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Green innovation for sustainable urban ecosystems: Overcoming challenges and promoting eco-friendly practices

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ABSTRACT

Background: Urban expansion has led to severe environmental degradation, often outpacing sustainability efforts. Green innovation, which integrates eco-friendly technology and economic models, offers a solution. However, its success depends on human involvement, including policymakers, scientists, and engineers. This study examines the role of humans in implementing green innovation in Jabodetabek, a densely populated and economically active region in Indonesia. **Methods**: This research uses a literature review to analyze studies on green innovation. The method helps identify key challenges and opportunities in implementing green innovation in urban areas, particularly Jabodetabek. **Findings**: The findings reveal that while green innovation is essential for creating a sustainable urban ecosystem, its implementation in Jabodetabek faces three major obstacles: lack of public awareness, high implementation costs, and regulatory uncertainty. Limited understanding among the public slows adoption, while significant financial investment is required to develop and apply green technologies. Additionally, inconsistent policies create barriers to implementation. To address these challenges, collaboration between the government, private sector, academics, and communities is crucial. Three main factors can accelerate the adoption of green innovation: strengthening regulations to support sustainability, developing better funding mechanisms to encourage investment, and promoting lifestyle changes that encourage eco-friendly habits. **Conclusion**: Green innovation is vital for sustainable cities, and human efforts play a key role in its success. In Jabodetabek, systematic and collaborative action can overcome obstacles and enhance both environmental and social well-being. **Novelty/Originality of this article**: This study highlights the human role in green innovation, emphasizing collaboration, commitment, and creativity. Unlike other studies focused on technology or policy, this research explores how human efforts can drive sustainability in urban areas.

KEYWORDS: green innovation; urban ecosystem; human role; Jabodetabek.

1. Introduction

Creating a viable and sustainable urban ecosystem has become the main focus in sustainable development in this modern era. When viewed in numbers and percentages, the human population living in urban areas continues to increase throughout the world. The process of urbanization, whose graph continues to increase, is becoming an increasingly urgent challenge to create a balance between urban growth and environmental preservation. In this context, the role of humans becomes very important in realizing a sustainable urban ecosystem, with an innovative approach that utilizes the "green" concept (Mutaqin et al., 2021). However, sustainable development with the 'green' concept is often

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forgotten because the urbanization process only pays attention to maximizing economic aspects.

Sustainable urban ecosystem development is offered because this concept can accommodate green innovation without sacrificing economic aspects. In sustainable development theory, environmental, economic and social elements are three very important elements to pay attention to. Therefore, basically, a sustainable urban ecosystem is an urban system that is able to meet the needs of its population without sacrificing its natural capacity to maintain ecological balance and a healthy environment. In a sustainable urban ecosystem, there is harmonious integration between social, economic and environmental aspects. This includes efforts to manage natural resources wisely, reduce negative impacts on the environment, and promote a good quality of life for urban residents.

One of the main characteristics of a sustainable urban ecosystem is efforts to minimize air, water and land pollution, and limit excessive energy consumption. This can be achieved through the use of environmentally friendly technologies, such as renewable energy and efficient waste processing technologies. Apart from that, a sustainable urban ecosystem also includes open space management and urban planning based on sustainability principles, by prioritizing public transportation, preserving natural habitats and replanting green areas (Sufayati et al., 2023). These various efforts can be called green innovations that will directly support the creation of a sustainable urban ecosystem. In other words, the application of green innovation is not limited to just one element of the urban ecosystem, but must be applied broadly so that a sustainable urban ecosystem can be realized.

