

## Technical and Sociocultural Aspects in Urban Forest Management in Dolok Sanggul District

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### Abstract

Urban forest management is crucial for urban development, significantly contributing to environmental, economic, and social well-being. Dolok Sanggul District, in Humbang Hasundutan Regency, offers a unique context for examining technical and sociocultural aspects of urban forest management. This research aims to analyze these aspects' influence on urban forest management in Dolok Sanggul District using a quantitative research method and multiple regression analysis. The study's results indicate that both technical and sociocultural aspects significantly impact urban forest management. Technical aspects, such as law and regulation regarding forestry, account for 51.0% of the influence. Sociocultural aspects, including community opinions on community awareness and participation, education and the social environment, as well as community interaction, contribute 55.2%. Combined, these aspects exert a synergistic effect, with a total influence of 63.4% on urban forest management. These findings underscore the importance of integrating technical and sociocultural considerations to develop effective urban forest management strategies. By leveraging the strengths of both aspects, policymakers and urban planners can create sustainable and resilient urban forests that benefit the community and environment. Additionally, this research highlights the need for a holistic approach that values community input and technical expertise, ensuring balanced and sustainable urban development. This study provides a foundation for future research and practical applications, emphasizing the critical role of comprehensive planning and community engagement in urban forest management.

Keywords: technical aspect, sociocultural aspect, urban forest, management, Dolok Sanggul

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### Introduction

Forests, are vital for sustaining ecological balance and supporting diverse forms of life. Despite their crucial role, these natural habitats are increasingly being replaced by industrial and urban infrastructure. The air starts to feel stuffy because of pollution (Manisalidis et al., 2020). Forests as an ecosystem not only store natural resources in the form of wood, but there is still much non-timber potential that the community can benefit from through cultivating agricultural plants on forest land (Indrajaya et al., 2022). As a function of the forest ecosystem, it plays a vital role in various things, such as providing water sources, producing oxygen, a place where millions of flora and fauna live, and balancing the environment, as well as preventing global warming (Nunes et al., 2020).

Urban forests must interact directly with their environment (land and water). The plants in it form an association that interacts directly with each other to achieve balance. Urban forests are green open spaces that function as a place to grow various types of woody vegetation in urban areas and can benefit the environment and city residents in terms of protection, aesthetics, and recreation (Kowarik et al.,

2019). Urban forests are one of the practical solutions to prevent environmental damage (Zhao et al., 2024). However, this concept will only be realized if it is accompanied by commitment and constructive efforts from various parties. These include strict sanctions from the government as the control centre and the community as monitors of the condition of the urban forest area itself (Jiménez et al., 2020).

The future fate of urban forests depends on humans at this time; the less green open land in urban areas, the less likely it is that adverse environmental effects will affect humans themselves. Any effort will only be successful if accompanied by severe commitment (Kumar et al., 2021). Appropriate government control and action, as well as community involvement in dealing with environmental damage, is greatly desired by nature itself for the sake of human life. All components of society need to be reminded that forests are comfortable homes that will never run out of resources for human life if preserved (Mariyam et al., 2023). With the increase in various development activities in the city centre and the area of green open space decreasing and often accompanied by a decline in the quality of the environment, this article presents essential things related to

the role of urban forests in improving the quality of the environment (Nawar et al., 2022).

The definition and scope of the urban forest are a vegetation community in the form of trees and their associations that grow on city land or its surroundings in the form of stripes, spread out or clustered (stacked), the structure of which imitates (resembles) natural forests, forms a habitat that allows life for wild animals, and creates an environment that is healthy, comfortable, relaxed, and has an aesthetic atmosphere (Susilowati, 2021). The urban forest functions as protection from direct sunlight, heavy rain, wind, and wrong views, providing beauty so that it can be used as a recreation area and a natural laboratory for education and research. In general, the aim of organizing urban forests is to preserve and rehabilitate critical land, eliminate pollutants, and create harmony and balance in urban ecosystems, which include environmental, social, and cultural elements (Alikhani et al., 2021).

