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CARTO SD : TECHNOLOGY Innovation In Ensuring Effectiveness Of PSO Subsidy Distribution

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Abstract*—PSO (Public Service Obligation) is a subsidy given by the government to transportation passengers, especially train passengers. Subsidies are useful to help people achieve prosperity. However, in its implementation, the PSO subsidy has not been well-targeted so that it has the potential to use subsidies that are not on target, causing a waste of budget that could have been used for other infrastructure development. PSO subsidies have been given from the government to service providers or operators of transportation facilities, namely PT KAI (Persero). The Ministry of Transportation through the Directorate General of Railways (DJKA) has a discourse to limit PSO according to criteria. However, restrictions need to be accompanied by an efficient usage system because KRL users are quite large and fast so that effectiveness in using the payment system must be prioritized so that queues do not occur. As a result of the review, innovation is needed to ensure PSO subsidies are right on target, one of which is CARTO SD (Card to PSO Smart Identification) technology. CARTO SD is an innovation that uses RFID and ESP32 technology to verify passengers who are entitled to receive PSO subsidies. RFID is used to identify passengers through e-money cards that contain passenger databases, while ESP32 enables remote data communication by utilizing Wifi and Bluetooth connections efficiently. The system consists of two main components: e-money card and passenger data verification tool. After the verification process, passengers who are entitled to subsidies will be given discounts during the payment process, while passengers who are not entitled can still use train services at normal rates. This innovation is expected to increase the effectiveness and efficiency of PSO subsidy implementation, reduce the potential for budget abuse, facilitate real-time monitoring and reporting of subsidy usage, and provide convenience for eligible passengers. This technology also has the potential to be further developed and implemented in other modes of transportation, thus creating a more integrated system in managing public transportation subsidies.*

Keywords: PSO Subsidy, CARTO SD, passenger verification, RFID, ESP32

I. INTRODUCTION

A subsidy is a form of financial assistance or support provided by the government or certain institutions to groups of people in need. According to experts, subsidies are financial assistance channeled by the government to certain sectors of the economy that are considered to be of strategic value or important to the national interest. These subsidies aim to maintain price stability and ensure the availability of essential products such as food, energy or health services [4]. Subsidies are given to the community and certain sectors to support and ease their burden, especially for sectors that really need government

support. With subsidies, it is hoped that economic problems in these sectors can be reduced, and overall economic conditions will improve. One form of subsidy provided by the government is PSO (Public Service Obligation).

PSO (Public Service Obligation) is a subsidy that is determined by the operator and issued by the government. Referring to this, PSO can be said to be a cost that must be incurred by the government because of the difference between the cost of goods sold and the price of certain products / services that have been determined by the government. The government has financed PSO with a large enough budget with a total unaudited PSO subsidy value of Rp 3.75 trillion and BPK made corrections with a value of Rp 224.62 billion, so that the audited subsidy value amounted to Rp 3.52 trillion. with this, of course, PSO really helps passengers buy train tickets. However, PSO needs to be reviewed with the aim of distributing PSO to be more efficient and effective. In the future, the use of PSO on KRL is given the right in accordance with the instructions of the minister of transportation. Then, according to KAI Commuter VP Corporate Secretary Anne Purba explained, throughout September 2023, the average user on weekdays was 905,845 people per day. The highest volume was recorded on Wednesday, (9/27/2023) which reached 952,595 people. With the high volume of increase, of course, it is expected to accelerate the requirement to use PSO, but if every day instructions are given regarding the use of PSO on KRL, there will be a buildup of passengers due to verification of passengers who are entitled and not entitled to subsidies so that it can interfere with the operation of the station.

Based on this phenomenon, the author creates an innovation to streamline the use of PSO and can sort and select targets that are entitled to PSO budget subsidies. CARTO SD is an innovative tool that functions as sorting and selecting passengers who are entitled to use PSO. CARTO SD is a tool developed through an ID card that is programmed through a chip in which there is a passenger data base. It is hoped that the creation of CARTO SD can provide comfort to passengers and can sort and select passengers who are entitled to use CARTO SD so as to reduce errors that are not on target and do not cause waste of PSO subsidy costs.

