

## The role of stakeholders and AI-based city forest management strategies in increasing public awareness of city forest ecosystem services and its implications for the success of the ecotourism program

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### ABSTRACT

Urban forest management has a strategic role in maintaining ecosystem balance and supporting the quality of life of urban communities. Urban forests provide various ecosystem services, such as providing clean air, temperature regulation, carbon storage, and being a habitat for biodiversity. In the midst of increasing urbanization and climate change, the existence of urban forests is increasingly important to support environmental sustainability. However, public awareness of the importance of urban forests and the ecosystem benefits they provide is often inadequate. This is a challenge in efforts to conserve and develop urban forests as an integral part of the urban environment. Palangkaraya City, Central Kalimantan, the Himba Kabui ecotourism program has been launched as an initiative to increase public awareness of urban forests and the ecosystem benefits, they provide. This research aims to analyze the role of stakeholders and artificial intelligence (AI)-based urban forest management strategies in improving public awareness of urban forest ecosystem services and their impact on the success of the Himba Kabui ecotourism program in Palangkaraya City, Central Kalimantan. Stakeholders involved include government, local communities, the private sector, and academia, each of which has an important role in the implementation and development of this program. The use of AI in urban forest management offers various innovations in monitoring, decision making, and conveying information to the public. This study found that the integration of AI technology was able to accelerate increasing public awareness of the importance of urban forests as providers of ecosystem services, such as providing clean air, climate regulation and biodiversity habitat. Additionally, this increased awareness contributes significantly to the success of the Himba Kabui ecotourism program, which aims to promote sustainable tourism and environmental conservation in the region. This research provides the implication that synergy between stakeholders and AI technology can become an effective and sustainable urban forest management model, which not only has a positive impact on the environment but also on the local economy through increasing tourism. It is hoped that these findings can become a reference for urban forest managers and policy makers in developing innovative and participatory environmental management strategies.

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## 1. Introduction

Urban forests have an important role in maintaining the balance of urban ecosystems and providing various benefits for local communities (Kundra et al., 2021). However, with population growth and rapid urban development, urban forests are faced with various challenges that threaten environmental sustainability and balance. One of the main problems faced by urban forests is

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environmental degradation due to unsustainable development and human activities (Hynes *et al.*, 2021). Urban forest resources are declining in many parts of the world, and the benefits produced are only a fraction of their potential. In many cases, the costs incurred are much higher than they should be (Turner-Skoff and Cavender, 2019). This understanding is still at the stage of the extent of the benefits and costs associated with trees and urban forests, as well as the many relationships between urban forest resources and the quality of urban life. Benefits to consider include goods and services produced by urban forests that are valuable to society (Nyirenda *et al.*, 2024). These benefits vary over time according to changes in the urban environment, its population, and the needs of the population. Some benefits can be easily measured in monetary or numerical terms, while other benefits are difficult to measure using these methods; but overall, these benefits are very significant for urban residents (Habibulloev *et al.*, 2024). Studies on the preferences and behavior of urban residents confirm a major contribution that trees and forests make to the quality of life in urban areas (Traoré, 2019). Trees and forests are important components of the landscape in most urban areas. The potential fuel cost savings from an urban environment enhanced by well-managed urban forests can be up to fivefold per year (Dwyer & Forsyth, 1993). Furthermore, substantially reduced fuel consumption will reduce air pollution and other related problems (Karantoni *et al.*, 2023). The definition and regulations for urban forest management in Indonesia have standard rules, namely Government Regulation (PP) Number 63 of 2002 concerning Urban Forests in Indonesia. Article 1 paragraph (1) PP No. 63 of 2002, City Forests are forests located in or around urban areas which have the main function of regulating water management, controlling floods, balancing urban ecosystems, and recreation areas. The area of urban forest in one compact expanse is at least 0.25 hectares. The percentage of urban forest area is at least 10% of the urban area and/or adjusted to local conditions. Benefits of urban forests according to PP Number 63 of 2002 concerning Urban Forests Article 27 paragraph 1: Urban forests can be used for natural tourism, recreation and/or sports, research and development, education, preserving germplasm, as well as cultivating non-timber forest products. However, based on research by Hutabarat (2022), the average field implementation of this PP is still below 10%.

Several obstacles were identified, such as policy incompatibility and different perceptions regarding the urban forest concept among designers, policy makers and the public. PP No. 63 of 2002 concerning City Forests and its derivative regulations, namely Minister of Forestry Regulation (Permenhut) No. 71 of 2009, still face challenges in encouraging urban forest development. One of the main issues is the difference in understanding of the concept of urban forest, both in terms of the concept as a whole and technical aspects such as the type of urban forest and the structure of plants or trees that must be present in it. This difference in views can cause the implementation of policies related to urban forests to be less than optimal. Things that need to be considered in efforts to improve PP No. 63 of 2002 and its derivatives include a clearer and more consistent understanding of the concept of urban forest, requirements for the size and compactness of urban forest areas so that conservation goals and functions can be achieved, providing appropriate incentives and sanctions to encourage active community participation in urban forest management, forest designation cities through Regional Regulations (Perda) taking into account the needs and characteristics of the local area, as well as increasing community participation in the development and management process of urban forests (Teampanpong *et al.*, 2024). In 2015, Indonesia launched a social forestry program which aims to provide communities with legal access to state forests, enabling communities to manage these resources sustainably for their own livelihoods and for forest protection. This program is an integrated forest management system implemented mainly by groups of forest farmers and indigenous communities with the aim of reducing poverty, improving community welfare, and protecting forests from degradation and land conversion (Dewi, 2018). Apart from that, Indonesia is also experiencing a paradigm shift towards sustainable forest management (Jotaworn & Nitivattananon, 2023). Himba Kahui City Forest in Palangka Raya is a secondary peat swamp forest area which is always flooded due to the ebb and flow of the Kahayan and Rungan Rivers during the rainy season with high rainfall (Palangka Raya Forestry Service, 2011). Based on a study conducted by Ludang *et al.*, (2016), the Himba Kahui urban forest in Palangka Raya has tree vegetation of 19 variants from 13 families, with the dominance of the perupuk tree variant (*Lophopetalum multinervium*). Biomass and carbon stock from tree vegetation are respectively 39.58 tonnes/ha and 18.60 tonnes C/ha, while CO<sub>2</sub> absorption reached 68.28 tons of CO<sub>2</sub>/Ha. In addition, the production potential of O<sub>2</sub> of tree vegetation in Himba Kahui City Forest is 49.84 tons O<sub>2</sub>/Ha. The oxygen produced by tree vegetation in this area is able to meet the oxygen needs of the people of Palangka Raya in 2016. Another study from Suryandari and Alviya (2015), shows that the location of the Himba Kahui urban forest is included in the Kahayan watershed and the Rungan-Manuhing sub-watershed, which are collectively administratively located in Petuk Katimpun Village, Bukit Tunggal, Palangka (Jekan Raya District), and Tumbang Rungan (Pahandut District). This area has the characteristics of natural peat swamp forest with vegetation such as jelutung swamp, pulai, punak, ramin, meranti, sand-sand, banana-pisang, nyatoh, guava-guava, Bintangur, terentang, as well as types of rattan and pitcher plants (Mthimkhulu & Nel, 2024).

