

ASEAN Transformation Toward Smart City Environment: A Resource Management Approach in Sustainable Waste and Energy Management.

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Abstract. The ASEAN region consists of ten countries, six of which are in the top twenty countries with less successful waste management. ASEAN produces the most marine plastic waste, contributing 1.4 to 3.54 million metric tons annually. This waste problem is exacerbated by shipping waste from Western countries, mainly recycled plastic from Australia, of which 80-87% is sent to Indonesia, Malaysia, Thailand, Vietnam, the Philippines, and Myanmar. The smart city environment approach effectively solves the waste pollution problem in ASEAN. The concept emphasizes efficient resource management, including energy, sustainable transportation, and water management, to create more innovative and sustainable cities. This research aims to determine the extent of resource management implementation in ASEAN to create a smart city environment concept. This research uses descriptive qualitative methods, using secondary data analyzed using NVIVO 12 Plus. The results show that waste generation, energy, and carbon footprint are the top priorities of ASEAN countries in implementing resource management to realize a bright city environment. As for air quality and water consumption, there is still a need for practical solutions, which need to be echoed by ASEAN countries to address these challenges. This research offers insights into adapting this concept to promote environmental sustainability and foster the global development of eco-friendly, advanced cities.

Keywords: waste, energy, smart city environment, resources management.

1 Introduction

The Southeast Asian region consists of ten countries, six of which are in the top twenty as countries that are currently less successful in implementing environmental waste

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management, especially in the issue of plastic waste management in the ASEAN region. The countries included are Thailand, Vietnam, Indonesia, and the Philippines. Marine plastic waste is the most generated waste in the ASEAN region, with the total population of plastic waste contributing to 1.4 to 3.54 million metric tons per year, as shown in Fig. 1 [1]

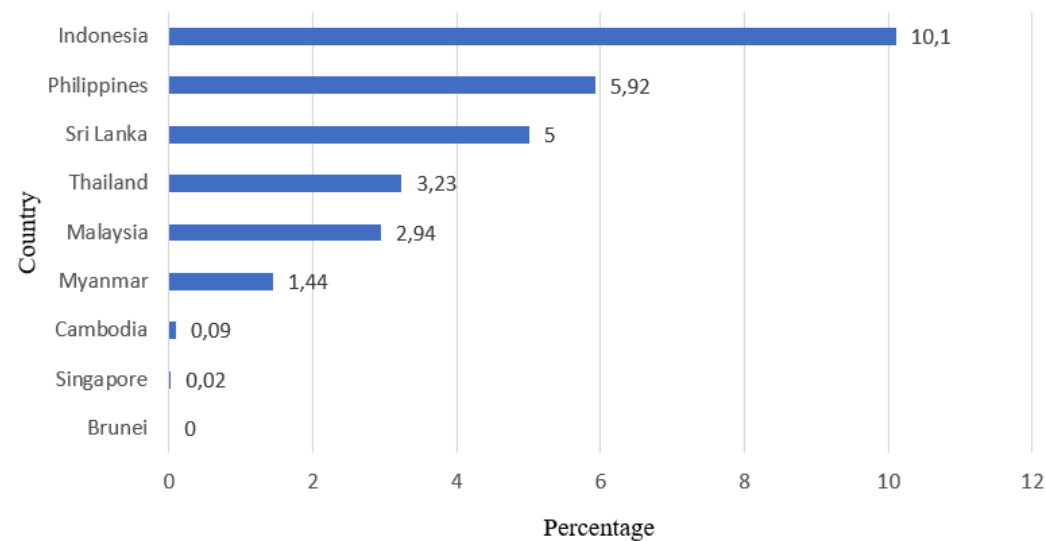


Fig. 1. Volume of Plastic Waste Pollution generated in ASEAN

The emergence of waste problems in ASEAN is due to the practice of shipping waste that has become a new destination for the West, which then makes the Southeast Asian region now a destination for shipping waste from the West, which is facing severe problems related to waste imports [2]. Southeast Asia has become a new destination for Australian recycled plastic, with 80-87% going to Indonesia, Malaysia, Thailand and Vietnam. Other regions, including the Philippines and Myanmar, are also beginning to accept Australian plastics. Western countries import their waste into ASEAN to reduce the negative impacts occurring domestically and reduce waste management costs. However, the waste initially sent to be recycled creates new problems in ASEAN countries that are the recipients. For example, the recycling process of imported waste in Vietnam is unprofessional, resulting in air and water pollution in the country [3]. This problem shows that it is essential to improve waste management efforts, especially in the ASEAN region, to protect and preserve the environment and create a sustainable one.

