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Social Studies Learning Model Based on Prince Hidayatullah's Character Values: Model Pembelajaran Ilmu Sosial Berbasis Nilai-Nilai Karakter Pangeran Hidayatullah

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General Background: The rapid advancement of science and technology in Indonesia has led to a decline in socio-cultural values, creating an urgent need for value-based education to preserve national identity. **Specific Background:** Social Studies (IPS) is a strategic subject for instilling character, yet current practices insufficiently integrate local historical figures. Prince Hidayatullah, a Banjar leader known for religiosity, courage, patriotism, and social care, represents a culturally relevant role model. **Knowledge Gap:** Previous studies addressed isolated aspects of his legacy without translating them into a structured, classroom-tested pedagogical model. **Aims:** This study aimed to develop and evaluate a Social Studies learning model based on Prince Hidayatullah's character values to enhance students' social care character. **Results:** Using the ADDIE design and Classroom Action Research cycles, trials in MTs Ats-Tsuur and SMPN 4 Cianjur showed significant improvements in social care scores (N-gain ≈ 0.76, high category) and student engagement. **Novelty:** The model uniquely integrates ethnopedagogical principles with historical character values into contextual Social Studies instruction. **Implications:** Findings support the integration of local historical figures into curricula as an effective approach to strengthening student character, fostering cultural identity, and providing adaptable frameworks for value-based learning across diverse educational contexts.

Highlight :

- Developing a social studies learning model based on the values of Prince Hidayatullah's struggle.
- Strengthening students' social awareness through contextual learning.
- Proven effective in improving students' understanding and character behavior.

Keywords : Social Studies Learning Model, Character Values, Pangeran Hidayatullah, Character Education, Contextual Learning

developing students' competencies through innovative and creative strategies. However, the character of the younger generation is in decline, as reflected in the 2021 Balitbang–Ministry of Religious Affairs survey showing a drop in the Pancasila character score from 71.41 to 69.52, and media reports of moral issues among students in Cianjur. This loss of local wisdom, which has long shaped Indonesia's cultural character, aligns with Budiarto's (2020) view that today's youth increasingly neglect moral values. The need for strong human resources with integrity is urgent to face global challenges and enhance competitiveness, yet current conditions still fall short of these educational ideals [3].

Currently, Indonesia is experiencing a severe moral crisis as a consequence of the rapid advancement of information and technology. In this context, education plays a crucial role in addressing the nation's pressing issues [4]. The negative impact of globalization in Indonesia has caused society to overlook the importance of character, ethics, and manners, as well as contributed to the decline in children's creativity due to the weakening of cultural and character education [5]. In response, the Indonesian government has formulated 18 character education values intended to be instilled in every citizen, particularly among the younger generation, as part of the effort to shape the national character (Ministry of National Education, 2010). The younger generation must possess strong character to withstand the overwhelming influence of globalization, which continues to erode the nation's longstanding cultural values. According to Putro (2016), national values can be cultivated through education, as education is essentially a means of preparing the nation's youth (students) for the future. One of the effective strategies to address this issue is through school-based education, particularly within the subject of Social Studies (Ilmu Pengetahuan Sosial or IPS). Social Studies serves as a subject that emphasizes values and character formation in students. Prince Hidayatullah was a Banjar royal figure born in 1821 in Banjarmasin. He was the son of Sultan Muda Abdurrahman and a noblewoman named Ratu Siti, the daughter of Prince Mangkubumi Nata, who was born in 1822 in Karang Intan, Martapura City [8]. He is recognized as a central figure in the history of the Banjarmasin War due to his significant leadership role, and he also served as the commander of the Banjar War [6]. As a result, the Dutch colonialists referred to him as "De Hoofdmuiteling" (the head rebel) [9]. Among the Banjar people, he is remembered as a unifying figure who rallied the community in resistance against Dutch colonialism [10]. His leadership embodied the values of solidarity and collective struggle, inspiring the Banjar people and becoming the driving force behind their resistance. At that time, the people of South Kalimantan required a strong spirit of resistance against colonial oppression, and Prince Hidayatullah was the leader who united and mobilized the Banjar community [11].

The leadership, heroism, and struggle of Prince Hidayatullah have been widely recognized by various groups for his dedication to the welfare of the people. Throughout his resistance, Prince Hidayatullah remained steadfast in his refusal to compromise or submit to Dutch colonial rule. His defiance persisted until he was deceived, misled, captured, and eventually exiled to Cianjur by the Dutch government [12]. His significance extended beyond the Banjar community; for the people of Cianjur, Prince Hidayatullah holds great meaning due to his role in the spread of Islamic teachings in the region. Despite being in exile, he continued his missionary work, preaching Islam to the Cianjur community until the end of his life [16]. A review of Prince Hidayatullah's life and struggle reveals several key character traits, including: (1) religiosity; (2) patriotism; and (3) social concern [13]. According to Subiyakto's (2019) writings on Prince Hidayatullah, his character was further exemplified by the following qualities: (1) deep religious knowledge (ʻālim) and understanding of Islamic teachings; (2) principled leadership, consistently reflected in his words and actions, with unwavering commitment to divine law and refusal to compromise with injustice; (3) noble personality and virtuous conduct, earning him great respect from all segments of society; (4) a constant source of encouragement for achieving independence and sovereignty from Dutch colonialism; (5) a unifier of community forces against oppression; (6) obedience and respect toward his parents, demonstrated through his attendance at Islamic study circles in "Pagar"; (7) artistic talent, especially in traditional performance arts and dance; (8) passion for horseback riding and archery; and (9) unwavering determination and resilience, not easily swayed by others [14]..

One strategic effort to transform the values of Prince Hidayatullah's struggle is through education, particularly within the Social Studies (Ilmu Pengetahuan Sosial/IPS) curriculum. According to Banks (1990), Social Studies education should develop four core competencies in students: (a) knowledge, (b) skills, (c) attitudes and values, and (d) civic practices. These competencies equip students to make reflective decisions, think critically, conduct social science research, collaborate effectively, and participate actively in civic life. As future citizens, they must uphold democratic and human values—such as dignity and equality—while engaging in activities that expand political understanding and empower them to influence social institutions [15]. The Kurikulum Merdeka, as the current national curriculum, provides a framework for embedding these competencies while strengthening character education, particularly through the Pancasila Student Profile. This aligns with the Ministry of National Education's (2010) formulation of 18 core character values—ranging from religiosity and honesty to environmental awareness and responsibility—intended to strengthen national identity [16]. Previous studies on Prince Hidayatullah have been limited in scope. Syarifah Al Jupri Alpiah (2019) examined only the value of nationalism in his struggle, while Tiara Nur Laila (2022) focused on his religious mission in Cianjur without translating these insights into a pedagogical model for Social Studies. To date, no research has comprehensively integrated the full spectrum of his character values—religiosity, responsibility, courage, patriotism, and social awareness—into a structured learning model tested in classroom settings. This study fills that gap by developing and validating a Social Studies learning model grounded in ethnopedagogical principles that transform local historical values into practical, contextually relevant instructional strategies. The model contributes theoretically by enriching discourse on local wisdom-based character education and practically by providing educators with an innovative approach to cultivating students' character within the framework of the Kurikulum Merdeka.

METHOD

This study employs a Research and Development (R&D) methodology using the ADDIE model, which consists of five phases: Analyze, Design, Develop, Implement, and Evaluate. In the Analyze phase, a hermeneutic study was conducted to extract the character values inherent in the struggle of Prince Hidayatullah through the interpretation of historical texts and cultural narratives. These identified values were then used in the Design phase to develop an initial draft of a Social Studies learning model based on character values. The learning model was further developed using a Classroom Action Research (CAR) approach based on the Kemmis and Taggart model, implemented at SMP Islam Al-I'anah Cianjur. This process involved three cycles: planning, action, observation, and reflection. The CAR approach was employed to iteratively design and refine the Social Studies learning model based on Prince Hidayatullah's character values through a collaborative process involving both teachers and students. The optimized outcome from the second cycle served as the foundation for the final model, which was subsequently tested for its effectiveness through limited trials at two schools: MTs Ats-Tsuur and SMPN 4 Cianjur. The model's effectiveness was evaluated using a quasi-experimental design with a One Group Pretest-Posttest approach to measure the impact of the model on improving students' social care character. Data collection techniques included attitude scale questionnaires, student and teacher activity observations, field notes, and interview guides. Research instruments were specially developed for each stage of the process, including textual analysis guidelines, observation sheets, and social care attitude assessment rubrics. Data were analyzed qualitatively, drawing on literature reviews and expert validator feedback, and quantitatively, employing tests for validity, reliability, normality, homogeneity, t-tests, and normalized gain. The results of both qualitative and quantitative analyses were used to evaluate and refine the learning model, with the aim of establishing an effective strategy for instilling social care character in students through meaningful and contextual Social Studies education. The research followed the ADDIE model, starting with analyzing Prince Hidayatullah's character values through hermeneutic study, designing a Social Studies learning model, and developing it using Classroom Action Research (three cycles of planning, action, observation, and reflection). The optimized model from the second cycle was implemented in limited trials at MTs Ats-Tsuur and SMPN 4 Cianjur, and finally evaluated through qualitative and quantitative analysis to assess its effectiveness in enhancing students' social care character.

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Each phase of the ADDIE model was grounded in empirical classroom evidence. In the Analyze phase, interviews and classroom observations revealed students' limited familiarity with local historical figures and low engagement in value-based discussions. In the Design phase, lesson plans and activities were crafted to address these gaps, incorporating discussion prompts and contextual examples linked to students' daily experiences. The Develop phase involved creating and piloting instructional materials—such as illustrated storyboards and student worksheets—which were refined based on teacher and student feedback. During the Implement phase, observation data showed measurable improvement in students' social care scores from Cycle I to Cycle II. Finally, in the Evaluate phase, both formative assessments (peer reviews, teacher reflections) and summative measures (pretest-posttest results, normalized gain scores) confirmed the model's positive impact while identifying areas for further refinement.

RESULT AND DISCUSSION

A. Result

Implementation of Cycle I and II

The implementation of Cycle I in this study was carried out over three sessions on May 20, 22, and 23, 2025, in Class VIII-B at SMP Islam Al-I'anah Cianjur. The instructional material focused on "The Indonesian Nation's Resistance against Dutch Colonialism," with a sub-theme on the Banjar War and the figure of Prince Hidayatullah. The intervention employed a learning strategy based on the character values reflected in Prince Hidayatullah's struggle. The main learning activities included content delivery, group discussions, the creation of concept maps, and student presentations. The researcher acted as the teacher and collaborated with the Social Studies teacher in designing and implementing the action plan. To provide an initial overview of student performance during Cycle I, the observation scores were first summarized in a visual diagram to highlight the distribution across qualification categories.