The Himba Kahui urban forest in Palangka Raya offers substantial ecological and social potential, supporting the government's vision of making it an urban icon. With its high biodiversity, the area exhibits an important ecological role through significant carbon storage and CO<sub>2</sub> sequestration capabilities (Zamzuki *et al.*, 2023). Apart from that, the resulting oxygen production is able to meet the needs of the local population. The social benefits offered include improved air quality and potential as an attractive ecotourism destination. However, there is still a lack of understanding regarding the views and support of various stakeholders. Therefore, research on stakeholder analysis is very necessary to ensure effective and sustainable management of the Himba Kahui

urban forest, by involving active participation from all relevant parties. Furthermore, the Palangka Raya City Government declared the Himba Kahui city forest as a city forest that could become an icon of Palangka Raya, and this city forest will even be used as an ecotourism object. However, as far as the information the author has, the Himba Kahui urban forest development program is still trending *Top-Down*, and has not used a participation approach from all stakeholders, so it has the potential to cause conflict in the future. Therefore, this research seeks to reveal the responses of stakeholders involved and affected (Arumugam et al., 2021). Based on the phenomenon that has been discussed above, there is also a research gap from previous research that will be explained in Table 1 below:

**Table 1**

**Research Gap**

Author	Result	Gap
(Zhang & Deng, 2024)	Significant	There are differences in results regarding the role of stakeholders in the success of ecotourism programs
(Tien et al., 2024)	Significant	
(Giraldo et al., 2024)	Not significant	

Source: (Zhang & Deng, 2024), (Tien et al., 2024) and (Giraldo et al., 2024)

Based on the phenomena and research gaps that have been explained, the problem formulation in this research is 1) is there a significant influence of the role of stakeholders on the success of ecotourism programs, 2) is there a significant influence of AI-based urban forest management strategies on the success of ecotourism programs, 3) is there a significant influence of AI-based urban forest management strategies on the success of ecotourism programs, 3) Is there a significant influence of the role of stakeholders on public awareness of urban forest ecosystem services, 4) is there a significant influence of AI-based urban forest management strategies on public awareness of urban forest ecosystem services, 5) is there a significant influence of public awareness of services urban forest ecosystem 6) is there a significant influence of the role of stakeholders on the success of ecotourism programs through public awareness of urban forest ecosystem services, 7) is there a significant influence of AI-based urban forest management strategies on the success of ecotourism programs through public awareness of ecosystem services urban forest.

## 2. Theory

### 2.1 The role of stakeholders in the success of ecotourism programs

The role of stakeholders in the success of an ecotourism program is very important because they are key actors who have influence and interest in the development, implementation and sustainability of the program (Choudhary et al., 2024). Theoretically, stakeholders include government, local communities, the private sector, as well as non-governmental organizations and academics. Each of these groups has a specific role that, if managed well, can strengthen the success of an ecotourism program. The government, for example, plays a role in providing regulations, policies and infrastructure that support ecotourism. Clear policies that support nature conservation and empowerment of local communities will be a strong foundation for the success of ecotourism programs (Samal & Dash, 2023). Local communities are stakeholders who have a direct relationship with the natural environment which is an ecotourism object (Akter et al., 2024). Their role is very important because the success of ecotourism programs depends heavily on their involvement and support. Theoretically, a participatory approach that involves local communities in planning and implementing ecotourism programs can increase their sense of ownership and responsibility for environmental sustainability. This is also in line with sustainable development theory, which emphasizes the importance of inclusiveness and empowerment of local communities in every conservation and ecotourism development initiative (Lokonon et al., 2023). The private sector and non-governmental organizations (NGOs) also play an important role in supporting the success of ecotourism programs (Arumugam et al., 2020). The private sector can contribute through investment in environmentally friendly tourism infrastructure and promotion of ecotourism destinations. They can also help in creating jobs for local communities, thereby providing economic benefits that are directly felt by the community. Meanwhile, NGOs and academics can provide the knowledge, research and training programs needed to support sustainable ecotourism management. Theoretically, close collaboration between all these stakeholders can create positive synergies, where each party contributes based on their expertise and resources, thereby supporting the long-term success of ecotourism programs (Forje & Tchamba, 2022). Based on this explanation, it can be concluded that there is a significant influence on the role of stakeholders on the success of ecotourism programs (Fanta et al., 2024).