Using the smart city concept can provide an effective solution to overcome waste and energy pollution problems in the ASEAN region, which will ultimately support creating a sustainable environment [4],[5]. According to [6] in [7], the smart city concept is a form of dream that must be implemented in various countries, especially the ASEAN region and is expected to be implemented so that it can bring a new change to its citizens. [8], states that efficient resource management is one of the main aspects of the smart city concept. With smart solutions such as energy management, sustainable transportation, and efficient water management, smart cities can reduce energy consumption, carbon emissions, and waste to help maintain environmental sustainability [9]. The presence of the smart city concept is believed to be an innovative solution to overcoming urban development problems in a country. The smart city concept is the right step in increasing the productivity of citizens so that information and digital technology can be utilized in all aspects, such as infrastructure

management, resources, the environment, and public services, to make a developed country with healthy, productive, and prosperous citizens [10].

According to [11,12] a smart environment with the concept of using renewable energy is the main focus in efforts to reduce air pollution and create a more sustainable and environmentally friendly city so that the idea is the right choice in overcoming waste and energy problems in the ASEAN region [13]. The smart environment concept emphasizes using technology and innovation to create more innovative, sustainable, environmentally friendly cities. Amid the dynamics of rapid urban development in the ASEAN region, waste and energy management challenges are increasingly becoming the focus.

From the gaps and problems above, this paper seeks to answer several key questions: how is the concept of smart city environment implemented in the ASEAN region? Then, the author analyzes the extent of resource management implementation in ASEAN to create the idea of a smart city environment in the ASEAN region. This analysis includes strategies for implementing a smart city environment that can be adopted as a reference for implementation in other countries. The problem is very appropriate to be reviewed through the perspective of a smart city environment through a resource management approach to find out how the implementation of resource management supports the smart city environment in the ASEAN region. In-depth research on this subject will provide new insights on how the resources management approach can be adopted and adapted to environmental challenges in various countries, as well as provide practical guidance for policies and actions at local, national and regional levels as an effort to promote sustainable urban development.

2 Literature Review

The development of smart cities has become a significant focus for improving the efficiency and welfare of people in various countries. Along with the times, environmental aspects are one of the main focuses of the smart city concept [14]. Research [15], states that smart cities have great potential to provide convenience for the community by utilizing information and communication technology optimally, precisely, and quickly. This finding is in line with research [16], which shows that the smart city concept integrates urban systems through information technology in sectors such as local government, education, transportation, health services and even the environment. Research [17] also confirms that innovative technology, effective governance, community participation, and stakeholder collaboration are essential for achieving a sustainable regional urban environment.

However, in implementing the smart city concept, the government still needs to overcome several challenges and obstacles, such as the limited budget used and the lack of technological knowledge of both the government and the community [13]. Research [18] shows that challenges such as waste problems, limited resources for field officers, consistency in implementing socialization, and lack of community social support are the main obstacles for a region in achieving smart city policy goals. Likewise, research from [9] found that implementing the smart city concept faces various challenges, such as lack of socialization and excessive focus on technological development. Therefore, the local government must design a policy and infrastructure to realize the smart city concept for a livable city and an intelligent and empowered society [10]. The need for broader socialization related to smart cities so that people have a better understanding of the concept has also been expressed in research [6]. Research [19] emphasizes that it is essential to have a strategy to build a supportive political environment, adopt the latest technology, provide a budget, and involve all stakeholders in carrying out this smart city concept.

There are six indicators of success in implementing the smart city concept, namely (1) Smart Economy, (2) Smart People, (3) Smart Governance, (4) Smart Environment, (5) Smart Living, (6) Smart Mobility [20]. Applying the concept of a smart environment is critical to developing an environmentally friendly smart city. This is by research from [21], which states that the smart environment is considered to provide significant benefits to a sustainable environment and strengthen the status of an innovative and environmentally friendly city in a city. Various studies have also highlighted the importance of integration between the use and development of technology and community participation to achieve a sustainable urban environment. This is to research from [22], which reveals that collective action from the community at the local level is critical in realizing development priorities to achieve climate change resilience and smart environment in urban areas. Research [23], also shows that smart neighbourhoods developed by local communities bring tangible benefits to residents and visitors and involve active participation in their development and maintenance.

In some areas, implementing the smart environment concept has shown significant success with the Waste Bank innovation [24]. Studies on the effectiveness of waste banks in certain areas show that although it is one of the alternatives expected to help in waste management, there are still several challenges faced by the government and the community in achieving optimal results. Where only about 10% of the total volume of waste collected can be successfully reduced by waste banks [25]. Research from [26] also states that the community has currently sorted waste, processed it into compost, and recycled non-organic waste. However, the energy aspect still needs improvement so that people can feel the direct impact of the energy produced by themselves. Significant major challenges were also expressed, such as the lack of sustainable buildings, limited smart home areas, pollution problems, and suboptimal waste management problems in various regions [27]. This is by research from [28], which states that environmental quality monitoring technology must be needed. In line with research from [29], implementing the smart environment concept in various regions still faces challenges regarding water management, energy, waste, and other environmental aspects, but also shows genuine efforts in achieving sustainability goals.

