Planning and Design Hardware Products Internet of Things in the Indonesian Market

Yani Iriani[1], Taufik Angga Saputra[2]
[1,2)] Industrial Engineering Study Program, Faculty of Engineering, Widyatama University
Jl. Cikutra No.204, Kota Bandung, Jawa Barat 40125
yani.iriani@widyatama.ac.id, taufik.angga@widyatama.ac.id

Abstract. Internet of Things (IoT) connects everyday objects to the internet, transforming them into digital data. In Indonesia, IoT hardware design is underdeveloped, particularly in using radio signals for data transmission, leading to limited guidelines and regulations. This design aims to optimize aesthetics, functionality, reliability, and affordability while complying with regulations governing the 915-925 MHz frequency band. By adapting Ulrich's method with additional steps like observation, interviews, and document studies, the project achieved efficient hardware development within three months, enabling companies to digitize processes and monitor Overall Equipment Effectiveness (OEE) in real time. This systematic approach helps accelerate production, improve quality, and boost Indonesia's competitiveness in the global IoT market.
Keywords: Internet of Things (IoT); Regulation; Radio; Frequency; Overall Equipment Effectiveness (OEE); 925MHz

1 Introduction

1.1 Background

The development of internet technology worldwide is advancing rapidly, while Indonesia lags behind in hardware and software. In 2017, Indonesia scored 4.33 on the index, placing it second lowest among G20 countries and 114th globally, reflecting challenges in infrastructure, accessibility, and technological adoption.[1].
The journal discusses how underdeveloped countries like Indonesia, which struggle to compete in producing advanced hardware, can create quality products that meet regulations, such as using LoRa at 915 Mhz. It proposes a modified version of the Ulrich & Eppinger method, which consists of six phases: Planning, Concept Development, System-Level Design, Detail Design, Testing and Refinement, and Production Ramp-Up, to achieve efficient and quick production. By adapting this method, these countries can enhance their technological capabilities and foster innovation, ultimately improving their competitiveness in the global market.

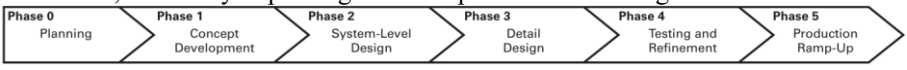

Figure 1 Product development process
(Source : Book Ulrich & Steven D,2016)

V. Mardiansyah and B. A. Prasetyo (eds.), *Proceedings of the Widyatama International Conference on Engineering 2024 (WICOENG 2024)*, Advances in Engineering Research 252,
https://doi.org/10.2991/978-94-6463-618-5_26

The development of this hardware is crucial for applying Industrial Engineering best practices, particularly in processing and predicting scenarios. Using IoT and Big Data, a robust transmission system with a serial communication protocol will ensure real-time updates. The design must be flexible and open-source, enabling collaboration with other companies, boosting efficiency, productivity, and competitiveness in local and global markets.The frequency allocation for IoT devices is regulated by the Ministry of Communication and Information[2].
The regulations manage licensing and frequency allocation to prevent interference, particularly in the 919-925 MHz range. This study finds the 920-925 MHz and 925-928 MHz bands suitable for M2M communication, considering spectrum availability and regulatory constraints.[3]

2 Flow Study

2.1 Flowchart

The flowchart will be used for each step in the research process that has been carried out. An overview of the sequence of the research process can be seen in the flowchart below:

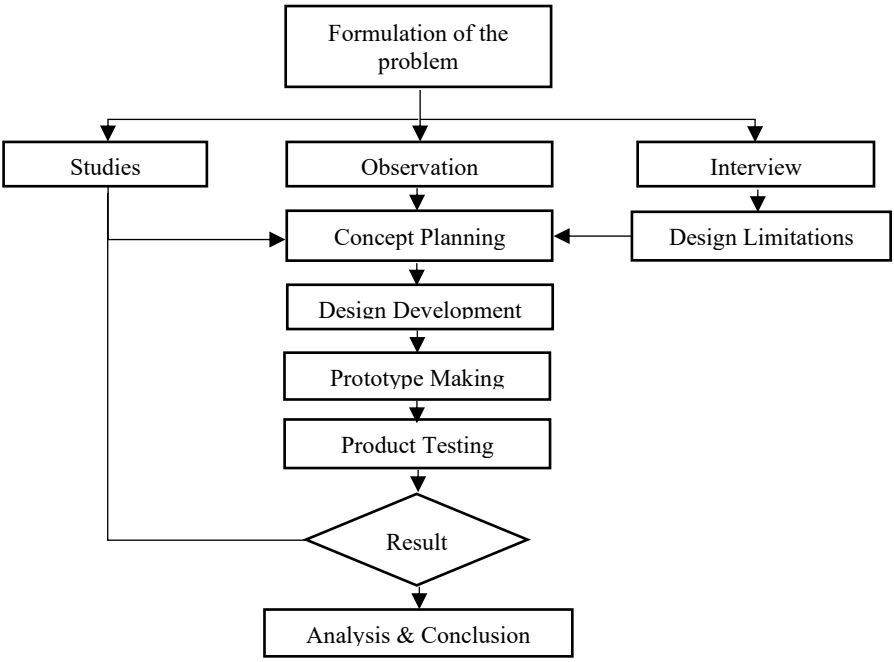

Figure 2 Flowchart of Ulrich method modification

2.2 Observation

According to Bagastio et al [4] Observation in digital transformation of SMEs is defined as an activity of direct observation and the implementation of a concept or theory in the field. This observation is carried out by delving deeper into practical aspects through product comparisons. The goal is to gain a more substantial understanding of the phenomenon being studied.

Table 1. Observation with products already on the market

Produsen	Telemetric (JiN) **Indonesia**	Bean Air IoT Gateway **German**	DSGW LoRaWan **China**	Advantech Wise **Europe**
Responsive	√	√	√	√
Max Node	50	30	20	100
Frequency	915Mhz	2,4Ghz	2,4~6Ghz	1Ghz
Bandwith/Node	*Custom*	80Mbps	120Mbps	20Mbps
Range Outdoor	2Km	800m	600m	1,5Km
Range Indoor	100~170m	20~29m	17~20	80~100
Power	5~35V	24V	7~24V	12~24V
Battery	-	-	√	√
Web Server	√	√	-	√
MQTT	√	-	-	√
RS485	√	√	-	-
Digital I/O	√	-	√	√
Waterproof	-	√	-	-
Customize	√	-	-	-
Battery RTC	√	√	√	-
Sensor 4-20mA	√	-	√	-
Sattelite GPS	-	-	-	√
Bluetooth	√	-	-	√

2.3 Interview

According to Thalha Alhamid & Budur Anufia form of dialogue conducted by researchers to obtain information from respondents is called an interview. The instrument is called an interview guide. In its implementation, interviews can be conducted in a structured and unstructured manner[5].

2.4 Document Study

Table 2. Document study

Writer	Year	Title	Summary	Relevance
Rochadiani, Widjaja, Santoso, et al Quote : [6]	2022	Implementation of IoT Technology Assisting in Monitoring Pool Water Quality	The study develops a LoRaWAN-based IoT system to monitor pH, TDS, and temperature in fish farms, addressing high pH levels identified through interviews.	This research is relevant for its use of LoRaWAN to transmit low data over long distances.
Ketut A, Afandi M, Pujiharsono H, et al Quote : [7]	2023	Implementation and Analysis Internet of Things System for electrical energy monitoring	The study develops an IoT-based system for real-time electrical energy monitoring in education, utilizing an Industrial Grade Power Meter connected through Modbus RS485 and mini PC. Data is sent via MQTT to a server and displayed on a dashboard, with tests validating its accuracy.	The report highlights the relevance of RS485, MQTT, and mini PCs for data processing and dashboard display.

2.5 Concept Planning

Making concept planning means making a decision in the form of steps to solve a problem or carry out work that is directed at achieving a certain goal. [8]. Planning is a crucial stage in product development, as the specifications for the CPU, memory, and RAM directly influence the final outcome of the product.

Table 3. Matrix of the relationship client needs and the product to be made

Relationship Matrix		**Target Metrics**	1 year warranty	Wireless Communication LoRa	Ethernet	*Mini PC*	Data Encryption	Adjust Regulations	Competitive price	*After Market Consult*	Cloud Database	Customize	Modular Design	Memory Log	Training	Function & Features Documentation	**Level of Need**
Consumer Needs																	
1	Must have warranty		5														5
2	Can be run on a local network			2	2	1											5
3	Consumer data security						2										2
4	Comply with regulations							5									5
5	Competitive prices								5								5
6	Q&A service									3							3
7	Guaranteed data will not be lost						2										2
8	Accurate data reading				1		1										2
9	Can be completed remotely				1	1					2			1			5
10	Informative and easy design											2			2	1	5
11	Can be integrated with old machines												2				2
12	Can integrate with the latest technology											3	1				4
13	Ability to add or remove devices												2				2
14	Easy to use product									1					2	2	5
15	Can connect MQTT				1						3						4
16	Can be used without internet access			3										2			5
	Level of Interest		5	5	5	2	5	5	5	4	5	5	5	3	4	3	

2.6 Design Development

The development design stage involves creating evaluation instruments to assess the effectiveness of a product. In this study, three levels of validity were implemented, beginning with expert adequacy [9]. This outline describes the PCB design process, which comprises several intricate stages, such as building a component library and understanding component specifications from literature and datasheets. For simplicity, we will focus on the initial step: creating a schematic diagram of the intended components.

