International Journal of Educational Review
Volume 5 (2) 2023, 87-100
E-ISSN 2685-709X, P-ISSN 2685-905X

SMART CADETS Prototype Design: Data-based RFID for Cadet Academic Hours Optimization Using ESP32 Microcontroller Media

Bambang Wijaya Putra[1], Parjan[1], M. Efaldes Syahputra[1], Hana Fatiha[1], M. Alamsyah[1], Afra Nabilah A[1]
[1]Politeknik Penerbangan Palembang, Indonesia

Corresponding author e-mail: bambang@poltekbangplg.ac.id

Article History: Received on 3 August 2023, Revised on 18 October 2023, Published on 4 November 2023

Abstract: In current conditions, many cadets do not comply with learning rules, especially academic hours. The regulation states the total academic hours are 8 hours. Of course, this causes less than optimal use of classroom learning time and until now there is no digital monitoring system that can provide academic hours data-based. This research aims to improve time discipline in cadet academic education to improve time efficiency and ease of monitoring cadets' compliance with compulsory education by developing a Prototype of an RFID attendance system provided with website data-based using an Arduino ESP32 system controller. The methodology used is Research and Development starts with an observation, literature study, design, and testing. The result is a prototype that can help monitor cadet learning time and activities using the ESP32 Microcontroller to connect to the website database. The system is set to not send data if cadets arrive and depart before the specified time. After that, the data will be distributed to a spreadsheet as material for the evaluation of each cadet. Based on the results, we can conclude that the RFID-based attendance system meets all the desired criteria and meets user needs. Based on the results of questions asked to 16 respondents, the survey results showed that 69% strongly agreed, 19% agreed, 9% were neutral and 3% disagreed. However, we will continue to evaluate and improve this RFID-based attendance system to improve its performance in the future.

Keywords: ESP32 Microcontroller, RFID, Database

A. Introduction

Politeknik Penerbangan Palembang cadets in all matters are regulated including the mandatory eight hours of study as regulated. However, in this case, cadets often go home earlier than what has been regulated and it is feared that this will reduce the effective hours of study which can be benefited by looking at the teacher's readiness, ability to use technology and applications the 8 hours study hours that have been determined (Nizam et al., 2022). In current conditions, many cadets do not comply with learning rules, especially academic hours. The regulation states the total academic hours are eight hours. Of course, this causes less than optimal use of classroom learning time and until now there is no digital monitoring system that can provide academic hours data-based. This *Smart Cadets* allows all cadets to tap Radio-Frequency Identification (RFID) which is defined as a method of collecting data from a distance of 3-4 cm (Prasetiyo et al., 2018), which each individual has as a media for entering and leaving according to with the provisions of cadet academic hours. *Smart Cadets* use the ESP32 Microcontroller as stated in (Amalia et al., 2022) as a module processor that has a *System on Chip* (SoC) with a processor, data storage, and access to *General Purpose Input Output* (GPIO) as a platform which is an open-source development tool that can be coded using the language *Integrated Development Environment* (IDE) programming (Halim et al., 2019; Pérez, 2023)which is a software package used for testing other software. (Samsugi et al, 2017) and (Setiawan, 2022) state in their research that Arduino is an open and closed system and will process the data read into a spreadsheet. After that, the data is calculated as material for assessing each cadet. ESP32 was introduced by Espressif Systems which is the successor to the ESP8266 microcontroller (Arrahma et al, 2023) and (Setiawan, 2022).

The research by (Fauziah et al., 2017) uses the NUC100 to implement RFID with a total of 32-bit microcontrollers but at a high cost. This research uses 32-bit ESP (Rukin et al., 2022) because the program or command processing speed is faster, a low-cost, low-power system with a WiFi module integrated with the microcontroller chip, and dual-mode Bluetooth with power-saving features making it more flexible. ESP 32 is compatible with mobile devices and Internet of Things (IoT) applications (Athallah Muhammad Yazid & Agung Permana, 2022). IoT has already been implemented in many projects such as for smart cities (In, 2017), smart parking systems (Ganesh Gopal et al., 2019; Gopal et al., n.d.; Khanna & Anand, 2016), and also implement to the smart home systems (Ravikumar & Kavitha, 2021; Utari, 2021). It is also used for developing firefighting robotic (Aulia et al., 2021) and a system monitoring in aerodrome airfield lighting system (Beacon et al., 2021). By using an ESP32 microcontroller it is not only possible to complete stand stand-alone system but also can be operated as a support device for a host microcontroller. ESP32 is a chip with 2.4GHz WiFi and Bluetooth with 40 nm technology design designed for the best power and radio performance demonstrating robustness, versatility, and reliability in a variety of applications and power scenarios as a bridge from existing microcontrollers to WiFi networks (Kusumah & Pradana, 2019).

