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Stakeholder Analysis and RFID Implementation Model for Vehicles Using Design Thinking

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ABSTRACT

In Indonesia, the number of motor vehicles in 2022 reached 152,001,696 units. However, the use of technology to monitor the condition of motor vehicles is not very popular yet. Some chips installed on vehicles only serve as monitors. Therefore, researchers are interested in analyzing RFID in motor vehicles when applied in Indonesia. Through this research, the researchers hope to identify the needs of the Indonesian population regarding the use of RFID chips in motor vehicles. The approach will involve interviewing individuals or parties with interests related to the utilization of RFID in motor vehicles. Additionally, the researchers aim to develop an RFID implementation model that can be used in Indonesia in the future. The methodology for this study is qualitative, employing the design thinking approach. Design thinking was chosen due to its four elements (people-centered, highly creative, hands-on, and iterative) that are user-oriented and promote innovation. It is hoped that through this research, stakeholders involved in RFID development can collaborate and integrate for the development and utilization of RFID in Indonesia.

KEYWORDS: Technology, Vehicles, Radio Frequency Identification (RFID), Design Thinking

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1. INTRODUCTION

The implementation of RFID technology in motor vehicles is still limited in Indonesia, despite the advancements in current technology. Many parts of motor vehicle assembly have been replaced by machines. By integrating vehicle engines with computers, manufacturers can increase profits by reducing operational costs, speeding up assembly time, and improving efficiency that is commonly caused by human errors. Additionally, with the latest technology embedded in a motor vehicle's engine, a motor vehicle can be akin to a human being with personal identity data and health history that can be accessed anytime to track the vehicle's life history from the year of assembly to its current usage.

Currently, the connection between computers and motor vehicles in Indonesia is established using RFID chips placed on each controllable part. Radio Frequency Identification (RFID) is a technology based on radio frequency for object identification or recognition, revolutionizing the identification of goods or products by embedding a chip with a wireless antenna on an object. In Indonesia specifically, the use of technology to monitor the condition of motor vehicles through RFID chips is not yet widely popular. Some parts of motor vehicles have been equipped with chips, but their implementation has not been fully optimized. The existing chips in motor vehicles in Indonesia are currently only used in the speedometer. There are no chips that can retrieve vehicle data such as the year of manufacture or owner information. The lack of integrated chips with other entities such as the Police makes it challenging for the government to monitor and regulate driving regulations in Indonesia.

The implementation of RFID in motor vehicles has been carried out in several large countries such as the United States and China. In Indonesia, however, the utilization of RFID technology for motor vehicles is still limited. Therefore, researchers are interested in analyzing the benefits of RFID in motor vehicles when implemented in Indonesia. The method employed in this study is qualitative and utilizes a design thinking approach.

Design thinking is an iterative process in which researchers seek to understand the problem, challenge assumptions, and redefine the problem to generate comprehensive and efficient strategies and alternative opportunities for implementation. Design thinking acts as a bridge between business needs and business expansion processes. Design thinking is chosen because it is a human-centered innovation approach. In this study, design thinking is used to analyze all aspects involved in RFID utilization, including stakeholders. By applying design thinking, a business is expected to discover innovative, effective, targeted, and consumer-oriented solutions that meet business and development needs.

The design thinking process consists of five stages: empathize, define, ideate, prototype, and test. However, this study will focus on three of the five stages: empathize, define, and ideate, due to the incomplete implementation of RFID in Indonesia. The prototype and test stages will still be conducted but limited to designing stickers and performing usability tests on the stickers. This is possible because the author works in an

RFID company. The researcher hopes that this study can accurately and comprehensively analyze the benefits of RFID in motor vehicles in Indonesia, providing valuable input for the company.

Through this research, it is expected that stakeholders involved in RFID development, including the Indonesian National Police as regulators and issuers of road regulations and permits, the Department of Traffic and Road Transportation (DLLAJ) as regulators of traffic and road transportation, the Regional Revenue Agency (DISPENDA) as regulators of local taxes, RFID experts providing information on RFID, and motor vehicle owners (both two-wheel and four-wheel) can collaborate and integrate efforts for the development and utilization of RFID in Indonesia.