II. RESEARCH METHODOLOGY

2.1 Research Method

This research uses an experimental method with an approach that reveals the causal relationship of two or more variables by controlling the influence of other variables [6]. The experimental method was chosen because it allows direct measurement of various important variables, such as subsidy allocation data, ridership data, and the amount of subsidy provided. With this method, the tool is tested in an actual situation, where the resulting data is analyzed to ascertain whether the tool is functioning in accordance with the predetermined objectives. This experimental approach is important to ensure the validity and accuracy of the research results, as well as to effectively evaluate and optimize the tool design [9].

RFID (Radio Frequency Identification) is a non-contact technology that uses radio waves to automatically identify people or objects [7]. In the CARTO SD innovation, RFID is used to detect whether passengers are entitled or not entitled to use PSO (Public Service Obligation). With this technology, the system can quickly and accurately identify eligible passengers. ESP8266 is a WiFi module that functions as a device to connect the system to a WiFi network and establish a TCP/IP connection [8]. In CARTO SD, ESP8266 is used to verify passenger data related to PSO usage rights. This module allows the system to communicate with the server in real-time and send verification data of passengers who are entitled or not to receive subsidies or services arranged by the PSO.

Tool design is a process of sensor selection, sensor placement and equipment system integration. The purpose of designing this tool is to measure the success of the tool manufacturing process and to monitor and evaluate the performance of the tool after the construction of the equipment and its working system, including ensuring what processes are carried out to assemble the tool according to the appropriate theoretical concept. In this tool design concept, it starts from the tool block diagram, sensor selection, tool prototype design, to the tool software design. Figure 1 will explain how the system works.

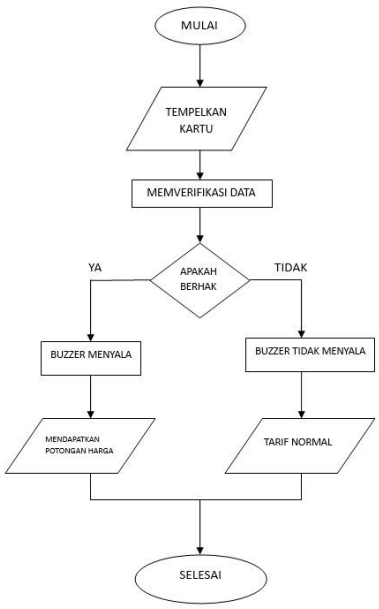
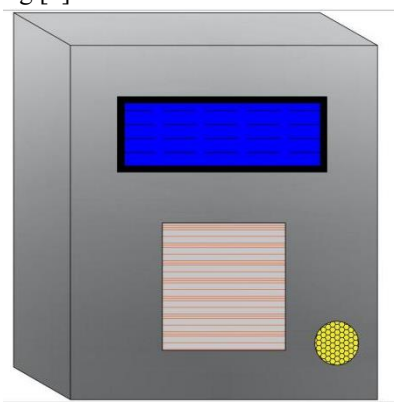


Figure 1. Flowchart of How the Tool Works

The tool design in Figure 2 involves the pin configuration used on the ESP8266 to ensure RFID sensor communication and the datasheet runs according to the software that has been created. The ESP8266 can be operated with an external supply between 3.3 VDC to 5 VDC, but the recommended voltage is 5 VDC to avoid stability issues and overheating [2].



Picture 2. Tool Design

2.2 Measurement Method

Measurements are performed using log analysis techniques, analyzing data collected automatically from system logs, which record various operational activities, such as the number of successful and failed verifications, verification processing time, and other activities [5]. In this experiment, researchers conducted experimental trials with the aim of understanding the technical and operational performance of the system in real-time or historically, providing a detailed quantitative picture of the system's effectiveness in detecting and verifying subsidy-eligible passengers.