Figure 1. Mikrocontroller ESP32

In the *Smart Cadets* design, only a few pins are used. Like RFID, it only uses Pins 4 and 5 as SS and RST Pins, then Pin 2 is used for VCC Buzzer input and Pin 12 for VCC Button Reset input. The Gnd Pin is written directly in the ESP 32 module. More detailed specifications are shown in the following Table 1.

Table 1. Specification of ESP32

Attribute	Details
CPU	Tensilica Xtensa LX6 32bit
Dual-Coredi 160/240MHz	
SRAM	520 KB
FLASH	2MB (max. 64MB)
Voltage	2.2V - 3.6V
Work Flow	Average 80mA
Programming	Ya (C, C++, Phyton, Lua,
dll)	
Open Source	Ya
Connectivity	
Wi-Fi	802.11 b/g/n
Bluetooth ®	4.2BR/EDR + BLE
UART	3
I/O	
GPIO	32
SPI	4
I2C	2
PWM	8
ADC	18 (12-bit)
DAC	2 (8-bit)

This *Smart Cadets* is equipped with an electronic display which is an electronic component that functions as a display of data, whether characters, letters, or graphics. *Liquid Cristal Display* (LCD) is a type of electronic display made with CMOS logic technology that works by not producing light but reflecting light around it towards the front-lit or transmitting light from the back-lit. LCD functions as a data display in the form of characters, letters, numbers, or graphics. LCD material is a layer of an organic mixture of clear glass layers with transparent indium oxide electrodes in the form of a seven-segment display and an electrode layer on the back glass. When the electrode is activated with an electric field (voltage), long, cylindrical organic molecules align themselves with the electrode of the segment (Yusup, 2022). The sandwich layer has a front vertical light polarizer and a rear horizontal light polarizer followed by a reflector layer working simultaneously (Son Maria & Susianti, 2022).

The reflected light cannot pass through the molecules that have adapted and the activated segments appear to darken and form the character of the data to be displayed. Controlling the LCD In the LCD module there is a microcontroller that functions as a controller for the LCD character display. LCD has 14 to 16 pins. These pins have their respective uses. Interface (Interfacing) can use 8-bit or 4-bit systems. It will save 4 microcontroller ports if you use a 4-bit system. The uses of each pin are as follows:

Table 2. The function of each Microcontroller PIN

PIN	Name	Function
1	God	Ground
2	Vcc	+5 Volts
3	Vref	Brightness Control
4	RS	Instruction/data selector
5	R/W	Read/Write selector
6	E	Bit Enable
7	D0	Data Bit 0
8	D1	Data Bit 1
9	D2	Data Bit 2
10	D3	Data Bit 3
11	D4	Data Bit 4
12	D5	Data Bit 5
13	D6	Data Bit 6
14	D7	Data Bit 7
15	*Backlight* (+)	Optional
16	*Backlight* (-)	Optional

PINs 15 and 16 are only available on LCDs that are equipped with a backlight which makes the LCD readable in dark conditions (Sani & Maha, 2017). Some LCDs do not have this backlight facility so PIN 15 and 16 are not available. The instruction word sent to the LCD will tell what the LCD controller must do. Before writing a message to the LCD, we must know the address of the character on the LCD. The following are the general character addresses on the LCD.

