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Original Article

Analysis of Pavement Damage Types on Provincial Roads in the Madura Region

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Abstract

Roads play a crucial role in fostering economic development and facilitating transportation within communities. However, in the Madura region, issues such as cracks, potholes, and raveling are frequently observed, posing challenges to road quality and safety. This study aims to investigate the prevalent types of road defects in this area in order to inform better infrastructure planning and management. To achieve this objective, the research focused on provincial roads in the Madura region, utilizing a combination of field surveys and questionnaires with road users in Pamekasan. The findings of the study highlighted cracks, potholes, and grain detachment as the most commonly observed forms of road damage in the region. These results are essential for guiding decision-making processes related to road maintenance and repair, ultimately enhancing the efficiency and quality of road infrastructure. The insights gained from this study offer valuable guidance for policymakers and stakeholders involved in road infrastructure development. Recommendations arising from the research include prioritizing the management of road damage, ensuring adequate budget allocation for repairs, and implementing regular maintenance practices to prevent deterioration.

Keywords: Highway, Road Damage, Cracks, Potholes, Raveling.

1. Introduction

Roads are important infrastructure in supporting economic development in an area. Good quality is prioritized for the safety and comfort of road users. Highway planning consists of road geometric planning and pavement thickness planning. Regulations from the Bina Marga Public Works Office that are generally used in road planning in Indonesia at certain periods are developed with the aim of producing more efficient road planning in terms of cost and time (Almufid, 2016). Roads provide important benefits to humans, because roads are the movement of all aspects. The progress of a country can be seen from the number of existing roads and good roads in terms of road functions and benefits. If the road is damaged, the economy will be hampered (Fitriani, 2018; Hendrawan et al., 2022).

Road damage sometimes occurs earlier than the service period caused by many factors, including human and natural factors (Ramadhani et al., 2022). Human factors include tonnage or vehicle loads - heavy vehicles that exceed capacity and increasing vehicle volumes (Talani, 2018). Roads are built as infrastructure for mobility and accessibility of an area, but if the condition of the road is damaged, it will interfere with the comfort, safety of vehicles and affect the performance of the pavement which will result in a decrease in road quality (Rahmah et al., 2020).

Road problems are an important part of a country's development. Damage to the road causes obstruction to the economy and industry (Hidayat et al., 2020; Mulyana, 2021;

Munggarani & Wibowo, 2017). With this research, it can be expected to determine the right and effective handling of road damage. So that it has a positive impact on the progress of a country. Various types of pavement road damage in the Madura region have an impact that can disrupt comfort and affect economic and social factors in the community. Road handling is done to solve the problem of road damage needs to be done. Costs for handling road damage must be appropriate and appropriate to make the budget more effective.

The government budget for road infrastructure is quite large. An appropriate and targeted budget is important for proper and effective use. By knowing the road damage, this research can provide road handling costs that are in line with the required budget (Rizal et al., 2019; Suhendi et al., 2021). With the problem of the required budget related to the handling of road damage is an option for research. With handling costs that are in accordance with road damage, it is expected to provide benefits for effective cost budget suitability (Saroni & Hakim, 2022; Yudaningrum & Ikhwanudin, 2017). From the background explanation above, this research aims to determine the type of road damage that occurs in the Madura Region.

2. Methods

2.1. Research Subjects

The subject of this research is pavement road damage analysis from the road condition survey form processed for the questionnaire method.

2.2. Data Collection Procedure

Primary data is taken from the road condition survey form conducted in the field and processed into primary data. Secondary data in the form of road condition survey data available at the East Java Province Bina Marga Public Works Office is then used as secondary data. Furthermore, research was carried out by conducting questionnaires conducted with google forms, which were then distributed and filled in by respondents. Respondents are from contractors, consultants, budget users and the general public, especially the Madura region. After the research is done, get the results of the research to analyze the data and enter the data into data that is drawn into the results of data processing.

2.3. Data Analysis Technique

Data analysis is a process that transforms data into information that is easy to understand, and can be used to find a solution to a problem formulation. In this research, the data analysis technique carried out is descriptive qualitative, namely by analyzing the data obtained and then describing the process, as well as the results of the data analysis. The data that has been obtained from observations in the field is in the form of a road condition survey form. The data is from the East Java Province Bina Marga Public Works Office. The data includes the type of road damage, the volume of damage (Length and Width), the location of the damage.