This shows that improvement is needed in every aspect of the smart environment to achieve complete suitability in realizing a sustainable environment [29]. Research from [30] emphasizes the need for technology integration and community involvement in its implementation. Innovations like the Internet of Things (IoT), machine learning, and blockchain offer efficient solutions, but challenges include high operational costs and standardization issues. Community empowerment is also an essential focus in some regions where communities are actively involved in environmental management [31]. This is in line with research from [32], which emphasizes that community empowerment efforts and increased socialization can effectively solve environmental management challenges. Likewise, the conceptual description of smart cities focuses on the comfort of people's lives and sustainable development. Meanwhile, research [33] states that international urban development experience emphasizes the urgent need to address waste disposal in an area.

The above studies have provided a strong illustration of the importance of developing a smart city environment in a country, especially in sustainable waste and energy management. By integrating technological innovation, effective regulation, and active community participation, cities can become more innovative, more sustainable, and environmentally friendly in the future [34].

Searches related to previous research were also carried out using VOSviewer Bibliometric analysis to find the Gap of the research studied. The data used in the

VOSviewer Bibliometric analysis comes from research publication data in the Scopus database from 2019 to 2024. More details can be seen in [Fig 2](#). below:



Fig. 2. VOSviewer Analysis with Smart City Keywords

Based on the results of the VOSviewer analysis above, studies on smart cities have previously been conducted. However, studies on developing the smart city environment concept, specifically through the resources management approach in sustainable waste and energy management, still need to be more widely researched. Most existing studies focus on the technological aspects of smart city development without specifically emphasizing the integration of the smart environment concept. Therefore, from the analysis above, it can be seen that a significant gap in the literature is the lack of research investigating how the concept of resource management can be implemented to address the issue of sustainable waste and energy management in ASEAN as a form of realizing smart cities. Therefore, the novelty of this research is to examine how the implementation of smart resource management in waste and energy management is achieved to support the realization of an innovative city environment in the ASEAN region.

The problem is very appropriate if reviewed through the resource management perspective to determine the achievement of a smart environment to realize smart cities in the ASEAN region. The theoretical basis used in this research is the smart environment theory, which focuses on resource management indicators because it is considered relevant to problems related to sustainable waste and energy management in ASEAN. According to [8], there are three variables in the Smart City Environment theory, namely (1) Smart Buildings, (2) Urban Planning, and (3) Resources Management [35]. In the resources management variable, there are five leading indicators, namely (1) water consumption, (2) waste generation, (3) energy, (4) carbon footprint, and (5) Air Quality.

3 Metod

This research uses descriptive qualitative research. This method allows the collection of comprehensive data related to a particular topic, subject matter, or issue in research [36]. This type of research also helps provide a complete picture systematically, factually and accurately in answering questions related to efforts to develop smart city environments with

a resource management approach in ASEAN. The data sources in this research come from secondary data obtained by desk study through online mass media reports in the 2019 - 2024 period and previous studies in the form of documents, archives, videos, photos and reports related to the focus of research that has similar topics on the development of a smart city environment with a resource management approach in ASEAN. The data obtained was then analyzed using an interactive model consisting of four analysis stages: First, collecting qualitative data sourced from secondary data. They were second; data can be reduced by mapping and selecting secondary data, which is then adjusted to the Smart Environment Theory [8]. Third, the data will be presented by writing the results of the mapping and sorting of data done previously in the form of news. Fourth, conclusions are drawn by describing the conclusions of the research findings obtained. This research is also assisted by using Qualitative Data Analysis Software (QDAS) in the form of NVIVO 12 Plus tools to facilitate analyzing the results of the data obtained using the crosstab and word cloud features.

4 Result And Discussion

This analysis uses the help of Nvivo 12 Plus tools by utilizing the crosstab function to assess the implementation of the smart city environment concept related to sustainable waste and energy management, focusing on the resources management parameter with specific details presented in Fig 3.

