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Strategies For Improving the Nutritional Status of Children Under Five (U5) Based on Knowledge and Socioeconomic Factors

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ABSTRACT

Nutritional problems among children under five remain a public health concern, reflecting the interplay between parental knowledge, household resources, and feeding practices. This study examined the associations between maternal knowledge, socioeconomic status, and the nutritional status of children under five and identified implications for strategies to improve nutritional outcomes in Kediri City, Indonesia. The study involved 200 mothers of children under five from the Mojoroto, Kota, and Pesantren subdistricts. Data were collected through interviews, observations, surveys, and document reviews using a Participatory Rapid Appraisal (PRA) approach. Descriptive statistics and structural equation modeling (SEM) were employed to characterize the respondents and examine the relationships among variables. The results showed that 42.0% of children were underweight, 39.0% had normal nutritional status, 18.5% were overweight, and 0.5% were severely malnourished. Maternal knowledge was significantly associated with children's nutritional status, with an estimated coefficient of 0.17 and a t-value of 3.05. Socioeconomic status showed no statistically significant direct association, with an estimated coefficient of 0.02 and a t-value of 0.40. These findings suggest that maternal knowledge plays a role in children's nutritional status, although the modest magnitude of the association indicates that additional contributing factors should be considered. Strengthening nutrition education, routine growth monitoring, and guidance on affordable, nutritious foods through integrated community health posts (posyandu) may support efforts to improve children's nutritional status. However, these strategies require further evaluation, as the study examined associations rather than intervention effectiveness or causal relationships.

INTRODUCTION

The National Development Planning Agency (Badan Perencanaan Pembangunan Nasional, Bappenas) stated in 2010 that nutrition was a major global public health concern (Alta et al., 2023; Dewi et al., 2005; Iskandar, 2026; Putra et al., 2024). Nutritional health

development, as part of efforts to promote comprehensive human development, should begin as early as possible, starting during pregnancy. Research conducted by Rangan (2007) demonstrated that adequate nutritional intake, including both macronutrients and micronutrients, plays a crucial role in children's growth and development. The Indonesian Ministry of Health (2011) stated that health improvement efforts, beginning during pregnancy and continuing through the first five years of life, aim to ensure children's survival while improving their quality of life. These efforts are intended to support optimal physical, mental, emotional, and social development, as well as the development of multiple intelligences in accordance with children's genetic potential. Data from the East Java Provincial Health Office (2011) indicated high morbidity rates, particularly among children under five, and suggested that developmental problems may be directly or indirectly associated with growth disturbances.

According to the World Health Organization (WHO, 2010), approximately 103 million children under five in developing countries were underweight. Approximately 30% of the world's population, including infants, children, adolescents, adults, and older adults, experienced some form of malnutrition. Furthermore, approximately 50% of child deaths were associated with malnutrition. Children who do not receive adequate food in terms of both quantity and nutritional quality may experience impaired growth and development. Prolonged nutritional deficiencies can result in growth faltering, which may eventually manifest as reduced height-for-age. According to Pudjiadi (2005), deficiencies in specific nutrients can disrupt normal growth. Inadequate intake of energy, protein, vitamins, and trace elements can impair physical development, while excessive intake of certain micronutrients may also negatively affect growth and development. These findings are supported by Benton (2008), who reported that inadequate micronutrient intake may interfere with neuronal myelination and other neurodevelopmental processes, potentially impairing children's cognitive, affective, and psychomotor development.

Nutritional problems constitute a significant public health concern that cannot be addressed solely through medical interventions and healthcare services (Filip et al., 2022; Gianfredi et al., 2025; Hadi, 2022; Organization, 2024; Silva et al., 2023). These problems are not merely consequences of poverty but are also closely associated with household food insecurity, inadequate nutritional knowledge, and behaviors that do not support healthy lifestyles. The nutritional status of a population influences overall health outcomes and life expectancy, both of which are important dimensions of national development and are reflected in the Human Development Index (HDI) (Elsamaharani, 2010).

Nutritional problems in Indonesia are particularly prevalent among children under five, despite progress in addressing malnutrition over the preceding decade. The nutritional status of children under five is an important indicator of a community's overall nutritional well-being. According to Soekirman (2005), approximately four out of ten Indonesian children under five experienced impaired physical growth and intellectual development associated with malnutrition, particularly protein-energy malnutrition (PEM).