3. Results and Discussion

From the questionnaire questions about the types of road damage known by respondents, the following results were obtained. First, most respondents are familiar with the type of road damage known as cracks, with 13 respondents identifying it. This is followed by depressions (12 respondents), potholes (11 respondents), raveling and patching (9 respondents), bleeding (8 respondents), and rutting (7 respondents). The data is illustrated in Figure 1.

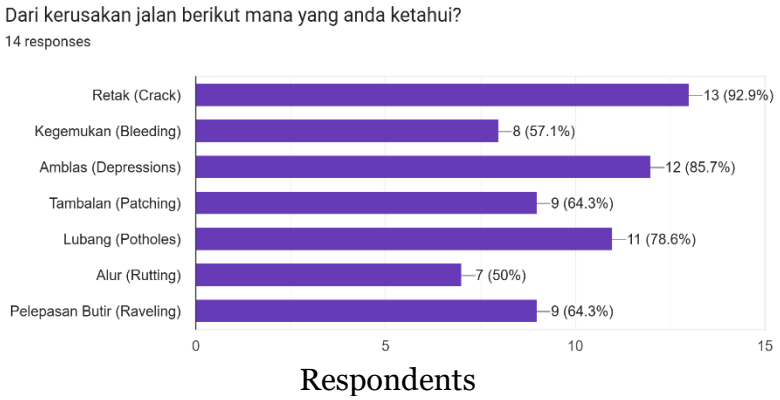

Figure 1. Types of Road Damage known to Respondents

From the types of road damage known by respondents, to find out the types of road damage that are often encountered in the Madura Region, respondents gave answers in Figure 2.

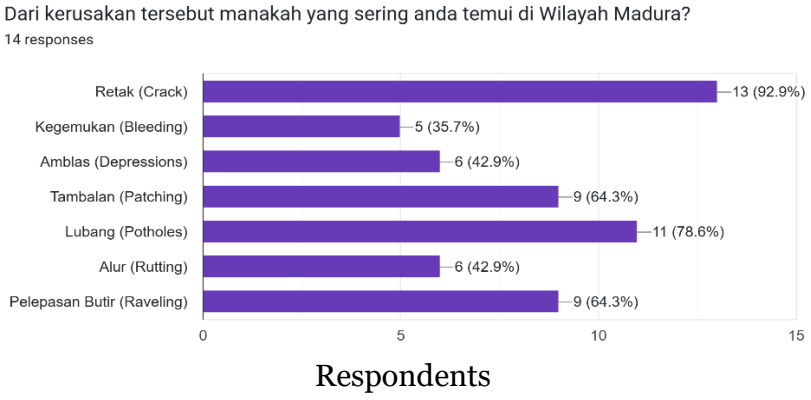

Figure 2. Types of Road Damage often encountered in the Madura Region

The most frequently encountered type of road damage is cracks, identified by 13 respondents. This is followed by potholes, reported by 11 respondents. Both patching and raveling were mentioned by 9 respondents each. Similarly, 6 respondents identified depressions and rutting as common road damages. Bleeding was the least frequently encountered type of road damage, with only 5 respondents noting it. To prioritize road damage, respondents were asked to rank the types of damage on a scale: 1 for not a priority, 2 for medium priority, and 3 for very high priority.