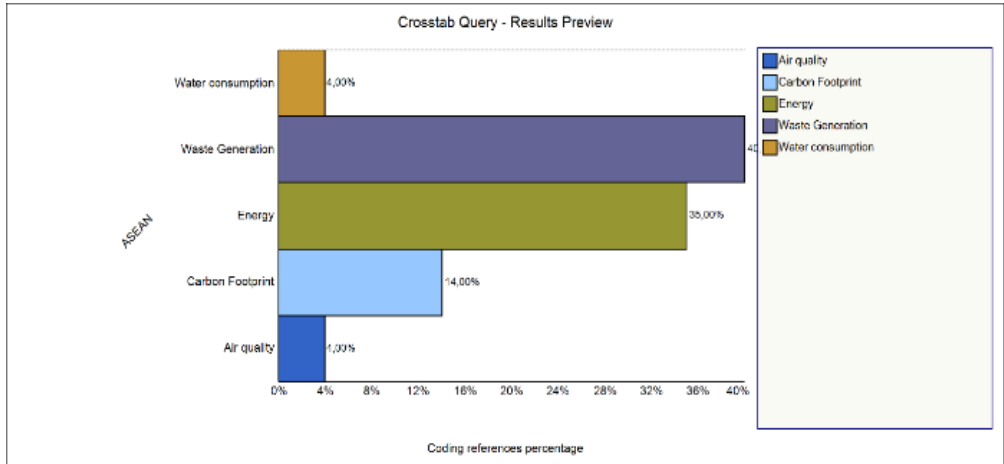


Fig 3. Analysis of Resources Management in Smart City Environment in ASEA

Fig 3. illustrates that five steps can be taken in assessing the achievement of resource management to support a smart city environment in the ASEAN region. The steps include managing water consumption parameters, waste generation, energy, carbon footprint, and air quality. Based on the data analyzed above, it shows that the category with the highest frequency in resources management is waste generation, with a percentage of 40%, followed by energy, with a percentage of 35%, and carbon footprint, with a percentage of 14%, and water consumption and air quality each have a percentage of 4%. Further explanation regarding the implementation of resources management in ASEAN is as follows:

4.1 Waste Generation

The waste generation parameter is the highest compared to other parameters, with a frequency of 40%. This makes implementing waste generation in the ASEAN region often the main focus of local governments in planning proper waste management. It is evident from the regional commitment that Southeast Asian regions, such as Indonesia, Vietnam, and the Philippines, have shown their commitment to reducing plastic and other waste. This is reflected in the various initiatives, policies, and regional partnerships that have been established. The United Nations on Environmental Assembly (UNEA) has been negotiating to develop an International Legally Binding Instrument (ILBI) to address plastic pollution since 2022. The ASEAN region, under the coordination of the ASEAN Secretariat, also continues to work together to address environmental issues. Initiatives such as the ASEAN Framework of Action on Marine Debris and ASEAN-Japan Countermeasures Against Marine Plastic Litter also help facilitate regional cooperation in addressing waste issues in the ASEAN Region [37]. The implementation of the ASEAN Framework of Action on Marine Debris is a policy undertaken by ASEAN for the Southeast Asian region in dealing with marine debris. Governments across the ASEAN region have taken policy measures to reduce single-use plastics and encourage recycling and more effective waste management. Single-use plastic bags, incentives for producers, and producer responsibility schemes were introduced to encourage behaviour change.

Companies and social organizations have also taken measures such as awareness campaigns, product and packaging innovations, and recycling and environmental clean-up projects. These results show that governments in the ASEAN region are more focused on creating programs and policies to address waste issues. The ASEAN region has also established national strategies to address challenges related to waste management and the environment. This is widely discussed in policy and regulatory frameworks and strategies such as green growth and sustainable development [38]. From the efforts made, governments in the ASEAN region focus on creating various programs and policies to address waste issues. In addition, regional and international collaboration demonstrates ASEAN's strong commitment to addressing environmental challenges and working towards more effective and sustainable waste management. These efforts are expected to have a long-term positive impact on the environment and society in the ASEAN region.

4.2 Energy

Data from the Nvivo analysis shows that energy parameters in the ASEAN region have a high frequency after waste management at 35%. In terms of energy, the analysis shows that in the ASEAN region, there are significant efforts to reduce the environmental impact of energy generation. One of the critical steps in this regard is to increase the role of renewable energy in national energy development plans. Collaboration between the World Bank and governments in the ASEAN region to develop carbon pricing mechanisms and regionally led clean energy transition partnerships such as Vietnam are essential parts of efforts to reduce the environmental impact of energy generation [39]. Technology also plays a significant role in this change. An example is the use of waste plastic gasification for power generation in the Philippines, which shows innovation in utilizing existing resources to produce clean energy [40]. The development of environmentally friendly hydropower technologies, such as those by companies like Turbulent, offer sustainable solutions that can be quickly adopted. In addition, developing other renewable energies, such as solar and

wind power, is also a significant focus in the ASEAN region, as demonstrated by Malaysia, Singapore and Vietnam's strong commitment to developing renewable energy sources.

4.3 Carbon Footprint

Data from the NVivo analysis shows that the carbon footprint in the ASEAN region has a pretty good frequency, 14% better than water consumption and air quality. This carbon footprint aspect shows that the ASEAN region has committed to achieving net zero emissions or carbon neutrality by 2050 or 2060 [41]. Efforts to achieve this goal include the development of renewable energy, improved energy efficiency, and using carbon capture and storage (CCUS) technologies. Some countries have already taken concrete steps, such as Malaysia promoting electric cars and Thailand looking to Malaysia as an example in reducing carbon emissions. Singapore is the only country in the region expected to see an absolute reduction in carbon emissions (9 per cent) by 2030 compared to 2019. Malaysia also has relatively low carbon emissions, which are expected to grow by about 12 per cent by 2030. Like Thailand, Malaysia has halted the construction of coal-fired power plants and announced it will retire existing ones and use domestic gas resources instead [42]. Countries in the ASEAN region are currently making the above efforts to achieve net zero or carbon-neutral emissions.

