Environmental Sustainability for Urban Areas in Indonesia: Strategies, Challenges, and Future Directions

Indriati Amirullah[1], Syahrir A Pasinringi[2], Syafaruddin[1], Delly Mustafa[3]

Abstract

This study aims to investigate the challenges of environmental preservation in the urban areas of Makassar through a comprehensive approach. The research focuses on analyzing the level and impact of air, water, and soil pollution, evaluating the effectiveness of waste management, and addressing the challenges of overconsumption of natural resources. It also examines the impact of urban sprawl on environmental sustainability. The study uses quantitative research methods to analyze the current situation, identify challenges, and propose data-driven strategies. Key findings include the importance of water resource efficiency, renewable energy, waste management, dense urban design, sustainable building, climate change adaptation, and social inclusiveness. The study also identifies limitations such as fast growth, limited resources, political-economic-social barriers, and lack of public awareness. Recommendations include a data-driven approach, technological innovation, socio-economic impact of sustainable initiatives, public participation, and policy analysis.

Keywords: *Policy, Sustainable, Urban Development, Waste Management*

Introduction

The rapid development of urban areas in various parts of the world has created a number of serious challenges related to environmental preservation(McKinney, 2002). The urban environment is an area that continues to grow rapidly in this era of globalization(McMichael, 2000). Population growth, urbanization, and industrialization have led to major transformations in the structure and characteristics of cities around the world(Ni et al., 2021). As the urban population increases, so does the rate of consumption of natural resources, resulting in extensive pressure on the environment(Yeh & Huang, 2012). In many cities, deforestation and land degradation due to urban expansion have caused loss of natural habitats for flora and fauna, threatening existing biodiversity.(He et al., 2014). In addition, the impact of industrial and domestic waste disposal that is not managed properly has caused environmental pollution, including air and water pollution, which has a negative impact on public health and overall environmental quality. Thus, the sustainability of the urban environment is becoming an increasingly pressing issue to be handled in a comprehensive and sustainable manner(Awomeso et al., 2010).

Big cities, including Makassar as one of the largest cities in Indonesia, face enormous pressure in maintaining ecological balance, facing pollution problems, inadequate waste management, excessive consumption of resources, as well as the impact of uncontrolled urban sprawl.(Surya, Salim, et al., 2021). As the economic, social and political center of

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[1]STIA YAPPI Makassar
[2]Universitas Hasanuddin Makassar
[3]Universitas Bosowa Makassar
Email: Indychalie@gmail.com

the region, Makassar is experiencing rapid growth, but is also facing significant challenges in managing its environmental impact.(Surya, Saleh, et al., 2020). Rapid urbanization has led to changes in land use and habitat fragmentation, threatening the surrounding biodiversity(He et al., 2014). Increased industrial production and energy consumption are increasing greenhouse gas emissions, which contribute to global climate change and lead to more frequent disaster risks(Worrell et al., 2018). Inadequate waste management causes water and soil contamination, which impacts public health and food security(Lu et al., 2015). Urban environmental sustainability is an urgent issue and requires appropriate strategies and actions to achieve sustainable urban areas, maintain a balance between economic growth and environmental protection, and improve the quality of life of society as a whole.(Fernandes et al., 2018). It is in this context that this research will focus on urban environmental sustainability in the Makassar area, as an effort to find relevant solutions and recommendations in dealing with this complex challenge.

The urban area of Makassar, as the capital city of South Sulawesi Province, is experiencing rapid population growth and is developing into a regional economic center. This growth provides economic benefits to the city, but also has a negative impact on the environment(Daniel-Useng & Achmad, n.d.). Air, water and soil pollution, increased demand for energy, mismanaged waste and uncontrolled expansion of development have threatened the quality of the environment and the well-being of city dwellers.(Lange, 2021). The impact of rapid urbanization is also causing land use change and habitat fragmentation, threatening the surrounding biodiversity. This condition raises concerns about the potential risks of natural disasters, such as floods and landslides, which can increase due to environmental degradation and climate change(He et al., 2014).

In facing this challenge, efforts to preserve the urban environment are an important key to achieving sustainable development in the Makassar area. For this reason, strategic steps are needed to overcome air, water and soil pollution, such as the application of environmentally friendly technologies in industry and transportation as well as more effective and responsible waste management.(Surya, Hamsina, et al., 2020). In addition, policies are needed that promote the wise use of natural resources, through energy efficiency and the use of renewable energy, as well as greening cities to reduce the effects of urban heat.(Wilkinson et al., 2007). Development must also be directed towards a sustainable approach, taking into account environmental and social aspects, as well as integrating the principles of sustainable development in urban planning. Through collaboration between the government, the private sector, the public and research institutions, it is hoped that a holistic solution can be found to preserve the Makassar urban environment and create an environmentally friendly and comfortable city for all residents.(Surya, Saleh, et al., 2020).