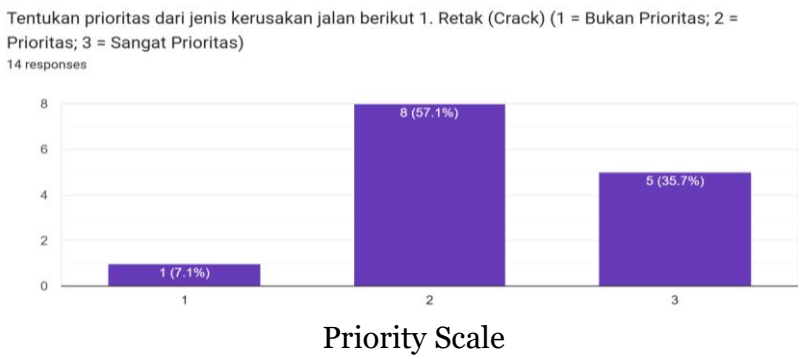

Figure 3. Prioritized Road Damage

The explanation of Figure 3 shows the type of road damage in the form of cracks, 8 respondents chose to be a priority with 5 respondents choosing very priority and 1 respondent not a priority. Figure 3 shows the survey results regarding the prioritization of road damage types in the form of cracks. Of the 14 respondents who provided answers, the majority, namely 8 respondents (57.1%), chose the "Priority" category (2). Meanwhile, 5 respondents (35.7%) considered this type of road defect as "High Priority" (3), and only 1 respondent (7.1%) considered it as "Not a Priority" (1). This shows that cracks are considered important enough to be repaired immediately, but not to the extent that they require more in-depth attention.

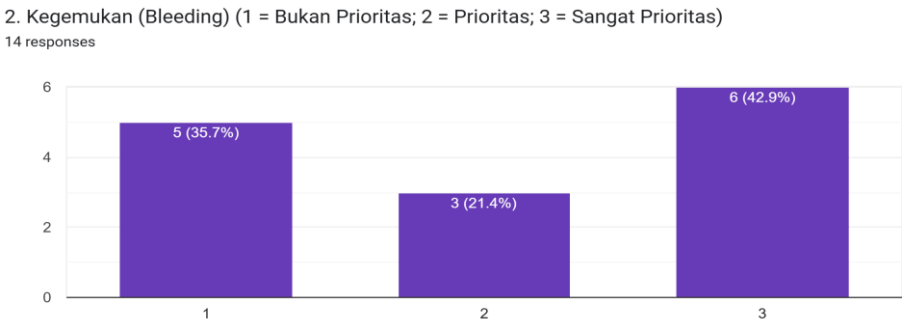

Figure 4. Prioritization Scale of Bleeding Road Damage Types

Figure 4 shows the differences in respondents' assessment of the urgency of addressing these defects. A total of 6 respondents chose this type of damage as a high priority, indicating that they considered that obesity damage, which is often caused by increased temperatures that cause bitumen to rise to the surface, can pose serious problems to road stability and driver comfort. However, 5 respondents chose not to prioritize this damage, which may be due to other influences such as the prevalence of other types of damage that are considered more dangerous or urgent to repair. Meanwhile, 3 respondents chose the priority category, indicating a moderate assessment of the level of urgency. This indicates that while obesity is not the most common type of damage, it is still considered important to repair, given its impact on overall road quality.

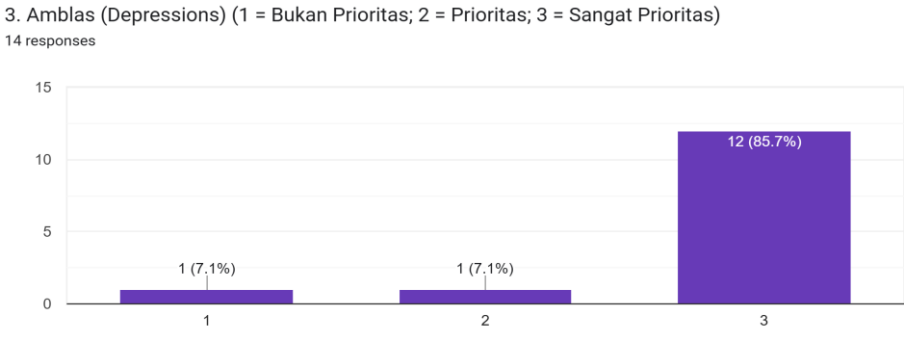

Figure 5. Prioritization Scale of Depressions Road Damage Types

Figure 5 shows that depressions were considered a very important priority by the majority of respondents, with 12 people choosing the very high priority category. This damage usually occurs due to subsidence of the road surface caused by uneven load distribution or

incomplete compaction. Depressions can have a direct impact on the safety and comfort of road users, so it is natural that many respondents considered repairing this type of damage to be very urgent. Only 1 respondent chose this type of damage as non-priority and 1 respondent chose priority, indicating that this damage is considered very important to repair immediately, despite different views on its urgency.

