

Monitoring Insole Shoes Condition Using Internet of Things

Nizar Ainul Yakin¹, Dadan Nur Ramadhan¹, Izanoordina Ahmad² & Radial Anwar¹

¹School of Applied Science, Telkom University, Bandung Indonesia

²Electronics Technology Section, Universiti Kuala Lumpur British Malaysian Insitute

Corresponding email: radialanwar@tass.telkomuniversity.ac.id

Abstract: Dermatitis frequently affects specific anatomical regions, notably the facial and foot areas. Human conduct, encompassing sock usage, holds the potential to influence both microclimatic conditions within shoes and ambient humidity. This study introduces a comprehensive examination framework tailored for employment within Telkom University, enabling the evaluation of sock-wearing effects on shoe humidity and the correlation between physical activity and perspiration levels. Employing the ESP32 microcontroller, the BME280 sensor facilitates tripartite parameter measurement—pressure, humidity, and temperature. This study outlines a continuous data transmission approach, with sensor values relayed at 15-second intervals following sensor activation cessation. Utilizing a foot-mounted sensor configuration, individual monitoring ensues, with constant scrutiny of body and insole temperatures. While the ambient temperature remains static, humidity levels persist, underscoring the need for an Internet of Things (IoT)-based insole monitoring prototype. The proposed methodology embodies the essence of the Fourth Industrial Revolution (IR4.0) and inter-device communication, underpinning real-time cloud-based data storage. This innovative approach demonstrates its potential to combat podiatric afflictions on a national scale.

Keywords: Internet of Things(IoT), Dermatitis, Sensor, Wi-Fi, FAVORIOT

1.0 INTRODUCTION

Skin irritation known as dermatitis can result in unsettling signs and symptoms like a red rash, itchy, dry, and scaly skin. Dermatitis comes in a variety of forms with various causes and traits. Figure 1 shows a statistical analysis of people with allergic contact dermatitis. The face and feet are the two body parts that experience dermatitis the third most frequently, as can be seen in the image. As a result, it is clear that wearing wet or damp shoes might result in dermatitis on the feet. Therefore, when our shoes are damp and wet, illness will result.

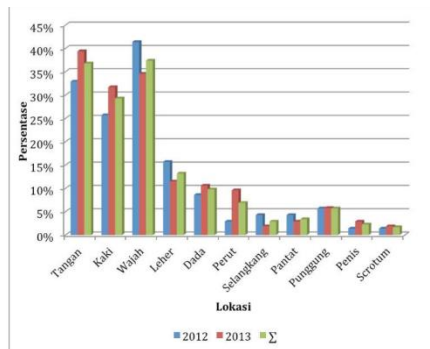


Fig. 1. statistical analysis of people with allergic contact dermatitis[1]

In [2], Nagano H. et al. conducted research on shoe-insole technology for injury prevention in walking. They

modified shoe insoles to include ankle joint support for fall prevention, shock absorption by using lower-resilience materials at the heel, improved reaction time by stimulating cutaneous receptors, and dynamic balance preservation through foot center of pressure control. Sensor technology, including motion capture systems and in-shoe pressure measurement, is used to conduct the experiment. The outcome shown that insole adjustments might enable more flexible ankle angles, enhance the distribution of foot pressure, absorb stress, and speed up proprioceptive reaction time.

To create wearable smart shoes, Meshram S. used wearable smart shoe technology for health and fitness in [3] GPRS, Arduino, and piezoelectric devices were used in the experiment that sends alert messages when tapped by foot when in danger. The outcome shows that Fitness Ratio is computed, communicated from a hardware component to an Android device, and graphically represented.

The development of smart, wearable electricity-generating shoes based on TENGs as described in [4] by Triboelectric Nanogenerator Enabled Smart Shoes for Wearable Electricity Generation by Zou Y. et al. Triboelectric nanogenerator used in experiment The findings suggested that smart electricity-generation shoes could serve as a widespread and sustainable energy source in the coming Internet of Things age.

To monitor gait using the sensor, in [5] the IoT-Based Sensor Shoes System For Gait Correction by Lee S was conducted. In order to distinguish between pigeon-toed walking and splay-footed walking, an experiment was undertaken. The outcome demonstrated the development of a shoe with gait analysis capabilities.

