Oxygen Availability Control and Monitoring System in Hospitals using IoT

Nikko Aji Bayu Nugraha¹, Mashoedah²

¹,²Post Graduate Program of Electronic & Informatics Engineering Education, Faculty of Engineering, Universitas Negeri Yogyakarta, Indonesia

E-mail: ¹nikkoaji.2020@student.uny.ac.id; ²mashoedah@uny.ac.id

Abstract. Medical Gas is an important component in the treatment of patients with COVID-19 disease. Medical gas is used to help COVID-19 patients to reduce the effects of respiratory disorders by providing oxygen ventilators to patients. With the surge in typical COVID-19 sufferers as of July 2021, the need for Oxygen in hospitals is getting higher. This is when the control and monitoring of medical gases in hospitals are late because the integrated system is very dangerous. Therefore, a system that can be used to control and monitor medical gases in hospitals that are integrated and automated can be monitored by the Government and Medical Gas Producers. This is useful for anticipating the lack of availability of Medical Gas in hospitals. In this study, the system used IoT systems as a base in delivery and control. This system uses Arduino as a minimum system that reads the press sensor on the Medical Gas tube and regulates the valve. The data obtained is then sent to the Local Server to be processed and delivered to the Hospital Officer. Local Servers also send the data to cloud servers to be monitored by the government funds of several medical gas producers. This design can help in the process of controlling and monitoring Medical Gases in hospitals in hopes of minimizing the risk of delays in supplying medical gases to hospitals.

1. Introduction

Lately in Indonesia and all countries are fighting the Covid-19 Pandemic. This resulted in the hospital being filled with patients with the disease. Patients suffering from this disease mostly experience respiratory problems. To reduce the effects of respiratory disorders, the medical treatment carried out is to provide oxygen ventilators to patients. It is also increasing the need for Medical Gas for oxygen ventilators for patients with Covid-19. It is as revealed by Hermawan [1] that Covid-19 patients in Java and Bali soared, thus requiring oxygen of 2,620 tons per day. This surge in patients resulted in insufficient oxygen supply in the hospital. This is as revealed by Novelino [2] that the oxygen supply for the treatment of Covid-19 patients in D. I. Yogyakarta is dwindling. Even Dr. Sardjito General Hospital clarified that in the duration of 1 day only on Sunday, July 4, 2021, 63 patients at this Hospital died after the hospital lacked oxygen supply [3].

From these problems, control and monitoring are needed to find out the supply of Oxygen in the Hospital in Real-Time and can be accessed by all parties who are concerned in the provision of Oxygen Medical Gas. This is also in line with the Ministry of Health's program that the government continues to strive for and
monitor the availability of Oxygen, following reports from each hospital related to Oxygen stock [4]. With the development of IoT technology at this time, the problem should be helped by this technology.

2. **Research Methods**
In this study, the research method used is the study of literature. Literature is a method of collecting data from libraries, reading, and recording, and managing research materials [5]. In addition, literary studies are a mandatory activity when conducting research to develop theoretical aspects and aspects of practical benefits. Literature studies are conducted by researchers as a basis in the research process. The rationale is used to find and create the basis of theory, frame of mind, and the initial hypothesis in research. This is expected so that the researcher can group, allocate organize, and use the variety of libraries in their fields. This circuit study is also used by researchers to have a broader and deeper understanding of the problems to be studied. Researchers did a literature study at the time after they determined the research topic and established the formulation of the problem until before they plunged into the field to collect the necessary data [6].

3. **Research Results**
In several journals analyzed, the development of control systems is used to detect medical gas pressure in hospitals. As in the research conducted by Nur Hudha Wijaya [7] about the design of a tool used for monitoring the pressure of medical gas installations with digital systems. This tool is used to perform medical gas monitoring that can show low and high-pressure indicator information displayed on LCD screens equipped with a buzzer. The study succeeded in developing an automation system that can warn officers to know the level of pressure of medical gases that are being installed in the medical gas system at the hospital. But in the study conducted by Nur Hudha Wijaya [7] is only a monitoring system with buzzer signs for alarms centrally in the hospital. It still requires action from the officer to manually.

In addition to the research mentioned above, the study conducted by Atika Hendryani [8] also made the Medical Gas automation system at the Hospital in the form of a manifold system equipped with pressure monitoring for the automatic exchange of Oxygen gas cylinders using pressure sensors and microprocessors. The research results in an automation system for the automatic exchange of active gas cylinders on manifolds. Unfortunately, this system only discusses how a working manifold valve automatically moves from the Primary tube to the Secondary tube. With this research, it can be redeveloped with a touch of IoT technology for control and monitoring processes. The following is a block diagram design of the system developed by Atika Hendryani.

![Figure 1. Block Diagram Automatic system exchange of gas cylinders [8](image)](image)
The use of IoT in Medical Gas systems in Hospitals has been alluded to by Miasih [9] in his Research entitled "Development of Oxygen Volume Monitoring as a Basis for Determining Tariffs with IoT-Based Real-Time". In his research, IoT was used to set regulators and tariffs. In this system, take data from the gas flow meter sensor to be processed with a microcontroller to produce a tariff value that is then displayed on the LCD and also WEB. The advantages of this system can facilitate the calculation of rates and monitoring of Medical Gas in hospitals in a real case.

The use of IoT in Medical Gas monitoring systems in Hospitals was also implemented by Basuki Rahmat [10] in his research entitled "Telemonitoring Medical Gases". In the study, IoT was used to monitor the availability of medical gases and inform officers using mobile phone communication networks. From the study, the use of a phone when used to send virgins in real-time will cost a lot of money. Therefore in this research, the network system is used for the process of sending data using the internet network.