2.3 Programming Method

In the software design in this study using the ESP8266 microcontroller in the sensor data retrieval section is intended to read the output data from the sensor which will be processed into a database [3], because basically the microcontroller will read the sensor value continuously [1]. Therefore, it is necessary to design software so that the tool works as needed. In this research, the ESP8266 microcontroller uses the Arduino IDE programming software. The first step in creating a program from the required tool is the initial design. The ESP8266 program design is made so that it can work properly and correctly. The manufacturing process is in accordance with the ESP8266 software design above. Making the Arduino IDE program was made up to 65 revisions, due to the process of simplifying the program so that it can work as quickly as possible (Abdai Rathomy, 2021).

III. RESULTS AND DISCUSSION

The test results of the tool aim to accurately determine the eligibility of PSO (Public Service Obligation) subsidy recipients, so that subsidies are given only to passengers who meet predetermined criteria. The criteria include Age, Occupation, and Social Status (abbreviated as UPS) of the passenger, which are determined through data stored in the e-money card and connected with RFID. In addition, the system uses an integrated ESP8266 module to facilitate automatic data verification at the time passengers enter the station. This verification process helps ensure that only eligible passengers receive subsidies, which in turn improves the effectiveness of budget allocation. The following is the power consumption data when before adjusting the brightness level.

Table 1. CARTO SD Trial Log Data

No	Date and Time	Passengers Name	ID PSO (Google Sheets)	E-Money Card ID (RFID)	Verificatin Status	Connection Status (ESP8266)	Note
1	2024-11-02 10:15:32	Budi Santoso	PSO001	1234567890	Valid	Connected	Verification Success
2	2024-11-02 10:17:45	Ani Wulandari	PSO002	9876543210	Invalid	Connected	PSO Data Doesn't match
3	2024-11-02 10:20:10	Siti Aminah	PSO003	2233445566	Valid	Disconnected	Disconnected Connection
4	2024-11-02 10:25:08	Agus Prasetyo	PSO004	4455667788	Valid	Connected	Verification Success
5	2024-11-02 10:30:22	Dedi Setiawan	PSO005	1122334455	Invalid	Connected	Unregistered Card ID
6	2024-11-02 10:35:15	Lina Kusuma	PSO006	6677889900	Valid	Connected	Verification Success
7	2024-11-02 10:40:05	Rina Marlina	PSO007	9988776655	Invalid	Disconnected	Disconnected Connection
8	2024-11-02 10:45:12	Bambang Sutrisno	PSO008	5566778899	Valid	Connected	Verification Success
9	2024-11-02 10:50:30	Tono Rahman	PSO009	3344556677	Invalid	Connected	PSO Data not Found
10	2024-11-02 10:55:55	Fitri Ananda	PSO010	7788991122	Valid	Connected	Verification Success

Source: Researcher Documents, 2024

Based on preliminary data from subsidized passenger verification experiments, out of 10 trials conducted, there were 6 successful verifications and 4 failed verifications. Success in this case means that the passenger data on the e-money card matches the PSO data stored in Google Sheets, and the ESP8266 connection is stable during the verification process. This indicates an initial success rate of 60% in a small sample. Although this data is preliminary, it can provide an initial idea of the accuracy and effectiveness of the verification system being tested.

If the system performs at the same success rate on a larger scale, we can anticipate the success percentage to reach around 60% of the overall experiment. The 60% success percentage can be used as a basis for evaluation to identify the limiting factors that still cause verification failures in 40% of the cases. These failures may be caused by unstable connections, data discrepancies between the e-money card and the PSO database, or even other technical constraints on the RFID or ESP8266 devices. By collecting more data and conducting in-depth analysis, this experiment can be continuously refined to achieve a higher success rate, so that it can be implemented more reliably in field operations.