In [6] Towards Industry 4.0: Digital Transformation of Traditional Safety Shoes Manufacturer In Thailand with a Development of Production Tracking System by Intalar N, et al. to transform its production system of 40 years. The experiment conducted uses an inductive case study research design by interviewing executives and participating in the digital tracking development project using IoT sensors and image processing. The result showed developed a conceptual design and production tracking prototype in the safety shoe manufacturer in Thailand.

The previously mentioned has examined the research gaps from earlier studies. The first paper uses a lot of sensors, which will increase the cost of the product; the second paper uses Arduino, which cannot connect to the internet and must use a Wi-Fi module, which will decrease the product's efficiency; the third paper, which is TENG-based, cannot be used in this product because it is not simple; the fourth paper, which only uses a pressure sensor, is insufficient for monitoring shoes; and the fifth paper, which can monitor the outside of the shoe but not the insole.

Therefore, the purpose of this study is to determine whether wearing socks will change how humid the shoes are and whether the activity will have an effect on how humid they are.

2.0 METHODOLOGY

An input, namely from the BME280 sensor, which can measure temperature, humidity, and pressure, is shown in a block diagram of the evidence of the suggested development of the concept in Figure 1. Then, after receiving data from the input, this data will be processed by ESP32 using the Upycraft IDE where data processing takes place. When the data is prepared for collection, the data will be sent to the output, specifically the cloud here using the FAVORIOT platform to view the resulting data from the output.

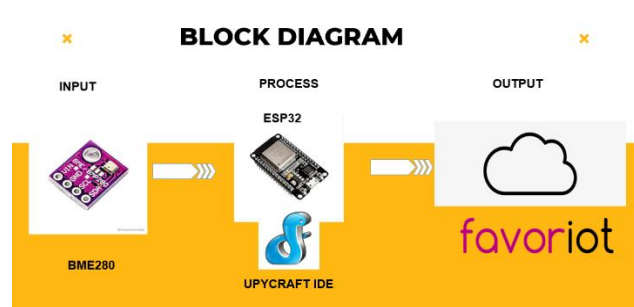


Fig 2. The block diagram of Monitoring Insole Shoes Condition Using Internet of Things

The operating flowchart in Figure 3 illustrates how the system begins with the initialization of the Wi-Fi module and BME280. T represents temperature, H represents humidity, and P represents pressure are then display by the BME280 sensor. The sensor values will be communicated to the FAVORIOT platform using the HTTP protocol in real-time. The application will then send the sensor readings periodically for 15 seconds and loop until the sensor or device is forced to cease, at which point the device will shut down.

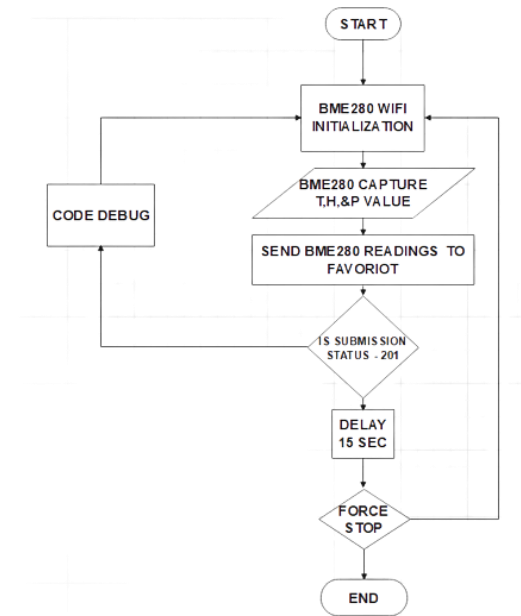


Fig.3 The flowchart of Monitoring Insole Shoes Condition Using Internet of Things

The circuit created here using the BME280 sensor and the ESP32 board is displayed in Figure 4 as the proposed modular insole monitoring circuit schematic. The BME280 sensor uses ESP32 as a processor to detect three parameters i.e temperature, humidity, and pressure. The pins VCC BME280 to 3v3 ESP32, GND BME280 to GND ESP32, SCL BME280 to pin D22 ESP32, and SDA BME280 to pin D21 ESP32 are some of the pins that connect BME280 and ESP32 are connected respectively.