Humbang Hasundutan, whose capital is Dolok Sanggul, has developed rapidly since its establishment in 2003, driven by a comprehensive urban development program. This program, implemented by the Humbang Hasundutan Regency government, emphasizes planned and integrated growth that considers spatial planning and environmental factors to create efficient, healthy, beautiful, and comfortable urban areas (Sigalingging, 2019). However, rapid development has led to an increasingly strained relationship between humans and natural vegetation, resulting in economic advancement at the expense of ecological health (Tong et al., 2022).

The ecological stability of Dolok Sanggul is critical and should be balanced with economic progress. Disruption of the urban ecosystem has manifested in rising air temperatures, reduced groundwater levels, and frequent flooding (Wang et al., 2023). Other issues include land subsidence, water pollution with heavy metals, increased air pollutants like carbon monoxide and nitrogen oxides, and a generally arid, noisy, and polluted atmosphere (Kenessary et al., 2019). Urban forests can mitigate these problems by absorbing heat, reducing noise and dust, enhancing aesthetics, and providing habitats for various wildlife (Liang & Huang, 2023).

The technical aspects of urban forest management in Dolok Sanggul include selecting appropriate tree species, implementing effective planting techniques, maintaining trees, and managing pests and diseases. Identifying native species suited to local climatic conditions is crucial for enhancing forest resilience and biodiversity (Eriksen et al., 2021). Proper planting and maintenance practices, such as adequate spacing, mulching, and watering, are essential for tree growth and survival in urban environments (Czaja et al., 2020). Integrated pest management strategies, which involve biological control and cultural practices, are necessary to mitigate pest and disease impacts on urban forests (Bueno et al., 2023).

Sociocultural dimensions of urban forest management in Dolok Sanggul encompass the relationships between local communities and urban forests, cultural values associated with trees and forests, and community participation in decision-making processes. Forests hold significant cultural

and spiritual importance for indigenous communities in the region, serving as sacred sites and repositories of traditional knowledge. Engaging local communities in forest management, respecting indigenous rights, and incorporating traditional ecological knowledge into management practices are vital for promoting social equity and cultural diversity (Boedihartono, 2017).

Urban development in Humbang Hasundutan Regency tends to minimize green open space. Green open land is converted into residential areas, trade, transportation networks, and other urban infrastructure and facilities. The urban environment ultimately only develops economically but declines ecologically (Puplampu & Boafo, 2021). The above conditions disrupt the balance of the urban ecosystem, which is characterized by increasing air temperatures, air pollution, increasing levels of carbon monoxide, ozone, carbon dioxide, nitrogen and sulfur oxides, dust, noise, and dirt (Nnaji et al., 2023). The heavy metal content of the soil increases, and the groundwater level decreases. The aim of this research is to analyze the technical aspects and sociocultural aspects of urban forest management in Dolok Sanggul District.

## Methods

The location of the research is Dolok Sanggul District, Humbang Hasundutan Regency, Sumatera Utara Province, Republic of Indonesia. The approach used in this research is quantitative research. This research starts with data collection, interpretation of the data, and the analysis of the results. This quantitative approach aims to detect the extent to which variables in a factor are related to variations in one or another factor. In this research, the data used are primary data and secondary data. Primary data was obtained or collected from the community around the Dolok Sanggul District. Meanwhile, secondary data was collected from the Central Statistics Agency of Dolok Sanggul District. The dependent variable in this research is satisfaction with urban forest management in Dolok Sanggul District. The independent variables in this research are technical aspects and sociocultural aspects. This research uses simple regression to analyze 2 aspects (the technical aspect and the sociocultural aspect), and there is no external intervention. The duration of the research for data collection is January 2023 to June 2023.

**Object, subject, population, and sample** The research focuses on studying the urban forest in Dolok Sanggul District, Humbang Hasundutan Regency, Sumatera Utara Province, Indonesia. The subjects of the research are the people living in this district, which has a population of approximately 45,961 individuals, as determined by a preliminary survey. The number of samples taken from the population is assumed to have a probability of 100% because the population is above 100, so the sample can be taken to represent the population. If the population is homogeneous/same and above 1,000, then the research sample can be taken from 0.5% to 15% (Arikunto, 2005). The sample size for this research was 230 people, with 0.5%. Sample selection was determined by drawing lots. For the sample of visitors taken incidentally for one month, it was

calculated that the number of visitors was 1,850 people, with 0.5% was 9 people. The total sample size was 239 people.