Social aspects are also a focus in a sustainable urban ecosystem, by ensuring fair access to basic services such as education, health and transportation for all levels of society. Efforts to build inclusive and empowered communities are also an integral part of the vision of a sustainable urban ecosystem. In this case, green innovation has a role in supporting openness and adequate access in cities. With a holistic approach that integrates these various aspects, sustainable urban ecosystems aim to create greener, healthier and environmentally friendly cities for all residents. The active role of humans in creating a sustainable urban ecosystem is the key to overcoming various environmental and social challenges facing modern cities. One of the main approaches to achieving this is through green innovation. Green innovation includes various strategies and technologies designed to minimize the negative impact of cities on the environment, while improving the quality of life of their residents (Hariati & Saputri, 2022). Through green innovation, humans can harness the potential of urban ecology to provide sustainable solutions. This includes the use of green land, development of open spaces, and planting trees in cities to improve air quality and reduce the effects of urban heat. In addition, green innovation also includes the use of environmentally friendly technologies in urban infrastructure, such as the use of renewable energy, efficient public transportation systems, and better waste management (Grahesti et al., 2022).

However, to successfully realize a sustainable urban ecosystem through green innovation, active involvement is needed from various parties, including government, the private sector, academics and civil society. This cross-sector collaboration is necessary to integrate green innovation into urban development policies, allocate adequate resources, and support the widespread adoption of green technologies and practices by society. Thus, this article will further explore the role of humans in realizing sustainable urban ecosystems through green innovation. Urban areas in the Jabodetabek area (Jakarta, Bogor, Depok, Tangerang, Bekasi) are the focus of research because they are very large urban areas, both in terms of growth and population size. This research uses a problem formulation in the form of the role of humans in the concept of green innovation in Jabodetabek and how to accelerate its implementation. With this problem formulation, this article synthesizes how the concept of green innovation in a sustainable urban ecosystem and the role of humans can accelerate and face obstacles in its implementation. By focusing on collaborative efforts and innovative strategies, ways can be identified to address today's urban challenges that ultimately create a healthy and sustainable environment for future generations.

2. Methods

This research uses a qualitative approach analysis. The descriptive analysis method will be strengthened by the literature review research design. This literature review research refers to studies originating from scientific articles related to the problem and objectives of the article which are then reviewed and analyzed to answer the questions in the problem formulation in this article, namely to identify and analyze the role of humans in realizing a sustainable ecosystem through green innovation in Jabodetabek area. In this method, data will be collected from secondary sources, namely various literature sources, then by utilizing the findings from these literature sources, information and novelty related to the topic in this article will be obtained. By reviewing various literature sources, you will understand the breadth and depth of this topic, including being able to identify existing research gaps (Watson & Xiao., 2019) .

There are three main steps used in this research method. The following is the sequence of steps in the literature review in this article: (1) Preparation of problem formulation. The first step used in this method is to determine the problem formulation based on the theme and topic of the role of humans in realizing urban ecosystems through green innovation. Determining the problem formulation is very important to limit the inclusion criteria in searching for literature sources that will be used. The formulation of this problem also serves as a guide in the analysis and synthesis of literature sources so that the focus of discussion remains on the role of humans and how to accelerate green innovation in creating a sustainable urban ecosystem. (2) Literary Source Search. The second step is the process of searching, sorting and assessing literature sources. This literature was obtained from digital sources via the Google Scholar and Lib UI platforms. Search keywords used in English and Indonesian. Key words in this research include human role, green innovation, sustainable city ecosystem, Jabodetabek green innovation, Jabodetabek green technology, Jakarta sustainable planning, Bogor sustainable planning, Depok sustainable planning, Tangerang sustainable planning, Bekasi sustainable planning, Jabodetabek green innovation barriers, accelerating the implementation of green innovation in Jabodetabek. The search process was divided into two parts for inclusion criteria. In the first part, the criteria used are the development and understanding of the role of humans in creating sustainable urban ecosystems in general and in the second part specifically for green innovation in Jabodetabek urban areas. In filtering the literature that will be used after obtaining keywords and inclusion criteria using abstract reading. In answering the case study problem formulation in Jabodetabek, 22 main journals were selected as references. (3) Analysis and synthesis.