**H<sub>1</sub>:** *There is a significant influence on the role of stakeholders on the success of the ecotourism program.*

### 2.2 AI-based urban forest management strategies for the success of ecotourism programs

Artificial intelligence (AI)-based urban forest management strategies play an important role in supporting the success of ecotourism programs, especially in terms of increasing efficiency, accuracy and community participation (Ullah & Kim, 2020). Theoretically, AI can be used to carry out more sophisticated environmental monitoring, such as monitoring air quality, biodiversity levels, and microclimate changes in urban forests. Data collected through sensors and AI algorithms can be analyzed in real-time,

allowing managers to make faster and more precise decisions regarding ecosystem management. The success of ecotourism programs depends on healthy and sustainable environmental conditions, so AI's ability to monitor and maintain environmental quality is an important contribution (Mancini et al., 2022). Additionally, AI can be used to develop interactive platforms that increase public awareness and involvement in ecotourism (Ihemezie et al., 2022). For example, AI-based mobile applications can provide visitors with real-time information about tourist routes, the types of flora and fauna that can be found, as well as conservation tips. By providing easy and informative access, AI can help improve tourism experiences that are more educational and immersive for visitors. Theoretically, this technology also supports a more sustainable tourism model, where visitors not only enjoy nature but also learn about the importance of conservation, which in turn increases their support for ecotourism programs (Hasana et al., 2022). AI-based management strategies also enable better integration between various stakeholders in ecotourism programs (Giraldo et al., 2024). Through AI-based management systems, relevant data and information can be shared transparently between governments, local communities, the private sector and academia. This approach is in line with evidence-based management theory, where management decisions are based on accurate and relevant data. In this way, all stakeholders can work more effectively and collaboratively, ensuring that ecotourism programs are not only successful in the short term but also sustainable in the long term. This creates a synergy between technology and management that supports the overall success of the ecotourism program being run (Kundra et al., 2021).

**H<sub>2</sub>:** *There is a significant influence of AI-based urban forest management strategies on the success of ecotourism programs*

### *2.3 The role of stakeholders in public awareness of urban forest ecosystem services*

The role of stakeholders in increasing public awareness of urban forest ecosystem services is very important because they have broad influence in shaping public opinion, directing policies, and facilitating educational programs and awareness campaigns (Tien et al., 2024). Theoretically, the government as one of the main stakeholders has a role in formulating and implementing policies that support the preservation of urban forests and promote the importance of the ecosystem services provided by these forests. Through regulations, public education programs, and mass media campaigns, the government can increase public knowledge about the benefits of urban forest ecosystems, such as providing clean air, climate regulation, and habitat for biodiversity. Supportive policies can also create incentives for communities to be actively involved in urban forest conservation (Adom, 2019). Local communities also have a significant role in increasing public awareness of urban forest ecosystem services (Zhang & Deng, 2024). Theoretically, direct participation of local communities in urban forest management can strengthen their sense of ownership and responsibility for the surrounding environment. When local communities engage in activities such as tree planting, forest maintenance, and environmental education programs, they become effective agents of change in spreading awareness to other community members. Social learning theory supports the idea that individuals tend to learn from those around them through observation and active participation. Thus, the involvement of local communities can accelerate the spread of ecological awareness at the wider community level (Kovács et al., 2021). The private sector and non-governmental organizations (NGOs) also play an important role in supporting public awareness of urban forest ecosystem services (Mancini et al., 2022). Theoretically, the private sector can contribute through corporate social responsibility (CSR) initiatives that focus on environmental preservation and public education. For example, companies can fund programs that educate the public about the importance of urban forests or run campaigns that encourage environmentally friendly behavior. NGOs, on the other hand, often have the capacity to organize broader and deeper awareness campaigns, with a focus on advocacy and education. Through collaboration between the private sector, NGOs and local communities, the resulting programs can create a greater and more sustainable impact in increasing public awareness of the importance of urban forest ecosystem services (Teampanpong et al., 2024).

**H<sub>3</sub>:** *There is a significant influence of the role of stakeholders on public awareness of urban forest ecosystem services*

### *2.4 AI-based urban forest management strategy for public awareness of urban forest ecosystem services*

Artificial intelligence (AI)-based urban forest management strategies can significantly increase public awareness of urban forest ecosystem services through the use of technology that enables wider and more effective education and participation (Lokonon et al., 2023). Theoretically, AI can be used to develop applications and digital platforms that provide real-time and interactive information to the public about the benefits of urban forest ecosystems. For example, AI-based applications can provide data related to air quality, species diversity and climate impacts provided by urban forests, which can be easily accessed by the public. By presenting data that is visual and easy to understand, this technology facilitates faster and more effective learning, thereby increasing public awareness regarding the importance of protecting urban forests (Karantoni et al., 2023). Additionally, AI can be used to create simulations and predictive models that show the potential impact of damage to urban forest ecosystems on urban life (Forje & Tchamba, 2022). Theoretically, the use of this simulation can influence public awareness by showing negative scenarios that might occur if urban forests are not managed properly, such as increased air pollution, reduced biodiversity, and increased urban temperatures. Behavioral theory suggests that when individuals are faced with the real consequences of an action, they are more likely to adopt behavior that supports environmental conservation. Therefore, AI-based management strategies involving

such simulations can strengthen people's awareness and encourage them to care more about urban forest ecosystem services (Habibulloev et al., 2024). AI-based urban forest management strategies also enable increased community participation in conservation activities through gamification and online community programs. Theoretically, AI could develop interactive games that invite people to participate in urban forest preservation activities, such as virtual tree planting or competitions to reduce carbon footprints (Samal & Dash, 2023). This gamification can increase community engagement in a fun and educational way, thereby creating a more personalized experience and motivating individuals to become further involved in conservation efforts. Additionally, AI-based online community platforms can connect individuals with environmental groups, facilitating discussions, sharing information, and organizing real-world activities. Through this increased involvement, public awareness of the importance of urban forest ecosystem services can continue to be increased and pushed towards real action in environmental conservation efforts (Nyirenda et al., 2024).