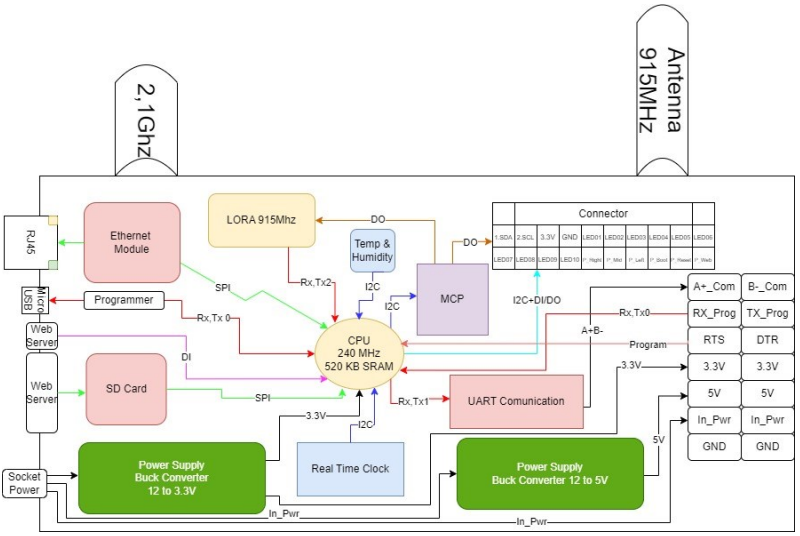

Figure 3 Flowchart Hardware Design

The Master Module handles data processing, encryption, and storage on an SD card in case of transmission issues. It also regulates communication between modules, organizing data in a queue before sending it via LoRa or Ethernet, ensuring smooth data transmission across the system.

2.7 Prototype Making

Prototyping itself is an initial method of developing a device to display a concept in real life. [10]. In the design of Printed Circuit Board (PCB) there are some detailed discussions that I might miss such as how to choose the right components, how to read a good datasheet to find the right components. How to make an enclosure case, and some other detailed things related to the design due to the maximum page limitations in making this journal, but here I will provide a picture of the final design.

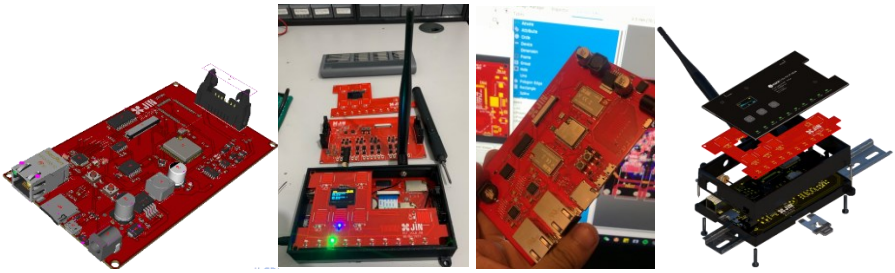

Figure 4 Product Assembly

2.8 Product Testing

Product product testing refers to the evaluation of product attributes in various environments. This testing involves assessing consumer reactions and behaviors when interacting with products, as opposed to traditional methods where physical handling occurs [11]. This is the final stage of the prototype development process, where all the components are assembled according to the previously established design. At this stage, the product undergoes testing to assess its reliability, data transmission capabilities, and the security of the data being sent.

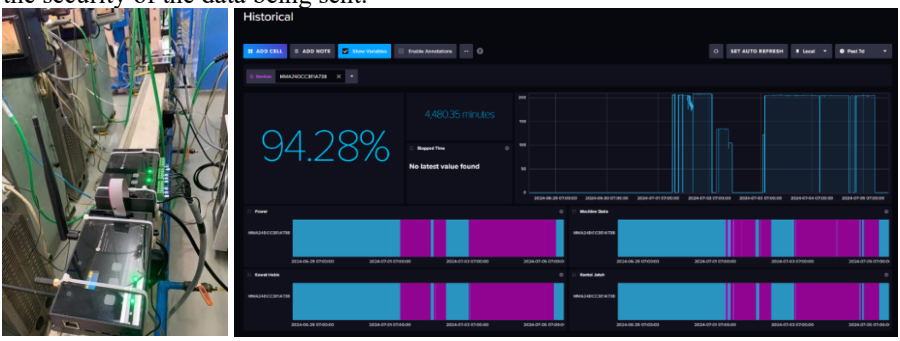

Figure 5 OEE data calculation

3 Result

3.1 Conclusion

In designing optimal Internet of Things (IoT) hardware for the Indonesian market, it is crucial to address consumer expectations and competitive factors. Key design criteria include:

a. A minimum one-year warranty.
b. Compliance with the 915-925 MHz frequency regulations.
c. Operational capability at a minimum distance of 100 meters without internet connectivity.
d. Accurate data transmission with robust security.
e. Competitive pricing.
f. Upgradeable systems compatible with both legacy and new devices.
g. Durable design with appealing aesthetics.