The final step in this method is to carry out analysis and synthesis of the literature sources that have been obtained to answer the research problem formulation. As previously explained, the problem formulation becomes a reference and guide in the synthesis of the literature obtained. Next, we conduct an in-depth analysis of the material found, identifying general patterns, trends, and key findings related to the topic of the article. This research also adopted a critical approach in evaluating the accuracy and reliability of the information presented in the literature we reviewed. Each literary source obtained provides understanding and the essence will be taken according to the writing of the article.

3. Results and Discussion

Based on the extraction data, several important syntheses were obtained which will display in a table to show research articles on green innovation in the Jabodetabek area. The following below are the results of a journal synthesis to answer the problem formulation regarding the role of humans in green innovation and how to accelerate it. Green innovation research synthesis in Jabodetabek can be seen in Table 1.

Table 1. Green innovation research synthesis in jabodetabek

No	Research Title	Journal	Author (Year)	Synthesis of Journals with Problem Formulation
1.	Implementation of Smart Environment City in Environmental Management in Tanggerang City	Moderat: Jurnal Ilmah Ilmu Pemerintahan	Nurlukman & Basit (2023.	The Smart City concept improves the quality and environmental sustainability of Tanggerang City and Technology and innovation improves urban infrastructure for a sustainable and greener city
2.	Implementation of Smart Society in Realizing Tanggerang City as a Smart City	Jurnal Ilmu Administrasi dan Informasi	Prasetyo (2023)	The Smart Society Program in Tanggerang City has been successful in increasing learning and inclusiveness for community development
3.	Comparison of the Success of Smart City DKI Jakarta with the City of Banda Aceh	Sanger: Journal Social, Administration and Government Review	Oktaviana & Asca (2023)	Jakarta is superior in Smart City Implementation compared to other City Districts and has shown advanced development in smart City initiatives
4.	Desau Vertical Garden concept in Kampung Tangguh, Curug District, Depok City	Lakar Jurnal Arsitektur	Ernawati et al. (2022)	Vertical Garden Design enhances urban settlements with green aesthetics, the principle of this green architecture is to improve air quality and open space conditions.
5.	Green Open Space Design concept as a sustainable environmental park in The Cibuluh Retention, Bogor City	Laskar Jurnal Arsitektur 7(1)	Hamdani et al. (2024)	Green open space design in Bogor City enhances urban areas with sustainable environmental parks.
6.	Effectiveness of using the Jabodetabek Commuter Line Electric Train (KRL) to reduce congestion in DKI Jakarta	Jurnal Ekonomikas45 *10*(2)	Sahara & Nugroho (2024)	KRL Cummuter Line Successfully reducing traffic congestion in Jakarta, users of this public transportation show its effectiveness in reducing traffic
7.	Sustainable Transportation in Southeast Asian Countries: Implementation of Green Transport	Journal of Environmental Science and Sustainable Developpment *6*(2)	Maudina & Purnomo (2023)	Green transportation applications in Manila, Bangkok, Jakarta have successfully contributed to achieving sustainable development goals
8.	Factors that Influence Interest in Purchasing Environmentally Friendly Products (Case Study of Gen Z in Jabodetabek)	Jurnal Ekonomi, Manajemen dan Perbankan *7*(3)	Utama & Komara (2021)	In purchasing behavior for environmentally friendly products, there are aspects of environmental awareness and environmental ethics that are positively correlated to encourage Gen Z in the Jabodetabek area to want to purchase and useenvironmentally friendly green innovation products.
9.	Implementation of Green Open Space Policy in Urban Areas (North Jakarta Administration City Development Study)	Spirit Publik *12*(2)	Wijayanto & Hidayati (2017)	The existence of national and regional spatial planning policies must be equalized. In the case of North Jakarta, which has minimal green open space, it is still very slow for the development of green open space to be realized.