**Data collection method** The data collected is documentation to obtain data in the form of information about a description of the research location and a questionnaire to obtain information from respondents. The documentation and questionnaires in this research cover sociocultural aspects and technical aspects. The sociocultural aspect includes community opinions on community awareness and participation, education, and the social environment, as well as community interaction. The technical aspect includes laws and regulations regarding forestry. Data collection techniques in research are modifications from previous research by Yusuf and Dermawan (2023): a) documentation; the documentation method is looking for data regarding things or variables in the form of transcript notes, books, newspapers, magazines, inscriptions, meeting minutes, agendas, and so on. In this research, the documentation method used to obtain data is in the form of information about a description of the research location; and b) a questionnaire; a questionnaire is a list of written questions used to obtain information from respondents. Questionnaires are the main thing for collecting data. The questionnaire results will be manifested in figures, tables, statistical analysis and descriptions and conclusions of research results. Data collection using a questionnaire was used to obtain primary data.

**Data analysis** The statistical package for the social sciences (SPSS) release 30 software was used to facilitate data analysis. The instrument used to measure public opinion was a checklist with a Likert scale; each alternative answer was given a score. Strongly agree = 5; Agree = 4, Quite agree = 3, Disagree = 2, and Strongly disagree = 1. The data analysis method uses descriptive statistical analysis. Descriptive statistics are statistics used to analyze data by describing or describing the data that has been collected as it is without the intention of making generally accepted conclusions or generalizations (Lempiälä et al., 2019). The need for data

analysis can be seen in Table 1.

According to Disman et al. (2017), the data collected in this research was analyzed using quantitative analysis methods to explain/describe phenomena related to the problem under study. According to Chicco et al. (2021), the coefficient of determination is used to determine how significant the independent variable's percentage contribution is to the dependent variable (van Ginkel, 2020). The *F*-test with level of significance,  $\alpha = 5\%$ , is used to determine the influence of variable *X* on variable *Y* simultaneously. The *t*-test is used to determine the significance of the influence of individual independent variables on the dependent variable by assuming the other independent variables are constant (Athiah, 2022).

## Results and Discussion

Dolok Sanggul District in Humbang Hasundutan Regency, Sumatera Utara Province, Republic of Indonesia. Dolok Sanggul District is the capital of Humbang Hasundutan Regency, with a land area of 2,502.71 km<sup>2</sup> and ten districts. This city is located in the highlands with a cool climate. Dolok Sanggul District is also an economic and trade centre in Humbang Hasundutan Regency.

Most ethnic groups in the Dolok Sanggul community are Batak, and almost all of the residents are Toba Batak ethnic who use the surname system as their family name. The majority of clans in Dolok Sanggul are Simamora, Purba, Lumban Gaol, Lumban Raja, Simanullang, Marbun, Nababan, Sianturi, Sihite, Sihotang, Sihombing, and Situmorang. Doloksanggul is a city developing very quickly compared to other districts that are being expanded similarly. Talking about their work, Doloksanggul residents mostly farm, and there are still strong Batak traditions that can still be seen in every corner of the residents' lives.

The majority of the religion adhered to by the people of Dolok Sanggul is Christianity (90.29%). Other religions were Catholics (5.54%), Moslems (3.61%), and others (0.59%). Economic growth relies solely on agriculture. The most developed agriculture is in Sijamapolang District, located on the border between Dolok Sanggul District and

Table 1 The need for data analysis

No	Variable	Indicator	Data Collection
1	Technical aspects (X <sub>1</sub> )	Law of the Republic of Indonesia Number 41/1999 concerning Forestry Government Regulation Number 63/2002 concerning City Forests Law of the Republic of Indonesia Number 26/2007 concerning Spatial Planning Minister of Home Affairs Regulation Number 1/2007 concerning Arrangement of Green Open Space in Urban Areas	Questionnaire
2	Sociocultural aspects (X <sub>2</sub> )	Community awareness and participation Education and social environment Community interaction	Questionnaire
3	Urban forest management (Y)	Criteria of urban forest development Concepts and principles of urban forest development The nature and characteristics of urban forest development	Questionnaire

Onan Ganjang Districts. The types of plants developed there are mostly horticulture, such as oranges, chillies, tomatoes, vegetables and others.