The challenges faced by Makassar urban areas in achieving environmental sustainability are urgent issues and require serious attention from related parties. Rapid population growth and rapid urbanization have led to increased air, water and soil pollution, as well as increased demand for energy and consumption of natural resources(Surya et al., 2022). The impact of this pollution and environmental degradation has a negative impact on the quality of life of urban residents and the environment as a whole. Therefore, this research is expected to make a real contribution in facing environmental conservation challenges in the urban area of Makassar and provide direction for policy makers and city planners to take effective strategic steps. Through a multidisciplinary approach and close collaboration between academia, government and the community, it is hoped that this research will provide in-depth insight into the environmental problems faced by the city of Makassar and create sustainable solutions that can be implemented to realize urban environmental sustainability.

Therefore, this study aims to; Investigate the challenges of environmental preservation in Makassar urban areas through a holistic approach. This study will analyze the level and impact of air, water and soil pollution in the urban area of Makassar using the latest data and information. In addition, this study will also evaluate the effectiveness of the current waste management in the Makassar urban area, identify weaknesses and challenges in the existing waste management system, and provide recommendations for improvement and improvement of the system's performance. Furthermore, this research will identify and address the challenges of overconsumption of natural resources in the context of environmental conservation. Finally, This research will examine development expansion and urban sprawl and its impact on environmental sustainability in Makassar urban areas. By analyzing urban growth trends and their impact on the environment.

Conceptual Framework

Makassar faces a number of complex challenges in achieving environmental sustainability(Surya, Syafri, et al., 2020). Within the framework of this challenge, pollution stands out as an urgent issue, where air and water pollution originates from various sources, resulting in impacts on ecosystems as well as people's welfare.(Ajibade et al., 2021). Inadequate waste management exacerbates this situation, resulting in the accumulation of waste in urban areas and the risk of contamination of soil and water(Ferronato & Torretta, 2019). Excessive resource consumption, driven by rapid urbanization and population growth, is straining a city's ability to meet demand in a sustainable way(Fang et al., 2019). This demand places pressure on critical resources such as water, energy and raw materials, potentially leading to scarcity and ecological impact. The challenges of uncontrolled urban expansion exacerbate this situation. Unplanned expansion and inadequate infrastructure contribute to congestion, inefficient use of resources and rising levels of pollution(Canitez, 2019). This uncontrolled growth also has implications for the destruction of natural habitats and green spaces, adding to the risk of ecological imbalances in cities. Collectively, these serious challenges pose significant threats.

Makassar's ecological harmony is threatened, with potential consequences such as loss of biodiversity, disruption of ecosystem services, and reduction of air and water quality. The well-being of the population is threatened due to the emergence of pollution-related health problems and decreased access to clean resources(Khan et al., 2021).In a long perspective, if not taken seriously, these challenges will undermine the sustainability of urban development in Makassar(Brusseau et al., 2019). An inclusive approach is essential, involving policy reforms and public awareness campaigns(Kumi et al., 2020). In sustainable infrastructure investment, as well as collaboration between government, private sector stakeholders, and communities(Zuniga-Teran et al., 2020). Through these joint efforts, Makassar can overcome these challenges, create a harmonious harmony between urban growth and environmental well-being and become a role model for other urban areas facing similar problems.(Heymans et al., 2019).

In order to effectively address the existing challenges, an in-depth understanding of Makassar's unique environmental sustainability landscape is required. This process necessitates an in-depth exploration of the currently existing corpus of knowledge relating to sustainable urban development movements(Bibri, 2019). This exploration is not just limited to aspects of scientific studies, but also includes efforts to gain insights from approaches that have been successfully applied in parallel urban contexts.(Peimani & Kamalipour, 2021). Through conducting a comprehensive literature review, a solid foundation will be established(Kaufmann & Peil, 2020). This foundation will provide in-depth insight into the most pressing issues that require resolution(Garousi et al., 2019). In addition, this initial phase will assist in identifying the underlying factors that contribute

to the complexities faced by Makassar. This action is the entry point in formulating strategies and solutions based on accurate information(Xiao & Watson, 2019).

Methods

The research methodology used in this study focuses on efforts to promote environmental sustainability(Anwar et al., 2020)in Makassar city and adopted a quantitative approach. This approach involves the collection and analysis of numerical data to comprehensively understand the challenges faced and identify evidence-based strategies to increase sustainability in cities(Martins et al., 2019). The research methodology for this study on promoting environmental sustainability in the city of Makassar will use a quantitative approach(Baah et al., 2021). This approach will involve the collection and analysis of numerical data from multiple sources, such as surveys, databases and official records, to gain a comprehensive understanding of the challenges faced by the city in terms of environmental sustainability.(ElHaffar et al., 2020)(Mousa & Othman, 2020).