By adhering to these criteria, we can ensure the development of effective and market-ready IoT hardware.

3.2 Suggestion

Ulrich's method assumes that product makers have experienced staff or sufficient capital, which may not apply in Indonesia. Thus, the author needs to adjust the planning method based on limited experience, requiring extensive literature review from journals and theses to guide pricing. Prototyping is time-consuming and costly, and while the author attempts to collaborate with local vendors, quality and pricing often fall short. The research aims to encourage local vendors to recognize opportunities in production processes, fostering development in Indonesia and reducing reliance on foreign vendors in the future.

References

[1] Dina, "Menangkap 'Pesan' dari ICT Development Index 2017," KOMINFO. Accessed: Apr. 04, 2024. [Online]. Available: https://www.kominfo.go.id/content/detail/11924/menangkap-pesan-dari-ict-development-index-2017/0/sorotan_media

[2] L. Judijanto, A. Triwiyatno, and S. Sofyan, "The Influence of Internet of Things (IoT) on Operational Efficiency and Competitive Advantage in the Information Technology Industry in Indonesia," *The Eastasouth Journal of Information System and Computer Science*, vol. 1, no. 03, pp. 155–166, Apr. 2024, doi: 10.58812/esiscs.v1i03.240.

[3] L. Nurpulaela and R. S. Hadikusuma, "IoT Frequency Band Channelization in Indonesia as A Recommendation for Machine-To-Machine Communication Preparation in the 5G Era," *Jurnal ELTIKOM: Jurnal Teknik Elektro, Teknologi Informasi dan Komputer*, vol. 7, no. 1, pp. 50–59, 2023.

[4] R. J. Bagastio, R. Harizillah, R. A. P. Subekti, and R. R. Saedudin, "Peran Proses Bisnis dalam Transformasi Digital UKM: Systematic Literature Review mengenai Teknologi yang Diadopsi," *SITEKNIK: Sistem Informasi, Teknik dan Ilmu Terapan*, vol. 1, no. 1, pp. 32–40, 2024.

[5] T. Alhamid and B. Anufia, "Resume: Instrumen pengumpulan data," *Sorong: Sekolah Tinggi Agama Islam Negeri (STAIN)*, 2019.

[6] T. Rochadiani, W. Widjaja, H. Santoso, Y. Natasya, U. Ariqoh, and R. Rahayu, "PENERAPAN TEKNOLOGI IOT DALAM MEMBANTU PEMANTAUAN KUALITAS AIR KOLAM PETERNAK IKAN," *Prosiding Konferensi Nasional Pengabdian Kepada Masyarakat dan Corporate Social Responsibility (PKM-CSR)*, vol. 5, pp. 1–10, Jul. 2022, doi: 10.37695/pkmcsr.v5i0.1789.

[7] A. E. I. Ketut, M. A. Afandi, H. Pujiharsono, F. N. Gustiyana, H. Krishna, and F. H. Juwono, "Implementation and Analysis of the Internet of Things System for Electrical Energy Monitoring At Institut Teknologi Telkom Purwokerto," *Jurnal Teknik Informatika (Jutif)*, vol. 4, no. 3, pp. 627–638, 2023.

[8] W. Kurniawati, "Desain Perencanaan Pembelajaran," *JURNAL AN-NUR: Kajian Ilmu-Ilmu Pendidikan dan Keislaman*, vol. 7, no. 01, pp. 1–10, 2021.

[9] E. Calle *et al.*, "Optimal design of water reuse networks in cities through decision support tool development and testing," *NPJ Clean Water*, vol. 6, no. 1, p. 23, 2023.

[10] H. Maulana, K. Kasmawi, and D. Enda, "Buku Penghubung Berbasis Android Menggunakan Metode Prototyping," *Jurnal Teknik Informatika dan Sistem Informasi*, vol. 6, no. 3, 2020.

[11] G. Branca, R. Resciniti, and S. M. C. Loureiro, "Virtual is so real! Consumers' evaluation of product packaging in virtual reality," *Psychol Mark*, vol. 40, no. 3, pp. 596–609, 2023.