**Respondent characteristics** The most significant number of respondents was 31–40 years old, with 97 people amounting to 40.59%, followed by 41–50 years old, with 74 people amounting to 30.96%, those aged 50 years with 53 people amounting to 22.18% and those aged 20–30 years as many as 15 people amounting to 6.28%. The respondents' work type was 136 farmers, amounting to 56.90%; 25 self-employed

people, amounting to 10.46%; and 78 private civil servants, amounting to 32.64%. The education level of 104 elementary/middle school respondents was 43.51%; 89 people were in high school at 37.24%, 40 had a bachelor's degree at 16.74%, and six had a master's degree at 2.51%. The distribution age (A), work type (B), and education level (C) of respondents can be seen in the Figure 1.

The scatterplot in Figure 2A shows points scattered both above and below zero without a clear pattern, indicating no heteroscedasticity in the regression model. For the normality test, histograms and P-P plots (Figures 2B, Figure 2C) were

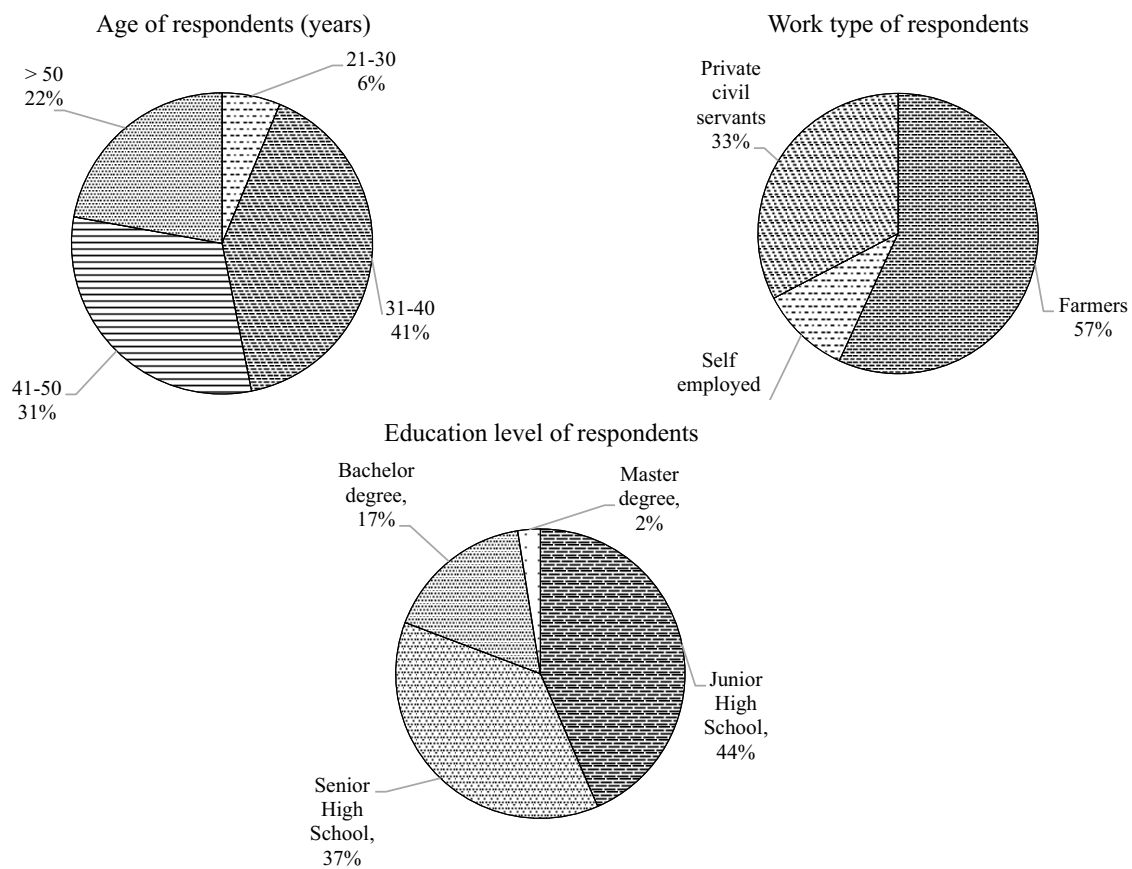


Figure 1 The distribution age, work type, and education level of respondents.