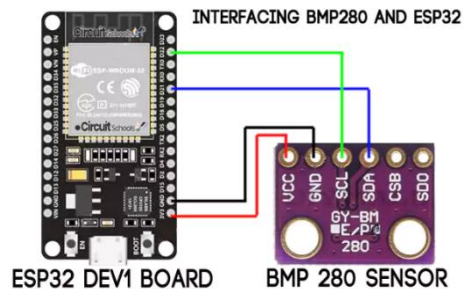


Fig. 4. Circuit diagram of the proposed system

3.0 RESULTS & DISCUSSION

Through the FAVORIOT platform, this project was created to keep track of the status of humidity, temperature, and pressure. The purpose of this experiment is to ascertain whether wearing socks will affect how humid the shoes are and whether activity will have an impact..

Figure 5 depicts the prototype project under development. A person's foot sensor is being used to measure him. In this project, campus shoes were used to test the built proof of concept's performance evaluation. Each micropython code file was downloaded and executed on the ESP32 microcontroller using the uPyCraft IDE to begin the system evaluation. To measure what is in the shoe's insole, then the BME280 sensor is inserted on the side of the foot.

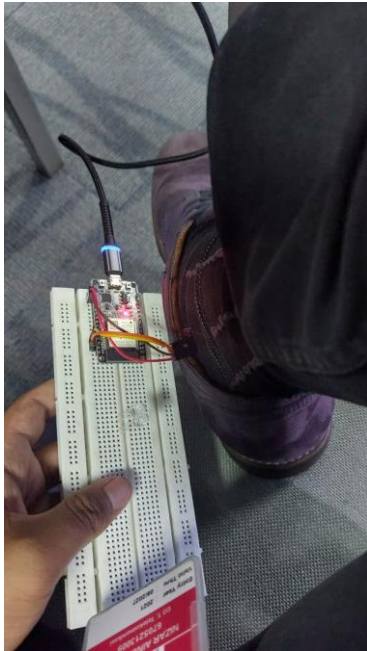


Fig. 5. Prototype of IoT Health Monitoring system for Elders

Figure 9 first depicts an insole measurement while wearing shoes and before engaging in physical exercise. Additionally, Figure 7 displays the temperature measurement findings. The graph there shows an increase as a result of the sensor's initial transformation of room temperature to insole temperature. The results of the humidity measurement are shown in Figure 6, where the graph reveals a drop caused by a factor associated with the sensor's initial determination of the room humidity. The outcomes of the pressure measurements are shown in Figure 8. Therefore, the pressure of the shoe insole also decreases the pressure on the graph.