4.4 Air Quality

Regarding air quality, the analysis shows significant changes in various ASEAN cities, especially in the decrease in nitrogen dioxide (NO2) emissions. This decrease is primarily due to reduced transportation and manufacturing activities during specific periods, such as during circuit breaker measures in some countries. For example, Kuala Lumpur, Malaysia, experienced a decrease in NO2 levels of about 60 per cent compared to the previous year during the same period, highlighting the significant impact of reduced human activity on air quality. However, challenges still need to be addressed, particularly concerning PM2.5 particulate levels that remain high in some cities, such as Jakarta, Hanoi, and Ho Chi Minh City, mainly due to suburban coal-fired power plants [43].

Table 1. Airborne PM 2.5 Concentration of ASEAN Countries in 2022

Number	Country	Value
1	Cambodia	8,3
2	Singapore	13,3
3	Philippines	14,9
4	Malaysia	17,7
5	Thailand	18,1
6	Myanmar	24,3
7	Vietnam	27,2
8	Laos	27,6
9	Indonesia	30,4

According to the World Health Organization (WHO), the ideal air quality standard has a PM 2.5 concentration weight between 0 to 5 micrograms per cubic meter. So, from the data above, all countries in ASEAN have poor air quality with PM 2.5 concentration weights above 5, which is higher than the WHO ideal standard, with Indonesia also making Indonesia's air quality the worst in ASEAN. Nonetheless, efforts such as the Clean Enviro Summit Singapore (CESS) demonstrate a commitment to addressing the region's environmental challenges through innovative solutions that include a combination of green energy technologies, such as hydropower and solar energy, that can be widely

applied across Southeast Asia.

4.5 Water Consumption

Data from the NVivo analysis shows that water consumption in the ASEAN region has a low frequency of only about 4%. This reflects some of the challenges and management efforts undertaken by countries in the region. Some ASEAN countries have abundant water resources, but access to clean water remains a significant challenge, especially in poor rural and urban areas [44]. Rapid urbanization and erratic climate change have exacerbated the water crisis in several countries, including ASEAN. Industrial, agricultural and urban activities are the leading causes of water pollution, adversely affecting public health and environmental sustainability. The ASEAN region continues to improve access to safe drinking water and sanitation in line with the Millennium Development Goals [45]. According to the 2014 ASEAN Statistical Yearbook 2012, 89 per cent of ASEAN residents had access to safe drinking water and 71 per cent to safe sanitation. However, only 41 per cent of Indonesians and about half of Cambodians had access to adequate sanitation.

Data from countries with water quality monitoring programs, such as Thailand, Malaysia, Indonesia, the Philippines, Singapore and Vietnam, show a decline in river and lake water quality every year, with an increase in moderate and poor-quality water. Declining water quality and increasing pollution negatively impact ecosystems, public health and the economy. These are the causes of poor water quality in the region. The main challenges in water resources management in the ASEAN region itself result from the increasing water demand and uncertainty in the availability of clean water resources, degradation of water quality, handling major floods, droughts, and sea level rise due to the adverse impacts of climate change and the lack of strengthened coordination and cooperation among ASEAN Member States and relevant institutions at the national level in the implementation of Integrated Water Resources Management (IWRM). This then makes the aspect of water consumption in ASEAN low.

5 Conclusion And Recommendations

Based on the discussion results, resource management in ASEAN in realizing a smart city environment is optimal. This can be seen from the various commitments and steps taken by countries in the ASEAN region in managing resources sustainably. These efforts are reflected in various initiatives covering waste management, energy consumption, carbon footprint, air quality, and water consumption. From the analysis, the implementation of resource management in realizing a smart city environment in ASEAN has been going well, although there are still challenges that must be overcome. In this case, waste management, energy, and carbon footprint are the main focus of ASEAN's sustainable waste and energy management.

Meanwhile, in the aspects of water quality and water consumption, further efforts still need to be made by countries in ASEAN. This research has several limitations that need to be considered. The data used in this analysis comes from secondary data, which has accuracy and information coverage limitations. Based on the results of the data analysis, the author recommends several solutions that can be adopted, namely increasing cooperation and coordination between ASEAN member countries to develop joint policies and programs to address air quality and water consumption problems in ASEAN. In this case, massive efforts are still needed to alleviate the problems of air quality and water consumption in the ASEAN region, which has yet to have the right solution.