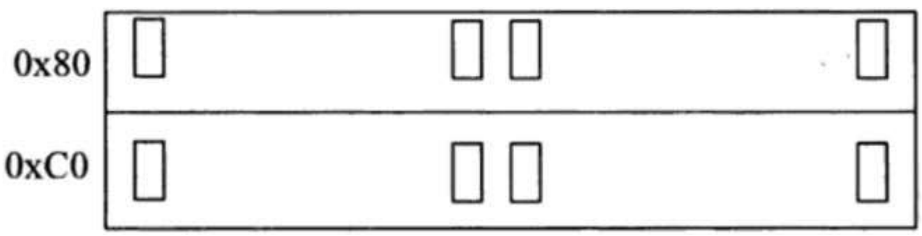

Figure 2. LCD 2 Line

On a 1-line LCD, the starting address is 0x80 and contains 8 characters. While the 9th character has the address 0xC0 and so on. Meanwhile, on a 2-line LCD, the starting address on the first line is 0x80 while the starting address on the second line is 0xC0 (Ibnu Malik & M.U, 2009).

B. Methods

This research uses the 4D method containing four steps: Devine, Determine, Design, and Disseminate (Riti et al., 2021) which is a research method to produce certain products and early stage testing and testing the effectiveness. Development research is characterized by the creation of a product at the end of the research (Arum & Fahmi Dzikirillah, 2023).

The sample in this study is 24 second-level cadets of Diploma IV Teknologi Rekayasa Bandar Udara (DIV-TRBU) Politeknik Penerbangan Palembang.

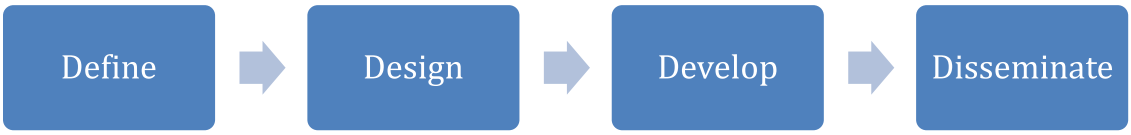

Figure 3. 4D Method Steps

The following are several analysis stages that need to be carried out in designing an RFID-based attendance system: 1) Define the first step for identifying user needs. This includes understanding the number of sample cadets, class location, distance between office locations, and the type of RFID card that will be used. At this stage, it is also necessary to understand what attendance reports are required. 2) After that Determining and designing Hardware and Software used After user needs have been identified, the next stage is determining and designing the hardware and software that will be used in the system. Hardware selection includes RFID readers, RFID cards, and software needed to process attendance data. Defining the problem that may arise in an RFID-based attendance system. This includes problems with inaccurate RFID card reading, network and connection problems, as well as problems with the attendance management system. 3) Next part is Design: After the problem is identified, the next stage is to design an RFID-based attendance system. In this stage, it is necessary to consider the design of a user interface that is easy to use, integration with existing attendance management systems, and the selection of attendance data processing methods. 4) Finally Developing the final stage in the analysis is testing the RFID-based presence system. This testing aims to ensure that the system works well and meets user needs. System testing includes RFID card reading trials, network and connection trials, as well as attendance management system trials.

C. Results and Discussion

This development research has an output in the form of a web-based attendance system product and RFID sensors. These Smart Cadets aim to be used as a tool to assist lecturers in making attendance to cadets who want to enter and leave the class when taking part in lecture activities. Also, as a reference source to see the level of efficiency of cadets in participating in learning activities every day. In general, the design of this presence tool utilizes an RFID sensor that is placed in a microcontroller box in a certain place, which has the function of receiving input in the form of TAP carried out by humans with an RFID card and then the data that has been input using the RFID card will be processed by the microcontroller and sent to the database on the website that was created previously. Each of these tools is installed at the entrance and exit of each classroom for each study program at the Politeknik Penerbangan Palembang.

Define step, this is the first step to identify the needs that need to be met by the Smart Cadets by conducting observation and literature study. The results to be considered are the number of cadets who will use the Smart Cadets, the type of RFID card that will be used, the RFID reading range, data security, and the type of report required. Smart cadets are placed at Second-Level Diploma IV Airport Engineering Technology (DIV-TRBU) cadets as a testing medium for the early stages of design. The data obtained is the basis for evaluating the initial stage of testing.

