DISCUSSION

The system built is to capture machine activity using internet technology, where the OEE process of recording activity data from machine activity is done automatically.

The process of implementing IoT (Internet of Things) in the production process at PT. Ultra Sakti is to use a digital input and digital output sensor system and M2M Controller installed on the production machine, where the sensor system will send data through the internet about the activities carried out by the device, starting from the engine running until it is turned off. This process is carried out automatically by using tools and data sent to the server, and then the data will be processed into reports that can be used for various analysis and strategy development to make the production process more efficient and effective.

The following Figure 7 shows the business process and IT infrastructure by utilizing IoT as a liaison or identifier for several devices in the system is built.

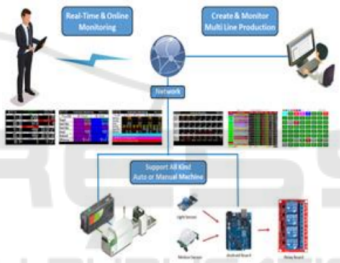

Figure 7: Business process and IT infrastructure by using IoT

And, to support the system to run better, it needs several supporting devices such as (1) The server computer (Figure 8) is used as a web server that functions to receive requests that have been sent by the device or that are called through a browser application and then respond to requests in the form of web pages or more generally in HTML documents, (2) CONPROSYS M2M Controller (Figure 9) is used as a data logger and receiver of signals sent by sensors or relays from Arduino Uno R3 installed on the production machine, Sensors or relays installed are LOSS sensors, DOWN sensors, GOOD sensors and NO GOOD sensors, where the data triggers the OEE (Overall Equipment Effectiveness) calculation, (3) Arduino UNO R3 (Figure 10) is used to receive digital input, and digital output signals which will then be transferred to the M2M Controller and the data will be forwarded to the webserver.

Figure 8: Computer server

Figure 9: CONPROSYS M2M Controller

Figure 10: Arduino UNO R3

As per Figure 7, the system generates information that supports business processes that are better and smarter. Intelligent information systems that are formed produce information in real-time based on data input from Arduino supported by IoT. Here are some access and dashboard views for each system user:

1. Management
   Management has access to see all activities that occur in the system; in general, management only sees the whole system through the dashboard report.

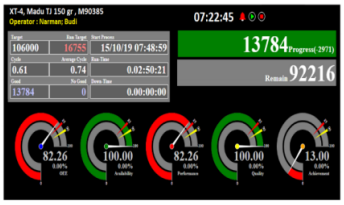

Figure 11: Management access

2. Division Head and Department Head (All Departments)
   Division Heads and Department Heads have access to view detailed data per production line, per batch (lot), per item, and view by the target.

Figure 12: Report Line Per Lot

3. Production Supervisor & Admin
   To make a schedule and configure the queue list in the system is done by the supervisor & admin of the production department.

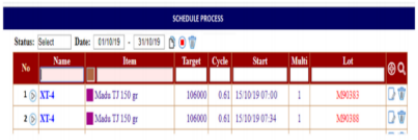

Figure 13: Production Schedule

4. Production Staff & Operators
   The user who interacts the most is the staff and operators of the production department, where every procedure for the process carried out follows the conditions set by the system.

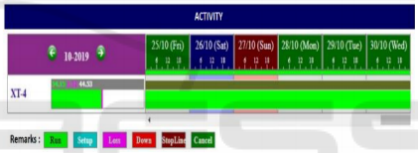

Figure 14: Daily Activity Machine

4 CONCLUSIONS

From the results of the ongoing system analysis, it is known that the OEE calculation process, availability, performance, quality, and achievement have several problems so that all of these problems can lead to an analysis process in dealing with issues and obstacles that occur in the production department requires a long time to find solutions and preventive maintenance. So, in the research conducted by the author, several results have been obtained, namely:

1. Industry 4.0 implementation by implementing data processing automation between machine devices and systems using IoT technology so that it can improve effectiveness and can be appropriately measured.
2. Communication between devices can be done using internet technology, where the tool sends a signal to the server, and the data is processed into the system.
3. M2M Controller can be made efficiently in a simple way, by developing a programming language

that can give commands to the controller to provide the data needed by the system.

4. Web Application-based systems can support OEE calculation processes, availability, performance, quality and achievement faster than before, this application system can be accessed by users through a variety of devices and platforms.
5. OEE calculation system which previously took 3 hours to prepare documents and calculations. However, the proposed system process that has been developed, then it accelerates the calculation process time in real time.

REFERENCES

Gunasekaran, M. and Periakaruppan, S. (2017). A hybrid protection approaches for denial of service (dos) attacks in wireless sensor networks. *International Journal of Electronics*, 104(6):993–1007.

Hashem, I. A. T., Chang, V., Anuar, N. B., Adewole, K., Yaqoob, I., Gani, A., Ahmed, E., and Chiroma, H. (2016). The role of big data in smart city. *International Journal of Information Management*, 36(5):748–758.

Hwang, G., Lee, J., Park, J., and Chang, T.-W. (2017). Developing performance measurement system for internet of things and smart factory environment. *International journal of production research*, 55(9):2590–2602.

Madakam, S., Lake, V., Lake, V., Lake, V., et al. (2015). Internet of things (iot): A literature review. *Journal of Computer and Communications*, 3(05):164.

Mahalakshmi, G. and Vigneshwaran, M. (2017). Iot based home automation using arduino. *Int. J. Eng. Adv. Res. Technol*, 3(8):1–6.

Murad, D. F., Abbas, B. S., Trisetyarso, A., Suparta, W., and Kang, C.-H. (2018). Development of smart public transportation system in jakarta city based on integrated iot platform. In *2018 International Conference on Information and Communications Technology (ICOIACT)*, pages 872–878. IEEE.

Nasir, N., Hashim, A. B., Fauadi, M. H. F. M., and Ito, T. (2018a). Statistical pattern recognition as an after service for statistical process control. In *Intelligent Manufacturing & Mechatronics*, pages 469–478. Springer.

Nasir, N., Ito, T., Hashim, A. B., and Fauadi, M. H. F. M. (2018b). The development of graphical overall equipment effectiveness interface. In *Intelligent Manufacturing & Mechatronics*, pages 671–683. Springer.

Ng, K.-C., Chong, K. E., and Goh, G. G. G. (2014). Improving overall equipment effectiveness (oee) through the six sigma methodology in a semiconductor firm: A case study. In *2014 IEEE International Conference on Industrial Engineering and Engineering Management*, pages 833–837. IEEE.

Tanwar, S., Tyagi, S., and Kumar, S. (2018). The role of internet of things and smart grid for the development of a smart city. In *Intelligent Communication and Computational Technologies*, pages 23–33. Springer.

Yang, H., Kumara, S., Bukkapatnam, S. T., and Tsung, F. (2019). The internet of things for smart manufacturing: A review. *IISE Transactions*, 51(11):1190–1216.