3.1 Implementation of the human role in Implementing the green innovation concept in the Jabodetabek area

The concept of green innovation is an approach that aims to develop new, environmentally friendly solutions to overcome environmental and social challenges in urban development. Green innovation is driven by awareness of the negative impacts that conventional patterns of urban development have on the environment, including air pollution, overuse of natural resources and environmental degradation. This concept calls for designing, implementing, and adopting technologies, products, or practices that take into account environmental, social, and economic impacts simultaneously (Hale et al., 2021). One of the main aspects of green innovation is the application of environmentally friendly technologies in various sectors, such as renewable energy, waste management, sustainable transportation, green building construction. These technologies are designed to minimize carbon footprints, reduce waste and conserve natural resources, thereby helping to reduce the negative impact of cities on the environment. In addition, green innovation also includes the development of environmentally friendly products, such as recycled building materials, electric vehicles and energy-saving household appliances, which aim to reduce energy consumption and reduce greenhouse gas emissions.

Referring to statements regarding green innovation technology, in the Jabodetabek area itself there has been a lot of innovation in the field of public transportation development and has provided considerable potential for sustainable change. Based on research conducted by Sahara et al. (2023) regarding the effectiveness of using the Jabodetabek Commuter Line Electric Train (KRL) to reduce congestion in DKI Jakarta, explaining that KRL has succeeded in achieving its goals, integration and adaptation to reduce traffic congestion even though public awareness and participation in public transportation is still relatively lacking.

This is also supported by research conducted by Maudina & Purnomo (2023) on Sustainable Transportation in Southeast Asian Countries: Implementation of green Transport explaining that the application of green transportation in Jakarta has successfully contributed to achieving sustainable development goals. Jakarta has succeeded in reducing congestion levels. In 2019, the level of congestion reached 62%, decreasing significantly to 34% based on the latest data for 2021. The strategic implementation of environmentally friendly transportation solutions has a positive correlation between improving the traffic situation and potential benefits in reducing traffic congestion and providing social impacts. wider economy.

The government's role is also crucial in implementing green innovation in cities. The government has the authority to regulate, incentivize and monitor the implementation of sustainable practices. Through supportive policies, such as green building regulations, emissions standards, and investment in sustainable infrastructure, governments can create a conducive environment for the adoption of green innovation in cities. Apart from that, the government also has a role in educating the public about the importance of green innovation and encouraging active participation in sustainable practices (Mayona, 2021).

In addition, implementing government policies that support green innovation, such as fiscal incentives for environmentally friendly technologies and regulations governing industrial emissions, is also an important part of the green innovation concept. In the context of urban development, green innovation is the key to creating better cities. green, efficient and sustainable. By applying the principles of green innovation, we can create a healthier, environmentally friendly and highly competitive urban environment, as well as improve the quality of life of its residents (Azilia et al ., 2023).

The efforts that have been made in the Jabodetabek area, apart from focusing on green innovation technology, also emphasize changes in behavioral patterns and policies that support sustainable development, efforts to increase green innovation in the Jabodetabek area in the infrastructure sector, such as implementing the Smart City concept. Based on research by Nurlukman, and Basyir (2023) regarding the Implementation of Smart City in Environmental Management in the City of Tangerang, it is known that the Smart City

Concept has developed globally, this concept can improve the quality and sustainability of the Tangerang City environment and technology as well as improve greener urban infrastructure (Hadomuan & Tuti, 2022). This effort is also inseparable from the programs offered such as the Society program which is a program related to community development by utilizing artificial technological intelligence to improve the quality of life of the community which focuses on three important elements such as Learning, Community and safety. However, the implementation of this program still prioritizes the learning element. The Smart Society Program in Tangerang City has succeeded in increasing learning and inclusiveness for community development in implementing the Smart City program (Prasetyo, 2023).

Not only that, the role of humans in green innovation can also be seen in efforts to green cities. Various community communities work together to plant trees, create city parks, and improve existing green open spaces. These efforts not only improve air quality but also provide healthy recreation space for residents. Like several efforts that have been made in the City of Bogor by designing green open spaces to improve urban areas with sustainable environmental parks and similarly to the City of Depok designing Vertical Parks to improve urban settlements with green aesthetics, the principle of this green architecture is to improve air quality and open space conditions(Ernawati et al., 2022).