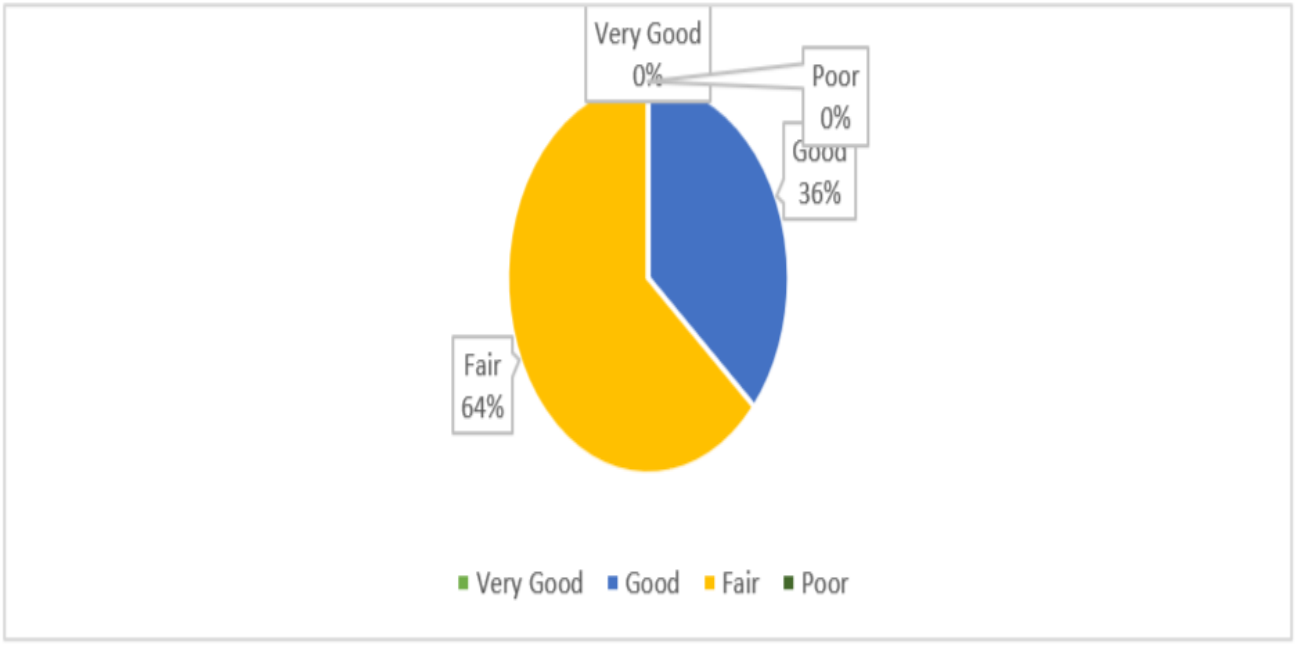

Figure 1. *Distribution of Student Qualifications in Cycle I*

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Figure 1. Distribution of student qualifications in Cycle I based on observation results, showing the proportion of students in the Good category (36.4%) and Fair category (63.6%), with no students falling into the Very Good or Poor categories.

Criteria	Qualification
3,33<Skor≤4,00	Very Good
2,33<Skor≤3,33	Good
1,33<Skor≤2,33	Fair
≤1,33	Poor

Table 1. *Observation Results of Cycle I*

The observation results indicated that the average level of student activity fell into the “fair” category, with an indicator achievement percentage of 66.7%. Students’ social care character was also rated as “fair,” with an average score of 2.2 on a 4-point scale. Several weaknesses were identified during this cycle, including a lack of teacher assertiveness, unclear instructions for concept map creation, and students’ limited understanding of character values. Additionally, the application of the Value Clarification Technique (VCT) was not yet optimal. Based on the reflection, the researcher and the collaborating teacher agreed on the need for improvements in instructional delivery, reinforcement of character content, and enhanced implementation of VCT in the subsequent cycle.

Cycle II was conducted over two sessions on May 26 and 28, 2025, in Class VIII-B at SMP Islam Al-I’anah Cianjur, continuing with the material "The Indonesian Nation's Resistance against Dutch Colonialism" and the sub-theme of the Banjar War, with a particular focus on internalizing the character values reflected in Prince Hidayatullah’s struggle. In this cycle, the learning process was designed to be more interactive and reflective through the integration of educational videos and the Value Clarification Technique (VCT). Students were divided into groups to complete worksheets, identify character values from narratives about Prince Hidayatullah, and relate these to current social issues faced by today’s youth. Group discussions, presentations, and the reinforcement of key values such as responsibility, social care, patriotism, and religiosity were the main focus of this cycle.

To provide a clearer picture of the observation results in Cycle II, the distribution of student qualifications is presented in a pie chart. This visualization illustrates the proportion of students in each qualification category, making it easier for readers to identify improvements or changes compared to Cycle I.

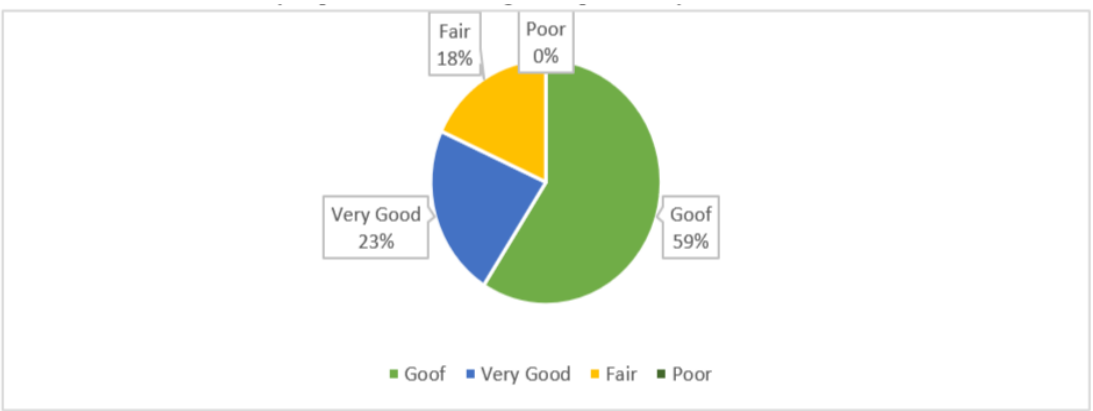

Figure 2. *Distribution of Student Qualifications in Cycle II*

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Figure 2. Distribution of student qualifications in Cycle II, showing 22.73% in the Very Good category, 59.09% in the Good category, 18.18% in the Fair category, and 0% in the Poor category.

Criteria	Qualification
3,33<Skor≤4,00	Very Good
2,33<Skor≤3,33	Good
1,33<Skor≤2,33	Fair
≤1,33	Poor

Table 2. *Observation Results of Cycle II*

The observation results indicated a significant improvement compared to the previous cycle. Student activity reached the “good” category, with an average indicator achievement rate of 86.7%. The assessment of students’ social care character also improved, with an average score of 3.1 out of 4, classified as “good.” All three indicators—helping peers without being asked, showing sensitivity to others’ difficulties, and respecting others’ opinions—demonstrated consistency in students' behavior. During the discussion process, students were able to identify the character values exemplified by Prince Hidayatullah and apply them to real-life situations. Based on observation and assessment data, it can be concluded that Cycle II effectively enhanced students’ social care character, as evidenced by the achievement of saturated data and the readiness of the instructional design for further testing through a limited trial.

Research Data Results at MTs Ats-Tsur Cianjur

Validity and Reliability Testing

Item	R Calculated	R Table	Cronbach’s Alpha	Description
P1	0,353	0,3438	0,842	Valid & Reliable
P2	0,351	0,3438		Valid & Reliable
P3	0,611	0,3438		Valid & Reliable
P4	0,609	0,3438		Valid & Reliable
P5	0,559	0,3438		Valid & Reliable
P6	0,547	0,3438		Valid & Reliable
P7	0,409	0,3438		Valid & Reliable
P8	0,593	0,3438		Valid & Reliable
P9	0,553	0,3438		Valid & Reliable
P10	0,369	0,3438		Valid & Reliable
P11	0,384	0,3438		Valid & Reliable
P12	0,587	0,3438		Valid & Reliable
P13	0,556	0,3438		Valid & Reliable
P14	0,555	0,3438		Valid & Reliable
P15	0,605	0,3438		Valid & Reliable
P16	0,395	0,3438		Valid & Reliable
P17	0,485	0,3438		Valid & Reliable
P18	0,563	0,3438		Valid & Reliable
P19	0,383	0,3438		Valid & Reliable
P20	0,375	0,3438		Valid & Reliable

Table 3. *Results of Validity and Reliability Testing*

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Validity testing of the 20 instrument items showed that all items had Pearson correlation (r-calculated) values ranging from 0.351 to 0.611, all of which exceeded the r-table value of 0.3438 (N = 24; α = 0.05). Therefore, all items were declared valid. The reliability test produced a Cronbach's Alpha value of 0.824, which falls into the high reliability category.

Normality and Homogeneity Testing of Pre-test and Post-test

Figure 3. *Results of Normality Test for Pre-test and Post-test*

Normality testing was conducted to determine whether the pre-test and post-test data were normally distributed. This test is essential for selecting the appropriate statistical analysis method. In this study, the normality test was performed using two methods: Kolmogorov-Smirnov and Shapiro-Wilk, with a significance level of 0.05. Based on the Kolmogorov-Smirnov test results for the pre-test data, the significance value was 0.022, while the Shapiro-Wilk test yielded a significance value of 0.002. Both values are below the 0.05 threshold, indicating that the pre-test data are not normally distributed. Similarly, the post-test normality test showed a Kolmogorov-Smirnov significance value of 0.003 and a Shapiro-Wilk value of 0.000. These results also fall below 0.05, indicating that the post-test data are not normally distributed. Thus, it can be concluded that neither the pre-test nor the post-test data meet the assumption of normal distribution. As a result, the subsequent data analysis employed a non-parametric statistical test, specifically the Wilcoxon Signed-Rank Test, which does not require normally distributed data.