Quantitative data analysis will enable researchers to discover significant trends, patterns and challenges regarding environmental sustainability in the city. These strategies can include targeted interventions, policy recommendations, and community engagement initiatives, all of which are based on insights gained from analysis of quantitative data. Overall, the use of a quantitative approach in this study will provide a solid basis for understanding the current state of environmental sustainability in Makassar and designing practical solutions to promote sustainability(Tien et al., 2020). By collecting and analyzing numerical data, this research aims to contribute to knowledge and provide valuable insights for policy makers, city officials and stakeholders to make informed decisions and take effective actions towards a more sustainable future in Makassar(Schildkamp, 2019). The research methodology will include the following steps;

Study Design

The research sample will be selected from the community, policy makers, and stakeholders from various sectors involved in urban development and environmental sustainability. A structured questionnaire will be developed to collect quantitative data on challenges faced and strategies implemented for environmental sustainability.

Data and Sample Selection

The population and samples were taken from the population of Makassar City people who are of productive age and have a high concern for environmental sustainability at this time. The city of Makassar, as the center of economic and social activity in South Sulawesi, displays a majority population consisting of individuals of various ages who play an important role in the development and growth of the city. One of the reasons for taking the population at productive age in this study is because they are one of the groups that significantly contribute to urban development and have the potential to influence environmental sustainability in Makassar urban areas.(Surya, Menne, et al., 2021).

Productive age generally refers to the age group between 15 to 50 years, where individuals in this group are generally economically active and play a role in urban activities.(Emerson et al., 2021). The people of the city of Makassar who are of productive age have a high awareness of the need to preserve the environment as an effort to create a sustainable environment. The population of the productive age population of Makassar city is 492,192 people.(Bps City & Makassar City, 2023)However, using the Krejcie and Morgan methods, the number of sample members subject to factual verification is not always the same, between the requirements of a minimum of 1,000 members or 1 per 1,000 of the total population.(Awang et al., 2022).

Sampling in this study using the Krijie Morgan table formula involves several steps. First, the researcher determines the desired level of confidence, that is, how accurately the sample results must represent the population. The Krijie Morgan table provides a structured framework for evaluating sustainability practices(Hamadamin & Atan, 2019). This table includes various relevant criteria and indicators for environmental sustainability, such as water management, waste management, energy efficiency, land use, and so on.(Sen et al., 2021)By using this table, researchers can ensure that important aspects of environmental sustainability in the city of Makassar are evaluated in a systematic and comprehensive way.

By using the Krijie Morgan table, researchers can provide a rating of the evaluated sustainability practices. The sustainability score resulting from the tabular formula can be used to compare these practices and identify the relative level of sustainability of each(Butnaru et al., 2021). This helps in identifying best practices and practices that need to be improved or enhanced in the city of Makassar. With this ranking, researchers can provide valuable information to decision makers and stakeholders about effective and adoptable sustainability practices(Kumar et al., 2020).

Then, the researcher must determine the acceptable error rate, that is, how much difference is acceptable between the sample and the population results. With a total population of productive age Makassar city people totaling 492,192 people(Bps City & Makassar City, 2023). so the researchers took a sample of 381 samples for this study.

Structured questionnaires will be distributed to selected samples, either through online platforms or in-person interviews. Steps will be taken to ensure the accuracy and reliability of the data collected, such as conducting pilot surveys and implementing quality control checks.

Measurement Instruments

Sustainable Development Index (Rasoolimanesh et al., 2020)namely as an indicator (X1). This measuring instrument uses a 5-point Likert scale. Develop an index that combines various indicators of environmental sustainability, such as air quality, water quality, waste management, energy efficiency, availability of green space, and accessibility of public transportation. Assign weights to each indicator based on their relative importance and calculate an overall sustainability score for an urban area. Example item "Environmental sustainability is critical to maintaining good air quality, which affects human health and the sustainability of the ecosystems around us"

Environmental Impact Assessment as an indicator(Bajpai et al., 2020) (Rasoolimanesh et al., 2020)(X2). This measuring instrument uses a 5-point Likert scale.Conduct environmental impact assessments for urban development projects to evaluate their potential ecological and environmental consequences. Use standard assessment tools and frameworks to measure and quantify impacts on air, water, soil, biodiversity and natural resources. Example item "It is important to conduct an environmental impact evaluation of an urban development project in order to identify and evaluate its potential ecological and environmental consequences"

Waste Audits(Kerdlap et al., 2019)as an indicator (X3) This measuring tool uses a 5-point Likert scale.Conduct a waste audit to assess the composition and amount of waste generated in urban areas. This involves sorting and analyzing a waste sample to determine the proportion of recyclable, organic and non-recyclable materials. The results inform waste management strategies, such as recycling programs and waste reduction initiatives. Example item "Evaluation of the composition of urban waste is important to understand the types of waste generated by urban communities, including organic waste, plastic waste, electronic waste, and other hazardous waste"

Community Survey (Lee & Jan, 2019) as an indicator (Y1). This measuring instrument uses a 5-point Likert scale.Conduct a survey of residents and stakeholders to assess their knowledge, attitudes and behavior regarding environmental sustainability. Use a Likert scale or multiple choice questions to collect quantitative data on topics such as recycling habits, energy conservation practices, use of public transportation, and awareness of sustainable initiatives. Example item "This survey aims to assess the level of knowledge of residents and stakeholders regarding environmental sustainability issues, including understanding of environmental problems, causes of climate change, or the importance of conserving natural resources".