Figure 4. Flow the research of Smart Cadets

To make the design process easier, researchers tried to map the design into three parts, there are Input, Process, and Output. In the input section, there is an RFID tag which is used as supporting equipment in designing Smart Cadets. Then in the process section, there is an RFID reader and ESP 32 Microcontroller as well as additional features with the help of an integrated database. Finally, Smart Cadets will produce output in the form of data which is integrated with website admin notifications and an LCD that lights up when the data starts processing.

The design step is conducted after the needs have been identified in the flowchart system (Ensmenger, 2016; Yilmaz, 2020; Xinogalos, 2013), the next step is to plan the attendance system based on the needs that have been determined. This involves selecting hardware and software that suits the needs, including RFID cards, RFID readers, databases, and software for processing attendance data. Creating a Smart Cadets After the system is planned, the next step is to create a Smart Cadets that suits our needs. This involves creating electronic circuits and assembling hardware, such as RFID readers, displays, and buttons for data input. The equipment needed for Smart Cadets will be integrated using the help of ESP 32 so that each module will work through one command and be integrated.

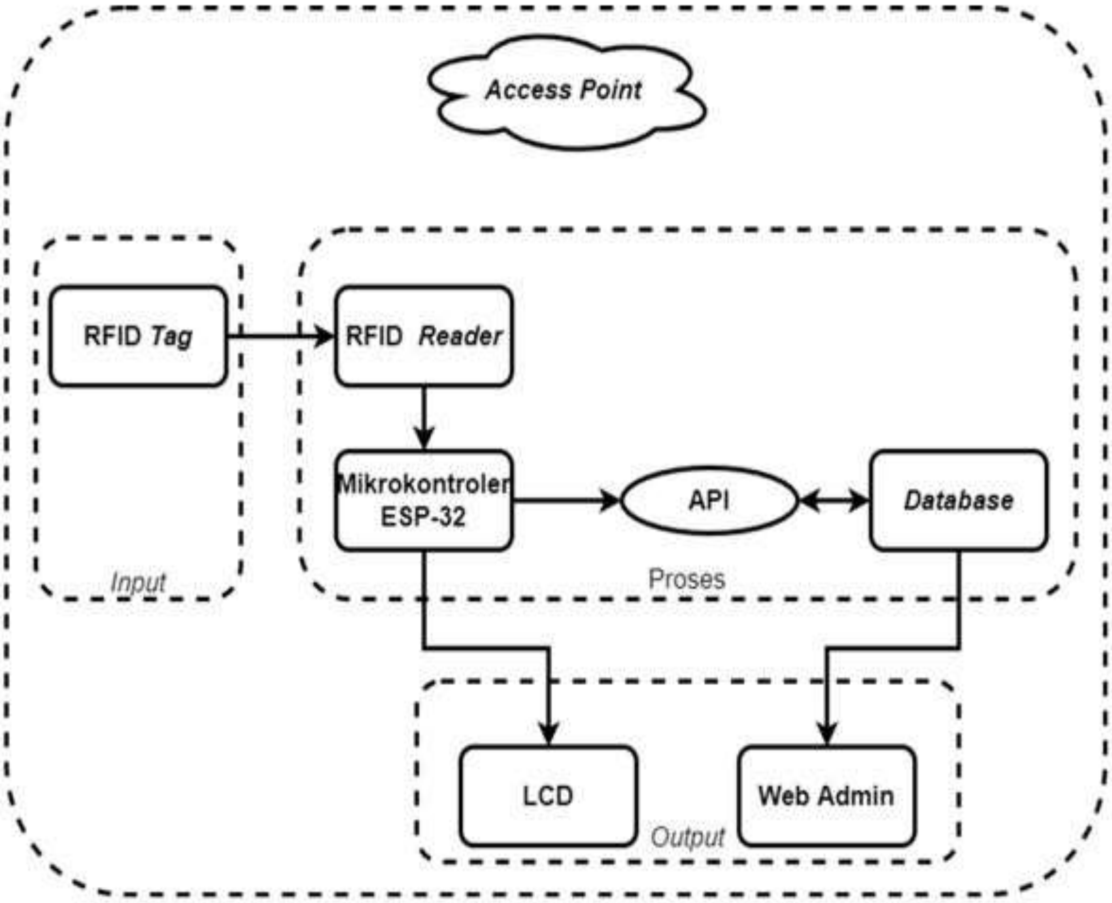

Figure 5. Flowchart system of Smart Cadets

Following the flowchart above, the first Input is an RFID Tag which then cadets can attach their RFID card to the RFID Reader. After that, the RFID Reader will read the RFID card data and check its validity in the database. If the RFID card is valid, Smart Taruna will send the data and then it will be sent to the ESP-32 Microcontroller System. Then the Request API will be informed to the database that a withdrawal or addition to the database will be made. The LCD will be integrated as the output of the

RFID Tap results, then the database will send the data to the Website Admin dashboard

The development step is the next step after the presence tool has been created, the next step is to carry out testing and debugging to ensure the tool functions correctly. This involves testing the RFID readers and RFID cards used, as well as testing the data input, display, and report functions, and integration with Existing Systems: Once the Smart Cadets are tested and working properly, the final step is to integrate the Smart Cadets with the existing system. This involves integration with existing employee databases and attendance management systems, as well as configuring software to process attendance data.

