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Implementation of Priority Scheduling Algorithm in Designing Infrastructure Damage Reporting System

Prio Kustanto¹, Wisnu Arizky Kurniawan², Achmad Noe'man³, Nurfiyah⁴, Ridwan⁵

¹Informatics Study Program, Faculty of Computer Science, University of Bhayangkara Jakarta Raya, Jakarta, Indonesia email: pkustanto@dsn.ubharajaya.ac.id

²Informatics Study Program, Faculty of Computer Science, University of Bhayangkara Jakarta Raya, Jakarta, Indonesia, email: 202010225290@mhs.ubharajaya.ac.id

³Informatics Study Program, Faculty of Computer Science, University of Bhayangkara Jakarta Raya, Jakarta, Indonesia, email: achmad.noeman@dsn.ubharajaya.ac.id

⁴Informatics Study Program, Faculty of Computer Science, University of Bhayangkara Jakarta Raya, Jakarta, Indonesia, email: nurfiyah@ubharajaya.ac.id

⁵Information Technology Study Program, Institut Teknologi dan Bisnis Dewantara, Jakarta, Indonesia, email: ridwans70@gmail.com

Corresponding Author: pkustanto@dsn.ubharajaya.ac.id¹

Abstract: The rapid growth of population and urbanization in Bekasi District has increased the demand for adequate road infrastructure, but it has also posed challenges in the maintenance and repair of existing infrastructure. The main constraint in addressing this issue is the limited available budget, although the Bekasi District Government has tried various innovative programs. In this context, it is important to have mechanisms that allow the public to report infrastructure problems quickly and accurately. Based on preliminary studies, many factors can cause road infrastructure damage. The aim of this research is to design and develop a Road Infrastructure Damage Complaint System in Bekasi District, providing easy access for the public to report road infrastructure damage and enabling authorities to prioritize infrastructure repairs more quickly and accurately, thus improving the quality of life for the community and building a complaint system that can help expedite the repair process.

Keyword: Road infrastructure, Complaint System, Priority Scheduling, Weight Sum Model

INTRODUCTION

The rapid growth of population and urbanization has increased the demand for road infrastructure including roadways, drainage systems, sidewalks, and road medians. This growth also brings challenges in maintaining and repairing existing infrastructure, such as road damage, waterlogging, clogged or damaged drainage channels, damaged sidewalks, and insufficient maintenance leading to the growth of wild vegetation in road medians. These damages not only disrupt the mobility and safety of the community but also affect the quality of life and economic

growth in Bekasi Regency.

The Department of Highways, Irrigation, and Water Resources of Bekasi Regency recorded that there are 60 kilometers of roads experiencing damage in the area. According to the Head of the Department, Iwan Ridwan, this damage is caused by vehicle loads exceeding the road capacity and poor soil conditions. In their effort to repair, they plan to utilize technology suitable for the physical condition of the damaged roads, but the main constraint is the limited budget, with only a budget of Rp 400 billion in 2021. Only about 12-15% of road repairs can be handled each year, with priority given to frequently traveled roads experiencing severe damage (Widiantoro, 2021).

According to the news from terkenal.co.id, Bekasi Regency has experienced imbalanced industrial sector growth compared to its infrastructure availability, especially concerning road repairs that have been ongoing for several decades. Previous local administrations have struggled to address this issue, while the budget limitation is only around Rp6-7 trillion per year, far from the approximately Rp40 trillion needed to evenly improve the infrastructure. The Bekasi Regency government seeks funding support from provincial and central governments but still faces significant challenges. Through the innovative program "Berani Jalan" (Dare to Walk), they attempt to address road maintenance issues, yet significant challenges in infrastructure recovery persist, and they are committed to meeting the substantial needs in building and maintaining the road network in this area (Maulana, 2023).

According to news from tribunbekasi.com, the National Public Service Complaints Management System - Online Aspiration and Complaint Service (SP4N - LAPOR) managed by the Bekasi Regency Government recorded receiving 517 complaints from the public during 2022. Out of this number, 314 reports have been followed up and resolved by various relevant government agencies (SKPD). The complaints mainly relate to infrastructure issues such as damaged roads and irrigation channels, with 68 reports addressed to the relevant department. Problems with the distribution of social assistance are also frequently complained about, with 52 reports related to the Social Services Department. Additionally, there are 40 reports submitted to the Manpower Department, 35 reports to the Population and Civil Registration Department, and 26 reports to the Transportation Department. Most of these reports are submitted through the official SP4N Lapor website managed by the central government, while the rest are through SMS and mobile phones. These reports are then handed over to the local government for further action (Baskoro, 2022).