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Result	Based on Mean	,033	1	46	,857
	Based on Median	,030	1	46	,863
	Based on Median and with adjusted df	,030	1	44,223	,863
	Based on trimmed mean	,068	1	46	,796

Table 4. *Results of Homogeneity Test for Pre-test and Post-test*

The homogeneity test aims to determine whether two data groups have equal variances, or are homogeneous. In the context of this study, homogeneity testing was conducted on the pre-test and post-test data to assess whether both groups met the assumption of homogeneity—one of the key requirements for applying parametric statistical tests such as the t-test. Based on the results of the Levene's Test, as presented in the Test of Homogeneity of Variance table, the significance value based on the mean was 0.857, based on the median was 0.863, based on the median with adjusted degrees of freedom was 0.863, and based on the trimmed mean was 0.796. All these values exceed the threshold of 0.05, indicating that there is no significant variance difference between the pre-test and post-test groups. Therefore, it can be concluded that the pre-test and post-test data exhibit

homogeneous variances, which confirms that the assumption of homogeneity is met. This condition theoretically allows the use of parametric analysis methods, provided the assumption of normality is also satisfied. However, considering that the earlier normality test results indicated that the data are not normally distributed, the use of non-parametric tests remains the more appropriate approach for this study.

Comparison Results of Pre-test and Post-test

Figure 4. *Comparison of Pre-test and Post-test Results*

The comparison test between the pre-test and post-test results was conducted to determine whether there was a significant difference before and after the intervention implemented in this study. The Paired Sample t-Test was used, as the data were drawn from the same group measured at two different points in time—prior to and following the treatment. Thus, it can be concluded that there is a statistically significant improvement from pre-test to post-test scores, with post-test scores being notably higher. These findings suggest that the implementation of the learning model based on the character values derived from the struggle of Prince Hidayatullah has had a positive impact on enhancing students' social care character.

N-Gain Results of Student Learning Outcomes Between Pre-test and Post-test

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Figure 5. *N-Gain*

Based on the results of the descriptive statistical analysis, the mean gain score was 0.7587, which, when converted into a percentage (N-gain percent), amounts to 75.87%. The median gain score was 0.8173 or 81.73%, indicating that half of the students experienced a learning improvement above that value. The standard deviation of the gain score was 0.24825, while the standard deviation for the percentage gain was 24.82%, reflecting variation in the level of improvement among students. Meanwhile, the minimum gain score was found to be -0.31 or -30.77%, indicating that one or more students experienced a decline in their scores after the intervention.

Research Data Results at SMPN 4 Cianjur

Validity and Reliability Testing

Item	R Calculated	R Table	Cronbach's Alpha	Description
P1	0.667	0.3515	0,716	Valid & Reliable
P2	0.667	0.3515		Valid & Reliable
P3	0.392	0.3515		Valid & Reliable
P4	0.525	0.3515		Valid & Reliable
P5	0.540	0.3515		Valid & Reliable
P6	0.581	0.3515		Valid & Reliable
P7	0.408	0.3515		Valid & Reliable
P8	0.595	0.3515		Valid & Reliable
P9	0.450	0.3515		Valid & Reliable
P10	0.505	0.3515		Valid & Reliable
P11	0.353	0.3515		Valid & Reliable
P12	0.377	0.3515		Valid & Reliable
P13	0.760	0.3515		Valid & Reliable
P14	0.688	0.3515		Valid & Reliable
P15	0.712	0.3515		Valid & Reliable
P16	0.388	0.3515		Valid & Reliable
P17	0.425	0.3515		Valid & Reliable
P18	0.560	0.3515		Valid & Reliable
P19	0.588	0.3515		Valid & Reliable
P20	0.503	0.3515		Valid & Reliable

Table 5. *Results of Validity and Reliability Testing*

Validity testing of the 20 instrument items at SMPN 4 Cianjur showed that all items had r-calculated values exceeding the r-table value of 0.3515 (N = 23; α = 0.05), with a range between 0.353 and 0.760. Therefore, all items were declared valid and suitable for use in measurement. The reliability test, using Cronbach's Alpha, yielded a value of 0.716, which falls into the "moderate" category and is considered acceptable for preliminary research purposes. This indicates that the internal consistency among items in the instrument is adequate, allowing the instrument to be reliably used in collecting data on the effectiveness of the Social Studies learning model based on the character values derived from Prince Hidayatullah's struggle.

Normality Test of Students' Pre-test and Post-test Learning Outcomes

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Figure 6. *Results of the Normality Test*

Based on the results of the normality test for the pre-test data, the significance value was 0.019 for the Kolmogorov–Smirnov test and 0.012 for the Shapiro–Wilk test. Both values are below the 0.05 threshold, indicating that the pre-test data are not normally distributed. In contrast, for the post-test data, the Kolmogorov–Smirnov test yielded a significance value of 0.200, and the Shapiro–Wilk test returned a value of 0.727. Both values are greater than 0.05, indicating that the post-test data are normally distributed.

Homogeneity Test of Pre-test and Post-test

Figure 7. *Results of the Homogeneity Test*

Based on the results of Levene's Test, as presented in the Test of Homogeneity of Variance table, the significance value was 0.001 across all four approaches: based on the mean, the median, the median with adjusted degrees of freedom, and the trimmed mean. Since all significance values are less than the 0.05 threshold, this indicates that there is a significant difference in variances between the pre-test and post-test groups.

Comparison Test of Pre-test and Post-test Results

Figure 8. *Results of the Comparison Test Between Pre-test and Post-test*

The results shown in the Paired Samples Test table indicate that the mean difference between the pre-test and post-test scores was -34.913, with a standard deviation of 11.020 and a standard error of 2.298. The calculated t-value was -15.194 with 22 degrees of freedom (df = 22), and the significance value (2-tailed) was 0.000. Since this significance value is far below the 0.05 threshold, it can be concluded that there is a statistically significant difference between the pre-test and post-test scores. Accordingly, these findings suggest that the intervention applied in this study had a significant impact on improving students' social care character. The increase in the average score—by nearly 35 points—reflects the effectiveness of the Social Studies learning model based on the character values of Prince Hidayatullah's struggle in enhancing students' social care character.

N-Gain Results

Figure 9. *N-Gain*

The results of the study show that the average normalized gain score (N-gain) was 0.76, which falls into the high category based on Hake's (1998) classification. According to this classification, gain scores are divided into three categories: low (< 0.3), medium ($0.3 \leq g < 0.7$), and high ($g \geq 0.7$). Therefore, it can be concluded that the intervention implemented in this study was effective in improving the learning outcomes of the majority of students, despite some individual variations—including one student who experienced a decrease in performance.

B. Discussion

The findings of this study indicate that the development of a Social Studies (IPS) learning model based on the character values of Prince Hidayatullah's struggle significantly contributes to strengthening students' character, particularly in terms of social care. Prince Hidayatullah, known as a religious scholar and fighter in the Banjar War, serves as a symbol of the integration of religious values, nationalism, courage, and social responsibility. These values are not only rooted in historical documents but also remain relevant for promoting contemporary character education. This study reveals that exploring the character of local historical figures can create a psychological

and cultural closeness for students, thereby facilitating a more effective internalization of values. In designing the learning model, the researcher employed the ADDIE instructional design approach, consisting of five key phases: Analysis, Design, Development, Implementation, and Evaluation. In the Analysis phase, learning needs and relevant character values to be integrated were identified. The Design phase focused on formulating learning strategies that emphasize value reflection and active student participation. This was followed by the Development of learning media and instructional tools such as lesson plans (RPP) and student worksheets (LKPD) based on the figure of Prince Hidayatullah. The Implementation of the model involved a series of classroom actions and limited trials, which were then evaluated both formatively and summatively to assess the success of integrating character values into the learning process.

The implementation of this model demonstrated that students became more actively engaged in the learning process—not only in the cognitive domain, but also in the affective and social dimensions. Students were able to contextualize and discuss the values of struggle and relate them to social realities in their own environment. This indicates that Social Studies learning functions not merely as a medium for knowledge transfer, but also as a means of personality and character development. These findings are in line with Lickona's (1991) perspective, which emphasizes that effective character education requires student involvement in moral decision-making and value reflection. Theoretically, the success of this model development is also supported by constructivist and humanistic approaches. Within constructivism, students are viewed as active learners who construct knowledge through experience and social interaction. By presenting Prince Hidayatullah as a representation of character values and historical struggle, students were given the space to explore, interpret, and internalize values both independently and collaboratively. Meanwhile, the humanistic approach highlights the importance of the teacher’s role as a facilitator who creates a learning environment that nurtures students’ moral and emotional development.

The results of classroom observations, teacher reflections, and character assessments during the implementation of the model indicated a clear improvement in students’ social care character, including behaviors such as helpfulness, empathy, and group responsibility. This improvement was evident not only in students’ behavior within the classroom but also in broader school activities such as community service, group discussions, and participation in religious programs. The results of this study are consistent with those of Syarifah Al Jupri Alpiah (2019), who found that incorporating elements of Prince Hidayatullah’s struggle in Social Studies could strengthen students’ sense of nationalism, although her research focused on a single value. Similarly, research by Tiara Nur Laila (2022) demonstrated that learning local history related to Prince Hidayatullah fostered religious understanding among students in Cianjur, but did not integrate the values into a complete instructional model. Compared to these studies, the present research offers a more comprehensive approach by integrating multiple character values—religiosity, responsibility, courage, patriotism, and social awareness—into a systematically developed and empirically tested learning model. This positions the current study as a significant contribution to the field of Social Studies education, providing both a theoretical framework for value-based learning and a practical model that can be adopted and adapted in various educational settings.

Thus, the developed learning model proved to be effective in addressing the core research questions: identifying the character values exemplified by Prince Hidayatullah, designing a value-based learning model, and testing its effectiveness in shaping students’ character. This study affirms that the integration of local historical figures into Social Studies instruction is a powerful strategy for instilling national character values. It not only enriches learning content but also strengthens students’ cultural identity and social commitment. The model developed in this research provides a new direction for Social Studies education—one that is value-driven, contextual, and transformative—in shaping a young generation that is not only intellectually capable but also morally grounded and globally competitive.

Although the model yielded positive results in both MTs Ats-Tsuur and SMPN 4 Cianjur, the magnitude and pace of improvement varied between the two schools. Students at MTs Ats-Tsuur

demonstrated quicker engagement in group discussions and value-reflection activities, with a higher proportion achieving “Very Good” scores in social care behavior by the final cycle. This may be linked to the school’s strong emphasis on religious-based character programs and students’ prior familiarity with Prince Hidayatullah’s historical contributions. In contrast, SMPN 4 Cianjur showed a more gradual improvement, with initial engagement levels lower and requiring greater teacher scaffolding to connect historical narratives with contemporary social contexts. These differences likely stem from variations in school culture, teacher readiness, and students’ socio-cultural backgrounds. Recognizing these contextual factors is essential for refining the model and ensuring its adaptability across diverse educational settings. Future research could systematically examine how such factors influence the effectiveness of value-based Social Studies learning and develop tailored implementation strategies for different school environments.