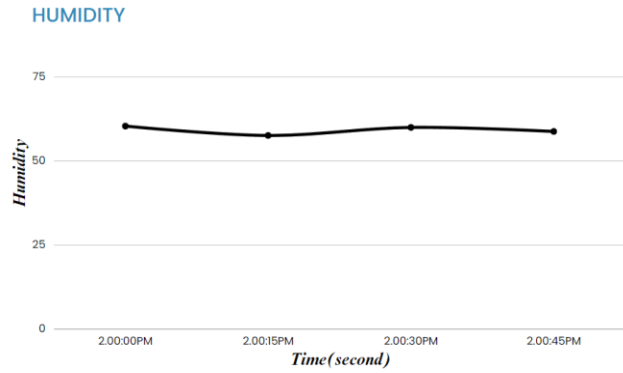


Fig. 6. Humidity testing when wearing socks before activity

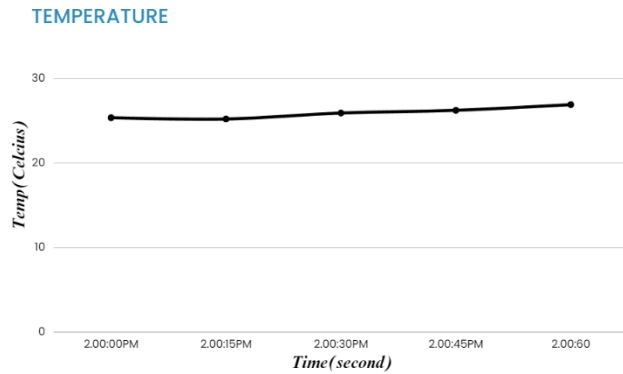


Fig. 7. Temperature testing when wearing socks before activity

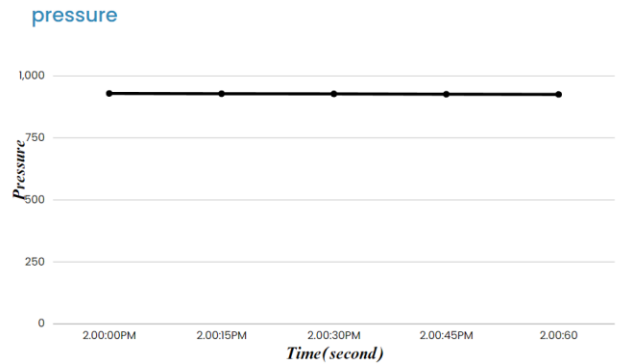


Fig. 8. Pressure testing when wearing socks before activity



Fig. 9. Condition sensor when measurements on shoes wearing sock before activity

Figure 13 from the second experiment depicts the insole measurement when wearing shoes without socks prior to exercise. The results of a temperature measurement are shown in Figure 10, where the graph shows a modest increase followed by a reduction. This is so that the sensor can measure both body temperature and the temperature of the insole in addition to the ambient temperature as the sensor starts to adjust to the insole's temperature.

The results of the humidity measurements are shown in Figure 11, where the graph indicates a reduction since the sensor initially detects wetness on the feet, where the condition of the feet is only after taking off socks. Due to the fact that the feet are still not very wet, the humidity will consequently fall. However, when the sensor adjusts, the humidity will increase, displaying the insoles' humidity. The outcomes of the pressure measurements are shown in Figure 12. Because the sensor is still measuring foot pressure, the pressure on the graph increases before it falls as a result of the sensor adjusting to the insole.

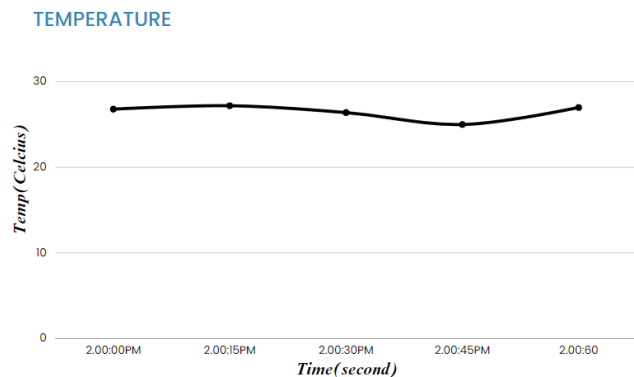


Fig. 10. Temperature testing when wearing not socks after activity

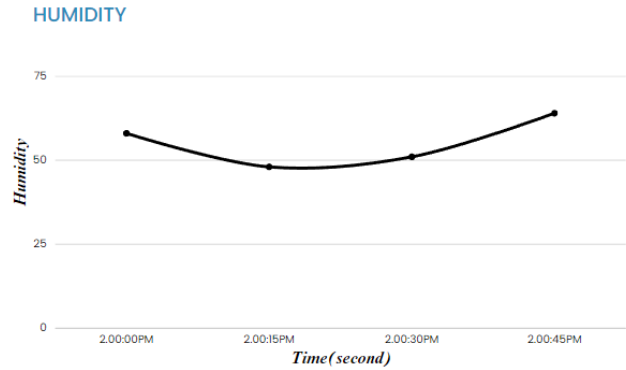


Fig. 11. Humidity testing when not wearing socks after activity

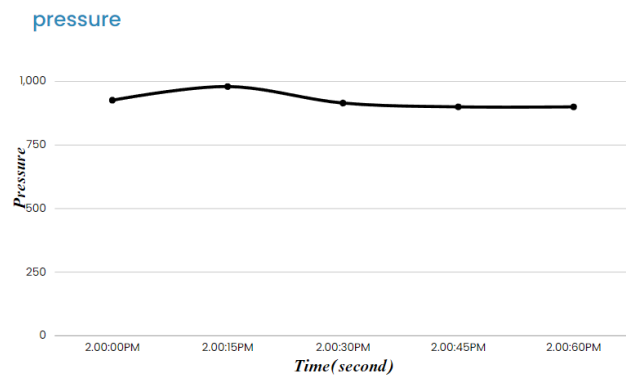


Fig. 12. Pressure testing when not wearing socks after activity



Fig. 13. Condition sensor when measurements on shoes not wearing sock after activity

Figure 17 from the third experiment depicts the insole measurement when wearing shoes without socks after exercise here using the right foot to measure it. Figure 14 displays the findings of the temperature readings, and the graph demonstrates a steady rise in temperature. This is performed so that the sensor can measure the temperature of the surrounding area before measuring the temperature of the insole and body.