Figure 6. Design Of RFID ESP 32

This stage is the design stage of Smart Cadets, there are several components used, namely the MFRC-522 RFID Module, ESP 32, LCD 12C, Buzzer, and Tactile Button. All these components are integrated into one programming with predetermined commands as seen in Figure 6.

The Smart Cadets design, especially in the development section, of course, must have several additional features, including the addition of a buzzer that is integrated with ESP 32. This is done to identify the need for warnings or signs that can be used as a reference that the data and tools are functioning properly. Then the MFRC-522 display is used as a development of the Smart Cadets product because it uses compatible and integrated features towards the RFID Module and ESP 32. Then the use of a 12C LCD which can be integrated with the Serial Clock (SCL) pattern, of course, can make The I2C LCD work in parallel as output data and input data in the Smart Cadet design series that will be developed.

No.	Nama	Tanggal	Prodi	Jam Keluar	Jam Masuk	Jam Masuk Siang	Jam Kembali Sore
1	RAKHA RACAHYO	2023-07-25	TRBU02	07:14:27	11:35:59	13:11:31	15:52:07
2	HAIMAM ALKAUSAR	2023-07-25	TRBU02	07:10:33	11:33:55	13:07:55	15:48:50
3	FADLY FEBRIANSYAH	2023-07-25	TRBU02	07:10:55	11:34:05	13:08:09	15:49:07
4	I GUSTI ADYATMIKA W	2023-07-25	TRBU02	07:11:11	11:34:27	13:08:40	15:49:49
5	M FARIZI HERNANDO	2023-07-25	TRBU02	07:11:44	11:34:49	13:08:57	15:49:27
6	EGIA KEYKENANTA M	2023-07-25	TRBU02	07:11:59	11:34:22	13:09:01	15:49:53
7	M ICHSAN RAMADHANI	2023-07-25	TRBU02	07:12:13	11:34:47	13:08:59	15:49:55
8	ANAS SYAHRA PUTRA	2023-07-25	TRBU02	07:12:22	11:34:58	13:09:15	15:49:57
9	M FAIQ ARRIDHO	2023-07-25	TRBU02	07:12:35	11:35:05	13:09:27	15:50:04
10	FRENDY KHAN THREMA	2023-07-25	TRBU02	07:12:47	11:35:15	13:09:36	15:50:19
11	ARYA YUDHISTIRA PERDANA	2023-07-25	TRBU02	07:12:55	11:35:24	13:09:51	15:50:31
12	PUTUT AIRLANGGA	2023-07-25	TRBU02	07:13:11	11:35:33	13:10:07	15:50:45
13	ARYA BIMA PRAMUDYA	2023-07-25	TRBU02	07:13:19	11:35:45	13:10:15	15:50:57
14	PUTU WISNU ARDIA CHANDRA	2023-07-25	TRBU02	07:13:27	11:35:58	13:10:26	15:51:07