CONCLUSION

Based on the findings and discussion of this study, it can be concluded that the development of a Social Studies learning model based on the character values of Prince Hidayatullah’s struggle is effective in strengthening students’ social care character through a contextual, reflective, and meaningful learning process. Values such as religiosity, responsibility, courage, and patriotism were successfully internalized by students through a learning approach that involved local historical figures, value-based discussions, and the implementation of the Value Clarification Technique (VCT). The model design developed through the ADDIE framework proved capable of creating a learning experience that not only transfers knowledge but also fosters comprehensive character formation. Therefore, it is recommended that this model be more widely implemented in Social Studies education across various educational levels and considered as a reference for developing locally rooted curricula that prioritize character education. In addition, teachers are encouraged to actively explore other local figures who embody noble values as learning resources, enabling students to build a stronger connection with their cultural roots and find real-life role models for everyday behavior. Therefore, it is recommended that this model be more widely implemented in Social Studies education across various educational levels and considered as a reference for developing locally rooted curricula that prioritize character education. For broader implementation, operational steps may include: conducting targeted teacher training programs on integrating local historical figures into lesson plans; adapting curriculum documents to incorporate value-based learning objectives; and developing instructional media—such as worksheets, digital content, and visual aids—that highlight character values from relevant local heroes. In addition, teachers are encouraged to actively explore other local figures who embody noble values as learning resources, enabling students to build a stronger connection with their cultural roots and find real-life role models for everyday behavior. This study was conducted within a limited scope—both in terms of the number of participating schools and the focus on a single local historical figure—so the findings may not fully represent broader educational contexts. In addition, the implementation period was relatively short, which may have influenced the depth of behavioral change observed in students. Given these limitations, the claim of effectiveness should be understood as context-specific, reflecting the cultural and historical relevance of the research setting. Future studies are encouraged to apply the model across diverse regions, educational levels, and cultural contexts, as well as to explore the integration of other local historical figures to further enrich the variety of character values conveyed through Social Studies learning.

References

1. [1] S. Arikunto, Metode Penelitian Kualitatif. Jakarta, Indonesia: Bumi Aksara, 2006.
2. [2] Trianto Al-tabani, Mendesain Model Pembelajaran Inovatif, Progresif dan Kontekstual. Surabaya, Indonesia: Prenadamedia Group, 2014.
3. [3] A. B. Barjie, Perang Banjar Barito 1859–1906. Martapura, Indonesia: Pustaka Agung Kesultanan Banjar, 2015.
4. [4] Baharuddin and E. N. Wahyuni, Teori Belajar dan Pembelajaran. Yogyakarta, Indonesia:

Ar-Ruzz, 2015.
5. [5] R. M. Branch, Instructional Design: The ADDIE Approach. New York, NY, USA: Springer, 2009.
6. [6] D. Budimansyah, Penguatan Pendidikan Kewarganegaraan Untuk Membangun Karakter Bangsa. Bandung, Indonesia: Widya Aksara Press, 2010.
7. [7] D. Budimansyah and K. Komalasari, Pendidikan Karakter: Nilai Inti Bagi Upaya Pembina Kepribadian Bangsa. Bandung, Indonesia: Widya Aksara Press, 2011.
8. [8] K. Budiyono, Nilai-Nilai Kepribadian dan Kejuangan Bangsa Indonesia. Bandung, Indonesia: Alfabeta, 2007.
9. [9] J. W. Creswell, Research Design: Pendekatan Kualitatif, Kuantitatif dan Mixed. Yogyakarta, Indonesia: Pustaka Belajar, 2010.
10. [10] J. W. Creswell, Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research, 2nd ed. Boston, MA, USA: Pearson Education, 2012.
11. [11] J. W. Creswell, Research Design: Qualitative, Quantitative, and Mixed Method Approaches. Thousand Oaks, CA, USA: Sage, 2014.
12. [12] H. Darmadi, Metode Penelitian Pendidikan. Bandung, Indonesia: Alfabeta, 2011.
13. [13] Daryanto, Belajar dan Mengajar. Bandung, Indonesia: Yrama Widya, 2016.
14. [14] M. Fadillah, Implementasi Kurikulum 2013 dalam Pembelajaran SD/MI, SMP/MTs & SMA/MA. Yogyakarta, Indonesia: Ar-Ruzz Media, 2014.
15. [15] H. Gunawan, Pendidikan Karakter: Konsep dan Implementasi. Jakarta, Indonesia: Prenada Media Group, 2012.
16. [16] Husamah, Pembelajaran Luar Kelas (Outdoor Learning). Jakarta, Indonesia: Prestasi Pustaka, 2013.
17. [17] H. Haudi and W. Hadion, Dasar-Dasar Pendidikan. Solok, Indonesia: Insan Cendekia Mandiri, 2020.
18. [18] N. Hawkes, “Does Teaching About Values Improve the Quality of Education in Primary Schools?,” Ph.D. dissertation, Dept. of Education, Univ. of Oxford, Oxford, U.K., 2005.
19. [19] H. Herdiansyah, Metode Penelitian Kualitatif untuk Ilmu-Ilmu Sosial. Jakarta, Indonesia: Salemba Humanika, 2010.
20. [20] Y. Ikbar, Perang Fi-Sabilillah di Kalimantan 1859–1863: Menguak Peranan Sultan Hidayatullah. Banjarmasin, Indonesia: Dispora Kalsel, 2014.
21. [21] M. T. Ilahi, Revalitas Pendidikan Berbasis Moral. Yogyakarta, Indonesia: Ar-Ruzz Media, 2012.
22. [22] Kementerian Pendidikan Nasional (Kemendiknas), Kebijakan dan Implementasi Pendidikan Karakter Bangsa pada Satuan Pendidikan. Jakarta, Indonesia: Direktorat Jenderal PTK Dikmen, 2010.
23. [23] J. R. Barth, Methods of Instruction in Social Studies Education. New York, NY, USA: University Press of America, 1990.
24. [24] E. B. Kielstra, De Bandjermasinsche Sultanspartij. Haarlem, Netherlands: Bohn, 1910.

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PENDAHULUAN

Semakin majunya teknologi di zaman digital, transformasi dalam pengelolaan dan pemeliharaan aset industri menjadi sebuah keharusan untuk menghadapi persaingan global yang semakin kompetitif. Kehadiran teknologi informasi telah mengubah paradigma tradisional dalam manajemen pemeliharaan alat berat, dari pendekatan reaktif menjadi lebih prediktif dan sistematis, dimana Total Productive Maintenance (TPM) sebagai metodologi pemeliharaan yang komprehensif menjadi semakin relevan ketika diintegrasikan dengan sistem informasi modern [1]. Alat berat merupakan aset penting dalam berbagai sektor industri seperti perkebunan, konstruksi, dan pertanian, yang membutuhkan investasi signifikan serta pemeliharaan berkelanjutan untuk memastikan produktivitas optimal [2]. Teknologi dalam bidang alat berat telah mengalami perkembangan yang signifikan, terutama dalam aspek pemeliharaan kinerja peralatan. Sistem informasi membantu memantau kondisi alat berat secara terus-menerus dan memprediksi kerusakan sebelum alat tersebut mengalami masalah yang akan terjadi. Teknologi informasi kini tidak lagi sekadar alat bantu, melainkan kebutuhan mendesak untuk menciptakan sistem pemeliharaan yang proaktif dan efisien [3]. Sistem informasi terintegrasi akan memungkinkan perusahaan melakukan analisis pemeliharaan secara berkala, dan manajemen risiko yang lebih akurat untuk setiap unit alat berat.

Namun, kenyataannya masih banyak perusahaan yang menghadapi tantangan dalam pengelolaan pemeliharaan alat berat. Selama ini, pemeliharaan alat berat sering kali tidak tercatat dengan baik, tidak terjadwal, dan bergantung pada proses manual [4]. Akibatnya, kerusakan mendadak yang tidak terduga menjadi hal yang sering terjadi dan berdampak pada peningkatan downtime serta biaya operasional. PT. Alam Mentari Indah Nuansa sebagai salah satu perusahaan yang mengoperasikan berbagai jenis alat berat seperti Excavator, Bulldozer, dan Crane, membutuhkan sistem pemeliharaan yang mampu menyesuaikan kebutuhan spesifik masing-masing alat. Setiap unit memiliki karakteristik unik yang memerlukan pendekatan pemeliharaan berbeda [5]. Penggunaan alat berat yang terus menerus membutuhkan perawatan yang tepat untuk menghindari penurunan performa dan kerusakan total (breakdown) yang bisa merugikan operasional [6]. Beberapa masalah umum yang dihadapi perusahaan dalam pemeliharaan alat berat adalah tingginya downtime, lambatnya penanganan kerusakan, serta penggunaan sumber daya pemeliharaan yang tidak efisien.

Implementasi Total Productive Maintenance yang terintegrasi dengan sistem informasi modern dapat dijadikan untuk menangani berbagai persoalan yang ada. Sistem ini memungkinkan standardisasi proses pemeliharaan, otomatisasi penjadwalan, dan analisis prediktif berbasis data historis. Penelitian [7] untuk menelaah pengaruh implementasi Total Productive Maintenance (TPM) downtime berdasarkan tinjauan literatur. TPM merupakan pendekatan manajemen pemeliharaan yang melibatkan partisipasi seluruh karyawan untuk meningkatkan efektivitas peralatan dan mengurangi pemborosan, khususnya waktu henti mesin. penerapan TPM meliputi komitmen manajemen, pelatihan dan pendidikan karyawan, budaya organisasi yang mendukung, serta penggunaan teknologi canggih seperti IoT, big data analytics, dan AI.

Penelitian ini berbeda dari [8] karena fokus utama bukan hanya pada teori TPM atau pengukuran efektivitas mesin, tetapi pada pengembangan sistem informasi terintegrasi yang mendukung praktik pemeliharaan alat berat secara langsung di lapangan. Selain itu, sistem yang dikembangkan dalam penelitian ini dirancang untuk mengatasi persoalan praktis seperti pencatatan manual, tidak adanya penjadwalan terpusat, dan kurangnya visibilitas kondisi alat berat secara real-time.

Artikel ini berkontribusi pada pengembangan sistem informasi pemeliharaan alat berat berbasis Total Productive Maintenance (TPM) yang dirancang untuk mengurangi downtime, meningkatkan efisiensi sumber daya, dan menyediakan fitur prediktif berbasis data. Dengan mengadopsi pendekatan yang lebih praktis dan terfokus pada integrasi langsung dengan operasional alat berat, penelitian ini menawarkan solusi yang relevan bagi industri yang menghadapi permasalahan kompleks dalam pemeliharaan peralatan berat. Meskipun sistem yang dikembangkan belum sepenuhnya otomatis, penelitian ini merupakan langkah awal penting dalam transformasi digital pemeliharaan alat berat di lingkungan industri.