**H4:** *There is a significant influence of AI-based urban forest management strategies on public awareness of urban forest ecosystem services.*

### 2.5 Public awareness of urban forest ecosystem services

Public awareness of urban forest ecosystem services is an important aspect in efforts to preserve the urban environment, because a deep understanding of the benefits of urban forests can influence people's attitudes and behavior towards the environment (Kovács et al., 2021). Theoretically, environmental awareness can be explained through behavioral theory which states that a person's knowledge and understanding of environmental issues will influence their attitudes, which ultimately determine their behavior towards the environment. In the context of urban forests, this awareness includes an understanding of the various ecosystem services provided by urban forests, such as carbon sequestration, providing habitat for flora and fauna, micro-temperature regulation, and providing recreational spaces that support people's mental and physical health. When communities are aware of these benefits, they are more likely to support and engage in urban forest conservation efforts (Arumugam et al., 2021). Furthermore, public awareness of urban forest ecosystem services is also influenced by education and access to information (Adom, 2019). According to social learning theory, individuals learn and develop environmental awareness through social interaction, observation, and education. Environmental education programs specifically designed to increase public awareness about the importance of urban forests, whether through schools, public campaigns, or the media, can be an effective tool in building this awareness. In addition, easy access to information, such as through digital media and online platforms, allows people to better understand and appreciate the important role of urban forests in maintaining the balance of urban ecosystems. When people have sufficient knowledge, they are more likely to engage in pro-environmental actions, such as supporting conservation policies and participating in urban forest preservation activities (Zamzuki et al., 2023). Finally, public awareness of urban forest ecosystem services is also influenced by direct participation in environmental conservation activities (Hasana et al., 2022). Community participation theory suggests that when individuals are directly involved in conservation efforts, such as tree planting, forest maintenance, or environmental education programs, they not only increase their knowledge and awareness, but also develop an emotional bond with the environment being conserved. This participation encourages a sense of responsibility and ownership, which in turn strengthens community commitment to support long-term urban forest conservation efforts. Thus, public awareness of urban forest ecosystem services is not only the result of education and information, but also from direct experience and active involvement in environmental conservation (Mthimkhulu & Nel, 2024).

**H5:** *There is a significant influence on public awareness of urban forest ecosystem services.*

**H6:** *There is a significant influence on the role of stakeholders on the success of ecotourism programs through public awareness of urban forest ecosystem services.*

**H7:** *There is a significant influence of AI-based urban forest management strategies on the success of ecotourism programs through public awareness of urban forest ecosystem services.*

## 3. Methodology

This research was carried out on the demographic group in Palangkaraya, namely 229,000. with a sample size of 200 people from various demographic groups. Table 1 presents the results of the Cronbach's Alpha on four key factors.

**Table 1**  
Cronbach's alpha

	Cronbach's Alpha
Ai-Based City Forest Management Strategies	0.942
The Success of The Ecotourism Program	0.940
Public Awareness of City Forest Ecosystem Services	0.950
The Role of Stakeholders	0.933

Source: SEM PLS 2024

**Table 2**  
Instrument

	AI-Based City Forest Management Strategies	The Success of The Ecotourism Program	Public Awareness of Ciy Forest Ecosystem Services	The Role of Stakeholders
KMT1			0.765	
KMT10			0.848	
KMT11			0.831	
KMT12			0.817	
KMT2			0.778	
KMT3			0.766	
KMT4			0.829	
KMT5			0.864	
KMT6			0.828	
KMT7			0.746	
KMT8			0.765	
KMT9			0.798	
KPE1		0.883		
KPE10		0.743		
KPE2		0.903		
KPE3		0.880		
KPE4		0.736		
KPE5		0.906		
KPE6		0.896		
KPE9		0.763		
PP10				0.836
PP2				0.856
PP3				0.850
PP4				0.766
PP5				0.786
PP6				0.763
PP7				0.847
PP8				0.779
PP9				0.783
SPH1	0.797			
SPH10	0.842			
SPH3	0.833			
SPH4	0.902			
SPH5	0.891			
SPH8	0.909			
SPH9	0.849			

Source: SEM PLS 2024

Based on the results of Cronbach's alpha analysis, it shows that the loading factor value is above  $>0.70$ , so it can be concluded that each instrument has a high validity value.

**Table 3**  
Reliability

Factor	Composite Reliability	Factor	Composite Reliability
Ai-Based City Forest Management Strategies	0.953	Public Awareness of City Forest	0.956
The Success of The Ecotourism Program	0.951	The Role of Stakeholders	0.944

Source: SEM PLS 2024

Based on the results of the reliability test, the results show  $>0.70$ , so the research instrument is declared to have high reliability and can be used as a measuring tool in this research.

#### 4. Result

Figs. 1-2 present the results of the outer and inner model for the proposed study of this paper and Table 4 summarizes them.

**Table 4**  
Test Result of *Path Coefficient*

	T Statistics ( O/STDEV )	P Values
Ai-Based City Forest Management Strategies → The Success of The Ecotourism Program	8.263	0.000
Ai-Based City Forest Management Strategies → Public Awareness of City Forest Ecosystem Services	3.629	0.000
Public Awareness of City Forest Ecosystem Services → The Success of The Ecotourism Program	5.414	0.000
The Role of Stakeholders → The Success of The Ecotourism Program	2.511	0.012
The Role of Stakeholders → Public Awareness of City Forest Ecosystem Services	10.553	0.000

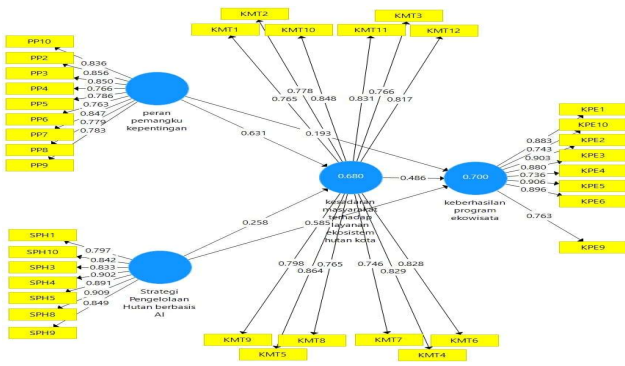


Fig. 1. Result of outer model

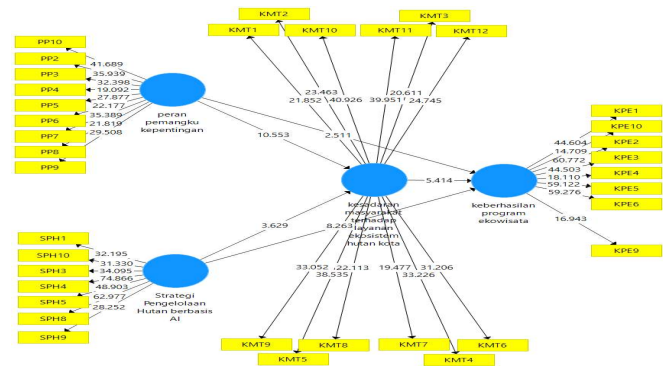


Fig. 2. Result of inner model

Source: SEM PLS 2024

Based on the results of the path coefficient test, it shows that from the five hypotheses analyzed, it was found that the five direct influence hypotheses had significant results and all hypotheses were accepted because they had t-statistic values >1.96 and <0.05.