Figure 7. Database 1 from Integrated Website

No.	Nama	Tanggal	Prodi	Jam Keluar	Jam Masuk	Jam Masuk Siang	Jam Kembali Sore
15	GADI AL AYUBI	2023-07-25	TRBU02	07:13:35	11:35:05	13:10:30	15:51:11
16	REHAN ZIKRI AVIAN	2023-07-25	TRBU02	07:13:40	11:35:11	13:10:40	15:51:19
17	MADE PUTRA DARSANA	2023-07-25	TRBU02	07:13:49	11:35:17	13:10:47	15:51:27
18	NABILAH HASNA ARINDA	2023-07-25	TRBU02	07:13:55	11:35:24	13:10:53	15:51:36
19	DEA MARTHA MILLENIA	2023-07-25	TRBU02	07:14:02	11:35:35	13:11:03	15:51:42
20	ADINDA SAFURA	2023-07-25	TRBU02	07:14:11	11:35:42	13:11:11	15:51:49
21	AFRA NABILAH ANDENI	2023-07-25	TRBU02	07:14:19	11:35:51	13:11:22	15:51:57
22	M. Alamsyah	2023-07-25	TRBU02	07:10:04	11:33:17	13:07:13	15:48:17

Figure 8. Database 2 From Integrated Website

Data from Smart Cadets testing results showed that the effectiveness of using RFID can improve cadet time discipline. Specifically, the academic hours for cadet learning are 8 hours see Figure 8. In testing this RFID-based attendance system, we used 22 RFID cards to carry out attendance in the Politeknik Penerbangan Palembang Cadet environment. The test results showed that the RFID reader was successful in reading all cards that were approached with an accuracy of 98% (Santoso & Nurmalina, 2017). According to (Ma et al., 2013) The RFID card reading speed is also quite fast, so the

International Journal of Educational Review
Volume 5 (2) 2023, 87-100
E-ISSN 2685-709X, P-ISSN 2685-905X

attendance process can be carried out quickly and efficiently. However, the result from testing of the maximum reading distance of the RFID reader without obstructions is 47mm, while the RFID reader cannot read if it is blocked by a conductor plane (Alamsyah et al., 2022). The presence of system connectivity with the server is also well-connected and stable. There were no connection issues or disconnections during testing. Presence data can be sent properly to the server. In terms of reliability, the RFID-based attendance system tool was proven to work consistently during testing 3 times. We didn't encounter any significant issues or glitches during testing. In terms of ease of use, the RFID-based attendance system user interface is quite simple and easy to use by all users. We have also provided a clear and easy-to-understand usage guide for users.

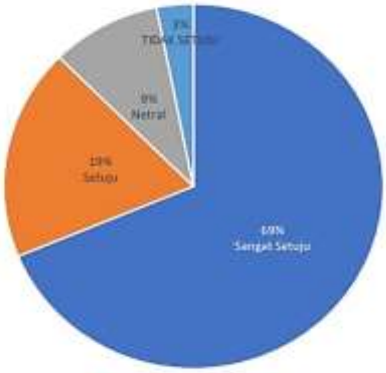

Figure 9. *Survey Calculation Diagram*

Based on the results of this trial, we can conclude that the RFID-based attendance system meets all the desired criteria and meets user needs. However, we will continue to evaluate and improve this RFID-based attendance system to improve its performance in the future. Based on the results of questions asked to 16 respondents, the survey results showed that 69% strongly agreed, 19% agreed, 9% were neutral and 3% disagreed.

D. Conclusion

Based on the data obtained and research results on data-based RFID Prototype Design for cadets Using ESP32 Microcontroller Media, media is needed to input data to optimize the academic hours of Politeknik Penerbangan Palembang cadets. the RFID-based attendance system meets all the desired criteria and meets user needs. We do not encounter any significant issues or glitches during testing. In terms of ease of use, the RFID-based attendance system user interface is quite simple and easy to use by all users. We have also provided a clear and easy-to-understand usage guide for users. However, we will continue to evaluate and improve this RFID-based attendance system to improve its performance in the future. the RFID-based attendance system tool was proven to work consistently during testing 3 times.

E. Acknowledgement

It is not easy to write for international publication. I, therefore, take this opportune moment to thank all those who have directly and indirectly helped me to finalize writing this paper. In specific, I thank colleagues who have commented positively on this paper. I pray that God Blwdaca ess you all.