The role of humans as consumers is very important in encouraging the adoption of green innovation in cities. By choosing environmentally friendly products and supporting sustainable practices, consumers can send a strong market signal to manufacturers and industry to increase green product offerings. This also cannot be separated from increasing education and public awareness, which are also part of the important factors in implementing green innovation for sustainable cities. Through formal and informal education, both in schools and through the mass media, people can be given a better understanding of the importance of the environment and ways to support sustainable urban development. In Utama and Komara's (2021) research on Factors that Influence Interest in Purchasing Environmentally Friendly Products (Case Study of Gen Z in Jabodetabek) explains that in purchasing behavior for environmentally friendly products, there are aspects of environmental awareness and environmental ethics that are positively correlated to encourage Gen Z. in the Jabodetabek area to want to purchase and use green innovation products that are environmentally friendly (Utama and Komara, 2021).

Based on several research findings related to green innovation in the Jabodetabek area, the role of humans in implementing green innovation to create sustainable cities is very important and has a significant impact on the success of these efforts. Humans act as innovators and developers of environmentally friendly technology. With creativity and continued research, humans can design new solutions that utilize natural resources wisely, reduce waste, and reduce the carbon footprint. Industrial innovators, scientists, engineers and critical thinkers around the world have a leading role in creating green technologies that can be used in urban contexts. With public awareness increased, it will be easier to encourage behavioral change and support the adoption of green innovation at all levels of society. Thus, through the active role of humans in various capacities, green innovation can be implemented effectively to create more sustainable cities in the future.

3.2 Accelerating the implementation of green innovation in sustainable city environments in Jabodetabek

As previously explained, the application of green innovation in cities is an important step in overcoming the environmental challenges faced by modern cities. Accelerated steps are needed to be able to implement it because environmental challenges are also rapidly threatening the sustainability of urban ecosystems (Mayona, 2021). However, there are several obstacles that need to be overcome so that green innovation can be implemented effectively and evenly in all cities in the Jabodetabek area. In general, implementing green innovation in urban areas has six main obstacles, namely: lack of public awareness and education, high implementation costs, infrastructure and space challenges, policy and

regulatory uncertainty, limited capacity and resources, and unequal access and participation (Chealsiyana et al., 2021).

One of the main obstacles in implementing green innovation in cities is the lack of public awareness and understanding of the importance of sustainable practices and their impact on the environment. Many urban residents do not fully understand the benefits of green innovation or are not even aware that there are environmental problems that need to be addressed. Environmental awareness is the ability to create a positive attitude in terms of awareness and showing support for solving environmental problems (Utama et al., 2021). Without understanding and awareness of the environment, creating a sustainable Jabodetabek urban ecosystem will be very difficult. This is because society is the largest community that will determine the sustainability of the urban ecosystem itself.

Therefore, environmental awareness needs to be formed by enriching knowledge about environmental problems and what behavior can overcome or worsen them. In the Jabodetabek area, apart from low education in marginalized communities, even higher education in communities does not necessarily increase awareness of the environment. The education curriculum in Indonesia does not mention much about environmental ethics, meaning knowledge about environmental issues is still very limited. Wider and in-depth public education about environmental issues and green solutions seems to be crucial for implementation to increase public awareness and participation in sustainable practices.

Another major obstacle is the high costs associated with implementing green innovations in cities. Although green innovation can ultimately result in long-term cost savings, the initial investment required to build green infrastructure or introduce environmentally friendly technologies is often very large. This can be an obstacle for local governments, companies and individuals in adopting green solutions. Small aspects that are basically more cost-effective in the long term still face a lot of resistance, especially from large, established economic players with extensive markets. One example that is a big challenge because implementation costs are high is green buildings that are environmentally friendly. The concept of green building has obstacles in Indonesia because its implementation requires expensive costs (Larasati & Wilis, 2023). In the Jabodetabek area, where the growth of buildings, both for economic areas and for residential areas, really requires the implementation of this green innovation. In the long term, if this green innovation is not implemented well, it will greatly affect the environment, especially in the aspects of carrying capacity and carrying capacity.