Tabel 5

Test result of path coefficient

	T Statistics (O/STDEV)	P Values
Ai-Based City Forest Management Strategies → Public Awareness of City Forest Ecosystem Services → The Success of The Ecotourism Program	2.832	0.005
The Role of Stakeholders → Public Awareness of City Forest Ecosystem Services → The Success of The Ecotourism Program	4.842	0.000

Sources: SEM PLS 2024

Based on the results of the path coefficient analysis of indirect influence, it was stated that two indirect influence hypotheses had a significant effect and both hypotheses were accepted because they had a t-statistic value > 1.96 and a p-value < 0.05.

## 5. Discussion

### 5.1 The effect of the role of stakeholders on the success of ecotourism programs

There is a significant influence of the role of stakeholders on the success of ecotourism programs because they have the capacity to direct, support and ensure the sustainability of ecotourism initiatives through various interventions and policies. Stakeholders, which include governments, local communities, the private sector, and non-governmental organizations (NGOs), have varying interests and responsibilities in ensuring that ecotourism programs run well and achieve their desired goals (Kundra et al., 2021). The government, for example, can establish regulations that support environmental conservation and provide the necessary infrastructure to support ecotourism. In addition, the government also has a role in directing policies that benefit ecotourism, such as tax incentives for environmentally friendly businesses and support for conservation initiatives. With clear regulations and government support, ecotourism programs have a strong foundation for development (Jotaworn & Nitivattananon, 2023).

Local communities also play an important role in the success of ecotourism programs because they are the owners and guardians of natural resources which are the main attraction of ecotourism. In theory, the active participation of local communities in planning and implementing ecotourism programs can increase their sense of ownership and responsibility for their environment (Nyirenda et al., 2024). When local communities are directly involved, they not only support program sustainability but also ensure that the economic benefits of ecotourism can be felt by local communities. The success of ecotourism programs often depends on the acceptance and support of local communities, as they are at the forefront of managing and maintaining the environment and interacting directly with tourists. This participation creates a mutually beneficial relationship between local communities and the ecotourism industry, supporting the long-term sustainability of the program (Fanta et al., 2024).

The private sector, including companies and business actors operating around ecotourism locations, also plays a significant role in supporting the success of the program. They can provide the resources, capital and expertise necessary to develop high-quality facilities and services for tourists (Habibullov et al., 2024). Additionally, the private sector often engages in corporate social responsibility (CSR) initiatives that support environmental conservation and the well-being of local communities. Through collaboration with government and local communities, the private sector can help create an ecotourism model that is sustainable and profitable for all parties. Thus, the role of the private sector is not only limited to economic profits, but also includes contributions

to environmental conservation and community development, all of which support the success of ecotourism programs (Arumugam et al., 2020).

Non-governmental organizations (NGOs) also have a significant influence in ensuring the success of ecotourism programs. NGOs often act as liaisons between various stakeholders and have the capacity to conduct advocacy, education, and provide technical support (Karantoni et al., 2023). They can organize public awareness campaigns, provide training for local communities, and support research related to environmental conservation. In addition, NGOs are often involved in monitoring and evaluating ecotourism programs to ensure that environmental and social goals are achieved. With their expertise and dedication, NGOs can play a key role in promoting sustainable ecotourism practices and ensuring that all stakeholders contribute effectively to the success of the program (Akter et al., 2024).

Collaboration between all stakeholders is an important factor influencing the success of an ecotourism program. Collaboration theory states that the success of complex programs, such as ecotourism, depends on the synergy between the various actors involved (Teampanpong et al., 2024). Each stakeholder brings different perspectives, resources, and interests, but when they work together within a coherent framework, the results achieved tend to be more sustainable and effective. This collaboration allows for a clear division of roles, increased efficiency, and reduced conflict, all of which support the achievement of ecotourism goals. Thus, the coordinated and synergistic role of stakeholders is a determining factor in the success of ecotourism programs, ensuring that the benefits can be felt by the wider community and the environment is preserved (Choudhary et al., 2024).

### *5.2 The effect of AI-based urban forest management strategies on the success of ecotourism programs*

There is a significant influence of artificial intelligence (AI)-based urban forest management strategies on the success of ecotourism programs because AI is able to increase efficiency and effectiveness in managing natural resources and provide a more interesting and educational experience for tourists (Jotaworn & Nitivattananon, 2023). AI enables more sophisticated urban forest management through real-time monitoring, data analysis, and prediction of environmental trends. For example, by using sensors and drones equipped with AI, urban forest managers can continuously monitor ecosystem conditions, identify threats such as fire or deforestation, and take quick and appropriate preventive action. This approach not only improves urban forest conservation, but also ensures the preservation of natural resources which are the main attraction in ecotourism programs, thus supporting the success of the program (Ihemezie et al., 2022).