Dengan demikian, penelitian ini menawarkan solusi yang lebih inovatif dalam meningkatkan efisiensi dan efektivitas pemeliharaan alat berat. Namun, Keunggulan penelitian ini terletak pada pendekatannya yang lebih praktis dan langsung menyelesaikan masalah di industri alat berat. Penelitian ini masih menggunakan metode manual yang belum sepenuhnya otomatis. Tetapi, penelitian ini lebih maju dalam mengintegrasikan teknologi informasi modern untuk menciptakan sistem pemeliharaan yang prediktif dan berbasis data [9]

METODE

Kajian ini menggunakan pendekatan kuantitatif deskriptif melalui studi kasus agar bisa menguraikan penerapan Total Productive Maintenance (TPM) terhadap sistem informasi pemeliharaan alat berat. Kajian menggunakan observasi lapangan, wawancara mendalam dan dokumen pendukung untuk memahami dampak TPM terhadap peningkatan produktivitas pemeliharaan alat berat.

Data ini diolah memakai Metode Overall Equipment Effectiveness (OEE) [10]. Overall Equipment Effectiveness (OEE) dipakai untuk menentukan seberapa efektif suatu mesin beroperasi. Pengukuran ini memiliki tiga dasar: Availability, Performance Eficiency, serta Quality Of Rate yang dirumuskan sebagai berikut:

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1. Availability rate ialah suatu rasio yang menyatakan dalam memanfaatkan jam yang ada dalam melakukan operasi mesin dan peralatan. Availability mengukur proporsi waktu yang benar-benar digunakan untuk mengoperasikan mesin dibandingkan dengan total waktu yang disediakan. Rasio tersebut diperoleh dengan mengurangi downtime dari waktu yang direncanakan [11]. Adapun rumus availability yaitu:

$$Avaibility = \frac{waktu\ operasi}{waktu\ loading}\ x\ 100\% \quad (1)$$

2. Performance efficiency Menggambarkan efisiensi kinerja mesin dalam memproduksi barang sesuai kapasitas idealnya. Rasio ini dihitung berdasarkan nilai dari operating speed rate dan net operating rate. Adapun formula untuk menghitung yaitu:

$$Performance = \frac{waktu\ setting * jumlah\ unit\ diproses}{waktu\ operasi}\ x\ 100\% \quad (2)$$

3. Rate of Quality Menggambarkan proporsi hasil produksi yang sesuai dengan spesifikasi mutu yang ditetapkan. Adapun rumus yang digunakan untuk menghitung rasio ini adalah:

$$Quality = \frac{jumlah\ produk - jumlah\ cacat}{jumlah\ produk}\ x\ 100\% \quad (3)$$

4. Nilai OEE didapatkan dengan menjumlahkan ketiga indikator kinerja utama. Adapun rumus perhitungannya secara matematis adalah:

$$OEE = Avaibility(\%) * Performance(\%) * Quality(\%) \quad (4)$$

1. Teknik Pengumpulan Data

Kajian ini dilakukan di PT. Alam Mentari Indah Nuansa khususnya pada unit pemeliharaan alat berat. Objek penelitian adalah Mesin Alat Berat seperti Excavator, Bulldozer, Crane, dll. Teknik pengumpulan data dalam kajian ini termasuk mencari jurnal lain serta pengamatan lapangan yang ditujukan untuk memperoleh data yang menggambarkan situasi aktual perusahaan [12]. Observasi merupakan metode pengamatan terencana yang dilakukan terhadap aktivitas individu atau objek tertentu secara sistematis. Kegiatan observasi difokuskan pada alat berat, di mana data primer diperoleh dari catatan pemeliharaan serta dokumentasi divisi maintenance terkait waktu henti dan perbaikan mesin. Data yang dianalisis mencakup periode tiga bulan, terhitung sejak Agustus hingga Oktober 2024.

Pengumpulan data dalam penelitian ini dilakukan secara sistematis berdasarkan laporan pemeliharaan selama tiga bulan terakhir, yakni Agustus hingga Oktober 2024. Tujuannya adalah untuk memastikan validitas temporal serta keterwakilan kondisi operasional alat berat di lapangan. Data yang dihimpun mencakup berbagai variabel penting, seperti nama alat berat, waktu operasi, waktu loading, jumlah unit yang diproses, waktu setting (dalam jam), jumlah produk (dalam meter), serta jumlah produk cacat (juga dalam meter). Sumber data diperoleh dari laporan internal pemeliharaan, wawancara langsung dengan teknisi, dan catatan waktu loading harian. Untuk menjamin keandalan data, dilakukan proses validasi melalui triangulasi sumber dengan membandingkan hasil wawancara teknisi, catatan downtime, dan laporan teknis serta pemeriksaan konsistensi waktu dan unit guna menghindari adanya anomali atau duplikasi. Validasi juga dilakukan melalui cek silang terhadap laporan operasional bulanan dan riwayat kerusakan alat[13].

Pengolahan dan analisis data dilakukan menggunakan perangkat lunak Microsoft Excel, karena kemampuannya dalam mendukung perhitungan numerik serta penyajian data dalam bentuk visual yang informatif. Tahapan analisis dimulai dari proses input data mentah yang dikumpulkan dari laporan lapangan, kemudian disusun dalam tabel sesuai kategori alat berat untuk masing-masing bulan. Selanjutnya, dilakukan perhitungan komponen Overall Equipment Effectiveness (OEE), yakni *Availability*, *Performance*, dan *Quality*, dengan menggunakan formula yang diintegrasikan ke dalam lembar kerja Excel sehingga menghasilkan nilai OEE secara otomatis. Setelah itu, data dikelompokkan berdasarkan jenis alat dan periode waktu untuk memudahkan proses komparasi, sekaligus menyaring unit-unit dengan nilai OEE di bawah standar sebagai objek analisis lanjutan. Analisis deskriptif kemudian diterapkan untuk mengidentifikasi alat berat yang paling efektif, unit yang paling sering mengalami downtime, serta komponen utama penyebab penurunan nilai OEE. Akhirnya, seluruh hasil perhitungan dan interpretasi disusun dalam dokumen analisis untuk mendukung pengambilan keputusan pemeliharaan secara lebih terarah dan berbasis data.

2. Metode Pengembangan Sistem

Metode pengembangan Sistem Website ini dibangun dengan pendekatan metodologi waterfall yang disesuaikan. Tahapan yang dilalui meliputi analisis kebutuhan, desain sistem, implementasi kode, dan pengujian fungsionalitas: [14]

a. Requirement Analysis

Tahap Requirement Analysis adalah langkah awal penelitian untuk menganalisis kebutuhan sistem Total Productive Maintenance (TPM) pada pemeliharaan alat berat. Peneliti melakukan pengamatan terhadap proses bisnis dan sistem informasi pemeliharaan yang berjalan dalam rangka mengkaji kebutuhan user. Aplikasi yang akan dibangun harus mampu memfasilitasi teknisi, operator dan admin dalam mencatat aktivitas pemeliharaan dengan informasi yang detail, dan akurat, sekaligus menyediakan antarmuka yang mudah digunakan[15]. Selain itu, sistem perlu mencakup pencatatan data pemeliharaan, downtime, dan uptime alat berat, penjadwalan pemeliharaan preventif, pembuatan laporan kinerja, serta pemberian notifikasi jadwal. Implementasi sistem ini bertujuan untuk mengoptimalkan proses pemeliharaan dan meningkatkan produktivitas alat berat.

b. System Design (Perancangan Sistem)

Tahap System Design atau perancangan sistem merupakan proses membangun kerangka kerja sistem informasi Total Productive Maintenance (TPM) berdasarkan kebutuhan yang telah diidentifikasi sebelumnya. Proses ini meliputi perancangan kerangka sistem, merangkum gambar tampilan pemakai, serta perancangan basis data. Cara kerja, serta fitur- fitur yang akan diimplementasikan. Sistem dirancang untuk mendukung pencatatan aktivitas pemeliharaan alat berat secara detail, dan pengelolaan jadwal pemeliharaan. Antarmuka sistem dirancang agar mudah digunakan, memudahkan teknisi operator maupun admin dalam pengoperasiannya. Struktur basis data dibuat untuk menyimpan informasi pemeliharaan secara efisien, mencakup data alat berat, komponen, jadwal, serta laporan kinerja[16]. Tahap ini menjadi fondasi utama untuk memastikan sistem yang dikembangkan mampu mendukung penerapan TPM dengan optimal dan efisien.

c. Implementation (implementasi)

Tahap Implementation atau implementasi adalah proses mewujudkan desain sistem menjadi sistem informasi Total Productive Maintenance (TPM) yang dapat digunakan. Pada tahap ini, pengembangan perangkat lunak dilakukan berdasarkan desain yang telah disusun, mencakup pengkodean, integrasi modul, serta pengujian awal untuk memastikan sistem berfungsi sesuai dengan kebutuhan. Setelah pengembangan selesai, sistem diterapkan di lingkungan operasional pengguna. Proses ini meliputi pemasangan perangkat lunak, konfigurasi sistem, serta migrasi data jika diperlukan. Selain itu, dilakukan pelatihan kepada teknisi, operator, dan admin pihak terkait agar mereka dapat menggunakan sistem dengan maksimal. Tahap implementasi bertujuan untuk memastikan sistem informasi TPM berfungsi secara efektif dalam mendukung aktivitas pemeliharaan alat berat, meningkatkan efisiensi, dan mengurangi downtime. Masukan dari pengguna selama proses ini juga menjadi bahan untuk penyempurnaan atau penyesuaian sistem di masa mendatang[17].

d. Verification (Pengujian)

Tahap Testing atau pengujian merupakan proses untuk memastikan bahwa sistem informasi Total Productive Maintenance (TPM) yang dikembangkan berfungsi pada keseharian yang telah ditetapkan. Pada tahap ini, dilakukan serangkaian uji coba menggunakan blackbox guna mendeteksi kesalahan, memastikan fungsi berjalan dengan benar, dan mengevaluasi kinerja system[18].

Pengujian mencakup berbagai jenis, seperti unit testing untuk memeriksa komponen secara individu, integration testing untuk menguji keterpaduan antar modul, serta system testing untuk menguji sistem secara keseluruhan. Tahapan ini bertujuan memastikan sistem berfungsi dengan baik, stabil, dan bebas dari kesalahan besar sebelum diterapkan secara menyeluruh. Hasil pengujian menjadi dasar untuk memperbaiki atau menyesuaikan sistem sehingga siap digunakan dalam lingkungan operasional.

e. Maintenance (Pemeliharaan)

Tahap Maintenance atau pemeliharaan adalah proses yang dilakukan setelah sistem informasi Total Productive Maintenance (TPM) diterapkan untuk memastikan sistem tetap berjalan dengan baik, efektif, dan relevan sepanjang waktu. Pada tahap ini, dilakukan pemeliharaan berkala untuk mengatasi masalah teknis, memperbarui perangkat lunak, serta memastikan sistem selalu dalam kondisi optimal[19].