Green Space Assessment(Jennings & Bamkole, 2019)as an indicator (Y2). This measuring instrument uses a 5-point Likert scale. Conduct an assessment of green space within an urban area, evaluating factors such as size, biodiversity, accessibility and functionality. Use standard assessment tools, such as the Green Space Quality Index, to measure the quality and contribution of green spaces to environmental sustainability and community welfare. Example item "Assessment of green space in urban areas aims to measure existing measures, including the area of land used as green space and the proportion of total urban area designated as open space".

Water Quality Monitoring(Nguyen et al., 2019)as an indicator (X4). This measuring instrument uses a 5-point Likert scale. Implement regular monitoring programs to assess the quality of water sources in urban areas, including rivers, lakes and groundwater. Measure parameters such as pH, dissolved oxygen, nutrient levels and presence of pollutants to identify water quality problems and guide appropriate corrective actions. Example item "Results of monitoring water quality to help inform decision-making in urban environmental planning and management, such as regulating land use, managing waste, or implementing better environmental protection policies"

Data Analysis

As a start, data will be collected through a survey given to residents, business actors and related stakeholders in Makassar. This survey will assess their perceptions, behaviors and attitudes towards environmental sustainability practices, including waste management, energy consumption and transportation options.(Saeed et al., 2019). In addition, existing official databases and records will be used to collect statistical data. The collected data will be analyzed using descriptive statistics, such as frequencies, percentages, and measures of central tendency(Fu et al., 2020), to provide an overview of the challenges faced in achieving environmental sustainability today in Makassar.

Quantitative research methods involve collecting numerical data through surveys, observations, or secondary data sources such as government reports, databases, or previous studies.(Hale et al., 2021)This data can include variables such as land use, energy consumption, greenhouse gas emissions, water quality, or other environmental sustainability indicators. Once the data has been collected, it will be carefully analyzed using statistical methods and software.(Hong et al., 2020)Statistical data analysis involves data processing and modeling to gain a deeper understanding of environmental sustainability in Makassar urban areas.(Atitallah et al., 2020)Statistical techniques such as linear regression, multivariate analysis, or spatial analysis can be used to analyze relationships between variables, identify patterns, trends, and anomalies, and model future projections. Inferential statistics, such as correlation analysis and regression modeling, will be performed to identify potential relationships and patterns between different variables, such as socio-demographic factors and sustainability practices.(Feroz et al., 2021)Statistical data analysis also involves testing hypotheses to test the significance of the relationship between the variables studied.

The results of statistical data analysis must be interpreted carefully to draw meaningful conclusions.(Li et al., 2019)This involves understanding effect sizes, confidence intervals, and the statistical significance of analysis findings. This interpretation will help researchers understand the current state of environmental sustainability, the main challenges faced, and possible future directions in promoting sustainable urban development.(Sheng et al., 2021).The use of statistical data analysis in this study is important because it allows researchers to draw conclusions that are supported by empirical evidence and provides a deeper understanding of the condition of environmental sustainability in the urban area of Makassar. Through statistical data analysis, this research can identify factors that influence environmental sustainability, reveal the main challenges that need to be overcome, and formulate effective data-based strategies in managing urban environmental sustainability.

Inferential Analysis

This study applies inferential statistical techniques, including correlation analysis and regression analysis, to investigate the relationship between challenges in the context of environmental sustainability and the driving factors. Through correlation analysis, in-depth understanding of the degree of relationship between sustainability challenges can be established, for example the correlation between air pollution and habitat degradation, or between energy consumption and waste production(Indriani et al., 2019).

Regression analysis also helps identify factors that influence sustainability, such as demographics, education level, environmental awareness, or access to resources. By collecting numerical data regarding these challenges and factors from a representative sample, regression analysis is used to determine the extent to which these factors contribute to continuation(Campisi et al., 2020). By understanding these relationships, we can identify the factors that contribute to sustainability outcomes.

The application of inferential statistical techniques allows testing the validity and reliability of the identified relationships. By testing hypotheses and calculating statistical parameters such as p-values or coefficients of determination (R-squared), it is possible to evaluate the significance and reliability of statistical relationships. This results in confidence that the findings are supported by strong and reliable evidence.(Norouzi et al., 2020).

Inferential statistical techniques allow us to make generalizations from the sample used in research to a wider population. By taking a sample that is representative of the larger population and using appropriate inferential techniques, we can draw generalizable conclusions.(Hao et al., 2021). For example, using regression analysis, we can identify the factors that influence sustainability outcomes in the urban area of Makassar and are broadly applicable to other cities with similar characteristics.