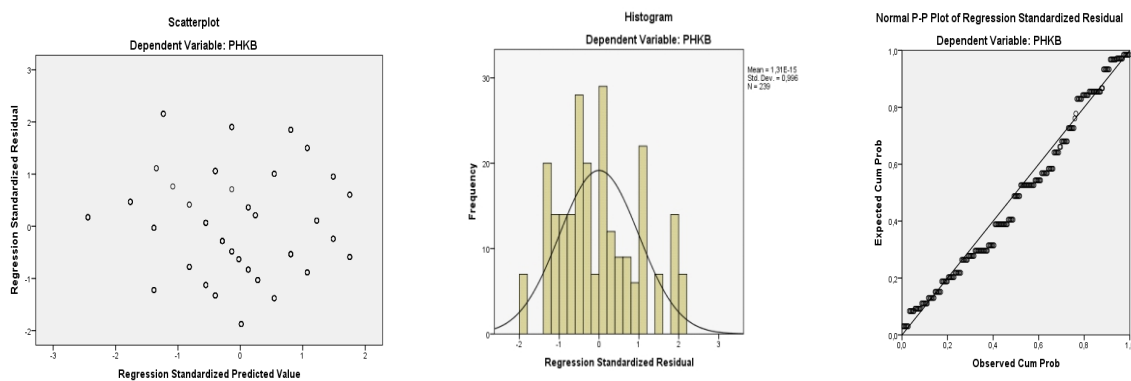


Figure 2 Heteroscedasticity graph (a) and normality graph (b and c).



used. The histogram shows even distribution on both sides, suggesting the data passes the normality test. Similarly, the P-P plot follows the diagonal line, indicating that the distribution aligns with normality assumptions for the regression model.

**Technical aspects impact on urban forest management**

Data analysis continued with the *t*-test. The *t*-count for the technical (law and regulation regarding forestry) aspect variable is 7.864 with *p*-value < 0.01, more significant than the *t*-table (1.651). The constant value is 4.207, and the variable coefficient value  $X_i = 0.533$ . So, the regression model for this research is  $Y = 4.207 + 0.533X_i$ . The coefficient of determination ( $R^2$ ) value obtained was 0.510 with *p*-value < 0.01, so it is known that technical aspects have a 51.0% influence on urban forest management. The results of statistical analysis of technical aspects for urban forest management can be seen in Table 2.

This result indicates that technical factors play a moderate level of influence with the  $R^2$  value between 0.25 to 0.75 (Abate et al., 2021; Nyengere et al., 2023). The result suggests that while technical aspects significantly contribute to urban forest management in Dolok Sanggul, other technical and non-technical factors also play crucial roles (Maruna et al., 2019). The moderate influence of technical aspects emphasizes the importance of integrating well-informed and effective technical solutions into urban forest management plans. Technical aspects involve the adoption of practices, the use of appropriate technology, and the implementation of best management practices for urban green spaces (Palomo et al., 2021).

Technical aspects in the context of forestry encompass a broader spectrum of considerations beyond just laws and regulations. While laws and regulations are indeed crucial components, technical aspects refer to the practical and operational dimensions involved in managing forests sustainably (Gallego-Valadés et al., 2020). These aspects encompass a range of factors related to scientific knowledge, management practices, and technological tools utilized in forestry and natural resource management (Tampekis et al., 2024).