These large costs will be closely related to the existing infrastructure and spatial planning that has been developed in cities. The absence of sustainability aspects in spatial planning means that existing spatial planning conditions often become a barrier to implementing green innovation. For example, the addition of green open space or bicycle lanes may require major restructuring of existing urban layouts, which may face resistance from affected parties. Additionally, existing infrastructure may be inadequate to support the implementation of green technologies, such as solar panel installations or modern waste treatment systems. The rapid and dynamic growth in urban Jabodetabek makes it difficult for green infrastructure to be implemented properly. Population and economic growth makes Jabodetabek's urban expansion spatially faster than it was planned to become a sustainable city. This will really hinder when Jabodetabek, both as a whole and its individual regional governments, will carry out appropriate planning for a sustainable city.

Uncertainty in policies and regulations can also be a barrier to implementing green innovation in cities. For example, in research in South Tangerang City, open dumping practices still occur, even though nationally in large urban areas there must be waste management and not just dumping it like that . Without clarity in regulations supporting sustainable practices, companies and investors may be reluctant to take risks in adopting green technologies or introducing sustainable solutions. As an agglomeration, Jabodetabek often has policies that are not in harmony between the regions within it. In fact, in green innovation, the sustainability of one city will be greatly influenced by other cities around it. Therefore, clear, consistent and supportive policies are needed to provide incentives for parties who want to invest in green innovation.

Limited human, financial and technical resources can also be obstacles in implementing green innovation in cities. The limited natural resource capacity in the Jabodetabek area means that this urban area must depend on the surrounding area, for example in meeting energy and food needs (Djakapermana, 2021). In this case, this dependency will also hinder the implementation of green innovation, where efforts to carry out green innovation in urban areas will be limited by the availability of supporting resource capacity. On the other hand, the rapid growth of urbanization and the economy is often not accompanied by growth in human resources. As a result local governments may not have the trained personnel or sufficient finances to design, implement and monitor sustainable projects effectively. Therefore, investment is needed in capacity development and adequate resources to support green efforts at the local city district level before becoming a sustainable urban agglomeration in Jabodetabek.

Inequality of access and participation can also hinder the implementation of green innovation in cities. Disadvantaged or marginalized groups in society may not have equal access to green technologies or sustainable services, which can increase social and environmental inequalities. Therefore, it is important to ensure that all urban residents have equal access to green innovation and the opportunity to participate in sustainable development. Collaboration and active participation from the community can open up opportunities for sustainable governance (Magriasti et al., 2023). An example is the low public awareness of the smart city in South Tangerang so that innovation in this area does not run optimally even though it has been planned by the local government.

In this article it can be found that the biggest obstacles in implementing green innovation in Jabodetabek are low public awareness, regulatory uncertainty and financing. The awareness factor is the most frequently encountered in various cases, such as in Depok City where there are still many traders who throw rubbish carelessly. What is also discovered in this article is that these obstacles are correlated with each other. For example, high costs cannot be overcome because the government is also unable to provide certainty about the rules for implementing green innovation and the residents of Jabodetabek are not immediately aware when a green innovation with high costs is implemented. Therefore, in overcoming these obstacles, it is very important that systematic efforts are needed through collaboration between government, the private sector, academics and society. This also requires joint efforts to identify appropriate solutions and ensure that green innovation can be implemented evenly and sustainably in all cities in Jabodetabek.

Basically, there is a positive relationship between green innovation and improving human and environmental welfare. This is related to the goals of green innovation which aims to form a sustainable city. In China, for example, when the government issued a policy to replace green innovation, there was a positive correlation with increasing people's welfare. Or in the Jabodetabek area where the commuter line is one of the green innovations that can reduce traffic jams, where traffic jams are an indicator of people's stress levels and well-being. Increasing the level of green innovation is when social welfare is highest (Wang., et al 2023). This positive correlation can be understood because green innovation, both in economic and technological aspects, is able to provide easier, broader and more affordable opportunities for the entire community.