According to news from sindonews.com, a budget of Rp 26 billion has been allocated by the Bekasi Regency government for the construction of sidewalks on Inspeksi Kalimalang Street, although the sidewalks are more likely to be used by vendors and as parking spaces for vehicles rather than serving their original purpose as pedestrian walkways since their construction in 2018. Although the original purpose of building the sidewalks was to support pedestrians, field observations indicate that the sidewalks are actually utilized by vendors, some of whom even build stalls and workshops on the sidewalks. Despite the street serving as an alternative route due to the absence of crowded areas or shopping centers, the sidewalks are underutilized for pedestrian activities. Despite the road being dry and surrounded by several factories, the allocation of Rp 26 billion for sidewalk construction has not been redirected as seen in some other projects that were canceled due to COVID-19 handling, including plans for building uninhabitable houses and classroom renovations in schools. The head of the relevant department has not yet provided confirmation regarding this sidewalk construction (Muhammad Surjaya, 2021).

Ineffectiveness in addressing road infrastructure issues can lead to traffic congestion, increased potential for accidents, and other negative impacts. Therefore, it is important to develop mechanisms that allow the public to report these infrastructure problems quickly and efficiently to the relevant authorities.

From the research conducted by researchers at the Bekasi District Highways Office, it

was found that several factors can cause road infrastructure damage. The main factors contributing to road infrastructure damage include heavy vehicle loads or overuse, such as trucks and buses, which can damage road surfaces; adverse weather conditions like heavy rain, which can damage road and sidewalk surfaces as well as medians; and the use of low-quality or inappropriate construction materials, which can lead to structural damage. These findings underscore the importance of a website-based road infrastructure damage reporting system in Bekasi District that utilizes Priority Scheduling algorithms combined with the Weight Sum Model method. This system can help optimize the handling of damage reports by prioritizing tasks based on their level of importance, thereby enhancing employee efficiency.

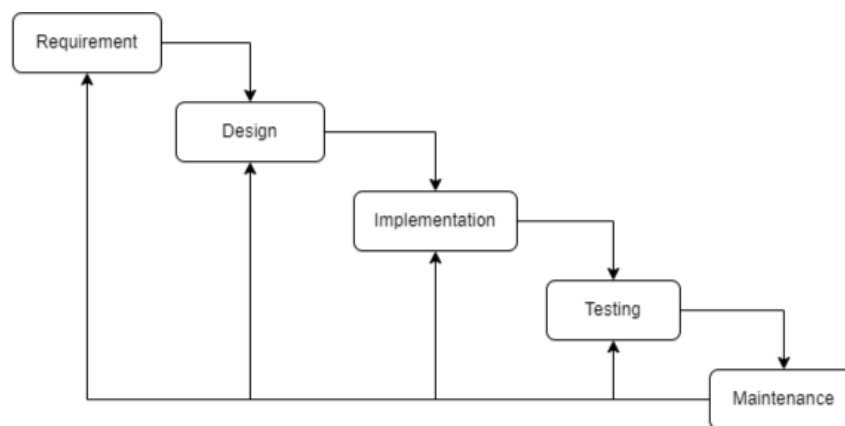
Therefore, based on the background explanation provided by the author, the decision was made to conduct research on "Implementation of Priority Scheduling Algorithm in the Design of Road Infrastructure Damage Reporting System Based on Website in Bekasi District."

The aim of this research is to design and develop the "Road Infrastructure Damage Reporting System" in Bekasi District, which will provide the community with easy access to report road issues. The data received will be used to prioritize repairs, monitor progress, and ensure safer road infrastructure. This initiative is crucial in improving the quality of life for residents, reducing accident risks, and supporting economic growth in the area. It also aligns with the global trend of using information technology to enhance the efficiency of urban infrastructure maintenance.

METHOD

In the design of this application system, the waterfall method is used. Here are the steps of implementing the waterfall method:

Picture 1 Waterfall method



Requirement

The system requirements analysis explains the process of identifying, understanding, and determining the needs that must be met by the system in order to operate according to the required specifications. Here are the results of the requirements analysis for the infrastructure road damage reporting system:

1. Road infrastructure damage reporting

Users should be able to report road infrastructure damage easily and quickly through the website. The reporting form should include information such as damage photos, road name, reporter's name, email, location, and message.

2. Report management

The system will be equipped with report management features that allow administrators

to receive, screen, and process incoming reports from users. This will assist in managing and handling reports more quickly and accurately.

3. Determination of damage type and level

Administrators will have the authority to determine the type and level of road infrastructure damage reported by users. They can evaluate the received reports and determine appropriate follow-up actions based on the provided information.

4. Calculation of final score

The system must implement the weight sum model method to calculate the value of infrastructure type and damage level.

5. Implementation of priority scheduling algorithm

The system should implement a priority scheduling algorithm to determine the sequence of repair priorities based on the highest scores.