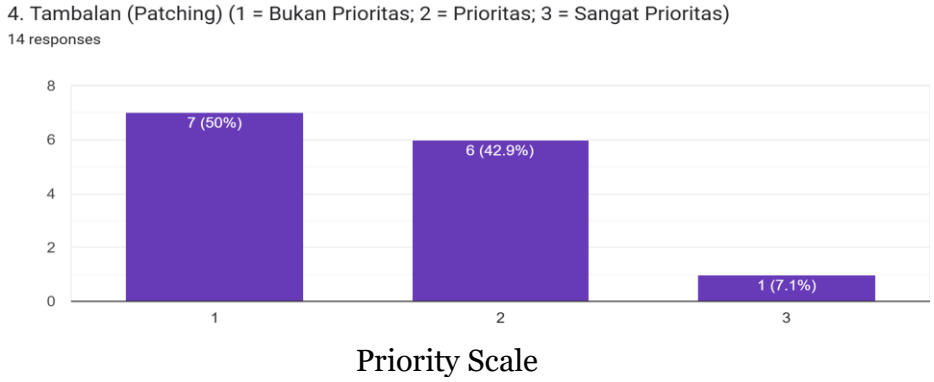

Figure 6. Prioritization Scale of Patching Road Damage Types

Figure 6 illustrates the patching type of road damage, showing that only 1 respondent selected this type of damage as a high priority, while 6 respondents selected it as a priority, and 7 respondents selected it as not a priority. This type of damage usually occurs when a road repair is not fully effective, requiring further treatment. This result suggests that patching damage may be considered less urgent than other damage such as sinkholes or potholes, so more respondents rated patching repairs as less urgent. This difference of opinion may reflect that patching defects do not cause as much disruption to traffic flow as other defects.

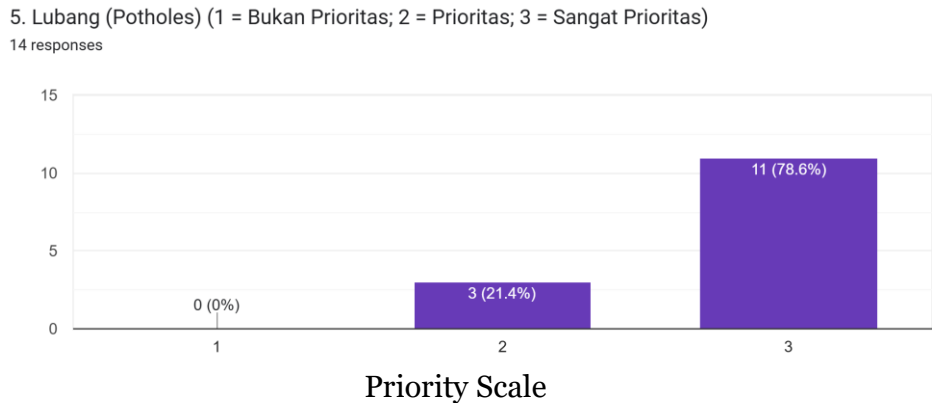

Figure 7. Prioritization Scale of Potholes Road Damage Types

The type of pothole damage based on Figure 7 shows different results on the type of pothole damage, with the majority of respondents choosing this damage as a high priority, namely 11 respondents. Pothole damage is often considered a major problem that must be fixed immediately because it can endanger motorists and damage vehicles. A total of 3 respondents chose this defect as a priority, while none chose it as a non-priority. This shows that pothole damage is very influential on comfort and safety, so it received more attention from respondents than other types of damage.