Lately, the concept of IoT has been widely used in the environment around us. However, IoT has been used on many devices to support daily life, the Internet of Things does not yet have a standard definition [11]. Therefore, based on some of the studies mentioned above, this study will develop the design of a centralized medical gas system control and monitoring system that can be monitored by various parties concerned with the IoT base. This system is expected to reduce the risk of delays in providing medical gas reserves. This is because the design of the development of this system aims so that every hospital, government, and medical gas producer can monitor the needs of medical gases at the hospital.

4. Discussion
4.1. Solenoid Valve Control
Based on research conducted by Atika Hendryani [8], the design developed in this study is a valve system that works automatically to move to a Secondary tube when the Primary tube is at a predetermined minimum pressure. The following are the valves and sensors in the Hospital Medical Gas installation system.
In the design, Medical Gas is divided into two, namely Primary Gas used to supply Medical Gas at Hospital Installations, while secondary gases are used as backup and turned into Primary Gas when primary gas was previously at minimum pressure.

The Medical Gas controller system uses an Arduino microprocessor to process the pressure sensor data and the position of the opened valve. This Arduino in addition to processing data from the sensor is also tasked with sending the data to the server with an Ethernet Shield device. The data sent to the server is in the form of large primary and secondary gas puzzles and the position of the valve opened.

### 4.2. Server

The server on this system has 2 parts, namely the local server and the cloud server. The Local Server is used by the Hospital to monitor the condition of the Medical Gas in the Hospital. This local server is tasked with processing data sent from Arduino which is then displayed on the computer for monitoring hospital officers. The data displayed from the computer is in the form of large pressures on primary and secondary gas cylinders and can provide warnings when there is an empty gas cylinder. In addition to monitoring, the Local Server is also used by the Officer to set the valve to work automatically or by the Officer's command.

Unlike the local server, cloud servers are useful for intermediaries in monitoring the condition of medical gases in hospitals. This server is used jointly by outside parties of the Hospital concerned in this case such as the Government and medical gas producers. This aims to monitor the condition and supply of Medical Gas at the Hospital so that there are no delays in the re-stock of Medical Gases such as the case that occurred at Dr. Sardjito Hospital [3]. The following is the design of the server system on the Hospital Medical Gas Control and Monitoring System.

![Server System Design](image)

**Figure 3. Server System Design**

### 4.3. Monitoring System

Monitoring on this system is divided into 2 parts, namely the first part and the second part. In the first part, monitoring is carried out in the form of pressure monitoring on the primary tube and secondary tube and can control the valve module fully in this system. Monitoring in the first part is carried out by hospital officials.

The second part is different from the first part. In the second part, this is only used to monitor the availability of Medical Gas in the Hospital. This monitoring is carried out by parties concerned in this case.
the Government and Medical Gas Producers. The following is the design of the monitoring system for both parts.

![Monitoring System Design](image)

**Figure 4. Monitoring System Design**

5. Conclusion

The conclusion of this study is based on several journals that have reviewed the design of Oxygen Availability Control and Monitoring Systems in Hospitals that can use IoT systems. This design can help in the process of controlling and monitoring Medical Gases in hospitals in hopes of minimizing the risk of delays in supplying medical gases to hospitals.

This study is only limited to making the design of the Oxygen Availability Control and Monitoring System in the Hospital. Therefore, it is necessary to review and further research so that this system can be realized. More research is needed to identify the minor needs needed to create a well-integrated system.

References

[1] H. Handaka, 09 July 2021. [Online]. Available: https://www.tribunnews.com/nasional/2021/07/10/pasien-covid-19-melonjak-jawa-bali-butuh-oksigen-2620-ton-per-hari-produksi-cuma-1400-ton. [Accessed 25 Agust 2021].

[2] A. Novelino, 23 June 2021. [Online]. Available: https://www.cnnindonesia.com/nasional/20210623145229-20-658349/stok-oksigen-di-yogyakarta-mulai-langka. [Diakses 25 Agust 2021].

[3] A. B. Tamtomo, 5 July 2021. [Online]. Available: https://www.kompas.com/tren/read/2021/07/05/173000165/-klarifikasi-kehabisan-oksigen-63-pasien-rsup-dr-sardjito-meninggal-dalam?page=all. [Accessed 25 Agust 2021].
[4] G. LOTULUNG, 04 July 2021. [Online]. Available: https://nasional.kompas.com/read/2021/07/04/15125391/kementerian-kesehatan-terus-upayakan-dan-monitor-ketersediaan-oksigen?page=all. [Accessed 25 Agust 2021].

[5] M. Zed, Literature Research Methods, Jakarta: Yayasan Obor Indonesia, 2008.

[6] H. Darmadi, Educational Research Methods, Bandung: Alfabeta, 2011.

[7] B. U. I. K. Nur Hudha Wijaya, “Medical Gas Pressure Monitoring at Hospital Medical Gas Installations,” Medika Teknika, 2019.

[8] V. N. N. D. Atika Hendryani, “Design of Manifold with Pressure Controller for Automatic Exchange of Oxygen Gas Cylinders in Hospital,” TEKNIK, 2021.

[9] B. G. I. A. K. Miasih, “Development of Oxygen Volume Monitoring as a Basis for Determining Tariffs with Real Time Equipped with IOT-Based Safety Regulators (Oxygen Volume as Tariff Determinants),” Doctoral dissertation Politekkes Kemenkes Surabaya, 2020.

[10] B. Rahmat, “TELEMONITORING GAS MEDIS,” Prosiding Seminar Nasional Widya Husada 1, 2019.

[11] A. Wijaya dan M. Rivai, “IoT-Based Irrigation System Monitoring and Control Using Banana PI,” Journal Teknik ITS, 2018.