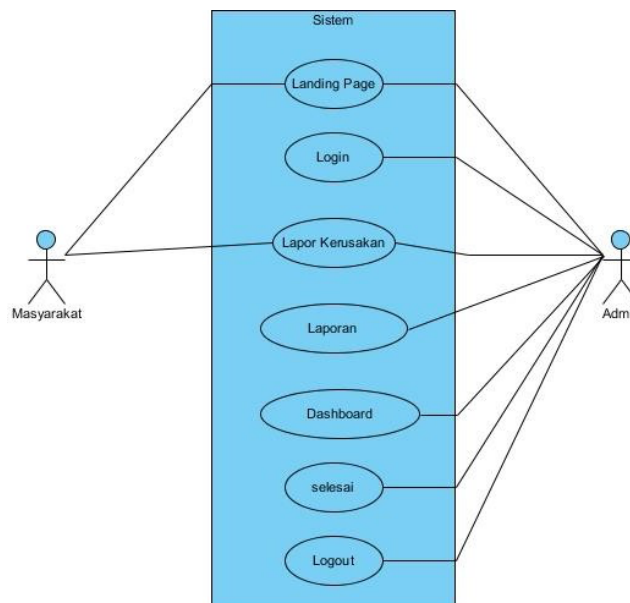
Design

In this research phase, it describes the design of the system to be built, namely the implementation of the priority scheduling algorithm in designing a road infrastructure damage reporting system based on a website in Bekasi Regency. The system design utilizes UML (Unified Modeling Language), consisting of a use case diagram and a sequence diagram as follows:

Use Case Diagram

The use case diagram illustrates how the system is used and how actors interact with each other. Here is the use case diagram for the road infrastructure damage reporting system based on a website in Bekasi Regency:

Picture 2 Use Case Diagram



Based on the above use case diagram, there are two system user actors: admin and the public. The admin has access rights to the landing page menu, login, report damage, damage categories, determine repairs, finish menu, and logout. Meanwhile, the public only has access to the landing page menu and the report damage feature.

Table Titles 1 Explanation of the Use Case Diagram

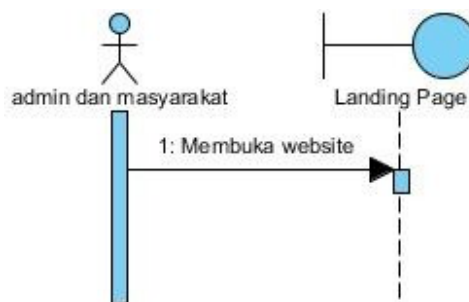
NO	Use Case Name	Scenario	Actor
1	Landing Page	The landing page containing important information within this website.	Admin and the public
2	Login	The page to access the system by entering a username and password.	Admin
3	Lapor Kerusakan	A feature that allows users to report road infrastructure damage by filling out the available reporting form.	Admin and the public
4	Laporan	The reporting page allows the admin to determine the category of damage, namely the level of damage and the type of infrastructure.	Admin
5	Dashboard	The dashboard page allows for the determination of which reports will be further processed.	Admin
6	Selesai	The finished page displays reports that have been further processed by the Department of <u>Public Works.</u>	Admin

Sequence Diagram

Sequence diagram is a visual representation of objects interacting with each other. This diagram illustrates the sequence of steps from left to right according to the timing and messages exchanged between these objects. Here is the sequence diagram for the road infrastructure damage reporting system:

1. Sequence Diagram Landing Page

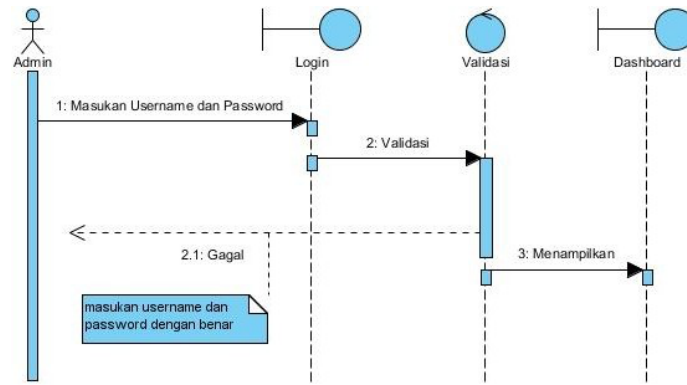
Picture 3 Sequence Diagram Landing Page



Based on the landing page sequence diagram above, both admin and the public can access the page. This page contains information about road infrastructure.

2. Sequence Diagram Login

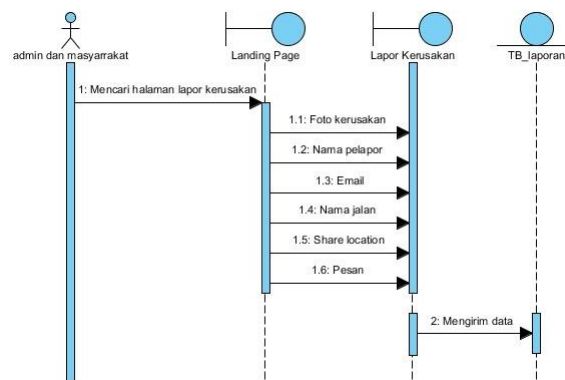
Picture 4 Sequence Diagram Login



Based on the login sequence diagram above, the admin can access the dashboard by logging in with a username and password. If the entered username and password are correct, the user will be directed to the dashboard page. However, if incorrect, the user will receive a notification to re-enter the credentials.