2. LITERATURE REVIEW

Related Work

Research on RFID in motor vehicles has been conducted extensively. RFID is used in motor vehicles due to its high-speed data reading capability, which is more precise compared to similar technologies like barcodes. An object equipped with an RFID tag can be read by an RFID reader within a certain distance. Therefore, RFID research continues to be used for development and innovation. In various studies, (Prabhakar Rao & Kumar Singh, 2022) suggested RFID has been proven to track the presence of vehicles in real-time. (Park & Jeon, 2022) suggested track vehicle speed during usage(Yang et al., 2023) suggested serve as a warning system for vehicle hazards. Additionally, (Wen, 2010) suggested RFID attached to motor vehicles can provide information on vehicle ownership data, which can assist the government in controlling the number of motor vehicles circulating in the market.

In the research conducted by (Liu et al., 2022) titled "Variation of spatio-temporal distribution of on-road vehicle emissions based on real-time RFID data," the aim is to develop a high-resolution spatio-temporal vehicle emission inventory in the major urban area of Chongqing. This is done based on real-time traffic data from 820 RFID detectors covering 454 roads and analyzing the spatio-temporal emission characteristics differences between inner and outer districts. The RFID in vehicles reads the time, location, and license plate number.

In the research conducted by (Oluwatobi et al., 2021) titled "The design of a vehicle detector and counter system using inductive loop technology," the focus is on designing a vehicle detection and counting system using counters. The design is simulated and tested in the virtual system modeling software Proteus. The simulation results reveal that the design can be used to detect and count vehicles at intersections, thus effectively controlling traffic.

In the research conducted by (Berlin et al., 2021) titled "Alert message based automated toll collection and payment violation management system using smart roadside units," the topic is about an automated toll collection system based on alert messages and a payment violation management system using Smart Roadside Units

(RSUs) and RFID readers. The research presents the operations to be performed at toll plazas and by RSUs, and also calculates the time required for vehicles to cross the toll plaza with successful/failed payments using SUMO and NS3

Klasifikasi RFID

Radio Frequency Identification (RFID) is a technology for identification or recognition based on radio frequency. It revolutionizes the identification of goods or products by embedding a chip with a wireless antenna onto an object. RFID is divided into several types based on their frequency ranges, including: Low Frequency Tag (125kHz - 134 kHz), High Frequency Tag (13.56MHz), Ultra High Frequency Tag (888MHz - 956MHz), and Microwave tag (2.45GHz).

RFID consists of several basic components, including: RFID Tag, which is a small device (chip) commonly referred to as a transponder that functions as an ID (identity); RFID reader, which reads the RFID tags; and an antenna, which serves as a medium for signal propagation. In general, the RFID antenna is integrated with the RFID tag.

Design Thinking

According to The Hasso Plattner Institute for Design (aka "d.School") at Stanford University, the implementation of design thinking in a project follows five stages or processes to create design solutions. The stages of the design thinking five-stage model are empathize, define, ideate, prototype, and test, as shown in Fig 1.

In creating design solutions using design thinking, four elements are necessary to consider in addressing existing problems. Starting with the People Centered element, it emphasizes that every action is rooted in what the users want and need. Next, the Highly Creative element allows for unrestricted creativity without rules. Then, the Hands-On element involves direct experimentation with the design by the design team. Lastly, the Iterative element represents a process that is repeated and allows for errors and failures in prototyping, aiming to achieve the best possible outcome for the product or application.