References

Alamsyah, F. Y., Baskoro, F., Agustin T, R. H. P., & Rakhmawati, L. (2022). Design and Build an Internet of Things Based Lecturer and Laboratory Assistant Attendance Information System using RFID and the Telegram Application. *JURNAL TEKNIK ELEKTRO*, *11*(1). https://doi.org/10.26740/jte.v11n1.p99-107

Amalia, D., Hadiansyah, R., & Septiani, V. (2022). Smart Parking IoT Based: Design and Prototype. *JMKSP (Jurnal Manajemen, Kepemimpinan, Dan Supervisi Pendidikan)*, *7*(1). https://doi.org/10.31851/jmksp.v7i1.6677

Arrahma, S. A., & Mukhaiyar, R. (2023). *P Testing Esp32-Cam Based on ESP32 Microcontroller*. *4*(1), 60–66. https://doi.org/10.24036/jtein.v4i1.347

Arum, W. F., & Fahmi Dzikirillah, E. (2023). Analysis of the Effect of Vortex Generators on Air Flow. *Teknika STTKD: Jurnal Teknik, Elektronik, Engine*, *9*(1). https://doi.org/10.56521/teknika.v9i1.793

Athallah Muhammad Yazid, Y., & Agung Permana, R. (2022). Design and Build a Prototype for Automatic Street Light Monitoring Using an ESP 32 Microcontroller and Telegram Bot API. *Jurnal Teknik Informatika*, *8*(1). https://doi.org/10.51998/jti.v8i1.477

Aulia, L. M. F., Adi Wibowo, S., & Vendyansyah, N. (2021). Application of IoT in the Design and Construction of a Miniature Fire Extinguisher Robot System to Assist the Pre-Evacuation Evaluation Process. *Jati (Jurnal Mahasiswa Teknik Informatika)*, *5*(1). https://doi.org/10.36040/jati.v5i1.3307

Beacon, R., Light, A., Light, T., & Light, O. (2021). IOT-Based AFL (Airfield Lighting System) Control and Monitoring Design as a Learning Means for Cadets at the Aviation Polytechnic. 1–6.

Ensmenger, N. (2016). The Multiple Meanings of a Flowchart. *Http://Utpress.Utexas.Edu/Index.Php/Genders*, *51*(3), 321–351. https://doi.org/10.7560/IC51302

Fauziah, H., Sukowati, A., & Purwanto Imam. (2017). Design and Construction of a Student Attendance System at the Scholar Engineering College (STTC) Based on Radio Frequency Identification (RFID) using Arduino UNO R3. *Jurnal Ilmiah Komputasi*, *16*(2). https://doi.org/10.32409/jikstik.16.2.2288

Ganesh Gopal, D., Asha Jerlin, M., & Abirami, M. (2019). A smart parking system using IoT. *World Review of Entrepreneurship, Management and Sustainable Development*, *15*(3), 335–345. https://doi.org/10.1504/WREMSD.2019.099409

Gopal, D., Jerlin, M., of, M. A.-W. R., & 2019, undefined. (n.d.). A smart parking system using IoT. *Inderscienceonline.Com*. Retrieved November 17, 2021, from https://www.inderscienceonline.com/doi/abs/10.1504/WREMSD.2019.099409

Halim, D. K., Ming, T. C., Song, N. M., & Hartono, D. (2019). Arduino-based IDE for embedded multi-processor system-on-chip. *Proceedings of 2019 5th International Conference on New Media Studies, CONMEDIA 2019*. https://doi.org/10.1109/CONMEDIA46929.2019.8981862

Ibnu Malik, M., & M.U, J. (2009). Various PICI16F84A Microcontroller Projects. *Elex Media Komputindo* .

in, P. S.-2017 I. conference on advances, & 2017, undefined. (2017). An IoT-based E-parking system for smart cities. *Ieeexplore.Ieee.Org*. https://doi.org/10.1109/ICACCI.2017.8125982