3. Sequence Diagram Lapor Kerusakan

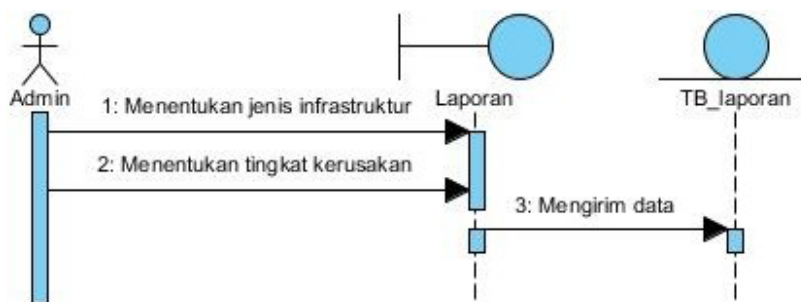
Picture 5 Sequence Diagram Lapor Kerusakan



Based on the "lapor kerusakan" sequence diagram above, both the admin and the public can access this page. This page is used to report damage to road infrastructure by taking photos of the damage, filling in the name, email, street name, sharing location, and also writing a message to be conveyed by the reporter.

4. Sequence Diagram Laporan

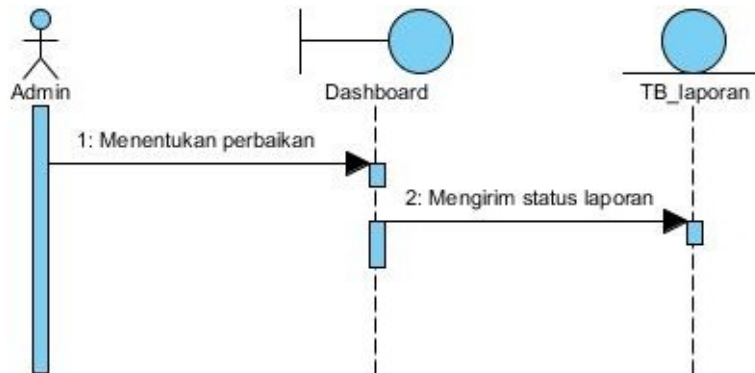
Picture 6 Sequence Diagram Laporan



Based on the "laporan" sequence diagram above, only the admin has access to this page. After users report the damage, the report will enter the "laporan" page. The admin will identify whether the report is appropriate or not. If appropriate, the admin will determine the type of infrastructure and the level of damage. However, if it is not appropriate, the admin can delete the report from the page.

5. Sequence Diagram Dashboard

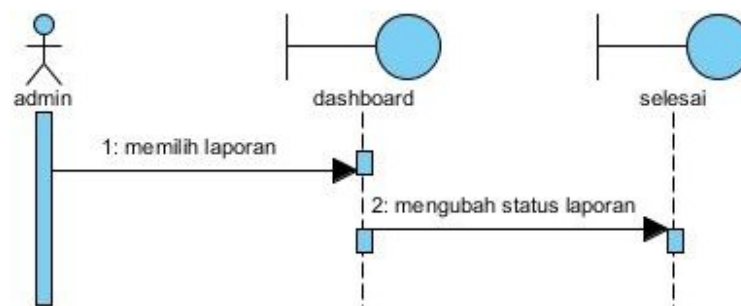
Picture 7 Sequence Diagram Dashboard



Based on the "dashboard" sequence diagram above, the dashboard page can only be accessed by the admin. After the admin determines the type of infrastructure damage and the level of damage, they select which damage report will be further processed by the Bina Marga authority by reviewing the highest scores. After selecting a report, the admin will change the status from "approved" to "in progress" by clicking the process button on the report. Reports with the "in progress" status will be displayed on the landing page to provide information to the public visiting the website.

6. Sequence Diagram Selesai

Picture 8 Sequence Diagram Selesai



Based on the "selesai" sequence diagram above, only the admin can access this page. After reports with the status "in progress" have been followed up, the admin then changes their status to "finished".

7. Implementation

In the implementation phase of applying the priority scheduling algorithm to the design of the infrastructure damage reporting system based on the website in Bekasi Regency, the process

involves coding to translate the design into a language understandable by computers. In the coding process, JavaScript programming language is used. JavaScript is a programming language that allows developers to interact with functions provided by websites. JavaScript is typically used to modify the behavior of other applications written in different programming languages, interpreted and executed in real-time (Theisen, 2019). Additionally, the database design is created using MongoDB, an open-source document database system known for its high performance, optimal availability, and automatic scaling (Chauhan, 2019). Furthermore, Visual Studio Code is utilized as the text editor, and Google Chrome is employed as the web browser.