According to Kodyat (1998), malnutrition during early childhood can have long-term consequences for children's growth and development. Early childhood is characterized by rapid physical growth and developmental changes, requiring an adequate and balanced supply of

nutrients. Malnutrition during infancy and early childhood may result in persistent physical, mental, social, and intellectual developmental impairments that extend into adulthood.

More specifically, malnutrition can cause growth faltering, impair brain development, and weaken immune function, thereby increasing children's susceptibility to infectious diseases. Malnutrition among children under five results from various interconnected direct and indirect factors, including inadequate dietary intake, infectious diseases, household conditions, and caregiving practices (Gibson, 2005).

According to statistics from the Ministry of National Development Planning/National Development Planning Agency of the Republic of Indonesia, approximately 18.4% of Indonesia's population of 241,973,879 experienced malnutrition, while 76,178 children under five were reported to be affected by malnutrition nationwide. According to the WHO (2010), hunger and malnutrition were among the leading contributors to mortality worldwide, with an estimated 17,289 children dying each day from causes associated with hunger and malnutrition.

According to the Indonesian Ministry of Health (2010), the prevalence of nutritional problems among children under five in Indonesia, based on the weight-for-age (WAZ) indicator, included 13.0% classified as underweight and 4.9% classified as severely underweight. Data from Kediri City indicated that 522 children under five, representing approximately 3.7% of the relevant population, were underweight. This prevalence exceeded the stated regional threshold of 1%.

Among children under five with poor nutritional status, 28 cases of respiratory tract infections, particularly pneumonia, were reported. Poor nutritional status may be associated with several factors, including household food insecurity, inadequate dietary intake, infectious diseases, and inappropriate caregiving practices. Additional morbidity data indicated 15 cases of diarrhea, 28 cases of pneumonia, and 14 cases of tuberculosis. Furthermore, a preliminary study involving five mothers of children under five used a 24-hour dietary recall to assess feeding practices. Three respondents reported providing rice as the primary staple food twice daily, with approximately half a plate per serving. Commonly consumed side dishes included tempeh prepared with soy sauce and, occasionally, tofu. The remaining respondents reported providing meals according to their children's perceived nutritional needs. All five respondents reported providing vegetables, particularly spinach. Regarding fruit consumption, two respondents reported occasionally providing bananas and papayas, although not regularly. One respondent reported rarely providing fruit, while the remaining two respondents stated that they provided fruit according to their children's needs.

These preliminary findings suggest that irregular feeding practices, potentially inadequate dietary intake, household food insecurity, and infrequent growth monitoring at integrated community health posts (posyandu) may contribute to poor nutritional outcomes among children under five. However, these observations do not establish causal relationships between feeding practices, household conditions, healthcare utilization, and nutritional status.

Nutritional problems are influenced by multiple interconnected factors. At the household level, children's nutritional status is influenced by the family's ability to provide adequate quantities and varieties of nutritious foods, as well as caregiving practices shaped by parental education, health-related behaviors, and household health conditions (Soekirman, 2000).

According to Pudjiadi (2005), the nutritional status of children under five may deteriorate when mothers have insufficient knowledge of balanced meal planning, appropriate complementary feeding practices, and equitable food distribution within the household. In larger families with limited financial resources, children may face an increased risk of inadequate nutritional intake because household income must be distributed among more family members. Greater parental knowledge of nutritious foods and appropriate feeding practices may contribute to improved nutritional outcomes, whereas inadequate nutritional knowledge may increase the risk of malnutrition. Furthermore, family structure and socioeconomic conditions may influence children's susceptibility to infectious diseases, nutritional well-being, and access to healthcare services.

Based on the preceding discussion, this study aims to examine the associations between maternal nutritional knowledge, socioeconomic factors, and the nutritional status of children under five. The findings are expected to inform strategies for improving nutritional outcomes through strengthened nutrition education, appropriate feeding practices, household food security, and community-based growth monitoring. Accordingly, the study is entitled "Strategies for Improving the Nutritional Status of Children Under Five (U5) Based on Knowledge and Socioeconomic Factors."

The main body of the article, including the reference list, should be formatted in a single-column layout, as specified in the journal template. Each new paragraph should have a first-line indentation equivalent to one tab. Manuscripts must be submitted in Microsoft Word format using A4 paper size, with top, bottom, left, and right margins of 2.54 cm. The document should use single-line spacing and Times New Roman, 12-point font, throughout the main text.