References

- [1] N. P. Purba and K. Agustina, Why collaboration in the ASEAN region is vital to tackle plastic waste in the oceans, *theconversation.com*, (2021). <https://theconversation.com/why-collaboration-in-the-asean-region-is-vital-to-tackle-plastic-waste-in-the-oceans-151849> (accessed Jun. 10, 2024).
- [2] R. Dermawan, Ancaman sampah impor dari Barat dan pentingnya kerja sama ASEAN untuk keamanan lingkungan, *theconversation.com*, (2019). <https://theconversation.com/ancaman-sampah-impor-dari-barat-dan-pentingnya-kerja-sama-asean-untuk-keamanan-lingkungan-121436> (accessed Jun. 10, 2024).
- [3] M. Retamal, E. Dominish, L. X. Thinh, A. T. Nguyen, and S. Sharpe, Here's what happens to our plastic recycling when it goes offshore, *theconversation.com*, (2019). <https://theconversation.com/heres-what-happens-to-our-plastic-recycling-when-it-goes-offshore-110356> (accessed Jun. 11, 2024).
- [4] J. A. Burt and A. Bartholomew, Towards more sustainable coastal development in the Arabian Gulf: Opportunities for ecological engineering in an urbanized seascape, *Mar. Pollut. Bull.*, vol. 142, no. January, pp. 93–102, (2019), <https://doi.org/10.1016/j.marpolbul.2019.03.024>.
- [5] C. Toma, A. Alexandru, M. Popa, and A. Zamfiroiu, IoT solution for smart cities' pollution monitoring and the security challenges, *Sensors (Switzerland)*, vol. 19, no. 15, (2019), <https://doi.org/10.3390/s1915340>.
- [6] S. W. Mursalim, Implementasi Kebijakan Smart City Di Kota Bandung, *J. Ilmu Adm. Media Pengemb. Ilmu dan Prakt. Adm.*, vol. 14, no. 1, pp. 126–138, (2017), <https://doi.org/10.31113/jia.v14i1.1>.
- [7] A. F. Sa'diyah, E. P. Purnomo, and A. N. Kasiwi, Pengelolaan Sampah Dalam Implementasi Smart City di Kota Bogor, *J. Ilmu Pemerintah. Widya Praja*, vol. 46, no. 1, pp. 271–279, (2020), <https://doi.org/10.33701/jipwp.v46i1.773>.
- [8] B. Cohen, The Smartest Cities In The World 2015: Methodology - Fast Company, *Fast Company*, (2014). <https://www.fastcompany.com/3038818/the-smartest-cities-in-the-world-2015-methodology> (accessed Jun. 11, 2024).
- [9] A. A. Wahyudi, Y. R. Widowati, and A. A. Nugroho, Strategi Implementasi Smart City Kota Bandung, *J. Good Gov.*, vol. 18, no. 1, (2022), <https://doi.org/10.32834/gg.v18i1.460>.
- [10] F. N. Izzuddin, Konsep Smart City Dalam Pembangunan Berkelanjutan, *Citiz. J. Ilm. Multidisiplin Indones.*, vol. 2, no. 3, pp. 376–382, (2022), <https://doi.org/10.53866/jimi.v2i3.96>.
- [11] C. F. Calvillo, A. Sánchez-Miralles, and J. Villar, Energy management and planning in smart cities, *Renew. Sustain. Energy Rev.*, vol. 55, pp. 273–287, (2016), <https://doi.org/10.1016/j.rser.2015.10.133>.
- [12] V. Oldenbroek, L. A. Verhoef, and A. J. M. van Wijk, Fuel cell electric vehicle as a power plant: Fully renewable integrated transport and energy system design and analysis for smart city areas, *Int. J. Hydrogen Energy*, vol. 42, no. 12, pp. 8166–8196, (2017), <https://doi.org/10.1016/j.ijhydene.2017.01.155>.
- [13] A. D. Nurlukman and A. Basit, Implementasi Smart Environment City Dalam Tata Kelola Lingkungan Di Kota Tangerang, *Moderat J. Ilm. Ilmu Pemerintah.*, vol. 9, no. 4, pp. 769–784, (2023).