In addition, AI can be used to improve the quality of tourist experiences through the development of applications that provide relevant and interactive information about urban forests (Mthimkhulu & Nel, 2024). AI technology makes it possible to create virtual or augmented reality tours that allow tourists to explore the urban jungle in more depth, even before they arrive at the location. Information about plant and animal species, forest history, and their ecological benefits can be presented in an interesting and educational form. This not only increases tourist satisfaction but also strengthens their awareness of the importance of preserving urban forests. Thus, AI-based management strategies contribute directly to the success of ecotourism programs by enriching tourists' experiences and educating them about the importance of the ecosystems they visit (Ullah & Kim, 2020). Furthermore, AI also enables more effective management of resources through operational optimization which can reduce costs and increase efficiency (Zamzuki et al., 2023). For example, AI can be used to manage human resource allocation, plan the most efficient tourist routes, and predict the number of visitors at certain times to prevent overcapacity which can damage urban forest ecosystems. With more structured and data-based management, ecotourism programs can run more smoothly and produce a greater economic impact. This reduction in operational costs and increased efficiency allows for better allocation of funds for conservation and development of tourist facilities, which in turn supports the long-term success of ecotourism programs (Zhang & Deng, 2024). Apart from operational aspects, AI also enables greater personalization of tourism experiences, which can increase the attractiveness of ecotourism (Arumugam et al., 2021). By leveraging visitor data, AI can provide specific recommendations tailored to individual preferences, such as travel routes, desired activities, or specific information about flora and fauna of interest. This personalization makes the tourism experience more satisfying and unique, thereby increasing the attractiveness of the ecotourism destination in the eyes of visitors. The success of an ecotourism program depends not only on preserving the environment but also on how the destination can attract and retain tourist interest. AI enables better management of visitor experiences, which has a direct impact on increasing the number of visits and revenues from the tourism sector (Tien et al., 2024).

AI-based urban forest management strategies also enable greater community involvement in environmental conservation through technology-mediated participation (Choudhary et al., 2024). AI can be used to develop online platforms that allow people to track and contribute to conservation activities, such as donations for tree planting or participation in conservation campaigns. This active community participation is critical to the success of ecotourism programs, as long-term success often depends on the support and involvement of local communities. With AI, this engagement can be more structured, organized and impactful, thus ensuring that ecotourism programs are not only economically successful, but also environmentally and socially sustainable (Giraldo et al., 2024).



### *5.3 The effect of stakeholders on public awareness of urban forest ecosystem services*

There is a significant influence from the role of stakeholders on public awareness of urban forest ecosystem services because stakeholders have the capacity to educate, mobilize and influence public opinion (Akter et al., 2024). Stakeholders such as the government, non-governmental organizations (NGOs), academics, and local communities can act as agents of change who support increasing public understanding of the importance of preserving urban forests and the ecosystem benefits, they provide. Through public awareness campaigns, education programs, and advocacy, stakeholders can disseminate accurate and relevant information about how urban forests contribute to environmental quality and human well-being. This is very important to shape people's attitudes and behavior that care more about the environment (Samal & Dash, 2023). The government, as one of the main stakeholders, has a key role in developing policies and programs that increase public awareness of urban forest ecosystem services. By integrating environmental issues into educational curricula and launching public campaigns highlighting the benefits of urban forests, governments can create a strong foundation of knowledge among the public (Arumugam et al., 2020). Additionally, through regulations and incentives, governments can encourage companies and communities to participate in urban forest conservation initiatives. This policy support is very important to strengthen educational efforts carried out by other stakeholders and ensure that messages about the importance of urban forest ecosystem services are well received by the community (Lokonon et al., 2023). Non-governmental organizations (NGOs) also play an important role in raising public awareness about urban forest ecosystem services. NGOs are often pioneers in facilitating dialogue between society, government and the private sector on environmental issues (Fanta et al., 2024). They can organize workshops, seminars, and campaigns that focus on the importance of urban forest ecosystems and ways in which communities can contribute to their conservation. NGOs are also often involved in research and collecting data that can be used to support public awareness campaigns. With the resources and expertise, they have, NGOs are able to reach various levels of society and influence their perceptions and actions regarding urban forest preservation (Forje & Tchamba, 2022). In addition, academics and researchers have a role in strengthening public awareness by providing scientific evidence regarding the benefits of urban forest ecosystems (Ullah & Kim, 2020). Research conducted by academics can reveal the positive impact of urban forests on air quality, flood control and people's psychological well-being. These findings can be published through mass media, scientific journals and public forums to increase public understanding of the importance of protecting urban forests. When people are presented with data that is valid and easy to understand, they tend to be more aware and moved to support conservation efforts. Thus, the contribution of academics in providing knowledge based on evidence is very influential in building strong public awareness (Mancini et al., 2022).

Local communities also have an important role in influencing public awareness, as they are at the forefront of daily interactions with urban forests (Ihemezie et al., 2022). When local communities are actively involved in efforts to preserve and utilize urban forests, they can become role models for the wider community. Through initiatives such as reforestation programs, training on the benefits of ecosystems, and sustainable resource management, local communities can demonstrate the importance of urban forests in everyday life. This role is very crucial because local communities often have a large influence in shaping the behavior and attitudes of the surrounding community. Thus, when local communities are committed to urban forest preservation, they can significantly increase public awareness of the ecosystem services provided by urban forests (Hasana et al., 2022).

### *5.4 The effect of AI-based urban forest management strategies on public awareness of urban forest ecosystem services*

There is a significant influence of artificial intelligence (AI)-based urban forest management strategies on public awareness of urban forest ecosystem services because AI can provide more accurate and easily accessible information regarding the condition and benefits of urban forests (Giraldo et al., 2024). With AI technology, urban forest managers can use data from sensors, drones and satellite monitoring to monitor ecosystem health in real-time. This data can be processed into interesting and easy to understand visual information, such as interactive maps or graphs that show the current conditions of urban forests. With clear and detailed information, people become more aware and understand about the condition of urban forests and the various ecosystem services they provide, such as providing clean air, flood control, and habitat for biodiversity (Kundra et al., 2021). Additionally, AI can facilitate more effective communication between urban forest managers and communities through digital applications and platforms (Tien et al., 2024). AI technology enables the development of mobile applications or websites that provide relevant and personalized information about urban forests. For example, AI-based applications can provide notifications about ongoing conservation activities, explain the benefits of specific ecosystem services, or offer virtual tours that allow citizens to "visit" and understand various aspects of an urban forest without having to go to the location in person. With easy access and tailored information, communities can more easily engage and realize the important role urban forests play in their well-being (Adom, 2019). AI can also be used to involve communities in urban forest management through gamification and interactive participation (Zhang & Deng, 2024). AI technology enables the creation of platforms that integrate game elements in urban forest conservation activities. For example, citizens can participate in challenges or competitions involving activities such as environmental data collection or tree planting, with the results monitored and analyzed by AI. This kind of active engagement and interaction can raise people's awareness in a fun and motivating way. When people feel involved and have a direct contribution, they are more likely to understand and appreciate the benefits of urban forest ecosystems (Kovács et al., 2021).