Walking from the third level to the fourth floor increased foot temperature, which was further measured upon returning to class. Figure 15 displays the results of the measurements of humidity, where the graph shows a significant increase because the sensor detects foot moisture first; in this case, the feet are very sweaty, the humidity will rise because they are too moist, then the sensor adapts and the humidity drops, showing the humidity in the insole after activity. The outcomes of the pressure measurements are shown in Figure 16. Because the sensor monitors the insole after activity, the pressure on the graph indicates that this is decreasing.

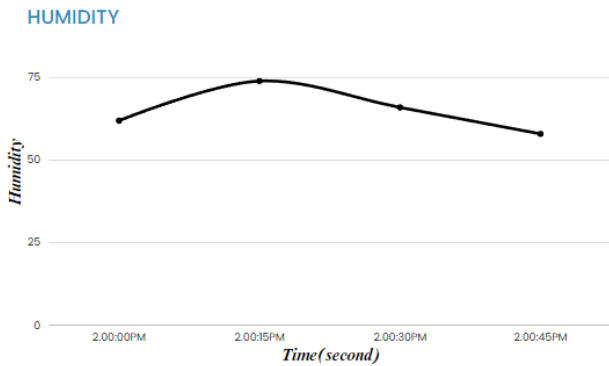


Fig. 14. Temperature testing when not wearing socks before activity

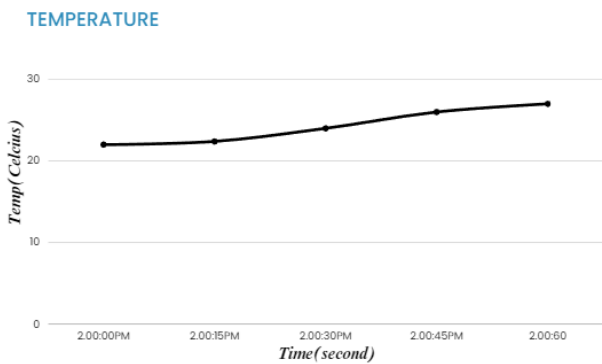


Fig. 15. Humidity testing when not wearing socks before activity

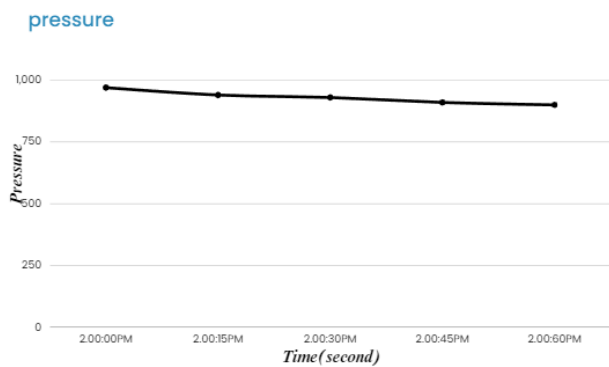


Fig. 16. Pressure testing when not wearing socks before activity



Fig. 17. Condition sensor when measurements on shoes not wearing sock before activity

Figure 21 from the fourth experiment displays the insole size when wearing socks following exercise using the left foot as a measuring tool. The results of temperature readings are shown in Figure 18, where the graph depicts a steady rise in temperature. This is due to the fact that the condition sensor monitors both body and insole temperatures after first determining the ambient temperature.

From walking the third floor to the fourth floor before returning to class for the measurement, which caused an increase in foot temperature. Figure 19 displays the results of humidity measurements. Because the sensor first detects moisture on the foot, where the condition of the socks is wet from perspiration, the graph shows a considerable increase in humidity. The sensor adjusts and the humidity persists as a result of the socks not being dry and still wet at the time, suggesting moisture in the insole following the motion. The humidity will increase because the feet are excessively damp. The outcomes of the pressure measurements are shown in Figure 20. When the sensor monitors the insole after activity, the pressure on the graph shows a reduction.