In the transportation aspect, for example. Green innovation by promoting the use of public transportation will make it easier for people to mobilize. Fulfilling basic needs in a sustainable manner that can be met by green innovation is the key to improving human social welfare. In the Jabodetabek area, the population is so high, and the corresponding high level of mobilization requires the provision of sustainable transportation. Commuter lines in Jabodetabek are one solution to this problem. Providing comfortable, efficient and economical transportation is the key to providing transportation in Jabodetabek (Nugroho et al., 2023). Apart from the commuter line, the development of Mass Rapid Trans and Light Rail Transit is a green innovation that will support the creation of a sustainable Jabodetabek.

Another example is green economic policy through environmental taxes. Environmental taxes can significantly reduce the greenhouse effect (Calin et al., 2023). This good effect on the environment also has a positive meaning on humans. Cities that have less

pollution and the negative effects of greenhouse gases will create an environment that can improve the welfare of its people. The results of green economy financing can be used for the construction of public facilities which also improve human social welfare. In Jakarta itself, it is one of the cities that massively implements vehicle emission tests. This policy not only aims to reduce emissions and pollution but is also important in encouraging green economic activities in the vehicle business.

On the ecological side, the application of green innovation also has a very good impact. Green innovation in the creation of green open spaces in urban areas, for example, will have a positive impact in the form of increasing biodiversity. For humans themselves, interaction with green open spaces and biodiversity can have a positive impact psychologically. Green innovation planning in the form of green buildings also has a positive impact on the environment. This concept will reduce the burden on the carrying capacity of the urban environment which continues to increase. Without green innovation, urban development will continue without paying attention to the consequences of environmental degradation. In fact, environmental degradation will also reduce environmental welfare, both for the ecology and for humans themselves.

As explained previously, the ideal concept of green innovation still has various obstacles in its implementation. On the other hand, environmental degradation, especially in urban ecosystems, also continues to increase. Therefore, accelerated efforts are needed in implementing green innovation in urban ecosystems. Based on the literature review that has been carried out, there are three key factors that can best accelerate the implementation of green innovation in a sustainable urban environment. These three factors are regulations and policies, financing schemes, and lifestyle changes. These three acceleration factors also address the obstacles that arise in implementing green innovation.

Regulations and policies play a very important role in accelerating the implementation of green innovation. As a global issue, environmental degradation has influenced policy makers to pay more attention (Ma et al., 2022). Having an environmental policy will encourage companies and cities to carry out green innovation. The Jabodetabek area, which has such a high population, will have such big changes if there are policies that can increase environmental awareness. Even so, in Jabodetabek awareness of green innovation will continue to increase in facing environmental challenges, and environmental regulations have been proven to have a positive correlation which plays a role in the development of green innovation technology (Lee., et al. 2021).

Strict regulations which of course are realized in the enforcement of these regulations will greatly accelerate the implementation of green innovation in the urban environment. This environmentally based policy will create conditions where green innovation is a must. Green innovation areas will be formed in cities. The existence of this green innovation area will encourage innovation in green technology and sustainability solutions (Firmansyah & Badru Zuhad, 2023). Communities and companies will also switch to using green technology, and most importantly public facilities such as waste processing will be used to support a sustainable city ecosystem. Various environmental measurement instruments by the government will also indirectly encourage economic stakeholders in the Jabodetabek area to improve their performance in a more environmentally friendly manner (Wikaningrum, 2016).

One of the most challenging challenges or obstacles in creating and implementing green innovation is related to financing. As explained in the previous chapter, initial financing or investment in green innovation is considered too high. This is what really hinders the implementation of green innovation. In the urban ecosystem environment, the right solution is to apply a financing scheme for the implementation of green innovation. Apart from offering policies in the form of certain incentives for implementing green innovation, the government can also collaborate on financing with companies in implementing green innovation. In the Jabodetabek area, the construction of green and sustainable flats can be realized through collaboration and financing cooperation (Larasati & Wilis, 2023). The construction of the MRT is also another example that a collaborative scheme can accelerate the implementation of green innovation.