METHOD

This study was conducted in Kediri City, Indonesia, covering three subdistricts: Mojoroto, Kota, and Pesantren. The research location was selected using criterion-based sampling (LeCompte and Preissle, as cited in Alwasilah, 2003; Kanto, 2003). Kediri City was selected because 522 children under five (approximately 3.7%) were reported to be underweight, exceeding the stated regional threshold of 1%. The study population comprised mothers of children under five residing in Kediri City. A total of 200 mothers were included in the study based on predefined eligibility criteria. The inclusion criteria required mothers to be healthy, able to communicate effectively, responsible for caring for their own children, and registered at an integrated community health post (posyandu). Eligible children were required to be free from acute illness and physical disabilities. Children with edema or hydrocephalus, as well as those who were hospitalized or had recently been discharged from a hospital, were excluded.

The study used primary and secondary data. Primary data were collected directly from respondents, while secondary data were obtained from relevant institutional records and documents. Secondary data sources included the Kediri City Health Office, the Kediri City Food Security Agency, and local subdistrict administrative offices. Data collection employed a Participatory Rapid Appraisal (PRA) approach involving interviews, field observations, surveys, and document reviews. The collected data were used to assess maternal nutritional

knowledge, household socioeconomic conditions, and the nutritional status of children under five.

Data were analyzed using descriptive and inferential statistical methods. Descriptive statistics were used to summarize respondents' characteristics and the distributions of the study variables, with findings presented in tables. Inferential analysis was performed using structural equation modeling (SEM) to examine the relationships between maternal knowledge, socioeconomic status, and the nutritional status of children under five. The analysis focused on estimating the associations between the independent variables and children's nutritional status and assessing their statistical significance.

RESULTS AND DISCUSSION

Respondent Characteristics

The characteristics of the respondents in this study include the gender of the toddler, the mother's educational level, the mother's occupation, the parents' income level, and the child's birth order. The following table presents these characteristics.

Table 1. Respondent Characteristics

Characteristics	Category	N	Percentage (%)
Child's sex	Male	111	55.5
	Female	89	44.5
Mother's educational level	Elementary School	6	3.0
	Junior High School	23	11.5
	Senior High School	128	64.0
	Diploma/Academy	25	12.5
	Bachelor's Degree	18	9.0
Mother's occupation	Self-employed	39	19.5
	Housewife	75	37.5
	Farmer	34	17.0
	Civil Servant	42	21.0
	Private-sector Employee	10	5.0
Parents' income level	< IDR 500,000	23	11.5
	IDR 500,000–1,000,000	80	40.0
	> IDR 1,000,000	12	6.0
	No Income	85	42.5
Birth order	First child	100	50.0
	Second child	48	24.0
	Third child	52	26.0
Total		200	100.0

Based on the table, the majority of toddlers are male (55.5%). The majority of mothers of toddlers have a high school education (64.0%) and are stay-at-home mothers (37.5%). Most parents fall into the "no income" category (42.5%), while among those with an income, the majority earn between Rp500,000 and Rp1,000,000. Additionally, half of the toddlers in this study are firstborn children (50.0%).

Characteristics of Toddlers' Nutritional Status in Kediri City

The distribution of respondents based on indicators of toddlers' nutritional status in Kediri City is shown in the table below

Table 2. Characteristics of Toddlers' Nutritional Status in Kediri City

No.	Nutritional Status	Frequency	Percentage (%)
1	Severely Malnourished	1	0.5
2	Underweight	84	42.0
3	Normal Nutritional Status	78	39.0
4	Overweight	37	18.5
	Total		**200**

Based on Table 2 above, it can be seen that the majority of respondents (42%) were classified as having inadequate nutritional status, while a small proportion (0.5%) were classified as having severe malnutrition.

Results of the Research Instrument Validity Test

A validity test was conducted to determine the extent to which the instrument was able to measure what it was intended to measure. Item validity can be tested using Pearson's product-moment correlation by comparing the correlation coefficient of each item against the established criteria. An item is considered valid if its correlation coefficient is greater than 0.30.

Furthermore, a reliability test was conducted to determine the level of consistency or reliability of the instrument in measuring the same object. Reliability testing in this study used Cronbach's Alpha. The instrument is considered reliable if it has a reliability coefficient of 0.60 or higher. The results of the validity and reliability tests for the instrument in this study are presented in the following section.