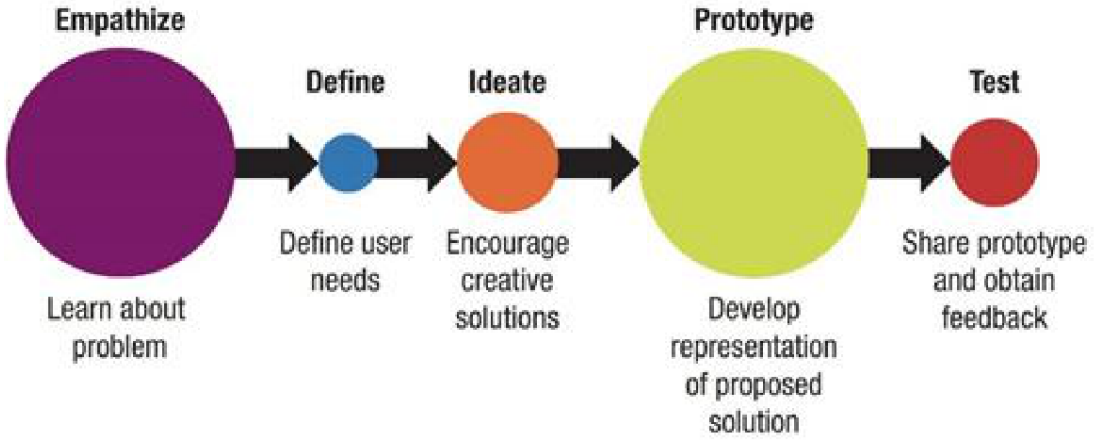

FIGURE 1. Design Thinking

3. METHODS

The research process begins with formulating questions and conducting in-depth interviews. The analysis focuses on understanding the stakeholder's needs in preparing an implementation model for RFID in motor vehicles using the design thinking method.

Step 1 - Creating a list of questions and conducting in-depth interviews. The questions asked aim to analyze and identify patterns related to the preferences or tendencies of the stakeholders. The author selected 10 stakeholders for the research.

TABLE 1. List of Questions

No	Category	List of Questions
1	Safety	How can the use of RFID technology in motor vehicles help improve transportation security and efficiency?
2		How can the police ensure that the data stored in the RFID tags of motor vehicles is accurate and reliable?
3		How can the police ensure that the RFID system in motor vehicles is not misused for unauthorized purposes?
4	Integration	How do you perceive the implementation of an RFID model integrated with other technologies, such as surveillance cameras or GPS systems?
5		How can the RFID system in motor vehicles assist the police in tracking lost or stolen vehicles?
6	Development	What are the government programs or policies related to the use of RFID technology in motor vehicles?
7		How do you envision the potential of RFID models in improving road safety and reducing the number of traffic accidents?

Step 2 - The first stage of design thinking is empathized. The results obtained in the empathize stage align with the processed interview findings, which include user personas, empathy maps, and user journey mapping.

Based on Figure 2, the user persona for the Police stakeholder is named Baktiono Wibisono, a police officer with the rank of Police Commissioner. Baktiono's goal is to maintain the security and order of society and possesses high integrity and ethics. Baktiono has the characteristics of integrity, high empathy, and discipline, with hobbies including playing badminton and reading books. The challenges for Baktiono are upholding human rights and individual freedoms, as well as protecting crime victims through the enforcement of law fairly and based on applicable regulations. Therefore, Baktiono's needs revolve around technological advancements and innovation to influence the tasks and functions of the Police force.