- [14] Z. Allam, A. Sharifi, S. E. Bibri, D. S. Jones, and J. Krogstie, The Metaverse as a Virtual Form of Smart Cities: Opportunities and Challenges for Environmental, Economic, and Social Sustainability in Urban Futures, *Smart Cities*, vol. 5, no. 3, pp. 771–801, (2022), <https://doi.org/10.3390/smartsities5030040>.
- [15] P. A. Insani, Mewujudkan Kota Responsif melalui Smart City, *PUBLISA (Jurnal Ilmu Adm. Publik)*, vol. 2, no. 1, pp. 25–31, (2017).
- [16] D. Suciawathi, W. Joniarta, and Y. Dewi, Konsep ‘Smart City’ Dan Tata Kelola Pemerintahan Di Kota, *Public Inspir. J. Adm. Publik*, vol. 3, no. 1, p. 12, (2018), [Online]. Available: <https://www.ejournal.warmadewa.ac.id/index.php/public-inspiration/article/view/825/916>
- [17] W. Listianingsih and T. D. Susanto, Toward Smart Environment and Forest City Success: Embracing Sustainable Urban Solutions, *Ind. J. Comput.*, vol. 8, no. 2, pp. 23–34, (2023), <https://doi.org/10.34818/indojc.2023.8.2.727>.
- [18] S. S. Azani and D. G. Purbaningrum, Implementation of ‘Zero Waste City’ Policy Program Realizing The Smart Environment in Depok City, *J. PubBis J. Pemikir. dan Penelit. Adm. Publik dan Adm. Bisnis*, vol. 7, no. 1, pp. 1–17, (2023), <https://doi.org/10.35722/pubbis.v7i1.723>.
- [19] A. H. Wanto, Strategi Pemerintah Kota Malang Dalam Meningkatkan Kualitas Pelayanan Publik Berbasis Konsep Smart City, *JPSI (Journal Public Sect. Innov.*, vol. 2, no. 1, p. 39, (2018), <https://doi.org/10.26740/jpsi.v2n1.p39-43>.
- [20] I. Hidayat and H. Soetarto, Smart City: Konsep Kota Cerdas Era Kontemporer (Studi Kebijakan Smart City di Kabupaten Sumenep), *J. Public Corner Fisip Univ. Wiraraja*, vol. 17, no. 1, pp. 1–4, (2022).
- [21] A. S. Zulfa and N. Nurhayati, Analisis Smart Environment Dalam Konsep Smart City di Surakarta Berdasarkan Peraturan Walikota Surakarta Nomor 47 Tahun 2019 Dalam Perspektif Pembangunan Berkelanjutan, *J. Wind Eng. Ind. Aerodyn.*, vol. 26, no. 1, pp. 1–4, (2019).
- [22] H. K. Dewi and T. M. Sunarharun, Peningkatan Ketahanan Iklim di Kabupaten Magelang: Telaah Kerangka Kebijakan Smart Environment, *J. Sinar Manaj.*, vol. 9, no. 2, pp. 183–191, (2022), <https://doi.org/10.56338/jsm.v9i2.2463>.
- [23] V. B. M. F. Koy and O. Rodrigues, Developing smart environment at Tourism spots in Jetisharjo RW. 07, Yogyakarta, *ARTEKS J. Tek. Arsit.*, vol. 4, no. 1, pp. 25–32, (2019), <https://doi.org/10.30822/arteks.v4i1.75>.
- [24] L. Salsabila and S. Sianturi, Pelayanan Pemerintah Berbasis Konsep Smart City Studi Kasus : Pelayanan Pemerintah Kota Yogyakarta berbasis Smart Environment, *Pros. Semin. Nas. Ilmu Sos. dan Teknol.*, vol. 5, pp. 467–478, (2023), <https://doi.org/10.33884/psnistek.v5i.8121>.
- [25] M. Dewanti, E. P. Purnomo, and L. Salsabila, Analisa efektifitas bank sampah sebagai alternatif pengelolaan sampah dalam mencapai smart city di kabupaten kulon progo, *Publisia J. Ilmu Adm. Publik*, vol. 5, no. 1, pp. 21–29, (2020), <https://doi.org/10.26905/pjiap.v5i1.3828>.
- [26] N. Nurimani, I. A. Kurniawan, and E. Prasetyo, Penerapan Smart Environment Pada Program Kampung Ikli Di Kampung Randakari Kecamatan Ciwandan Dalam Mewujudkan Kota Cilegon Sebagai Smart City, *J. Ilm. Wahana Pendidikan, Febrruari*, vol. 10, no. 4, pp. 595–604, (2024).
- [27] R. Komalaningtyas and T. Tarlani, Strategi Ketercapaian Smart Environment di SWK Gedebage, *Bandung Conf. Ser. Urban Reg. Plan.*, vol. 2, no. 2, pp. 770–778,