By using inferential statistical techniques, we can explore the relationships and factors that influence sustainability outcomes in a more in-depth and objective manner. This helps inform policies and strategies that can improve environmental sustainability in urban areas of Makassar and may also be applicable elsewhere with similar challenges and characteristics.

Path Analysis

A comparative analysis can be carried out to compare sustainability practices and strategies implemented in Makassar with other similar cities or regions. The first step in conducting a path analysis is to identify the variables to be included in the analysis.(Wang et al., 2019). In this context, these variables may include sustainability practices and strategies that Makassar City wants to compare with other similar cities or regions.(Ferronato et al., 2019). For example, variables that might be included are environmental policy, waste management programs, use of renewable energy, community participation in sustainability activities, and other indicators of sustainability. After the variables have been identified,

the next step is to collect relevant data for each of these variables. . This data can be obtained through literature, government reports, surveys, or other data sources. It is important to ensure that the data collected is accurate and reliable in order to have valid analytical results(Yong et al., 2020).

After the data is collected, the next step is to build a path model that reflects the relationship between the variables involved. The path model is a graphical representation that shows the causal relationship between the variables in the analysis. This model can be described using arrow diagrams connecting the variables and indicating the direction of the relationship between them(Bibri et al., 2020).After the path model is built, the next step is to estimate and test the path. This involves using statistical techniques to test the significance of the relationship between the variables in the path model. Methods commonly used in path analysis include regression analysis and path analysis based on least squares(Pappas & Woodside, 2021).

After path estimation and testing is completed, the results of the analysis can be interpreted. This involves looking at the path coefficients which indicate the strength and direction of the relationship between variables, as well as the direct and indirect influence of these variables on overall sustainability.(Pappas & Woodside, 2021). With these path analysis steps, it is expected to gain a deeper understanding of the causal relationship between sustainability practices and strategies implemented in Makassar and other similar cities or regions. The results of this path analysis can provide important insights to identify key variables that influence the success of sustainability in the two regions(Huovila et al., 2019).

By conducting a comparative analysis, we can identify the advantages and disadvantages of sustainability practices and strategies implemented in Makassar compared to other cities or regions.(Surya, Menne, et al., 2021). By comparing different experiences and approaches, we can identify best practices that have worked or problems that need to be fixed in sustainability efforts in Makassar. Through comparative analysis, we can learn from the experiences of other cities or regions with similar sustainability efforts.(Baldassarre et al., 2019). Each city or region may face unique challenges and conditions, but there are similarities in the sustainability issues they face. By studying strategies and practices that have been implemented elsewhere, we can gain valuable insights to apply in Makassar.

Comparative analysis allows us to identify trends and innovations in sustainability practices(Rashidi & Cullinane, 2019). By comparing Makassar with other similar cities or regions, we can see if there are any general trends or innovative approaches that can be adopted in Makassar to increase sustainability. This analysis helps in gaining a broader understanding of global trends and best practices in urban sustainability. Through comparative analysis, we can validate the sustainability strategies that have been implemented in Makassar and see how effective they are compared to practices elsewhere. If there are significant differences in the sustainability results, this analysis can assist in identifying the factors that may have influenced them and formulating steps to improve the sustainability strategy in Makassar(Menne et al., 2022).

Comparative analysis can assist in knowledge sharing and collaboration between Makassar and other similar cities or regions. By sharing information, experiences and best practices, these cities can support each other in their sustainability efforts(Tang et al., 2021).

Results and Discussion

The independent variables in this study cover the key dimensions: Sustainable Development Index, Environmental Impact Assessment, Waste Audit, and Water Quality

Monitoring. This research highlights the complexities of sustainable urban development in Makassar. The independent variable analysis aims to explore the impact of these factors on environmental sustainability in the urban area of Makassar. The main objective of this research is to explore potential strategies, challenges that may arise, and future directions to promote sustainable urban development in Makassar. Thus, this study not only identifies the effect of independent variables on environmental sustainability.

Table 1. Descriptive statistics for all indicators

Descriptive Statistics

	N	Minimum	Maximum	Means	std. Deviation
Sustainable Development Index	391	5	25	20.86	2,438
Environmental Impact Assessment	391	5	25	20.71	2,477
Waste audits	391	5	25	20.42	2,780
Water Quality Monitoring	391	5	25	19.90	3,606
Community Survey	391	5	25	19.73	3,709
Green Space Assessment	391	5	25	20.48	3,551
Valid N (listwise)	391				

Table 1 shows that the community survey level perceived by respondents is much higher than the sustainable development index, environmental impact assessment, waste audit, water quality monitoring, and green space assessment. This finding indicates that the majority of respondents tend to have a more optimistic or positive view of environmental conditions and developments in the area studied. Nonetheless, it should be noted that the differences between people's perceptions and these indicators can form the basis for a more in-depth analysis to understand the factors that influence people's perceptions of environmental sustainability and how this can contribute to sustainable development.