FIGURE 2. User Persona

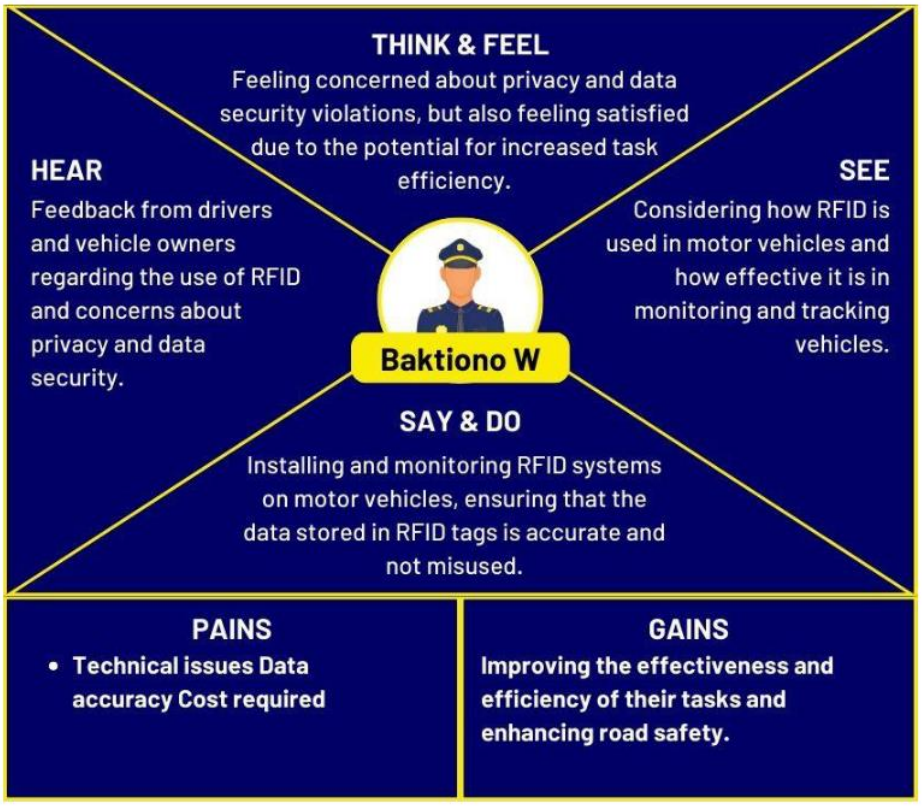

FIGURE 3. Empathy Map

Each stakeholder is provided with an empathy map as shown in the above image. The above image is an example of an empathy map for the Police stakeholder. The expected benefits for Baktiono when implementing RFID on motor vehicles are to enhance task effectiveness and efficiency, as well as improve road safety. In this case, the use of RFID technology on motor vehicles can assist in facilitating these tasks by

expediting the vehicle identification process, optimizing road usage, and reducing potential traffic violations.

The next step is the user journey mapping phase, which aims to create several scenarios based on stakeholder categories. There are three scenarios in this study, namely: the Police, RFID Experts, and Motor Vehicle Owners. Here is the User Journey Mapping image for the Police stakeholder.

FASE	STEP 1	STEP 2	STEP 3
What do the police think or feel?	Desiring the latest technology on vehicle documents	Proposing the implementation of the latest technologies such as e-KIR and digital vehicle registration in Europe	Starting to consider UHF RFID stickers for implementation on motor vehicles
What actions do the police take?	Seeking information about the latest technology for vehicle documents	Discussing the desire for the adoption of new technologies	Conducting a test of UHF RFID stickers on motor vehicles in a city
Emotion Level	😄	😄	😄☹
Challenges and Opportunities for the Police	The document easy to duplicate or fake it	Discovering a new technology in the form of UHF RFID stickers	• Reducing the risk of duplication or counterfeiting of motor vehicle documents • Determining the placement points of stickers and regulations regarding window tinting on vehicles
Needs Analysis	Need the latest technology to replace the vehicle documents	Procurement of UHF RFID stickers as a replacement for vehicle documents	Implementing UHF RFID stickers on all motor vehicles in Indonesia and mass-producing them

FIGURE 4. User Journey Mapping

Step 3 - In the defined stage, the author will learn how to identify problems by focusing on specific users based on their needs. The problem identification process is carried out by defining the problem based on the Point of View analysis obtained from synthesizing the empathize phase of each category. Based on the Point of View analysis conducted from the three stakeholder categories, different needs and insights will be obtained for each category.

Then, the POV Madlib method and How Might We (HMW) Questions will be used to create value and provide useful solutions based on the observations that have been made. Here are the summary results of the two methods that have been conducted.