Table 3. Results of the Research Instrument Validity Test

Variable	Item	Correlation	Description
Knowledge	X1.1	0.464	Valid
	X1.2	0.740	Valid
	X1.3	0.458	Valid
	X1.4	0.538	Valid
	X1.5	0.667	Valid
	X1.6	0.464	Valid
	X1.7	0.554	Valid
	X1.8	0.538	Valid
	X1.9	0.817	Valid
	X1.10	0.735	Valid
	X1.11	0.752	Valid
	X1.12	0.458	Valid
	X1.13	0.668	Valid
	X1.14	0.645	Valid
	X1.15	0.723	Valid
	X1.16	0.458	Valid

Variable	Item	Correlation	Description
	X1.17	0.685	Valid
	X1.18	0.538	Valid
	X1.19	0.469	Valid
	X1.20	0.473	Valid
Cronbach's Alpha		**0.903**	**Reliable**
Socioeconomic	X2.1	0.529	Valid
Status	X2.2	0.468	Valid
	X2.3	0.513	Valid
	X2.4	0.572	Valid
	X2.5	0.518	Valid
	X2.6	0.458	Valid
	X2.7	0.682	Valid
	X2.8	0.498	Valid
	X2.9	0.638	Valid
	X2.10	0.697	Valid
	X2.11	0.529	Valid
	X2.12	0.561	Valid
	X2.13	0.797	Valid
	X2.14	0.467	Valid
	X2.15	0.749	Valid
	X2.16	0.498	Valid
	X2.17	0.620	Valid
	X2.18	0.483	Valid
	X2.19	0.666	Valid
	X2.20	0.503	Valid
	X2.21	0.650	Valid
	X2.22	0.483	Valid
	X2.23	0.650	Valid
Cronbach's Alpha		**0.908**	**Reliable**

Based on the table above, all items in the knowledge and socioeconomic variables had Pearson Product-Moment correlation coefficients greater than 0.30; therefore, all items were deemed valid. The reliability test results also showed that both variables had Cronbach's Alpha values greater than 0.60, so the instrument was deemed reliable. Consequently, this research instrument can be used as a measurement tool in this study.

Testing the Linearity Assumption

The linearity assumption was tested using the curve-fit method performed with SPSS software. The criterion used was that if the Sig value for the linear model was < 0.05, then the linearity assumption was met.

Table 4. Testing the Linearity Assumption

Relationship	Test Result	Description
Knowledge → Nutritional Status	Deviation from Linearity = 0.206 > 0.05	Linear
Socioeconomic Status → Nutritional Status	Deviation from Linearity = 0.774 > 0.05	Linear

Based on Table 4, the linearity test results show that the relationship between knowledge and nutritional status has a Deviation from Linearity value of 0.206 > 0.05. Meanwhile, the relationship between socioeconomic status and nutritional status has a Deviation from Linearity value of 0.774 > 0.05. Therefore, both relationships between variables satisfy the linearity assumption, so it can be concluded that the relationships between knowledge and socioeconomic status and nutritional status are linear.

Table 5. Goodness-of-Fit Test

Relationship	Test Result	Description
Knowledge → Nutritional Status	p-value = 0.123 > α = 0.05	Model Fit
Socioeconomic Status → Nutritional Status	p-value = 0.470 > α = 0.05	Model Fit

Berdasarkan hasil perhitungan X^2-*Chi-square* memperlihatkan bahwa seluruh nilai signifikasi lebih dari nilai *cut-off value* 0,05 sehingga dapat disimpulkan bahwa model layak dikatakan memiliki nilai prediktif yang relevan

Results of the Structural Model Test

To determine the results of testing the relationships among variables in the structural model, the estimated values and t-values were tested. The results of the structural model test are shown in Table 6 below.

Table 6. t-Values and Estimates in the Structural Model

No.	Path	Estimate	t-value	Conclusion
1	Knowledge → Nutritional Status	0.17	3.05	Significant
2	Socioeconomic Status → Nutritional Status	0.02	0.40	Not Significant

Note: Significance at the 5% level (with a t-value < -1.96 or > 1.96)

Based on Table 6, the results of the structural model testing indicate that knowledge has a significant relationship with nutritional status, with an estimated value of 0.17 and a t-value of 3.05. Since this t-value is greater than 1.96, the relationship between knowledge and nutritional status is deemed significant. Meanwhile, socioeconomic status has an estimated value of 0.02 with a t-value of 0.40. Since the t-value is less than 1.96, the relationship between

socioeconomic status and nutritional status is deemed insignificant. Thus, of the two variables tested, only knowledge shows a significant relationship with nutritional status.