AI technology also supports data-driven approaches in spreading awareness about urban forest ecosystem services. AI can analyze patterns and trends in environmental data to identify problems that may not be immediately apparent (Mancini et al., 2022). For example, AI can detect changes in air quality or land use patterns that could impact the health of urban forests. By informing communities about these findings and providing data-driven recommendations, AI helps improve communities' understanding of the impacts of their actions on urban forests. This increased awareness motivates communities to support conservation efforts and take more environmentally friendly actions (Teampanpong et al., 2024). AI enables more efficient and impactful management of educational resources and efforts. With AI's ability to process and analyze data on a large scale, urban forest managers can design more focused and effective education strategies (Lokonon et al., 2023). AI can identify segments of society that require additional information or have a special interest in certain aspects of urban forest ecosystem services. Based on this analysis, awareness campaigns and educational programs can be tailored to meet specific needs and interests, thereby increasing the impact and effectiveness of educational efforts. With a more targeted approach, AI helps ensure that public awareness of urban forest ecosystem services is significantly and sustainably increased (Karantoni et al., 2023).

### *5.5 The effect of public awareness on urban forest ecosystem services*

There is a significant influence of community awareness on urban forest ecosystem services because this awareness directly influences community actions and behavior in supporting the preservation and sustainable use of urban forests (Forje & Tchamba, 2022). When people understand the importance of the ecosystem services provided by urban forests, such as providing clean air, flood control, and habitat for flora and fauna, they are more likely to participate in efforts to preserve and manage urban forests. High awareness leads to actions such as reducing pollution, participation in reforestation programs, and support for environmental policies that support the preservation of urban forests. Thus, public awareness is a key factor in ensuring the long-term sustainability and health of urban forests (Habibulloev et al., 2024). Additionally, public awareness of urban forest ecosystem services increases support for conservation policies and programs implemented by governments and non-governmental organizations (Samal & Dash, 2023). People who are aware of the benefits of urban forest ecosystems are more likely to support policies that prioritize the protection and maintenance of urban forests. This support can take the form of participation in public forums, advocacy, and fundraising for conservation projects. When communities actively participate in decision-making processes and support conservation initiatives, this increases the effectiveness of policies and programs designed to protect and manage urban forests (Nyirenda et al., 2024). Public awareness also impacts consumer behavior and their preferences for environmentally friendly products and services (Kovács et al., 2021). For example, people who are aware of the importance of urban forests may choose to use products that do not harm the environment or support businesses that contribute to forest conservation. This awareness can influence consumption patterns and motivate companies to adopt more sustainable business practices. Thus, public awareness plays a role in creating market demand that supports the sustainability of urban forest ecosystems and encourages the private sector to invest in environmental conservation (Arumugam et al., 2021). In addition, public awareness can encourage local initiatives that support urban forest preservation. Communities that have a good understanding of the benefits of urban forests tend to organize activities such as reforestation programs, environmental cleaning and environmental education (Adom, 2019). This local initiative not only helps improve the quality of the environment around urban forests but also strengthens the community's sense of ownership and responsibility for preserving this ecosystem. Active community participation in these types of activities strengthens social ties and increases the effectiveness of conservation efforts undertaken (Zamzuki et al., 2023). Public awareness of urban forest ecosystem services also influences the community's ability to overcome the environmental challenges faced by urban forests (Hasana et al., 2022). When people are aware of the negative impacts of climate change, urbanization, or pollution on urban forests, they are better prepared to adapt and find solutions to overcome these problems. This awareness can motivate communities to engage in research, collaboration with scientists, and adoption of technology that supports the maintenance and rehabilitation of urban forests. With a deep understanding of challenges and solutions, communities can be more proactive in maintaining the health of urban forest ecosystems and contribute to long-term sustainability (Mthimkhulu & Nel, 2024).

### *5.6 The effect of the role of stakeholders on the success of ecotourism programs through public awareness of urban forest ecosystem services*

There is a significant influence from the role of stakeholders on the success of ecotourism programs through public awareness of urban forest ecosystem services because stakeholders can facilitate the dissemination of information and education needed to increase public understanding. Stakeholders such as governments, non-governmental organizations (NGOs), academia, and the private sector play an important role in designing and implementing education and communication campaigns that convey the benefits of urban forest ecosystems to the public (Kundra et al., 2021). By educating communities about how urban forests contribute to their well-being and quality of life, stakeholders increase awareness which in turn supports the success of ecotourism programs. When people understand the value of urban forest ecosystems, they are more likely to support and participate in sustainable ecotourism activities (Jotaworn & Nitivattananon, 2023). Furthermore, the role of stakeholders in developing and implementing urban forest conservation policies and initiatives greatly influences the success of ecotourism programs. By integrating ecotourism aspects in environmental policy, stakeholders can create a framework that supports the preservation and management

of urban forests while promoting ecotourism (Nyirenda et al., 2024). For example, the government could design regulations that protect urban forests from damage caused by tourism activities and provide incentives for ecotourism entrepreneurs to invest in environmentally friendly infrastructure. This policy ensures that ecotourism not only utilizes urban forest resources but also contributes to their conservation, thereby supporting the long-term success of ecotourism programs (Fanta et al., 2024). Stakeholders also play a role in building partnerships between various interested parties in ecotourism programs (Habibulloev et al., 2024). Partnerships between government, local communities, the private sector and environmental organizations can produce synergies that strengthen conservation and ecotourism promotion efforts. Through collaboration, stakeholders can develop tourism packages that highlight urban forest ecosystem services, optimize tourist experiences, and increase the attractiveness of ecotourism destinations. By leveraging the expertise and resources of various parties, this partnership can increase public awareness of the importance of urban forest ecosystems and strengthen support for sustainable ecotourism programs (Arumugam et al., 2020). In addition, the role of stakeholders in providing facilities and services that support ecotourism, such as visitor information centers, well-managed hiking trails, and environmental interpretation programs, can strengthen the relationship between communities and urban forest ecosystem services (Karantoni et al., 2023). These facilities and services not only enhance the tourist experience but also provide opportunities for the community to learn firsthand about the benefits of urban forests (Basrowi & Ghofur, 2019; Junedi et al., 2024; Sintani et al., 2024). By accessing information and participating in activities related to urban forests, communities can increase their awareness and understand the contribution of urban forests to ecotourism and environmental sustainability (Akteer et al., 2024).