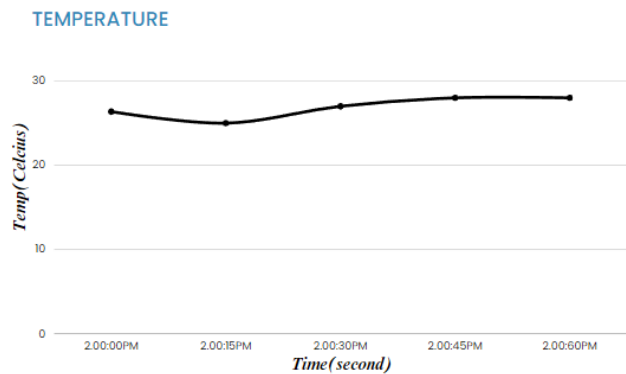


Fig. 18. Temperature testing when wearing socks before activity

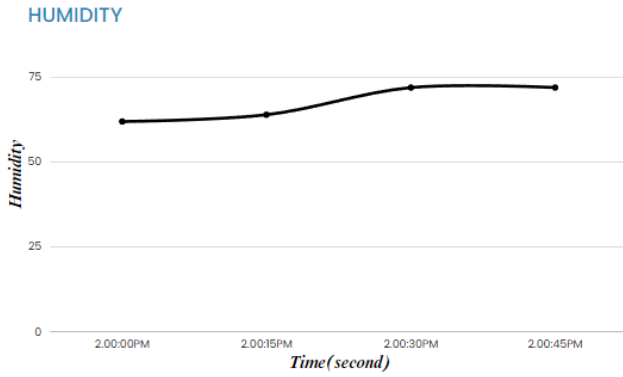


Fig. 19. Humidity testing when wearing socks before activity

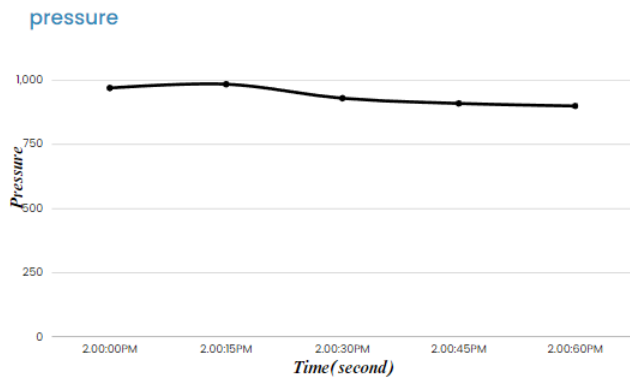


Fig. 20. Pressure testing when wearing socks before activity



Fig. 21. Condition sensor when measurements on shoes wearing sock before activity

4.0 CONCLUSION & RECOMMENDATION

This study proposes an IoT-based prototype for insole monitoring. The findings of the four tests showed that there were gaps in each one as well as gaps between the experimental measures made after and before the activity. Thus, based on the four trials that when our feet are in good

condition and we are wearing socks prior to an activity, the humidity is still good, but when shoes are sweating after the activity, the humidity must be high. In terms of avoiding foot illness in a nation, the proposed method has achieved industrial revolution 4.0 (IR4.0). Real-time data is managed in a cloud database and device-to-device connectivity is enabled utilizing the internet of things (IoT) concept.

ACKNOWLEDGMENT

Telkom University students and staff worked on this initiative, and the school provided financial assistance for the publishing. The authors are grateful to UniKL BMI for providing the lab space and funding, among other things.

REFERENCES

- [1] A. Dian Adiani, "KARAKTERISTIK DERMATITIS KONTAK ALERGI (DKA) DI RSUP DR. KARIADI JURNAL MEDIA MEDIKA MUDA," 2014.
- [2] H. Nagano and R. K. Begg, "Shoe-insole technology for injury prevention in walking," *Sensors (Switzerland)*, vol. 18, no. 5. MDPI AG, May 08, 2018. doi: 10.3390/s18051468.
- [3] S. Meshram, "Wearable Smart Shoe Technology for Health Fitness using IOT," *International Research Journal of Engineering and Technology*, p. 1820, 2008, [Online]. Available: www.irjet.net
- [4] Y. Zou, A. Libanori, J. Xu, A. Nashalian, and J. Chen, "Triboelectric Nanogenerator Enabled Smart Shoes for Wearable Electricity Generation," *Research*, vol. 2020, pp. 1–20, Jan. 2020, doi: 10.34133/2020/7158953.
- [5] S. Y. Lee, "IoT-Based Sensor Shoes System for Gait Correction," *International Journal of Electrical and Electronics Research*, vol. 10, no. 2, pp. 62–68, Jan. 2022, doi: 10.37391/IJEER.100202.
- [6] N. Intalar, K. Chumnumporn, C. Jeenanunta, and A. Tunpan, "Towards Industry 4.0: Digital transformation of traditional safety shoes manufacturer in Thailand with a development of production tracking system," *Engineering Management in Production and Services*, vol. 13, no. 4, pp. 79–94, Dec. 2021, doi: 10.2478/emj-2021-0033.