Corporate social-environmental responsibility can be an emphasis in green innovation financing schemes. Companies that have the same interests can work together to create green innovations that can be applied to sustainable cities. Cooperative financing positively influences the level of implementation of green innovation (Wu., et al. 2024). When costs are no longer considered a problem and investments are large, the acceleration of the implementation of green innovation will soon be massive in urban areas. An example is the use of electric vehicles. Collaboration between vehicle manufacturing companies, battery providers and fuel filling facility providers is a compact accelerator in financing the implementation of green innovation in urban areas.

The last role that is no less important is lifestyle. The wider community as consumers has a very important role in implementing green innovation in cities. The encouragement of broad demand will encourage the supply of green innovation to become increasingly diverse. Meanwhile, if people's lifestyles are still not environmentally friendly and do not implement green innovation, then the acceleration of offering green innovation will also be slow. Collectively, the lifestyle of this community plays a very important role in implementing green innovation. Socialization to the wider community in the Jabodetabek area has been proven to have a positive correlation in providing lifestyle changes. In the case of MSMEs in Depok, for example, business owners are interested in changing tools and materials to be more environmentally friendly after increasing knowledge through outreach (Sufayati, 2023; Sholeh et al., 2021). The lifestyle of people who can adopt various green innovations shows increasing public awareness of the importance of urban environmental sustainability. Lifestyle can also encourage policy makers to issue environmental regulations for green innovation. In other words, lifestyle changes have an impact on the previous two acceleration solutions. The government will also be encouraged to be able to formulate and accommodate the implementation of green innovation when the community is considered to have a sustainable lifestyle that is in accordance with the implementation of green innovation in Jabodetabek.

The three solutions above are solutions that are related to each other. There is no best solution that can stand alone. In this article, three key factors, namely regulations and policies, financing schemes, and lifestyle changes are the most likely solutions to accelerate green innovation in the Jabodetabek area. These three solutions show that accelerating the implementation of green innovation is still possible in the Jabodetabek area. Therefore, the role of humans is very important if this green innovation is to be carried out and implemented. These acceleration factors are the most important role of humans in realizing Jabodetabek as a city with a sustainable ecosystem within it.

4. Conclusions

Continuous urban growth and expansion has resulted in increasingly severe environmental degradation. Population and economic growth is often not accompanied by the sustainability of the city itself, so that the urban ecosystem is no longer able to provide prosperity for its residents. As a concept and idea, green innovation is offered to overcome this problem. Green innovation is promoted as a concept that prioritizes the development of environmentally friendly technology and an environmentally friendly economy to overcome negative social, environmental and economic impacts. The application of green innovation is greatly influenced by the role of humans. Human efforts in innovation and commitment are the key to the success of green innovation for sustainable cities. Humans have an important role as innovators and developers of environmentally friendly technology. Creativity and continuous research enable humans to design new solutions by utilizing natural resources wisely, reducing waste and reducing the carbon footprint. In it there is a major role for industrial innovators, scientists, engineers and critical thinkers throughout the world to be able to create green technology that can be used in urban contexts.

The population in Jabodetabek is so high and economic activity is so dynamic that it can be both a potential and an obstacle in implementing green innovation. In the Jabodetabek area, it can be concluded that there are main obstacles that most influence the implementation of green innovation in the form of lack of public, high implementation costs, and regulatory uncertainty. To overcome this, systematic efforts are needed in collaboration between the government, the private sector, academics and the community. Therefore, in the Jabodetabek area, it is necessary to accelerate the implementation of green innovation. The three factors that are most likely to play a human role in accelerating green innovation in Jabodetabek urban areas are through regulations and policies, financing schemes, and lifestyle changes. Proper implementation will have a positive impact on Jabodetabek as a sustainable city and will simultaneously improve human and environmental welfare in various aspects.

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