Pemeliharaan meliputi beberapa aktivitas, seperti perbaikan bug atau kesalahan yang muncul, pembaruan sistem untuk menambahkan fitur baru atau menyesuaikan dengan perubahan kebutuhan, serta pemantauan kinerja untuk memastikan sistem berfungsi dengan lancar. Tujuan utama

tahap pemeliharaan adalah untuk menjaga agar sistem tetap efisien, mengurangi downtime, dan memastikan bahwa sistem dapat terus mendukung kebutuhan operasional dalam jangka panjang. Feedback dari pengguna juga digunakan untuk melakukan perbaikan atau pengembangan lebih lanjut.

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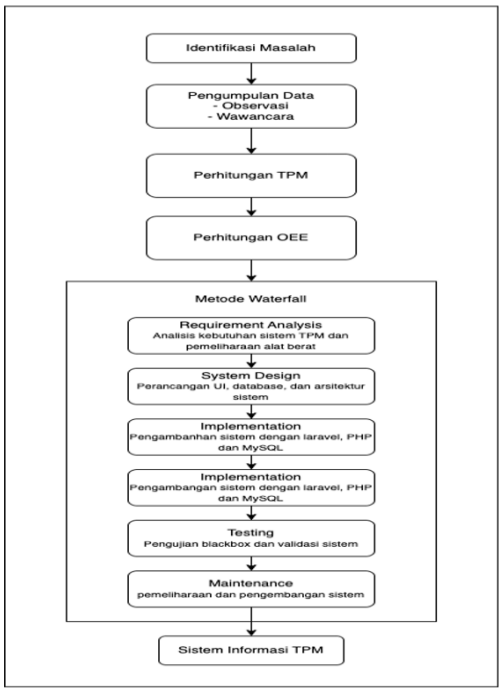

Gambar 1. Kerangka Penelitian

HASIL DAN PEMBAHASAN

A. Pengumpulan Data

Data primer yang dikaji meliputi pemeliharaan alat berat dan laporan downtime serta perbaikannya dari bagian maintenance, dikumpulkan dalam kurun waktu tiga bulan, mulai Agustus hingga Oktober 2024.

No	Nama Alat Berat	Lokasi Alat Berat	Waktu Operasi	Waktu Loading	Jumlah Unit Di Proses (Meter)	Waktu Setting (Jam)	Jumlah Produk (Meter)	Jumlah Cacat (Meter)
1	Excavator	Kec. Bangun Purba, Kab.Deli Serdang	750	820	660	1	66.000	1.000
2	Crane	Kec.tiga johar, Kab.deli serdang	750	800	550	1	33.000	1440
3	Grader	Kec. Petumbukan Kab.Deli serdang	780	800	750	1	75.000	2400
4	Roller	Kec.sawit seberang Kab.Langkat	765	810	120	1	54.000	1464
5	Bulldozer	Kec.Hinai Kab.langkat	735	805	750	1	45.000	1440
6	Truck	Kec.tanjung pura Kab.Langkat	790	825	843,75	1	46.800	2640

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7	Sceraper	Kec.pangkalan susu Kab.Langkat	760	820	611,11	1	49.500	1944
8	Diesel	Kec.Longkip Kab.subussalam Prov. Aceh	770	830	540,98	1	33.000	1464
9	Bucket	Kec.barumun tengah,Kab.padang lawas	745	819	546	1	34.498	1512

Tabel 1. Data Pemeliharaan Alat Berat

B. Penerapan Overall Equipment Effectiveness (OEE)

Adapun penerapan Overall Equipment Effectiveness (OEE) ialah :

1. Avaibility

$$Avaibility = \frac{waktu\ operasi}{waktu\ loading}\ x\ 100\%$$

Excavator $= \frac{750}{820}\ x\ 100\% = 79\%$

Crane $= \frac{750}{800}\ x\ 100\% = 66\%$

Grader $= \frac{780}{800}\ x\ 100\% = 91\%$

Roller $= \frac{765}{810}\ x\ 100\% = 14\%$

Bulldozer $= \frac{735}{805}\ x\ 100\% = 90\%$

Truck $= \frac{790}{825}\ x\ 100\% = 97\%$

Sceraper $= \frac{760}{820}\ x\ 100\% = 72\%$

Diesel $= \frac{770}{830}\ x\ 100\% = 62\%$

Bucket $= \frac{745}{819}\ x\ 100\% = 62\%$

2. Performace

$$Performance = \frac{waktu\ setting * jumlah\ unit\ diproses}{waktu\ operasi}\ x\ 100\%$$

Excavator $= \frac{1*660}{750}\ x\ 100\% = 88\%$

Crane $= \frac{1*550}{750}\ x\ 100\% = 73\%$

Grader $= \frac{1*750}{780}\ x\ 100\% = 96\%$

Roller $= \frac{1*120}{765}\ x\ 100\% = 16\%$

Truck $= \frac{1*843{,}75}{790}\ x\ 100\% = 107\%$

Sceraper $= \frac{1*611{,}11}{760}\ x\ 100\% = 80\%$

Diesel $= \frac{1*540{,}983}{770}\ x\ 100\% = 70\%$

Bucket $= \frac{1*546}{745}\ x\ 100\%.\quad = 73\%$

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Bulldozer $= \frac{1 * 750}{735} x\ 100\% = 102\%$

3. Quality

$$Quality = \frac{jumlah\ produk - \ jumlah\ cacat}{jumlah\ produk} x\ 100\%$$

Excavator $= \frac{66.000 - 1.000}{66.000} x\ 100\% = 98\%$

Truck $= \frac{46.800 - 2640}{46.800} x\ 100\% = 94\%$

Crane $= \frac{33.000 - 1440}{33.000} x\ 100\% = 96\%$

Sceraper $= \frac{49.500 - 1944}{49.500} x\ 100\% = 96\%$

Grader $= \frac{75.000 - 2.400}{75.000} x\ 100\% = 97\%$

Diesel $= \frac{33.000 - 1464}{33.000} x\ 100\% = 96\%$

Roller $= \frac{54.000 - 1464}{54.000} x\ 100\% = 97\%$

Bucket $= \frac{34.498 - 1512}{34.498} x\ 100\% = 96\%$

Bulldozer $= \frac{45.000 - 1440}{45.000} x\ 100\% = 97\%$

4. OEE

$$OEE = Availability(\%) * Performance(\%) * Quality(\%)$$

Excavator $= 91\% * 88\% * 98\% = 79\%$

Truck $= 96\% * 107\% * 94\% = 97\%$

Crane $= 94\% * 73\% * 96\% = 66\%$

Sceraper $= 93\% * 80\% * 96\% = 72\%$

Grader $= 98\% * 96\% * 97\% = 91\%$

Diesel $= 93\% * 70\% * 96\% = 62\%$

Roller $= 94\% * 16\% * 97\% = 14\%$

Bucket $= 91\% * 73\% * 96\% = 64\%$

Bulldozer $= 91\% * 102\% * 97\% = 90\%$

No	Nama Alat Berat	Lokasi Alat Berat	Avaibilty (%)	Performance (%)	Quality (%)	OEE
1	Excavator	Kec. Bangun Purba, Kab.Deli Serdang	91%	88%	98%	79%
2	Crane	Kec.tiga johar, Kab.deli serdang	94%	73%	96%	66%
3	Grader	Kec. Petumbukan Kab.Deli serdang	98%	96%	97%	91%
4	Roller	Kec.sawit seberang Kab.Langkat	94%	16%	97%	14%
5	Bulldozer	Kec.Hinai Kab.langkat	91%	102%	97%	90%

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6	Truck	Kec.tanjung pura Kab.Langkat	96%	107%	94%	97%
7	Sceraper	Kec.pangkalan susu Kab.Langkat	93%	80%	96%	72%
8	Diesel	Kec.Longkip Kab.subussalam Prov. Aceh	93%	70%	96%	62%
9	Bucket	Kec.barumun tengah,Kab.padanglawas	91%	73%	96%	64%

Tabel 1. Data Pemeliharaan Alat Berat

Berdasarkan hasil perhitungan nilai Overall Equipment Effectiveness (OEE) terhadap sejumlah alat berat, dapat disimpulkan bahwa prioritas pemeliharaan perlu difokuskan pada alat-alat yang memiliki nilai OEE di bawah standar ideal 70%. Alat dengan performa terbaik adalah Truck, dengan nilai OEE mencapai 97%, yang mencerminkan tingkat ketersediaan (availability), performa (performance), dan kualitas (quality) yang sangat optimal. Hal ini menunjukkan bahwa proses perawatan dan pengoperasian alat Truck telah berjalan dengan baik dan efisien. Sebaliknya, Roller menjadi alat yang menunjukkan performa paling rendah dengan nilai OEE hanya 14%. Meskipun memiliki nilai availability dan quality yang cukup tinggi, nilai performance-nya sangat rendah, hanya 16%, yang mengindikasikan adanya masalah serius dalam kecepatan operasi atau produktivitas aktual alat dibandingkan targetnya. Oleh karena itu, Roller perlu menjadi prioritas utama dalam program pemeliharaan, khususnya pada aspek performa, yang bisa disebabkan oleh keausan komponen, kondisi jalan kerja, atau keterbatasan operator. Selain itu, alat seperti Diesel dan Bucket juga menunjukkan nilai OEE di bawah ambang batas efisiensi, yaitu masing-masing 56% dan 65%. Hal ini menunjukkan adanya potensi ketidakefisienan baik dari segi waktu henti alat (downtime), kecepatan kerja aktual, maupun kualitas hasil kerja. Kedua alat ini juga patut menjadi fokus dalam strategi pemeliharaan preventif, agar tidak terjadi penurunan produktivitas secara berkelanjutan. Di sisi lain, alat berat seperti Grader dan Bulldozer memiliki nilai OEE di atas 90%, yang menunjukkan bahwa kedua alat ini beroperasi dengan sangat efisien dan dapat dijadikan benchmark atau acuan dalam pelaksanaan pemeliharaan untuk alat lainnya. Dengan demikian, fokus pemeliharaan jangka pendek sebaiknya ditujukan pada alat Roller, Diesel, dan Bucket, guna mengoptimalkan kinerja keseluruhan sistem operasional dan menjaga stabilitas produktivitas di lapangan.Hasil perhitungan OEE ini menjadi dasar untuk melakukan perbaikan sistem pemeliharaan dan efisiensi alat berat.