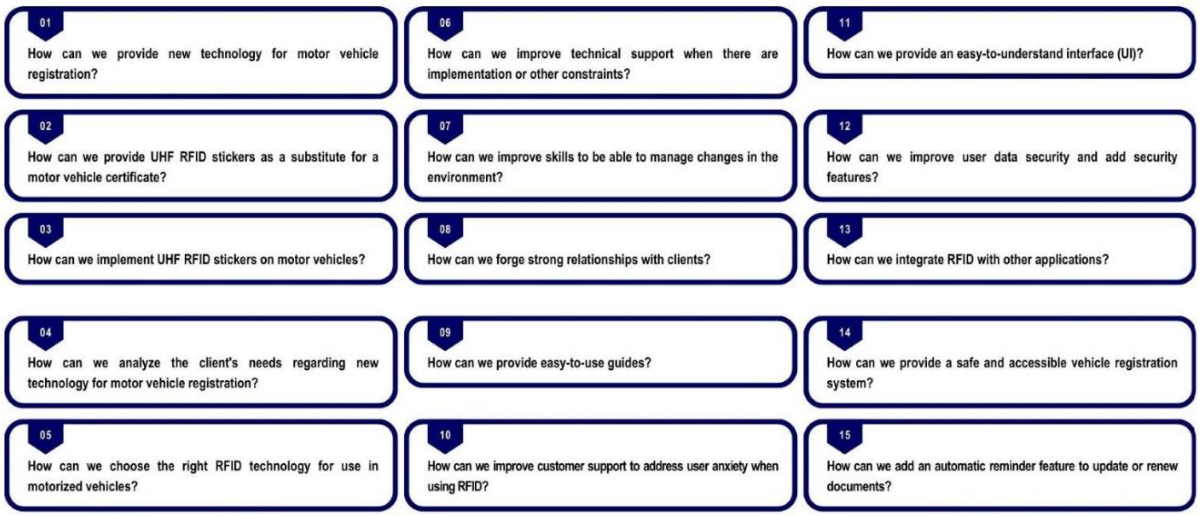

FIGURE 5. Summary HMW Question

Step 4 - In the Ideate stage, a brainstorming process is conducted, and the results of the brainstorming are visualized on a post-it board to generate new concepts and ideas for implementing RFID in motor vehicles. The outcomes of brainstorming are depicted in Figure 6.

FIGURE 6. Brainstorming

Step 5 - Prototype, the stage where ideas are turned into tangible products. The prototype process also focuses more on implementing the research model so that the development team can explore the robustness of the solutions built in the previous step.

FIGURE 7. Vehicle RFID Sticker

Based on Figure 7, there are several security features that will be implemented on motor vehicles. There are 11 features that will be implemented, including: Static Matte, Guilloche Achromatic, Achromatic Effect, Color Effect, Guilloche Colorful, Diffractive Watermark Achromatic, Surface Relief Effect, Colorful Movement, Black Mirror, Pump Effect Colorful, and Microtext Achromatic Movement.

Step 6 - The usability testing phase involves the trial of attaching RFID stickers and testing the speed of using RFID stickers on motor vehicles because RFID implementation in Indonesia is not yet fully established. This step can be repeated multiple times to find the right solution that meets the expectations of the designers and potential users

4. RESULTS

From the brainstorming results, several innovation recommendations were found that could be implemented in RFID innovation for motorized vehicles according to the needs of stakeholders

Police Brainstorming Results

Stakeholder Analysis:

Replacing physical vehicle registration documents with a digital version accessible through a mobile application or online platform. This would reduce the need for printing and physically delivering registration documents, making it easier for vehicle owners to access their vehicle information. Replacing vehicle registration documents with UHF RFID stickers attached to the vehicles. These stickers would contain important information such as vehicle identification number, owner data, and other technical information. RFID scanners installed at toll gates or checkpoints can automatically read these stickers to verify and identify the vehicles.

Replacing motor vehicle registration documents with UHF RFID stickers as a means of uniquely identifying vehicles. This can assist in parking management, traffic law enforcement, and road security management. The police hope that by implementing this

replacement for registration documents, vehicle owners can easily renew and extend their registration online through an application or platform connected to the UHF RFID stickers. This would reduce administrative complexities and the time required for the registration renewal process. Additionally, RFID implementation for fleet management. By tracking the location, condition, and real-time usage of vehicles, more efficient planning and management can be achieved for fleet operations. This can help monitor trips, verify, and provide real-time information about the status of motor vehicles to relevant parties.

Implementation Model:

The desired implementation model for RFID in motor vehicles by the police involves the placement of UHF RFID stickers with easy installation, creating a streamlined scheme for phasing out physical registration documents. RFID would be used during traffic inspections with a centralized vehicle management system and can be further developed using a mobile application. Additionally, the RFID implementation model should be compatible with other systems. Furthermore, the police expect the RFID implementation model to be used on road infrastructure such as traffic signs or road markings to provide information and warnings to drivers. This can help reduce accidents and improve road user safety

RFID Experts' Brainstorming Results

Stakeholder Analysis:

RFID experts require a trained technical support team to assist users in implementation, training, and proactive monitoring. User involvement in the development of RFID technology for motor vehicles can be encouraged. Responsive customer service, collaboration with partners, direct support, and providing implementation, maintenance, and usage information for RFID stickers in the form of documents and videos are essential.