3.1 Verification Time Efficiency with CARTO SD

The efficiency of verification time with CARTO SD shows a significant improvement compared to the manual method. Before using this tool, the average time taken to verify one passenger reached 15 seconds with the manual method. This often led to long queues at the entrance, especially during peak hours, such as morning and evening when many passengers are leaving or returning from work. This manual process slowed down the flow of passengers wanting to enter the platform, creating the potential for backlogs and longer waiting times.

Table 2. CARTO SD Verification Time Log Data

No	Date and Time	Passengers Name	E-Money Card ID (RFID)	Verification Start Time	Verification End Time	Verification on Time (Second)	Verification Status
1	2024-11-02 10:15:32	Budi Santoso	123456789	10:15:32	10:15:34	2	Valid
2	2024-11-02 10:17:45	Ani Wulandari	987654321	10:17:45	10:17:50	5	Invalid
3	2024-11-02 10:20:10	Siti Aminah	223344556	10:20:10	10:20:13	3	Valid
4	2024-11-02 10:25:08	Agus Prasetyo	445566778	10:25:08	10:25:10	2	Valid
5	2024-11-02 10:30:22	Dedi Setiawan	112233445	10:30:22	10:30:28	6	Invalid
6	2024-11-02 10:35:15	Lina Kusuma	667788990	10:35:15	10:35:18	3	Valid
7	2024-11-02 10:40:05	Rina Marlina	998877665	10:40:05	10:40:12	7	Invalid
8	2024-11-02 10:45:12	Bambang Sutrisno	556677889	10:45:12	10:45:15	3	Valid
9	2024-11-02 :50:30	Tono Rahman	334455667	10:50:30	10:50:36	6	Invalid
10	2024-11-02 10:55:55	Fitri Ananda	778899112	10:55:55	10:55:57	2	Valid

Source: Researcher Documents, 2024

The ESP8266 is quite efficient in performing identification and validating passenger data. This speed can be considered adequate for applications in the railway environment that require fast processing to serve passengers effectively.

The variation in verification time indicates that there are factors that affect the length of the process. Cases where the verification time is longer, such as those recorded up to 7 seconds, may be due to technical issues, such as unstable connections or slow data reading. This indicates the need for further evaluation of the system is used to ensure that all components function optimally and there are no obstacles that hinder the efficiency of the verification process.

Given the effectiveness of CARTO SD, this system has great potential to be implemented at other stations with high passenger volumes. This implementation will be very beneficial at other large stations to reduce the burden of misdirected subsidies and improve operational efficiency. By expanding the use of CARTO SD to several other large stations, the government and operators can save the overall PSO subsidy budget, while providing more optimal services to passengers who really need them. This expansion enables the implementation of new standards in subsidy management across major transportation hubs.

Besides expansion to other stations, the potential of CARTO SD also includes integration with other modes of public transportation, such as buses and boats. This is important to ensure that subsidies can be enjoyed across the public transportation ecosystem in an easy and integrated manner. By developing a system that supports interoperability between modes, passengers can enjoy subsidies across the different modes of transportation they use, creating a smoother and more economical transportation experience. On the other hand, improving data security is a priority in the future development of CARTO SD. Stronger data encryption and the implementation of two-factor authentication on e-money cards will keep passengers' personal data safe, ensuring that sensitive information remains protected during the verification and transaction process.

IV. CONCLUSION

Based on the series of explanations above, the development and testing of a tool called CARTO SD, which uses RFID and ESP8266 technology, serves to improve the accuracy of providing PSO (Public Service Obligation) subsidies to train passengers who meet certain criteria. By utilizing e-money cards containing passenger data, CARTO SD automatically verifies passengers who are entitled to subsidies, thereby reducing the use of untargeted subsidies and increasing budget efficiency. The test results show that this tool can verify passengers in an average of 4 seconds, faster than the manual method. It is expected that the creation of CARTO SD can potentially reduce the buildup of passenger queues at the station caused by long waiting times when wanting to use PSO.

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