Tindak lanjut yang dapat dilakukan mencakup peningkatan performance unit seperti Roller dan Diesel melalui pelatihan operator dan penjadwalan kerja yang lebih efisien. Pengurangan downtime dilakukan dengan preventive maintenance dan perbaikan dini atas kerusakan kecil. Sementara itu, peningkatan quality dapat dicapai melalui pengawasan proses kerja dan penggunaan material yang sesuai standar.

Berdasarkan hasil pengolahan data OEE pada sembilan jenis alat berat selama tiga bulan terakhir, diperoleh nilai rata-rata OEE sebagai berikut: Excavator (79%), Crane (66%), Grader (91%), Roller (14%), Bulldozer (90%), Truck (97%), Scraper (72%), Diesel (62%), dan Bucket (64%). Nilai OEE tertinggi dicapai oleh Truck dengan nilai 97%, sementara nilai terendah terdapat pada Roller sebesar 14%. Jika dibandingkan dengan hasil penelitian sebelumnya (Fawwaz & Budi Hariono, 2024) pada alat mesin Seamer, yang memiliki nilai OEE sebesar 73,3%, maka dapat disimpulkan bahwa sebagian besar alat berat yang diteliti saat ini memiliki kinerja OEE yang bervariasi lebih ekstrem. Beberapa alat berat seperti Truck, Grader, dan Bulldozer menunjukkan kinerja di atas mesin Seamer, terutama dari aspek Performance yang bahkan bisa mencapai lebih dari 100% seperti pada Truck (107%) dan Bulldozer (102%), yang menunjukkan penggunaan alat yang sangat optimal dari sisi kecepatan operasional.

Namun, terdapat pula alat berat seperti Roller dengan nilai Performance hanya 16%, yang menyebabkan nilai OEE-nya sangat rendah (14%), jauh di bawah standar internasional maupun nilai OEE mesin Seamer sebelumnya. Ini menunjukkan bahwa meskipun nilai Availability dan Quality tinggi, rendahnya nilai Performance secara signifikan menurunkan efektivitas keseluruhan alat. Secara umum, alat berat yang digunakan menunjukkan performa yang lebih bervariasi dibandingkan mesin Seamer, menandakan bahwa faktor-faktor operasional dan teknis di lapangan sangat mempengaruhi efektivitas alat berat, baik dari segi pemeliharaan, pemanfaatan waktu operasi, hingga kualitas hasil kerja alat.

C. Implementasi Sistem

Setelah dilakukan proses pengumpulan data serta penerapan Overall Equipment Effectiveness (OEE), maka sistem diimplementasikan, yaitu:

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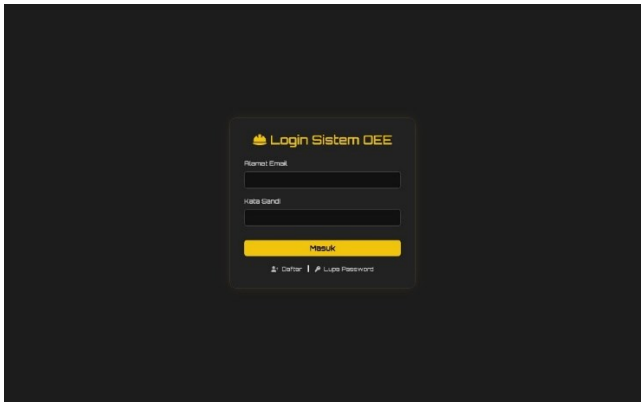
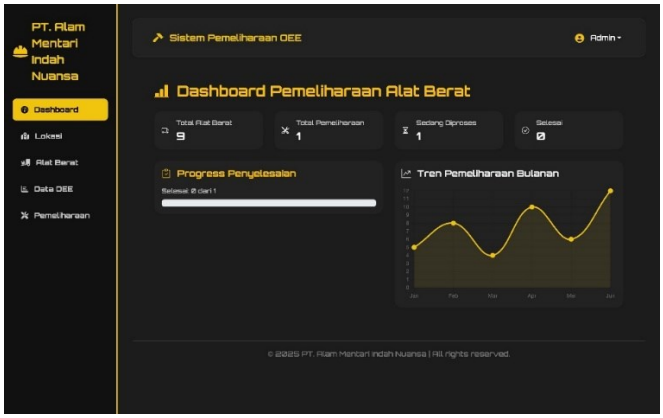


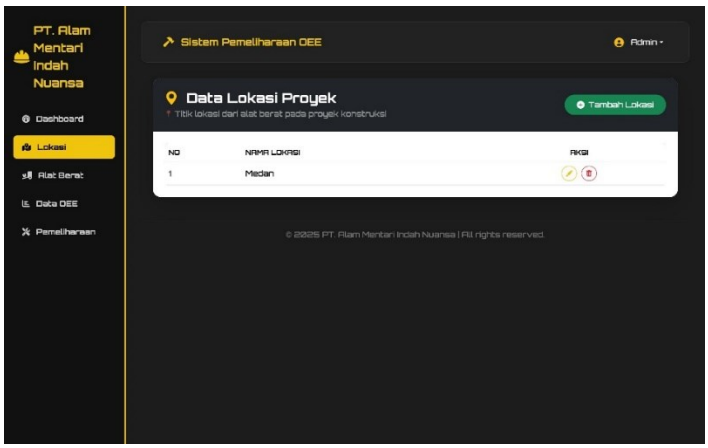
Gambar 2. Halaman Login

Gambar di atas menampilkan halaman login yang dirancang secara ringkas dan fungsional. Terdapat dua kolom input utama, yaitu "Alamat Email" dan "Kata Sandi", yang memudahkan pengguna untuk mengakses sistem secara cepat. Di bawahnya, tersedia tombol berwarna kuning bertuliskan "Masuk" yang berfungsi sebagai pintu masuk ke dalam akun. Selain itu, halaman ini juga menyediakan tautan “Daftar” bagi pengguna baru serta “Lupa Password” untuk pemulihan akses, sehingga keseluruhan antarmuka tidak hanya tampil sederhana, tetapi juga mendukung proses autentikasi yang efisien dan minim hambatan.



Gambar 3. Halaman Dashboard

Gambar tersebut menampilkan dashboard dari sistem pemeliharaan alat berat milik PT. Alam Mentari Indah Nuansa. Tampilan ini menyajikan data penting seperti total alat berat, jumlah serta status pemeliharaan, progres penyelesaian, dan grafik tren bulanan yang menggambarkan dinamika kegiatan pemeliharaan. Navigasi berada di sisi kiri dengan desain gelap berpadu aksen kuning yang modern dan kontras, memberikan struktur visual yang jelas. Seluruh elemen dirancang untuk menyampaikan informasi secara ringkas dan terorganisir, sehingga memudahkan pemantauan menyeluruh dalam satu tampilan terpadu.



Gambar 4. Halaman Data Lokasi Proyek

Gambar ini menampilkan halaman *Data Lokasi Proyek* dalam sistem pemeliharaan OEE milik PT. Alam Mentari Indah Nuansa. Halaman ini menyajikan daftar lokasi di mana alat berat digunakan dalam proyek konstruksi, dengan contoh lokasi seperti

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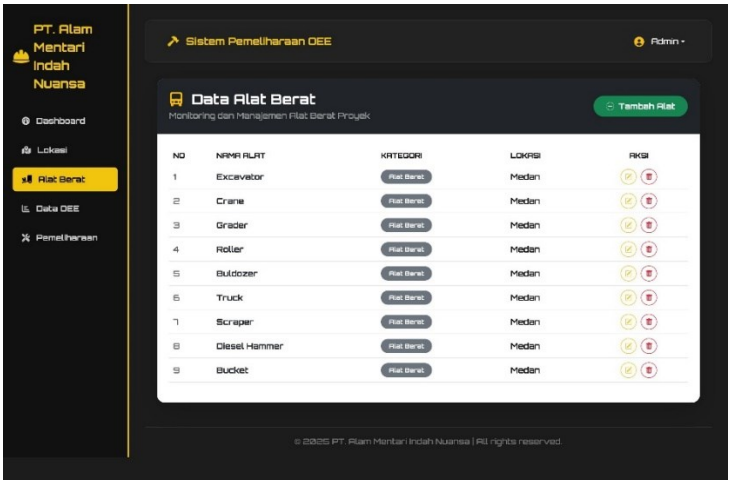
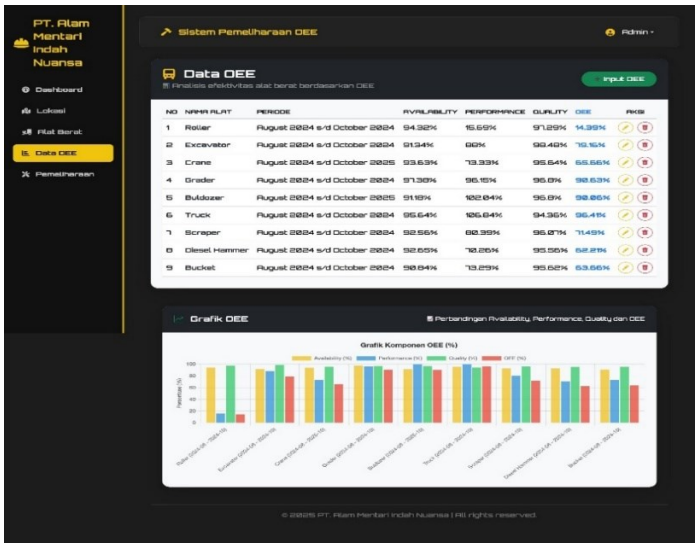
Medan. Antarmuka dilengkapi dengan tombol *Tambah Lokasi* untuk penambahan data baru, serta ikon khusus yang memungkinkan pengguna mengedit atau menghapus data yang sudah ada. Desain yang sederhana dan terfokus mendukung penyajian data lokasi secara ringkas dan mudah diakses.



Gambar 5. Halaman Data Alat Berat

Gambar ini menampilkan halaman Data Alat Berat dalam sistem pemeliharaan. Halaman ini memuat daftar alat berat yang digunakan dalam proyek, mencakup informasi seperti nama alat, kategori, dan lokasi. Seluruh alat tercatat berada di wilayah Medan, dengan contoh jenis alat seperti Excavator, Crane, dan Bulldozer. Tersedia pula tombol Tambah Alat untuk penambahan data baru, serta ikon yang memungkinkan pengguna melakukan pengeditan atau penghapusan data yang sudah tercatat. Tata letak yang terstruktur mendukung pengelolaan informasi secara efisien dan terorganisir.