8. Testing

The testing process focuses on the validity of the software's internal logic, ensuring that all instructions have been tested, and on the external functional aspects, aiming to find errors and verify that the input entered will produce the expected output. Testing is conducted using the black box testing method to

evaluate the features of the built system. Black Box Testing is a software testing method that involves specific evaluation by considering input values in a scenario, without taking into account the internal implementation details of the application (Pramaishella & Maryam, 2023). This testing stage is crucial for identifying potential application failures before proceeding to the next stage.

9. Maintenance

The final stage in the method used is maintenance, which involves repairing the application system after it has been implemented and passed through adequate testing stages. The system is then ready for use by the library head, officers, and users in the road infrastructure damage reporting system in Kabupaten Bekasi. Additionally, periodic maintenance can also be performed to fix errors or bugs that may arise from time to time.

RESULTS AND DISCUSSION

The next step is the Results and Discussion of this Research, which is a road infrastructure damage reporting system that can facilitate the public in reporting road infrastructure damage in Bekasi District. Here are the results and discussions on the implementation of priority scheduling algorithms in the design of a road infrastructure damage reporting system based on a website in Bekasi District.

Implementation of Weight Sum Model Method

The road infrastructure damage reporting system implements the Weight Sum Model method to assist the Bina Marga department in determining the priority for repairing damages. In this case, repairs with the highest final score are given priority. There are two criteria considered in determining the repair of damages, namely the type of road infrastructure and the level of damage.

1. The assessment criteria consist of the type of road infrastructure and the level of damage. To obtain the criteria values, data were obtained from interviews with stakeholders at the Bina Marga of Bekasi District. These criteria values are assigned appropriate weights, which will be calculated and used for comparison to determine the priority for addressing road infrastructure damage. The following are the criteria in table titles 2.

Table Titles 2 Table of Criteria and Weights

CODE	CRITERIA	WEIGHT
K1	Road Infrastructure	60%
K2	Level of Damage	40%

Each mentioned criteria has various sets of criteria and values depending on its attribute level. These set values are obtained through interviews with stakeholders at the Public Works Department of Bekasi Regency, as shown in table titles 3.

Criteria	Set	value
Road Infrastructure	Road Body	9
	Drainage	8
	Sidewalk	7
	Median	6
Level of Damage	Heavy	9
	Medium	8
	Light	7

The alternative values for each criterion are listed in table titles 4, where the values of each criterion set are stated in table 3, and the weight values for each criterion are listed in table titles 2.

Table Titles 4 Alternative Value Data

Code	Alternative	K1	K2
A1	Jalan Kampung Bogor	Drainage	Medium
A2	Jalan Pangkalan Muara Bakti	Road Body	Heavy
A3	Jalan Kalen Keramat – Galian	Sidewalk	Medium
A4	Jalan Wanasari - Cikarang Sejajar CBL	Road Body	Light
A5	Jalan Rawa Julang - Telajung	Median	Light

If the alternative values of the criteria in Table 4 are changed to numbers, the results of the changes can be seen in table titles 5.

Table Titles 5 Conversion of Alternative Values and Criteria Weights

Alternative	Criteria Weights	
	K1	K2
	0.6	0.4
A1	8	8
A2	9	9
A3	7	8
A4	9	7
A5	6	7

2. Based on the alternative values listed in table titles 5, the decision matrix can be formed as follows:

8	8
9	9
7	8
9	7
[6	7]

$$X =$$

3. To optimize the matrix for each alternative, the multiplication of criterion weights by alternative values is performed to yield the final score values. Therefore, the result of $x_{ij} * w_j$ is as follows:

$$A1 = (x_{1,1(max)}^{*} \cdot w_1 + x_{1,2(max)}^{*} \cdot w_2)$$

$$A1 = (8 * 0.6) + (8 * 0.4) A1 = 8$$

$$A2 = (x_{2,1(max)}^{*} \cdot w_1 + x_{2,2(max)}^{*} \cdot w_2)$$

$$A2 = (9 * 0.6) + (9 * 0.4)$$

$$A2 = 9$$

$$A3 = (x_{3,1(max)}^{*} \cdot w_1 + x_{3,2(max)}^{*} \cdot w_2)$$

$$A3 = (7 * 0.6) + (8 * 0.4)$$

$$A3 = 7.4$$

$$A4 = (x_{4,1(max)}^{*} \cdot w_1 + x_{4,2(max)}^{*} \cdot w_2)$$

$$A4 = (9 * 0.6) + (7 * 0.4)$$

$$A4 = 8.2$$

$$A5 = (x_{5,1(max)}^{*} \cdot w_1 + x_{5,2(max)}^{*} \cdot w_2)$$

$$A5 = (6 * 0.6) + (7 * 0.4)$$

$$A5 = 6.4$$

The Implementation of Priority Scheduling Algorithm

After calculating with the Weight Sum Model method, the final scores of each alternative are used to determine the priority of reports for repairing road infrastructure damage. This algorithm ensures that each highest final score gets top priority in the repair process as shown in table titles 6.