While technical aspects are significant, it is crucial to

recognize that urban forest management is a multidimensional challenge. A holistic approach that considers technical factors and sociocultural, economic, and environmental aspects is necessary for comprehensive and sustainable management (Moldavska & Welo, 2019). The result underscores the importance of interdisciplinary collaboration between environmental scientists, urban planners, ecologists, and other stakeholders. Working together can help create holistic strategies that balance technical expertise with a broader understanding of the complex urban ecosystem (Mrak et al., 2022).

**Sociocultural aspects impact on urban forest management**

The *t*-count for the sociocultural aspect (community opinions on community awareness and participation, education and the social environment, as well as community interaction) variable is 6.283 with *p*-value < 0.01, more significant than the *t*-table (1.651). The constant value is 3.370, and the variable coefficient value  $X_i = 0.712$ . So, the regression model for this research is  $Y = 3.370 + 0.712X_i$ . The  $R^2$  value obtained was 0.552 with *p*-value < 0.01, so it is known that technical aspects have a 55.2% influence on urban forest management. The results of statistical analysis of sociocultural aspects for urban forest management can be seen in Table 3.

The result indicates that sociocultural factors play a moderate level of influence with the  $R^2$  value between 0.25 to 0.75 (Abate et al., 2021; Nyengere et al., 2023). This result also suggests that sociocultural aspects have a significant, albeit moderate, influence on urban forest management in Dolok Sanggul. Sociocultural factors emphasize the importance of understanding and integrating cultural and social dimensions into forest management practices (Gunawan et al., 2022).

Further exploration is needed to identify and understand the sociocultural factors contributing to this influence. Sociocultural factors could encompass local beliefs, traditional practices related to forests, community engagement, and the role of cultural values in shaping perceptions and behaviours towards urban green spaces (du Toit et al., 2018). The result highlights the need for active community engagement in urban forest management.

Table 2 The statistical analysis of technical aspects for urban forest management

Model	Unstandardized coefficients		Standardized coefficients	<i>t</i>	Sig.
	B	Std. error	Beta		
Constant	4.207	0.535	-	7.864	0.000
Technical aspects	0.533	0.034	0.714	15.713	0.000

Table 3 The statistical analysis of sociocultural aspects for urban forest management

Model	Unstandardized coefficients		Standardized coefficients	<i>t</i>	Sig.
	B	Std. Error	Beta		
Constant	3.370	0.541	-	6.283	0.000
Sociocultural aspects	0.712	0.042	0.743	17.096	0.000

Understanding and incorporating local perspectives and traditional knowledge can lead to more culturally sensitive and community-supported initiatives, fostering a sense of ownership and stewardship (Souther et al., 2023).

Sociocultural aspects may include practices and traditions related to using and conserving natural resources. Examining how these practices align or conflict with modern urban forest management goals can provide insights into potential areas for collaboration or necessary adjustments (Erbaugh, 2019). Enhancing public awareness and education regarding the importance of urban forests is crucial. The result suggests that sociocultural factors are influential, and therefore, efforts to promote sustainable practices should include educational programs that resonate with the local community's values and traditions (Julsrud, 2023).

Urban forest management strategies should incorporate inclusive decision-making processes that involve local communities (Barona et al., 2023). Sociocultural factors ensure that diverse sociocultural perspectives are considered and respected, leading to more effective and sustainable management practices (Méndez-Picazo et al., 2021). Building partnerships with local institutions, such as community leaders, religious organizations, and cultural groups, can facilitate the integration of sociocultural aspects into urban forest management plans. This collaborative approach can help align initiatives with the values and aspirations of the community (Pasaribu et al., 2020). The findings have implications for policy development, suggesting that policies related to urban forest management should address technical considerations and incorporate provisions that acknowledge and respect sociocultural diversity. Policies should encourage practices that align with the community's cultural identity and values (Shayan et al., 2022).

**Combination technical aspects and sociocultural aspects impact on urban forest management** The final analysis of data was carried out using *F*-test. The obtained *F*-count value (206.870) with *p*-value < 0.01 more significant than *F*-table value (3.04). The constant value is 2.040, with the variable coefficient value for  $X_1$  (technical aspects) is 0.292 and the variable coefficient value for  $X_2$  (sociocultural aspects) is 0.460. So, the regression model for this research is  $Y = 2.040 + 0.292X_1 + 0.460X_2$ . The coefficient of determination (Adjusted  $R^2$ ) value obtained is 0.634 with *p*-value < 0.01, so the influence of technical aspects and sociocultural aspects on urban forest management was 63.4%. The results of statistical analysis of combination technical aspects and sociocultural aspects for urban forest management can be seen in Table 4.