Stakeholders play a key role in monitoring and evaluating the impact of ecotourism programs on community awareness and urban forest conservation. By collecting and analyzing data on how ecotourism programs influence people's understanding and the state of ecosystems, stakeholders can identify areas for improvement and adjust their strategies to increase effectiveness (Teampanpong et al., 2024). Proper evaluation allows stakeholders to make necessary adjustments, ensuring that ecotourism programs not only achieve their economic goals but also contribute to increasing public awareness of urban forest ecosystem services (Fauzi, Effendi, & Basrowi, 2024; Hamdan & Basrowi, 2024; Mulyani & Basrowi, 2024; Nuryanto, Basrowi, Quraysin, Pratiwi, et al., 2024). Thus, the role of stakeholders in monitoring and evaluation supports the sustainable success of ecotourism programs and urban forest conservation (Choudhary et al., 2024).

### *5.7 The effect of AI-based urban forest management strategies on the success of ecotourism programs through public awareness of urban forest ecosystem services*

There is a significant influence of artificial intelligence (AI)-based urban forest management strategies on the success of ecotourism programs through public awareness of urban forest ecosystem services because AI enables more efficient and effective management of urban forests (Jotaworn & Nitivattananon, 2023). AI technology can process large amounts of environmental data quickly and accurately, providing up-to-date information on the health of ecosystems and the services provided by urban forests (Fauzi, Effendi, & Basrowi, 2024; Fauzi, Effendi, Basrowi, et al., 2024; Hamdan & Basrowi, 2024; Mulyani & Basrowi, 2024). This information can be presented in a format that is easy for the public to understand, such as interactive maps or data visualizations that show how urban forests contribute to air quality, flood control, and biodiversity habitats (Junedi et al., 2024; Nuryanto, Basrowi, Quraysin, Pratiwi, et al., 2024; Sintani et al., 2024). With clearer and more detailed information, people become more aware of the value of urban forests, which increases their support for ecotourism programs (Ihemezie et al., 2022). Furthermore, AI can increase public awareness by providing an interactive and informative digital platform about urban forests and their ecosystem services. AI-based apps and websites can offer features such as virtual tours, game-based education, and real-time reporting of environmental conditions (Mthimkhulu & Nel, 2024). Through this platform, people can explore urban forests virtually, learn the benefits of ecosystems in depth, and participate in conservation activities online. This approach not only increases people's knowledge but also motivates them to visit urban forests and participate in ecotourism. In this way, AI plays an important role in building public awareness and interest in urban forests and related ecotourism programs (Ullah & Kim, 2020). AI also enables better monitoring and evaluation of the impact of ecotourism programs on urban forest ecosystems (Zamzuki et al., 2023). By using AI technology to collect and analyze data on the impacts of ecotourism, managers can identify changes in the condition of urban forests and assess the effectiveness of implemented conservation strategies. This information can be used to adjust ecotourism programs to be more sustainable and have a positive impact on the ecosystem (Nuryanto, Basrowi, Quraysin, & Pratiwi, 2024). When people see that ecotourism programs contribute to the preservation of urban forests and do not damage the environment, they are more likely to support and be involved in the program (Himmatul et al., 2024; Kharis et al., 2024; Saeri et al., 2024). Thus, AI helps ensure that ecotourism programs are successful in a way that is consistent with urban forest conservation goals (Zhang & Deng, 2024). In addition, AI-based management strategies can strengthen collaboration between various stakeholders in ecotourism programs (Arumugam et al., 2021). AI can facilitate coordination between governments, the private sector, non-governmental organizations, and local communities in designing and implementing ecotourism programs (Kharis et al., 2024; Saeri et al., 2024; Shofwa et al., 2024). For example, AI can help in the planning and management of tourist visits, optimizing tour routes, and managing resources more efficiently. By improving coordination and efficiency, AI contributes to the success of

sustainable ecotourism programs and ensures that the benefits of urban forest ecosystems can be enjoyed by society at large (Tien et al., 2024).

The use of AI in urban forest management enables the implementation of more effective marketing strategies for ecotourism programs (Choudhary et al., 2024). AI can analyze data about traveler preferences and behavior to develop marketing campaigns that target the right audience. Information obtained from AI can be used to inform the public about the benefits of visiting urban forests and the ecotourism programs offered (Himmatul et al., 2024; Himmatul & Junaedi, 2024; Lisaria et al., 2024). With more targeted and relevant promotions, people become more aware and interested in participating in ecotourism, which in turn increases the success of ecotourism programs. Thus, AI plays an important role in connecting public awareness with positive and sustainable ecotourism experiences (Giraldo et al., 2024).

## 6. Conclusion

Based on the results of the analysis of the seven hypotheses, it can be concluded that all hypotheses are accepted and have a significant effect, as shown by the t-statistic value  $> 1.96$  and p-value  $< 0.05$ . The active role of stakeholders and the implementation of AI-based urban forest management strategies have significantly increased public awareness of urban forest ecosystem services, which has had a positive impact on the success of the HIMBA Kabui ecotourism program in Palangkaraya City. Through effective education, the use of AI technology for monitoring and information, and conservation policies that involve the community, public awareness of the benefits of urban forests is strengthened, supporting active participation, and ensuring the sustainability and success of ecotourism programs.

## 7. Limitation

Limitations of this research include the lack of longitudinal data that can show changes in community awareness and the long-term success of ecotourism programs, as well as potential bias in data collection that may not include all community and stakeholder perspectives. In addition, the adoption of AI technology in urban forest management still faces technical and financial challenges that may limit implementation in various regions. These factors may influence the accuracy of the results and the generalizability of the findings, and require further studies to evaluate the long-term impact and effectiveness of the implemented strategies.

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