- (2022), <https://doi.org/10.29313/bcsurp.v2i2.4145> .
- [28] D. Febriyanti and H. Burhanudin, Studi Kelayakan Perencanaan Pengembangan Kawasan Pendidikan di Kabupaten Majalengka Berdasarkan Kriteria Smart Environment, *Bandung Conf. Ser. Urban Reg. Plan.*, vol. 2, no. 2, pp. 438–444, (2022), <https://doi.org/10.29313/bcsurp.v2i2.3503> .
- [29] D. A. H. Sari, M. J. Rahayu, and B. S. Pujantiyo, Kajian Kesesuaian Penerapan Konsep Smart Environment sebagai Bagian dari Smart City (Studi Kasus : Kota Semarang), *Desa-Kota Jurnak Perenc. Wilayah, Kota, dan Permukim.*, vol. 6, no. 1, pp. 154–170, (2024).
- [30] D. Szpilko, A. de la Torre Gallegos, F. Jimenez Naharro, A. Rzepka, and A. Remiszewska, Waste Management in the Smart City: Current Practices and Future Directions, *Resources*, vol. 12, no. 10, pp. 1–25, (2023), <https://doi.org/10.3390/resources12100115> .
- [31] R. Gunawan, F. Kurnianingsih, and R. Setiawan, Penerapan Konsep Smart Environment Melalui Program Kampung Iklim Menuju Tanjungpinang Smart City (Studi kasus Kelurahan Tanjung Unggat Kecamatan Bukit Bestari), *J. Hukum, Polit. Dan Ilmu Sos.*, vol. 2, no. 2, pp. 303–320, (2023), <https://doi.org/10.55606/jhps.v2i2.1763> .
- [32] S. Sheina, A. Fedorovskaya, and K. Yudina, ‘smart City’: Comfortable Living Environment, *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 463, no. 3, (2018), <https://doi.org/10.1088/1757-899X/463/3/032095> .
- [33] T. Khudyakova, A. Shmidt, and S. Shmidt, Sustainable development of smart cities in the context of the implementation of the tire recycling program, *Entrep. Sustain. Issues*, vol. 8, no. 2, pp. 698–715, (2020), [https://doi.org/10.9770/jesi.2020.8.2\(42\)](https://doi.org/10.9770/jesi.2020.8.2(42)) .
- [34] A. Hasibuan and O. K. Sulaiman, Smart City, Konsep Kota Cerdas Sebagai Alternatif Penyelesaian Masalah Perkotaan Kabupaten/Kota, di Kota-Kota Besar Provinsi Sumatera Utara, *Bul. Utama Tek.*, vol. 14, no. 2, pp. 127–135, (2019). Available: <https://jurnal.uisu.ac.id/index.php/but/article/view/1097>
- [35] I. Widiyastuti, D. Nupikso, N. A. Putra, and V. A. Intanny, Smart Sustainable City Framework: Usulan Model Kota Cerdas Yang Berkelanjutan dan Integratif, *J. PIKOM (Penelitian Komun. dan Pembangunan)*, vol. 22, no. 1, p. 13, (2021), <https://doi.org/10.31346/jpikom.v22i1.3297> .
- [36] P. Aspers and U. Corte, What is Qualitative in Qualitative Research, *Qual. Sociol.*, vol. 42, no. 2, pp. 139–160, (2019), <https://doi.org/10.1007/s11133-019-9413-7> .
- [37] R. A. Puspita and M. A. Kresnawati, Kerjasama Jepang-Asean Dalam Mengurangi Marine Plastic Debris Asean Di Kawasan Indo Pasifik, *Aliansi J. Polit. Keamanan Dan Hub. Int.*, vol. 2, no. 2, pp. 104–111, (2023), <https://doi.org/10.24198/aliansi.v2i2.49753> .
- [38] A. Jain, *Waste Management In ASEAN Countries*. (2017). Available: <https://www.unep.org/ietc/resources/publication/waste-management-asean-countries-summary-report>
- [39] World Bank, Carbon Pricing Aids Vietnam’s Efforts Towards Decarbonization, *worldbank.org*, (2021). <https://www.worldbank.org/en/news/feature/2021/11/11/carbon-pricing-aids-vietnam-s-efforts-towards-decarbonization> (accessed Jun. 16, 2024).
- [40] C. B. Agaton, C. S. Guno, R. O. Villanueva, and R. O. Villanueva, Economic analysis of waste-to-energy investment in the Philippines: A real options approach, *Appl. Energy*, (2020), <https://doi.org/10.1016/j.apenergy.2020.115265> .

- [41] X. Wu, Z. Tian, and J. Guo, A review of the theoretical research and practical progress of carbon neutrality, *Sustain. Oper. Comput.*, vol. 3, no. August 2021, pp. 54–66, (2022), <https://doi.org/10.1016/j.susoc.2021.10.001> .
- [42] M. Hiebert, Southeast Asia’s Challenge of Decarbonizing While Growing Rapidly, *www.csis.org*, (2022).
<https://www.csis.org/analysis/southeast-asias-challenge-decarbonizing-while-growing-rapidly> (accessed May 24, 2024).
- [43] T. N. Do, Bold action needed to address Vietnam’s air pollution, *East Asia Forum*, (2020). <https://eastasiaforum.org/2020/03/25/bold-action-needed-to-address-vietnam-s-air-pollution/> (accessed Jun. 11, 2024).
- [44] A. S. Suryani, Pembangunan Air Bersih dan Sanitasi saat Pandemi Covid-19, *Aspir. J. Masal. Sos.*, vol. 11, no. 2, pp. 199–214, (2020), <https://doi.org/10.46807/aspirasi.v11i2.1757> .
- [45] WHO, “Millennium Development Goals (MDGs),” *World Health Organization*, (2018).
[https://www.who.int/news-room/fact-sheets/detail/millennium-development-goals-\(mdgs\)](https://www.who.int/news-room/fact-sheets/detail/millennium-development-goals-(mdgs)) (accessed Jun. 14, 2024).