The combined influence of technical and sociocultural aspects highlights the importance of adopting an integrated approach to urban forest management. Recognizing that both dimensions significantly contribute to sustainability underscores the need for strategies addressing urban ecosystems' complexity (Fiel'ardh et al., 2023). Urban forest management requires a delicate balance between ecological considerations (technical aspects) and the needs and values of the community (sociocultural aspects). Striking this balance is essential for ensuring that urban green spaces are ecologically resilient and socially and culturally relevant (Kaplan et al., 2023).

The result emphasizes the necessity for interdisciplinary collaboration among professionals from various fields, including environmental science, urban planning, sociology, and cultural studies. Collaboration provides a comprehensive understanding of the diverse factors influencing urban forest dynamics (Heymans et al., 2019). Recognizing the joint influence of technical and sociocultural aspects underscores the importance of tailoring strategies to the region's specific context, such as Dolok Sanggul District in Humbang Hasundutan Regency. The combination of technical and sociocultural aspects involves adapting technical solutions and engaging with local communities in ways that respect their cultural values and practices (Semeraro et al., 2021).

Urban forest management practices should adopt community-centric approaches that involve residents in decision-making processes. Engaging with the community ensures that both technical and sociocultural aspects are considered, fostering a sense of ownership and commitment to the management of urban green spaces (Khair et al., 2020). Promoting awareness and understanding of the interconnectedness between technical and sociocultural aspects is crucial. Educational initiatives can empower communities to appreciate the value of urban forests and participate in their preservation and sustainable management (Mensah, 2019).

The result has implications for policy development, suggesting that policies related to urban forest management should be comprehensive and consider both technical and sociocultural dimensions (Klobucar et al., 2020). Policies should encourage practices that align with environmental sustainability while respecting the community's cultural diversity (Roman et al., 2020). Given the dynamic nature of urban environments, continuous monitoring and adaptation of strategies are essential (Mauree et al., 2019). Regular assessments help ensure that management practices remain effective and responsive to changing technical and sociocultural dynamics.

Table 4 The statistical analysis of combination technical aspects and sociocultural aspects for urban forest management

Model	Unstandardized coefficients		Standardized coefficients	<i>t</i>	Sig.
	B	Std. Error	Beta		
Constant	2.040	0.520	-	3.923	0.000
Technical aspects	0.292	0.039	0.392	7.413	0.000
Sociocultural aspects	0.460	0.051	0.480	9.067	0.000

## Conclusion

Technical aspects play a moderate role, constituting 51.0% of the influence on urban forest management. Technical aspects suggest that considerations such as land-use planning, technological interventions, and other technical strategies are significant contributors but may not be the sole determinants of sustainable practices in the region. Sociocultural aspects exert a moderately substantial influence, accounting for 55.2% of the impact on urban forest management. Sociocultural aspects emphasize the importance of understanding and incorporating local beliefs, traditions, and community engagement in shaping effective and culturally sensitive management strategies. The combined influence of technical and sociocultural aspects is higher, reaching 63.4%. This result underscores the synergy between technical and sociocultural dimensions, highlighting that a comprehensive approach, considering both ecological and human elements, is essential for achieving sustainable urban forest management in Dolok Sanggul. The findings suggest that considering both technical and sociocultural aspects, a balanced and integrated approach is crucial for fostering sustainable urban forest management in Dolok Sanggul District. The moderate influence of technical factors, the slightly more substantial influence of sociocultural factors, and the significantly higher impact when both are considered collectively emphasize the need for holistic strategies that bridge ecological and cultural considerations. Effective policies and practices should be context-specific, acknowledging the region's unique sociocultural and environmental characteristics. This conclusion highlights the importance of interdisciplinary collaboration, community involvement, and ongoing adaptation to ensure the resilience and sustainability of urban green spaces in the specified area.

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