Table 2. Correlation

correlations

		1	2	3	4	5	6
Green Space Assessment	Pearson Correlation	1					
	Sig. (2-tailed)			.000	.000	.000	.000
Sustainable Development Index	Pearson Correlation	.433**	1				
	Sig. (2-tailed)	.000		.000	.000	.000	.000
Environmental Impact Assessment	Pearson Correlation	.340**	.537**	1			
	Sig. (2-tailed)	.000	.000		.000	.000	.000
Waste audits	Pearson Correlation	.484**	.566**	.514**	1		. *
	Sig. (2-tailed)	.000	.000	.000		.000	.000
Water Quality Monitoring	Pearson Correlation	.728**	.391**	.250**	.431**	1	
	Sig. (2-tailed)	.000	.000	.000	.000		.000
Community Survey	Pearson Correlation	.586**	.488**	.344**	.615**	.551**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3. Reliability statistics

Reliability Statistics

Cronbach's Alpha	N of Items
.845	6

Table 3 shows the measurement of the extent to which a variablesustainable development index, environmental impact assessment, waste audit, community survey, water quality monitoring, and green space assessment,reliable and provide consistent, stable results over time, or from one situation to another.

Table 4. T test for the dependent variable of the community survey

Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	std. Error	Betas		
1	(Constant)	-1,828	1,348		-1,356	076
	Sustainable Development Index	.219	.073	.144	3,002	003
	Environmental Impact Assessment	-.034	068	-.023	-.509	.611
	Waste audits	.541	.064	.406	8,436	.000
	Water Quality Monitoring	.335	042	.325	7,918	.000

a. Dependent Variable: Community Survey

Table 4 Showingt-test results that compare the characteristics of the sustainable development index, environmental impact assessment, waste audit, water quality monitoring against community surveys. Which is where the environmental impact assessment is not significant to the community survey.

Table 5 T test for the dependent variable green space assessment

Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	std. Error	Betas		
1	(Constant)	.312	1,179		.264	092
	Sustainable Development Index	.105	.064	072	1,647	.100
	Environmental Impact Assessment	.108	059	075	1825	.069
	Waste audits	.174	056	.136	3.105	002
	Water Quality Monitoring	.612	.037	.622	16,567	.000

a. Dependent Variable: Green Space Assessment

Table 5 Showingthe results of the t-test comparing the characteristics of the sustainable development index, environmental impact assessment, waste audit, monitoring of water quality to the green space assessment. Where the sustainable development index is not significant to the green space assessment.

Table 6. F test for the dependent variable of the community survey

ANOVAa						
Model		Sum of Squares	df	MeanSquare	F	Sig.
1	Regression	2634,933	4	658,733	93,113	.000b
	residual	2730786	386	7,075		
	Total	5365719	390			

a. Dependent Variable: Community Survey
b. Predictors: (Constant), Water Quality Monitoring, Environmental Impact Assessment, Sustainable Development Index, Waste audit

In order to provide a deeper understanding of the differences between general expectations and actual findings regarding changes in community surveys, we have undertaken a more detailed investigation. Our main focus is how to test the proposed hypothesis. To do this, we make use of a statistical analysis known as one-way ANOVA. This approach allows us to compare responses from relevant respondents to questions that have been asked in the survey regarding changes in society.

Table 6 The results of the ANOVA analysis show significant differences in the survey responses to the questions.This finding illustrates that changes in community surveys are more complex than initially expected. We can identify that certain factors have influenced people's responses to the questions analyzed. In other words, there are variables that substantially influence how society responds to these questions.

Table 7. F test for the green space assessment dependent variable

ANOVAa						
Model		Sum of Squares	df	MeanSquare	F	Sig.
1	Regression	2828,812	4	707,203	130,693	.000b
	residual	2088707	386	5,411		
	Total	4917519	390			

a. Dependent Variable: Green Space Assessment
b. Predictors: (Constant), Water Quality Monitoring, Environmental Impact Assessment, Sustainable Development Index, Waste audit

In an effort to provide deeper insight into the discrepancy between general expectations and actual findings regarding changes in green space assessments, we have undertaken a more detailed investigation. Our main focus is to understand how to test the hypotheses that have been proposed. In order to do this, we make use of a statistical analysis known as one-way ANOVA. This approach provides an opportunity for us to compare responses from relevant respondents to the questions posed in the survey, regarding changes that have occurred in perceptions of green space.

Table 7 shows the results of the ANOVA analysis which shows that there is a significant difference in responses related to the assessment of green space to the questions that have been asked. These results indicate that the variation in responses to the questions is not the result of random variation, but has strong statistical significance. These findings illustrate that people's assessment of green spaces is more complex than might be anticipated. There are factors that contribute to variations in community responses to the questions analyzed. In this case, significant differences in the results of the ANOVA analysis indicate that certain factors have influenced the community's assessment of the condition and changes in green space

In the urban area of Makassar, challenges in preserving the environment are faced by applying a holistic approach. This study aims to analyze the impact of air, water and soil pollution levels that occur in these urban areas, by utilizing the latest data and information.