The Effect of Knowledge on Nutritional Status

The test results show that knowledge has a significant relationship with the nutritional status of toddlers. This is indicated by an estimated value of 0.17 with a t-value of 3.05, which is greater than the critical value of 1.96. These results indicate that knowledge is one of the factors associated with the nutritional status of toddlers. Knowledge about nutrition can help mothers or parents understand toddlers' dietary needs—from selecting food types and planning menus to providing meals that meet the child's growth requirements (Prasetyo et al., 2023).

Knowledge plays a crucial role because nutritional problems are often linked to a lack of information and understanding regarding the fulfillment of nutritional needs. The knowledge a person acquires can serve as the foundation for shaping responses and actions, including determining feeding behaviors toward toddlers (Bimpong et al., 2020). However, the results of this study indicate that the estimated value of the relationship between knowledge and nutritional status is relatively small. This finding suggests that having good knowledge does not necessarily mean it is directly applied in daily nutritional practices.

These results align with a study (Worsley, 2002) stating that knowledge about nutrition is not necessarily the dominant factor in shaping nutritional behavior. Dietary patterns and the fulfillment of nutritional needs can also be influenced by other factors, such as the availability of food and community eating habits. Meanwhile, (Grunert et al., 2010) explain that the knowledge possessed by homemakers is not always directly used as a basis for meeting the family's nutritional needs because there are various conditions that can limit its application.

In addition, parental knowledge is one of the factors associated with meeting children's nutritional needs, although its influence may interact with other factors, such as family eating habits and culture (Grosso et al., 2013). This finding is also consistent with the concept proposed by Ajzen and Fishbein (1973), which states that behavior formation is influenced not only by knowledge but also by various other considerations that underlie a person's actions. Therefore, increasing knowledge about nutrition must be accompanied by efforts to encourage its application in daily life.

Based on these findings, improving families' knowledge of toddler nutrition can be a key component in efforts to improve nutritional status. Education can be provided through outreach, communication, and information sessions on food selection, menu planning, and food preparation methods appropriate for toddlers' needs. Posyandu activities and health services can be utilized as a means to expand parents' access to nutritional information so that the knowledge they gain can be more easily applied to meeting the nutritional needs of toddlers.

The Socioeconomic Impact on Nutritional Status

The test results show that socioeconomic status has no significant direct relationship with the nutritional status of toddlers. This is indicated by an estimated value of 0.02 and a t-value of 0.40, which is smaller than the critical value of 1.96. Therefore, based on the results of this study, socioeconomic conditions do not yet show a significant direct relationship with the nutritional status of toddlers. This finding suggests that a family's economic status is not the sole factor determining a child's nutritional status.

Theoretically, socioeconomic conditions are related to a family's ability to meet food needs. Family income can determine the quantity and quality of food that can be provided, while low economic status can limit a family's ability to obtain a diverse and nutritious diet (Rosegrant et al., 2024). Poverty and limited income are often associated with a family's limited ability to meet food and other basic needs (Roedjito, 1989). However, economic status does not always directly determine nutritional status, as there are other factors that can either facilitate or hinder the fulfillment of toddlers' nutritional needs.

The results of this study can be explained by the presence of various factors that work together to determine nutritional status. (Ali et al., 2019) explain that children's nutritional status is influenced by direct factors, such as food sufficiency and health conditions, as well as indirect factors, which include household food security, parenting practices, environmental sanitation, and access to health services. Therefore, socioeconomic conditions can play a role through these factors and do not always manifest as a direct relationship with nutritional status.

In general, increased income can enhance a family's ability to purchase food and provide a more diverse diet (Salois & Tiffin, 2010). However, greater access to economic resources does not necessarily result in better nutritional status if it is not accompanied by an understanding of and proper implementation of nutritional practices. Conversely, families with limited economic resources can still make efforts to ensure adequate nutrition through appropriate food selection, good parenting practices, and the utilization of available nutrition services and programs.