Gambar 6. Halaman Data OEE

Gambar ini menampilkan halaman Data OEE dari sistem pemeliharaan milik PT. Alam Mentari Indah Nuansa. Halaman ini menyajikan analisis efektivitas alat berat berdasarkan tiga pilar utama: Availability, Performance, dan Quality, yang secara keseluruhan membentuk nilai OEE (Overall Equipment Effectiveness). Setiap unit alat berat ditampilkan lengkap dengan periode evaluasi, nilai masing-masing komponen, serta persentase OEE akhir. Di bagian bawah, terdapat grafik batang yang menyajikan perbandingan visual antara ketiga komponen dan nilai OEE dari setiap alat. Tampilan ini dirancang untuk menyajikan data secara visual dan terstruktur, sehingga informasi kinerja alat dapat dipahami secara menyeluruh dalam satu halaman.

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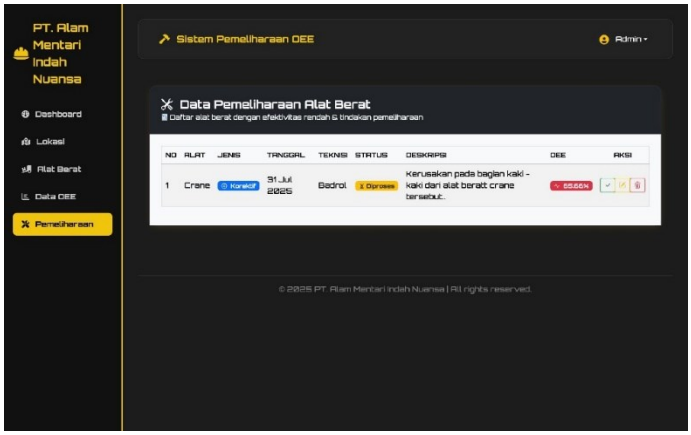

Gambar 7. Halaman Data Pemeliharaan Alat Berat

Gambar ini menampilkan halaman *Data Pemeliharaan Alat Berat* yang berfungsi sebagai modul pencatatan dan pengelolaan alat berat dengan efektivitas rendah dalam sistem pemeliharaan. Halaman ini menampilkan entri alat berat, salah satunya *Crane*, dengan jenis pemeliharaan *Korektif*, status *Diproses*, nilai OEE 65,66%, serta deskripsi kerusakan pada komponen kaki-kaki. Antarmuka dilengkapi dengan ikon aksi untuk *edit*, *selesaikan*, dan *hapus* data, memungkinkan pengelolaan siklus pemeliharaan secara langsung dari tampilan utama. Desain ini mengintegrasikan data performa dan status pemeliharaan guna mendukung proses evaluasi kondisi aset secara sistematis.

SIMPULAN

Kajian ini menyimpulkan bahwa implementasi Total Productive Maintenance (TPM) yang terintegrasi dengan sistem informasi modern terbukti efektif dalam meningkatkan produktivitas pemeliharaan alat berat di PT. Alam Mentari Indah Nuansa. Sistem informasi yang dikembangkan tidak hanya memfasilitasi pencatatan aktivitas pemeliharaan secara sistematis, tetapi juga memungkinkan pemantauan kinerja alat berat secara real-time, serta penyusunan laporan pemeliharaan berbasis data yang akurat dan mudah diakses. Melalui penerapan metode Overall Equipment Effectiveness (OEE), penelitian ini memberikan gambaran komprehensif terhadap efektivitas masing-masing alat berat berdasarkan komponen availability, performance, dan quality. Hasil analisis menunjukkan bahwa sebagian besar alat berat mencapai efektivitas kerja yang cukup tinggi, dengan nilai OEE tertinggi sebesar 97% (Truck) dan terendah 14% (Roller). Temuan ini mengindikasikan bahwa sistem yang diimplementasikan mampu membantu dalam mengidentifikasi alat dengan performa rendah secara cepat sehingga perbaikan dapat segera dilakukan. Dengan sistem ini, proses pemeliharaan menjadi lebih terstruktur, downtime dapat ditekan, serta efisiensi sumber daya meningkat secara signifikan. Meskipun demikian, penelitian ini memiliki beberapa batasan, antara lain keterbatasan pada periode pengamatan selama tiga bulan dan masih terbatasnya variabel lingkungan kerja yang diperhitungkan (misalnya kondisi cuaca, keterlambatan suku cadang, dan beban kerja operator). Oleh karena itu, penelitian selanjutnya disarankan untuk memperluas cakupan waktu pengamatan serta mengintegrasikan variabel eksternal yang memengaruhi performa alat. Sebagai saran, sistem informasi yang dikembangkan dalam penelitian ini dapat diimplementasikan lebih luas di sektor industri lainnya, seperti industri pertambangan, perkebunan, atau konstruksi, yang juga bergantung pada pemeliharaan alat berat. Selain itu, pengembangan fitur prediktif maintenance berbasis machine learning dapat menjadi pengembangan lanjutan untuk meningkatkan kemampuan sistem dalam mendeteksi potensi kerusakan sejak dini. Dengan pendekatan yang sistematis dan berbasis data, integrasi TPM dan sistem informasi ini dinilai sebagai solusi strategis dan aplikatif dalam mendukung manajemen aset industri secara berkelanjutan.

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REFERENSI

[1] H. Amaruddin, “Analisis Penerapan Total Productive Maintenance,” Ekomabis: Jurnal Ekonomi Manajemen Bisnis, vol. 1, no. 2, pp. 141–148, 2020, doi: 10.37366/ekomabis.v1i02.46.
[2] A. C. A. Caswito, “Peningkatan Kinerja Mesin Kapal Tunda Dengan Implementasi Total Productive Maintenance (TPM),” Kilat, vol. 12, no. 1, pp. 20–29, 2023, doi: 10.33322/kilat.v12i1.1890.

[3] N. Hairiyah, I. Musthofa, and A. Aminah, “Analisis Kerusakan Bearing Main Shaft Pada Mesin Screw Press MSB 15 Dengan Metode Total Productive Maintenance (TPM) di Pabrik Kelapa Sawit PT. XYZ,” Jurnal Teknologi Pertanian Andalas, vol. 28, no. 1, 2024, doi: 10.25077/jtpa.28.1.1-7.2024.
[4] N. Anshori and M. I. Mustajib, Sistem Perawatan Terpadu (Integrated Maintenance System). Yogyakarta, Indonesia: Graha Ilmu, 2020.
[5] D. Limantoro and S. T. Felecia, “Total Productive Maintenance di PT X,” vol. 1, no. 1, 2022.
[6] S. Mago, S. Informasi, and S. KHARISMA Makassar, “Sistem Informasi Penyewaan dan Pemeliharaan Alat Berat Menggunakan Metode Linear Sequence pada CV. Sun Pasific Diesel,” KHARISMA Tech, vol. 13, no. 2, pp. 43–52, 2021. \[Online]. Available: [https://jurnal.kharisma.ac.id/kharismatech/article/view/270]
[7] G. Muhaemin and A. E. Nugraha, “Penerapan Total Productive Maintenance (TPM) Pada Perawatan Mesin Cutter di PT. XYZ,” Jurnal Ilmiah Wahana Pendidikan, vol. 8, no. 9, pp. 205–219, 2022, doi: 10.5281/zenodo.6645451.
[8] S. M. Muhajir and F. Yuamita, “Analisis Total Productive Maintenance Dengan Menggunakan Metode Overall Equipment Effectiveness pada Mesin Mixing Batching di PT. Wijaya Karya Beton Tbk Boyolali,” Jurnal Inovasi dan Kreativitas (JIKa), vol. 3, no. 1, pp. 1–9, 2023, doi: 10.30656/jika.v3i1.6048.
[9] N. Hamzah, A. Nurmala, and A. Momon, “Analisis Total Productive Maintenance (TPM) Menggunakan Metode Overall Equipment Effectiveness (OEE) pada Mesin Injection 2500T New di PT. XYZ,” Jurnal Serambi Engineering, vol. 8, no. 1, 2023, doi: 10.32672/jse.v8i1.4996.
[10] A. Romadhon, “Analisis Total Productive Maintenance (TPM) Dengan Menggunakan Metode Overall Equipment Effectiveness (OEE) pada Paper Machine di PT. M,” 2023.
[11] H. Timisela, G. N. Priambadi, N. Luh, P. Lilis, S. Setiawati, W. B. Adnyana, G. Agung, and K. Suriadi, “Analisis Optimasi Pola Maintenance Turbin pada Pembangkit Listrik Tenaga Air PT. Nusantara Infrastructure di Kab. Dairi Dengan Metode Total Productive Maintenance (TPM),” Kohesi, vol. 1, no. 2, 2024, doi: 10.8734/kohesi.v1i2.365.
[12] M. D. Poernomo, “Perancangan Modul Implementasi Total Productive Maintenance (TPM) pada Departemen Maintenance di PT X,” vol. 12, no. 2, pp. 153–160, 2024.
[13] M. A. N. Fawwaz and B. Hariono, “Analisis Penerapan Metode Total Productive Maintenance Berdasarkan Perhitungan OEE dan Faktor Six Big Losses pada Mesin Seamer Hor Yang Di,” vol. 24, no. 2, pp. 151–156, 2024.
[14] J. Guritno and A. S. Cahyana, “Implementation of Autonomous Maintenance in Total Productive Maintenance,” Procedia of Engineering and Life Science, vol. 1, no. 2, 2021, doi: 10.21070/pels.v1i2.914.
[15] B. Hafid, T. Siagian, D. Derlini, and R. SIlvany, “Pengukuran Dampak Penerapan Sistem Total Productive Maintenance Terhadap Waktu Henti Mesin,” Jurnal Review Pendidikan dan Pengajaran, vol. 7, no. 3, pp. 6798–6805, 2024.
[16] I. Management and E. Juornal, “Analisis Penerapan Total Productive Maintenance (TPM) dan Overall Equipment Effectiveness (OEE) pada Sanding Machine (Studi Kasus PT. Kutai Timber Indonesia),” vol. 3, no. 2, 2025.
[17] A. Mutaqiem, D. Soediantono, and S. Staf Dan Komando Angkatan Laut, “Literature Review of Total Productive Maintenance (TPM) and Recommendations for Application in the Defense Industries,” Journal of Industrial Engineering & Management Research, vol. 3, no. 2, pp. 2722–8878, 2022. \[Online]. Available: [http://www.jiemar.org]
[18] G. Muhaemin and A. E. Nugraha, “Penerapan Total Productive Maintenance (TPM) pada Perawatan Mesin Cutter di PT. XYZ,” Jurnal Ilmiah Wahana Pendidikan, vol. 8, no. 9, pp. 205–219, 2022, doi: 10.5281/zenodo.6645451.
[19] D. Wahjudi, R. Lim, and E. Budi, “Perancangan Sistem Penjadwalan Perawatan Yang Mendukung Total Productive Maintenance di PT. X,” Jurnal Dimensi Insinyur Profesional, vol. 2, no. 1, pp. 48–55, 2024, doi: 10.9744/jdip.2.1.48-55.