Table Titles 6 Priority Scheduling Table

Order	Code	Alternative	Final Score
1	A2	Jalan Pangkalan Muara Bakti	9
2	A4	Jalan Wanasari - Cikarang Sejajar CBL	8.2
3	A1	Jalan Kampung Bogor	8
4	A3	Jalan Kalen Keramat – Galian	7.4
5	A5	Jalan Rawa Julang - Telajung	6.4

To consider the time factor, the algorithm employs the aging technique. When the status of infrastructure damage is still "approved" or "in progress", every 24 hours will add a value of 0.2 to the final score of the alternative. This is done to ensure that priorities are dynamically adjusted according to the actual condition of the reported damage. Once the reports have been selected by the admin and have the "approved" status, those with the highest scores will be prioritized for repair. Therefore, the admin will change the status of the highest-scoring report to "in progress" for further processing as shown in table titles 7.

Table Titles 7 Implementation of Aging Technique

Order	Alternative	Status	Day 1	Day 2
1	A2	In Progress	9	9.2
2	A4	Approved	8.2	8.4
3	A1	Approved	8	8.2
4	A3	Approved	7.4	7.6
5	A5	Approved	6.4	6.6

In table titles 7, the aging technique will continue to be applied every 24 hours as long as the status of the report is still "approved" or "in progress". However, if a report with the status "in progress" has been completed, the admin will change its status to "finished". Reports that have the status "finished" will not apply the aging technique, thus the aging process will be stopped as shown in table titles 8.

Table Titles 8 Reports with Finished Status

Order	Alternative	Status	Day 2	Day 3
1	A2	Finished	9.2	
2	A4	In Progress	8.4	8.6
3	A1	Approved	8.2	8.4
4	A3	Approved	7.6	7.8
5	A5	Approved	6.6	6.8

Interface Implementation

Interface implementation in this system involves developing various web pages that align with the previously designed layout. Here are the details of the interface implementation:

1. Landing Page

The landing page serves as the starting point for users to access the website, providing essential information relevant to the website's content. Both admins and the general public can find the necessary information before further exploring other sections of the website. Here is the display of the landing page:

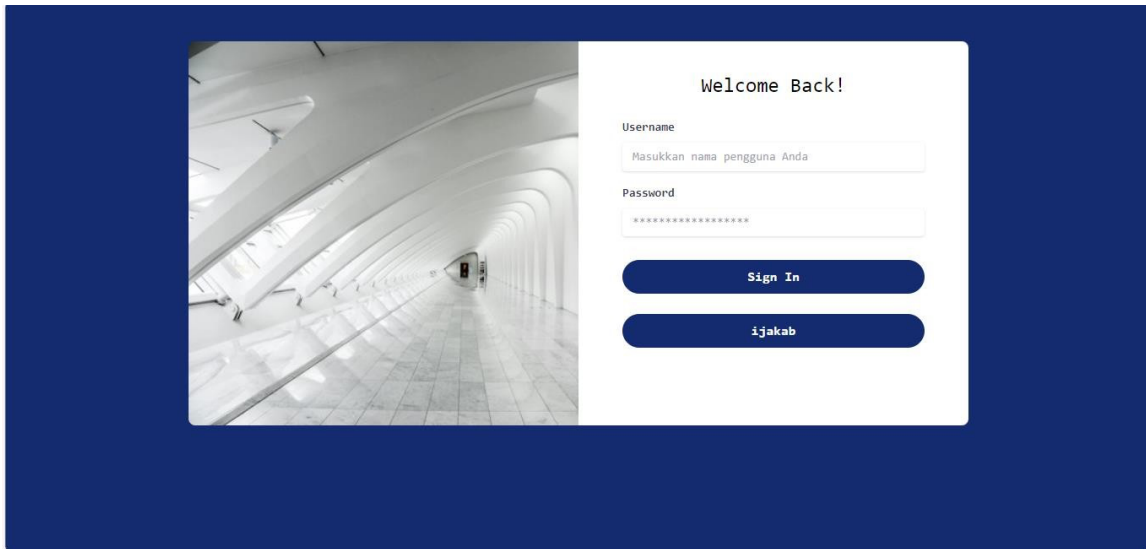
Picture 9 Display of Landing Page



2. Login Page

The login page is where the admin can access the system by entering their username and password. Here is the display of the login page:

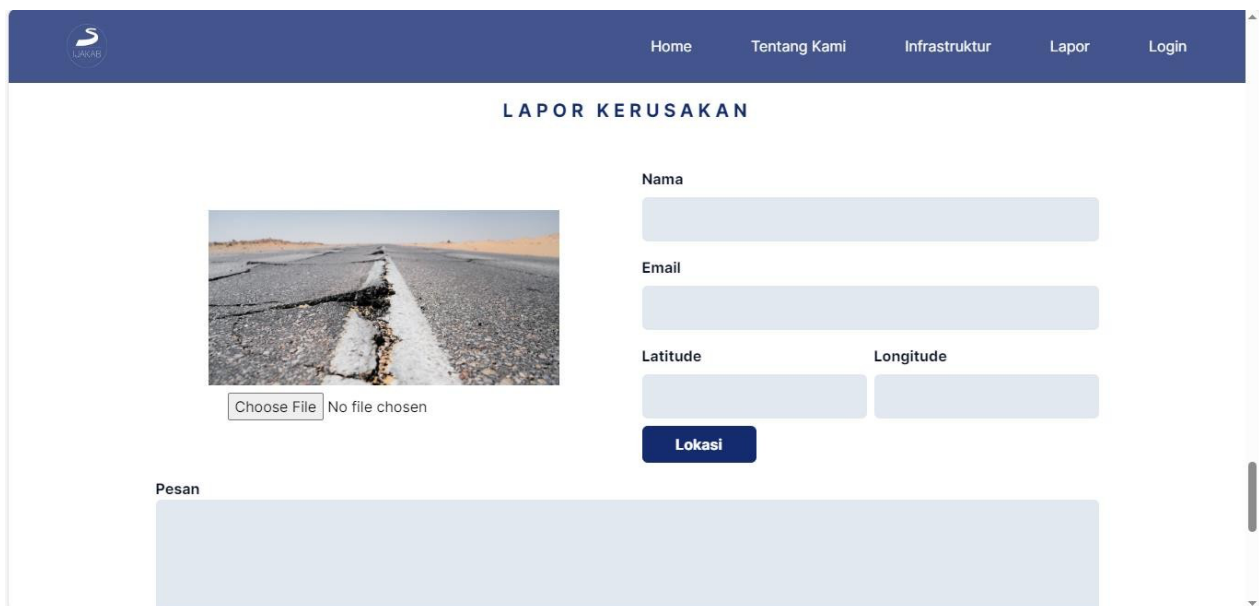
Picture 10 Display of Login Page



3. Damage Reporting Feature

The damage report feature allows users, both administrators and the public, to report road infrastructure damage. They can fill out the available reporting form to provide information about the damage they encounter. Here is the display of the damage reporting page:

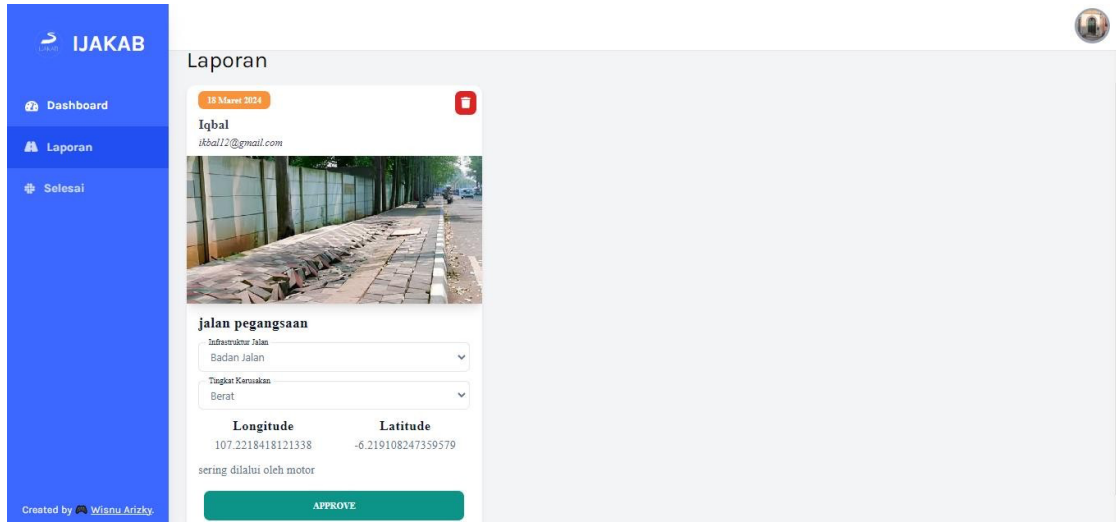
Picture 11 Display of Damage Reporting Feature



4. Laporan Page

The “laporan” page allows administrators to determine the category of road infrastructure damage. Admins can set the level of damage and the type of infrastructure affected by the damage through this feature. Here is the display of the damage category page:

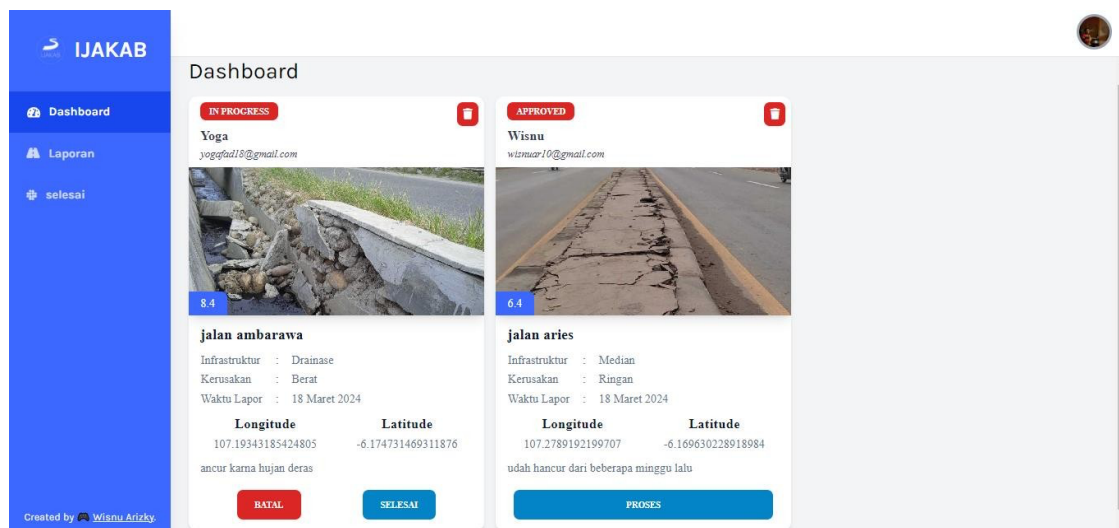
Picture 12 Display of Laporan Page



5. Dashboard Page

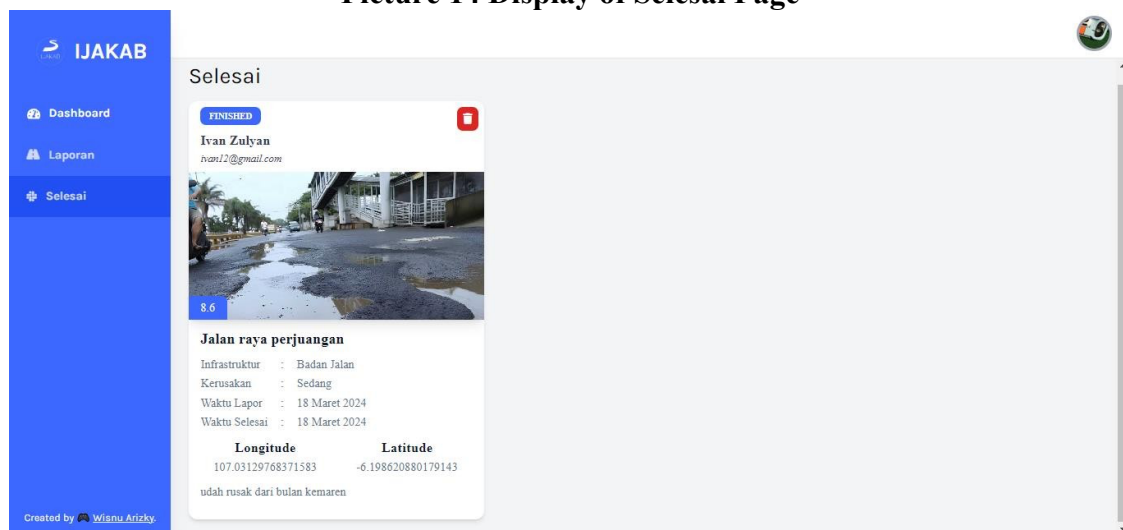
The dashboard page allows administrators to prioritize handling reports of road infrastructure damage. Admins can select reports to be addressed first based on the highest final score. Here is the display of the repair determination page:

Picture 13 Display of Dashboard Page



6. Selesai Page

Picture 14 Display of Selesai Page



CONCLUSION

Based on the research results and discussions regarding the Implementation of Priority Scheduling Algorithm in the Design of Road Infrastructure Damage Reporting System Based on Website in Bekasi Regency, it can be concluded that the road infrastructure damage reporting system contributes positively to the community and related parties. With structured and efficient reporting and management features for road damage, this system becomes easier to manage by the Bina Marga administrators and accessible to the public. The purpose of designing this system is to build an information channel regarding the status and location damaged road infrastructure and to help expedite the repair process. The system also includes features for reporting various elements of road infrastructure damage, such as road surface, drainage, sidewalks, and road medians in the vicinity. Additionally, this system can be accessed online anytime.

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