Implementation Model:

The desired implementation model for RFID in motor vehicles by RFID experts includes RFID with long-range capability, resistance to Indonesian temperatures, integration with other systems, and cost-effectiveness. Data security for users when using RFID stickers is important, including data encryption, strong authorization and authentication, data backup and recovery, and the use of SSL/TLS certificates.

Motor Vehicle Owners' Brainstorming Results

Stakeholder Analysis:

Motor vehicle owners expect the use of RFID as an authentication method in security systems, such as a replacement for Vehicle Registration Certificates (STNK), so

that users don't need to carry physical documents. Motor vehicle owners also expect vehicle tracking systems to reduce the potential for motor vehicle theft.

Implementation Model:

The desired implementation model for RFID in motor vehicles by vehicle owners includes RFID systems in vehicles for automatic payments at toll gates and parking lots. This would reduce waiting time and congestion at gates while improving payment efficiency. It can be integrated with public services, such as city parking systems or public transportation systems. This would facilitate access and the use of various services by motor vehicle users

5. CONCLUSIONS

This research produces stakeholder identification and prepares an implementation model for RFID in motor vehicles using a qualitative research strategy to understand the stakeholder preferences in the development of RFID technology in motor vehicles. Using design thinking as an effective approach to identify problems, understand stakeholder needs, and generate innovative solutions. Through the four stages of design thinking (empathize, define, ideate, prototype), solutions that meet stakeholder needs and implementation goals can be designed and developed. Based on the analysis and discussion, the following conclusions have been obtained.

Stakeholder analysis is to be involved in the implementation of RFID for motor vehicles including the Police, RFID experts, and motor vehicle owners. Each stakeholder has interests and needs that need to be considered in the design and implementation of the RFID system. The Police is a stakeholder with an important role in regulating and overseeing the use of RFID technology for motor vehicles. From the in-depth interviews with Ibrani Nashiruddin, Fitriani Hartati, and Baktiono Wibisono, it is evident that the Police want to ensure that RFID implementation meets legal and security requirements. Additionally, the Police have an interest in improving transportation efficiency and reducing congestion. RFID experts are stakeholders who play a role in providing the necessary RFID technology for implementation. From the in-depth interviews with Karsa Winarno, Zulfikar Hadi, and Dian Purnama, it is evident that they aim to enhance RFID technology development in Indonesia and ensure customer satisfaction with the quality and functionality of RFID devices. Motor vehicle owners are stakeholders who play a role in the use of RFID technology for motor vehicles. From the in-depth interviews with Wira Tirta, Trizona Chist, Herlina, and Rusmawan Burhanuddin, it is evident that they want to utilize RFID for vehicle tracking, vehicle security, and facilitate vehicle-related payments.

The implementation model for RFID in motor vehicles involves steps such as prototype development, testing, technology infrastructure development, implementation, evaluation, and scalability. This process involves active involvement from stakeholders and continuous iterations to ensure an effective and successful solution. Some RFID implementation ideas for motor vehicles generated through brainstorming

are as follows: Police- The desired implementation model for RFID in motor vehicles by the Police includes placing UHF RFID stickers with easy installation, establishing a scheme for eliminating physical vehicle registration documents, using RFID during traffic inspections with a centralized vehicle management system that can be developed using a mobile application. Additionally, the RFID implementation model should be compatible with other systems. The Police expect the RFID implementation model to be used on road infrastructure such as traffic signs or road markings to provide information and warnings to drivers. This can help reduce accidents and improve road user safety. RFID Experts- The desired implementation model for RFID in motor vehicles by RFID experts includes RFID with long-range capability, resistance to Indonesian temperatures, integration with other systems, cost-effectiveness, and data security for users when using RFID stickers through data encryption, strong authorization and authentication, data backup and recovery, and the use of SSL/TLS certificates. Motor Vehicle Owners- The desired implementation model for RFID in motor vehicles by motor vehicle owners includes RFID systems in vehicles for automatic payments at toll gates and parking lots, and integration with public services such as city parking systems or public transportation systems. This would facilitate access and the use of various services by motor vehicle users.

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