Thus, the results of this study indicate that efforts to improve the nutritional status of toddlers are insufficient if they focus solely on improving socioeconomic conditions. Economic improvement remains important for enhancing families' ability to meet basic needs, but it must be supported by increased knowledge and capacity among families to manage available resources. Such an approach can help families adopt nutritional practices appropriate to their individual circumstances and capabilities.

Strategies for Improving the Nutritional Status of Toddlers in the Community

Based on the research findings, strategies to improve the nutritional status of toddlers in the community need to take into account the results of the analysis of the two research variables. Knowledge shows a significant relationship with nutritional status, whereas socioeconomic status has not yet shown a significant direct relationship. Therefore, the main strategy can be directed toward strengthening families' knowledge regarding meeting the nutritional needs of toddlers, while still considering socioeconomic conditions as factors that can influence families' ability to provide and access food.

Knowledge can be increased through nutrition education activities that are easy for families to understand and implement. The information provided should not only address the importance of nutritious food but also cover food selection, menu planning, food preparation, and feeding practices appropriate for toddlers' developmental stages. Families with a good level of knowledge are expected to have a more adequate understanding of determining their children's nutritional needs, although implementation is still influenced by other factors, such as habits and food availability (Worsley, 2002; Grunert, 2010).

Posyandu can serve as a key platform for implementing these strategies, as Posyandu activities enable the community to access health services and information directly. In addition

to growth monitoring, Posyandu activities can be utilized to provide nutrition education and detect growth disorders in toddlers at an early stage. Increased family participation in Posyandu activities can also support continuous monitoring of nutritional status and help families obtain information tailored to their children's needs.

From a socioeconomic perspective, strategies to improve nutritional status can focus on making more optimal use of family resources. A family's economic situation is indeed linked to its ability to obtain food, but meeting nutritional needs does not always depend solely on income level. Families can be educated on selecting affordable local food items that still provide adequate nutritional value for toddlers. This approach can help families apply nutritional knowledge in line with their economic capabilities.

Based on the findings, strategies for sustainably improving toddlers' nutritional status need to integrate knowledge enhancement with support for families' socioeconomic conditions. Strengthening nutrition education through Posyandu and health services, routine growth monitoring, and guiding families in selecting and managing food can serve as complementary measures. With this approach, improving nutritional status is not merely focused on providing information but is also aimed at enabling families to apply that knowledge in accordance with their available resources and circumstances.

CONCLUSION

Based on the study findings, the nutritional status of children under five requires continued attention through efforts to ensure adequate nutritional intake. Of the two variables examined, maternal knowledge demonstrated a statistically significant association with children's nutritional status. Therefore, improving parental knowledge regarding the selection, preparation, and provision of nutritionally appropriate foods is an important component of strategies to improve nutritional outcomes. In contrast, socioeconomic status showed no statistically significant direct association with children's nutritional status, suggesting that household economic conditions alone may not adequately explain variations in nutritional outcomes.

Theoretically, these findings highlight the importance of family nutritional knowledge in supporting appropriate feeding practices while recognizing that socioeconomic conditions may influence household food accessibility and dietary choices. From a practical perspective, the findings may inform local health authorities and healthcare providers in strengthening nutrition education, enhancing the role of integrated community health posts (posyandu) in monitoring children's growth, and providing context-specific dietary guidance to families. Further research should incorporate additional factors potentially associated with children's nutritional status, including dietary diversity, household food security, caregiving practices, and access to healthcare services. Longitudinal and intervention-based studies are also recommended to clarify potential causal relationships and evaluate the effectiveness of nutrition improvement strategies in achieving sustainable nutritional outcomes among children under five.

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CONFLICT OF INTEREST

The author states that there are no conflicts of interest, whether personal, commercial, or financial, that can affect the implementation and results of this study.

AUTHOR CONTRIBUTIONS

Nurwijayanti contributes to research design, data collection and processing, system development, result analysis, and article manuscript preparation.

GENERATIVE AI STATEMENT

In the process of compiling this article, the author uses generative artificial intelligence (AI) as a tool in language refinement, writing structure, and grammar improvement. The use of AI is carried out on a limited basis and remains under the supervision of the author. All data, analysis, interpretation, and scientific substance in this article have been checked and verified by the author. The author is solely responsible for the accuracy, authenticity, and final content of the manuscript.

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