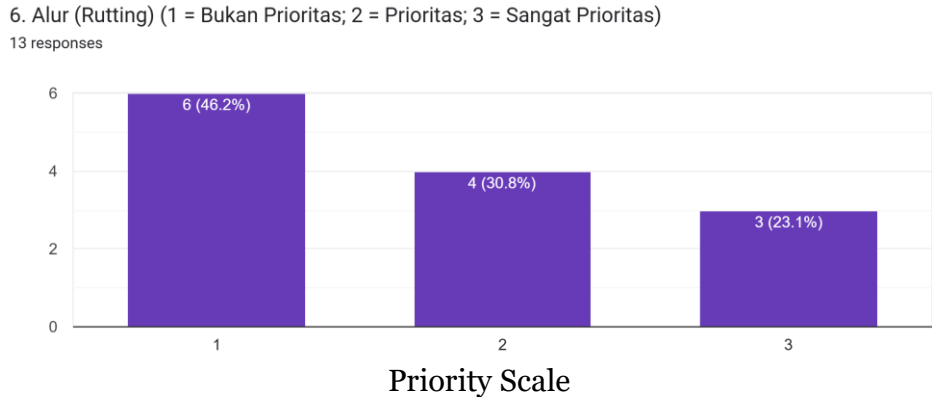

Figure 8. Prioritization Scale of Rutting Road Damage Types

Figure 8 shows that for rutting, most respondents did not consider it to be a high priority, with 6 respondents selecting the category "Not a Priority." In contrast, 4 respondents selected it as a "Priority," and 3 respondents considered it a "High Priority." This suggests that while there is awareness of the damage, not all parties consider it urgent to address.

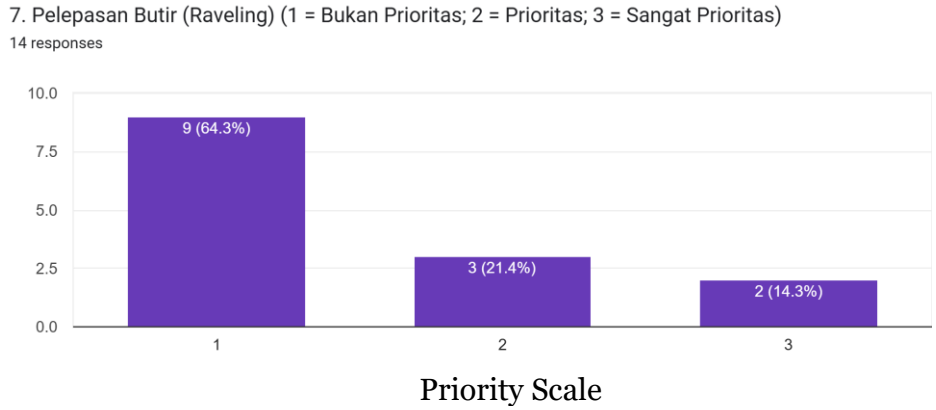

Figure 9. Prioritization Scale of Raveling Road Damage Types

Meanwhile, figure 9 shows that 9 respondents chose "Not a priority," 3 respondents chose "Priority," and 2 respondents chose "Very Priority." This shows that the majority of respondents do not consider this type of damage to be a priority either, although there is a small minority who consider it important for immediate handling. Overall, these two types of road defects tend to be considered less urgent than other types of road defects.

Figure 10. Road Handling of Minor Pavement Road Damage

Figure 10 shows the type of treatment for minor pavement damage. All respondents (100%) agreed that routine maintenance of the road is the appropriate treatment (shown in blue). This suggests that minor pavement damage is more appropriately addressed by routine maintenance, which involves periodic repairs without the need for larger road construction or reconstruction. This reflects the importance of regular road maintenance to prevent further damage to existing road infrastructure.

Figure 11. Road Handling on Medium Pavement Road Damage

Figure 11 shows that the majority of respondents (92.9%) stated that when major pavement damage occurs, the treatment action taken is "Road construction and reconstruction". Meanwhile, only 7.1% of respondents chose "Routine maintenance of roads." No respondents chose the option "Periodic maintenance of roads." These results suggest that major pavement damage generally requires more significant remedial measures, such as rebuilding or reconstruction, than just routine or periodic maintenance. This may be due to the extent of the damage, which requires comprehensive repairs to restore optimal road function.

Figure 12. Road Handling on Large Pavement Road Damage

Based on Figure 12, the majority of respondents (92.9%) stated that when major pavement damage occurs, the handling action taken is "Road construction and reconstruction". Meanwhile, only 7.1% of respondents chose "Routine maintenance of roads." No respondents chose the option "Periodic maintenance of roads." These results suggest that major pavement damage generally requires more significant remedial measures, such as rebuilding or reconstruction, than just routine or periodic maintenance. This may be due to the extent of the damage, which requires comprehensive repairs to restore optimal road function.