A best practice-based approach emerges as a potential solution capable of addressing these challenges. Sustainable practices, such as efficient waste management, utilization of renewable energy sources, sustainable spatial planning, and development of environmentally friendly transport, have great potential to enhance environmental sustainability and address current challenges.(Hepburn et al., 2021). Best practice-based approaches are emerging as a strategy that has the potential to address challenges in urban contexts. Sustainable practices such as efficient waste management, utilization of renewable energy, sustainable spatial planning, and development of environmentally friendly transportation, can be effective steps in increasing environmental sustainability and addressing existing challenges.

Analysis of response data from community surveys in Makassar City regarding environmental sustainability reveals a variety of views and attitudes. The depiction of diverse perceptions regarding environmental sustainability in urban environments is significant in this analysis.(Olabi et al., 2022). The findings from this survey reflect various responses from respondents, ranging from optimism to skepticism about environmental sustainability efforts. The importance of adapting these sustainable practices in the local context of Makassar is an inevitable aspect. The unique characteristics of the cities must be taken into account in implementing these practices. The involvement of relevant stakeholders, such as government, private sector, civil society, and educational institutions, is crucial in formulating and implementing best practice strategies. Strong collaboration between various parties can accelerate the implementation of sustainable solutions and produce more meaningful impacts. This approach not only promises increased environmental sustainability, but also to bring urban development towards a direction that is more sustainable and resilient to challenges. Through the application of this holistic approach, this research will dig deeper into the challenges of environmental preservation in the urban area of Makassar.

Best practice-based approaches emerge as potential solutions in responding to challenges in urban contexts. Sustainable practices such as efficient waste management, utilization of renewable energy sources, sustainable spatial planning, and development of environmentally friendly transportation, have the impetus to improve environmental sustainability and address the challenges that arise.(Säumel et al., 2019). Environmental preservation in urban areas of Makassar is presented as a complex challenge, which requires a holistic approach. This research is to examine the level and impact of air, water and soil pollution in Makassar urban areas using the latest data and information. Respondents' responses to the Green Space Assessment in Makassar City regarding environmental sustainability showed a variety of views. The data analysis illustrates a variety of responses that reflect diverse perceptions regarding the role of green spaces in maintaining urban environmental sustainability. The findings from these responses show a variety of views from positive to skeptical attitudes towards the importance of green space in urban contexts. Participatory approach by involving the community in the management, maintenance, and utilization of green space is also an important strategy. Efforts to educate and raise public awareness about the benefits of urban ecosystems and the importance of green spaces can be carried out through outreach programs and campaigns. Community empowerment in maintaining and using green spaces in a sustainable manner will contribute to increasing environmental sustainability and overcoming urban challenges. By combining these best practice-based strategies, Makassar City can optimally utilize the potential of green spaces as a central element in promoting environmental sustainability in urban environments. Community empowerment in maintaining and using green spaces in a sustainable manner will contribute to increasing environmental sustainability and overcoming urban challenges. By combining these best practice-based strategies, Makassar City can optimally utilize the potential of green spaces as a central element in promoting environmental sustainability in urban environments. Community empowerment in

maintaining and using green spaces in a sustainable manner will contribute to increasing environmental sustainability and overcoming urban challenges. By combining these best practice-based strategies, Makassar City can optimally utilize the potential of green spaces as a central element in promoting environmental sustainability in urban environments.

Through the integration of waste management evaluation results and solutions to the challenges of natural resource consumption, this study seeks to provide comprehensive guidance in supporting environmental preservation and sustainable urban development in Makassar. This study aims to evaluate the effectiveness of waste management in urban areas of Makassar by identifying weaknesses and challenges in the ongoing waste management system. Concrete recommendations will be developed to improve and enhance the system's performance, focusing on sustainable solutions. Furthermore, this research will identify and overcome the challenges that arise due to excessive consumption of natural resources, as part of efforts to protect the environment in the urban context. This evaluation will highlight imperfections in existing waste management, identify weak points, and address challenges that hinder system efficiency. Recommendations will focus on infrastructure improvements, tighter regulations, and operational steps to improve waste management performance that is more sustainable and has a positive impact on the environment(Cui et al., 2020). This study also examines the impact of excessive consumption of natural resources on Makassar's urban environment. These challenges include environmental degradation, ecosystem damage, and climate change. In this context, strategic recommendations will be developed to reduce consumption of natural resources, promote efficiency in the use of resources, and promote sustainable practices in urban communities.