Ismail Setiawan. (2022). Performance Comparison of Integrated Development Environment (IDE) in Executing Python Commands. *SATESI: Jurnal Sains Teknologi Dan Sistem Informasi*, *2*(1), 52–59. https://doi.org/10.54259/satesi.v2i1.784

Khanna, A., & Anand, R. (2016). IoT-based smart parking system. *2016 International Conference on Internet of Things and Applications, IOTA 2016*, 266–270. https://doi.org/10.1109/IOTA.2016.7562735

Kucuk Yilmaz, A. (2020). Transformation process risk management to sustainable corporate performance and quality management: developing flowcharts for an approved training organization. *Aircraft Engineering and Aerospace Technology*, *92*(2). https://doi.org/10.1108/AEAT-07-2019-0151

Kusumah, H., & Pradana, R. A. (2019). Application of ESP32 Based Microcontroller and Internet of Things Interfacing Trainer in Interfacing Courses. *Creative Education of Research in Information Technology and Artificial*, *5*(2).

Ma, D., Saxena, N., Xiang, T., & Zhu, Y. (2013). Location-aware and safer cards: Enhancing RFID security and privacy via location sensing. *IEEE Transactions on Dependable and Secure Computing*, *10*(2). https://doi.org/10.1109/TDSC.2012.89

Nizam, M., Yuana, H., & Wulansari, Z. (2022). Esp 32 Microcontroller as a Web-Based Door Monitoring Tool. In *Jurnal Mahasiswa Teknik Informatika)* (Vol. 6, Issue 2).

Pérez, I. (2023). Arduino IDE. *Publicación Semestral*, *11*(21).

Prasetiyo Aji, K., Darusalam, U., & Dian Nathasia, N. (2018). Presence for Employees with IoT-Based RFID Using NodeMCU ESP8266 (Vol. 3, Issue 1).

Ravikumar, S., & Kavitha, D. (2021). IoT-based home monitoring system with secure data storage by Keccak–Chaotic sequence in a cloud server. *Journal of Ambient Intelligence and Humanized Computing*, *12*(7), 7475–7487. https://doi.org/10.1007/S12652-020-02424-X/METRICS

Riti, Y. U. R., Degeng, I. N. S., & Sulton, S. (2021). Development of a Project-Based Learning Model by Applying the Design Thinking Method to Improve Students' Critical Thinking Skills in Chemistry Subjects. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *6*(10). https://doi.org/10.17977/jptpp.v6i10.15056

Rukin, M. V., Molchanova, V. A., & Urazakov, K. R. (2022). Method For Determining The Mean Time Between Failures Of Esp Units. *Bulletin of the Tomsk Polytechnic University, Geo Assets Engineering*, *333*(12). https://doi.org/10.18799/24131830/2022/12/3792

Samsugi, S., & Kastutara, D. (2017). *Proceedings of the XII National Seminar "Industrial and Information Technology Engineering.*

Sani, R. A., & Maha, A. I. (2017). *Digital Scale Construction Using Arduino Uno-Based Load Cell with LCD Display (Liquid Crystal Display)*. http://jurnal.unimed.ac.id/2012/index.php/inpafie-issn:2407-747x,p-issn2338-1981

Santoso, S., & Nurmalina, R. (2017). Planning and Development of Student Attendance Applications Using Smart Cards for Smart Campus Development (Case Study of Tanah Laut State Polytechnic). *Jurnal Integrasi*, *9*(1).

Son Maria, P., & Susianti, E. (2022). Programming Algorithm on MCS-51 for Alphanumeric Liquid Crystal Display (LCD) Simplified Driver Circuit. *Indonesian Journal of Electrical Engineering and Renewable Energy*, *2*, 1.

Utari. (2021). IOT-Based Automatic Home Light Control and Monitoring System Using Wemos D1 Mini. 1, 70.

Xinogalos, S. (2013). Using flowchart-based programming environments for simplifying programming and software engineering processes. *IEEE Global Engineering Education Conference, EDUCON*, 1313–1322. https://doi.org/10.1109/EDUCON.2013.6530276

Yusup, M. (2022). 367 Radio Frequency Identification (RFID) Technology as an Automatic Door Opening System Tool in Smart Houses. *Jurnal Media Infotama*, *18*(2).