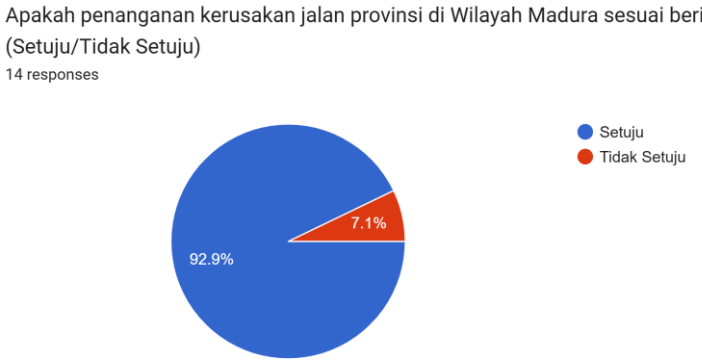

Figure 13. Suitability of Provincial Road Damage Management in Madura Region

A total of 92.9% of respondents stated "Agree" that the handling of provincial road damage in the Madura region was appropriate. Meanwhile, only 7.1% of respondents stated "Disagree." These results show that the majority of respondents have a positive view of the efforts to deal with provincial road damage in the Madura region. This indicates that the steps taken in handling road damage are considered to have met the expectations or needs of the community. However, there are still a small number of respondents who feel that these efforts are inadequate, which may reflect that there are certain aspects that still need to be improved.

Figure 14. Appropriateness of Road Damage Implementation in Madura Region

The majority of respondents, 92.9%, agreed that the implementation of road damage in the Madura region was well targeted. This indicates that most people are satisfied with the efforts made to address road infrastructure problems in the region. However, 7.1% of respondents stated the opposite, namely that the handling of road damage has not been on target, which indicates a perception of dissatisfaction or a need for improvement in terms of the effectiveness and prioritization of handling road damage in Madura. Determining the types of road damage often encountered in the Madura Region can provide important insights into the condition of infrastructure in the region (see Figure 15).

Figure 15. Types of Road Damage Potholes

Based on the data obtained through questionnaires, the most common type of damage is crack, which was recorded by 13 respondents. This damage may be due to the age of the road or the suboptimal quality of materials used in road construction. Furthermore, potholes were recorded by 11 respondents, which are generally caused by extreme weather and heavy traffic loads. Other frequently encountered defects, such as patching and raveling, were recorded by 9 respondents each, which may reflect problems with the pavement layer deteriorating due to inadequate maintenance. Depressions and rutting were recorded by 6 respondents, which usually result from uneven load distribution or incomplete compaction. Bleeding was the least common type of damage, with only 5 respondents identifying it, which may occur due to high temperatures causing bitumen to rise to the surface.

Damage cases that occurred on the road section Bts. Pamekasan City - Sotabar in 2022 shows a mismatch between the road maintenance method and the real conditions on the ground. Damage that could initially be handled by routine maintenance, became more severe due to high rain intensity and the absence of adequate drainage. This resulted in more serious damage, which required reconstruction of the road in 2023 using Inpres funds. This incident illustrates the importance of careful planning in road maintenance, where weather factors and other supporting infrastructure, such as drainage, need to be considered so that damage can be prevented and repaired in a timely manner. As such, effective road maintenance depends not only on the frequency of routine repairs, but must also consider local conditions and potential risks that could exacerbate existing damage.

4. Conclusion

Based on the research conducted, the most common types of road damage found in the Madura region are cracks, potholes, and raveling. These damages were identified through field surveys and questionnaires to respondents consisting of contractors, consultants, budget users, and local communities. Cracks were the top priority with 57.1% of respondents selecting it as the type of damage that needed attention. Meanwhile, potholes were considered a high priority by 78.6% of respondents.

Local governments and relevant agencies need to prioritize damage types that have a significant impact on road user safety, such as potholes and cracks. This should be done thoroughly to prevent further damage. Budgeting should be based on damage data obtained from field surveys and road condition analysis. This will ensure that the budget allocated matches the repair needs on the ground, making it more efficient and targeted. Regular monitoring of road conditions should be conducted to identify early defects. Preventive

maintenance such as drainage cleaning and vehicle load management can help reduce the frequency of road damage.

The community needs to be involved in road maintenance, especially in keeping the load of passing vehicles within the road capacity. Education on the importance of maintaining road conditions is also necessary to reduce damage caused by road user behavior. The use of the latest technology and efficient handling methods should be applied to extend the service life of roads. For example, by using high-quality materials or durable repair methods. With the implementation of these suggestions, it is expected that road conditions in the Madura region can be well maintained, supporting community activities and improving economic efficiency.

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