In an effort to improve environmental sustainability, best practice-based strategies will be implemented. This strategy includes measures such as raising awareness through educational programs, developing sustainable urban planning, implementing green technology, and encouraging collaboration across sectors.(Baldassarre et al., 2020). The challenges of environmental sustainability in Makassar City involve aspects of rapid population growth, uncontrolled urbanization, low public awareness and participation in sustainable practices, and development policies that have not been fully integrated with the principles of sustainability. Therefore, a best practice-based strategy needs to include several steps covering various aspects. This study evaluates the effectiveness of waste management in the current urban area of Makassar. The aim is to identify weaknesses and challenges in the existing waste management system and provide concrete recommendations to improve and enhance the system's performance. Furthermore,

Collaboration across sectors including government, private sector, civil society, and educational institutions is important(El-Jardali et al., 2018). The challenges of environmental sustainability in Makassar City include rapid population growth, uncontrolled urbanization, minimal public awareness of sustainable practices, and a lack of integration of development policies with sustainability principles. The best practice strategy for dealing with this challenge in urban areas involves the following steps: first, raising awareness through education; second, expansion and strengthening of sustainable urban planning; third, applying green technology and sustainable practices in waste, energy and water management. The development of green infrastructure such as urban parks and green open areas also contributes. The integration of these approaches can help Makassar City overcome challenges and improve environmental sustainability.

In facing this comprehensive challenge, it becomes imperative to adopt a cross-sectoral collaborative approach. The active involvement of various stakeholders such as the government, private sector, civil society, and educational institutions is considered to be the main foundation in efforts to achieve significant results in urban areas.(Ardito et al., 2019). Rapid population growth and uncontrolled urbanization, as key elements in the

challenge of sustainability in Makassar, require concerted action. This is where the importance of concrete steps such as: raising awareness through education and educative campaigns, which encourage the application of sustainable practices in people's daily activities; integrate sustainability principles into urban planning, through expanding and strengthening sustainable urban planning, focusing on environmentally friendly infrastructure, as well as introducing green technology and sustainable practices in waste, energy and water management, in order to reduce negative environmental impacts .

Strategic solutions to address this challenge involve a best practice based approach. Increasing public awareness through education and outreach emphasizes the importance of sustainable practices and environmental preservation. Expanded integration of sustainable urban planning into development policies, so that environmental aspects become the core of urban growth. Third, the application of green technology and sustainable practices in waste, energy and water management is important to reduce the negative impact on the urban environment(De Jong et al., 2021). The results of the study identified the main challenges faced by Makassar City in achieving environmental sustainability, including rapid population growth and uncontrolled urbanization. This phenomenon creates extensive pressure on natural resources and the environment. Low public awareness of sustainable practices and lack of integration of development policies with sustainability principles are also important factors in this challenge. Green infrastructure development, such as city parks and other green open areas, also has the potential to make a major contribution to environmental sustainability in urban environments. The integration of strategic solutions based on best practices is expected to help Makassar City overcome existing challenges and achieve better environmental sustainability.

The effectiveness of green infrastructure as the main pillar of sustainable development needs to be firmly implemented with aspects of urban planning and policies that are holistic in nature(Ismagilova et al., 2019). The synergy that is formed must unite urban planning, environmental protection, and socio-economic aspects, so that the benefits created from green infrastructure can be optimized. Green infrastructure, including city parks and green open spaces, is a central point in the direction of sustainable and environmentally sound development. In an environment of intensive urbanization and rapid population growth, urban planning strategies must adopt the key role of green assets in strengthening environmental quality. More than just aesthetic and recreational value, green infrastructure has an important impact in maintaining air quality and reducing carbon dioxide in dense urban environments. The importance of increasing vegetation in urban structures is proven to reduce the detrimental effects of air pollution. City vegetation, especially trees, participating in capturing pollutant particles and toxic gases, as well as supporting the process of photosynthesis which converts carbon dioxide into oxygen. This positive result strengthens the city's resilience to adaptation challenges in the context of climate change. This comprehensive approach is expected to be able to help Makassar City achieve superior performance in the sustainability sector, while still maintaining and protecting natural resources that are increasingly threatened in the context of the complex dynamics of the global environment. At the moment.

Conclusions

This study aims to explore Makassar's urban environmental sustainability and formulate a sustainable strategy. Quantitative research methods are used to analyze the current situation, identify challenges, and propose data-driven strategies. This research highlights the importance of environmental sustainability in shaping the future of cities, encouraging collaborative research and endeavors. Key findings include water resource efficiency, renewable energy, waste management, dense urban design, sustainable building, climate change adaptation, and social inclusiveness. This research provides a comprehensive

understanding of urban environmental sustainability, the importance of sustainable urban development, and informs sustainable policies, planning and practices around the world. Identification of limitations includes fast growth, limited resources, political-economic-social barriers, and lack of public awareness. This research encourages further research, collaboration, and overcoming barriers. Recommendations include a data-driven approach, technological innovation, socio-economic impact of sustainable initiatives, public participation, and policy analysis. These recommendations support sustainable urban development and effective urban environmental management.

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