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The New Capital Nusantara Net Zero Strategy of Indonesia: Sustainable and Environmental Friendly City Through Level of Service Standardization

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ABSTRACT

This research aims to provide standards for construction, operations, and maintenance activities in the development of IKN Forest City to achieve net zero strategy through level of service. This research was conducted by systematic literature review related to indicators of level of service for buildings in IKN that contribute to Nusantara Net Zero Strategy 2045 and validation through focus group discussion (FGD) process with the experts. Standards or regulations are also identified as reference standards for measuring parameters from each indicator. The results show that level of service related to Nusantara Net Zero Strategy 2045 consists of six criteria and nineteen sub-criteria that can be used for building infrastructures.

1. INTRODUCTION

The Indonesian Government, through Law No. 3 of 2022, is taking a strategic step in moving capital from Jakarta to Nusantara Capital City (IKN) in East Kalimantan to realize the vision of Indonesia Emas 2045 (Golden Indonesia 2024). The relocation of the capital to Kalimantan realizes inclusive economic growth [1, 2], equitable population distribution [3] overcoming the clean water crisis on Java island [2], sustainable development [4, 5], and increasing international competitiveness and national unity [1]. Based on Presidential Regulation No. 63 of 2022, the construction and development of the IKN are carried out in stages 1 (2022-2024), 2 (2025-2029), 3 (2030-2034), 4 (2035-2039), and 5 (2040-2045) concerning building city ecosystem, strengthening the core area of the IKN, continuing the development of the infrastructure, completing infrastructure construction, and ensuring a reputation as "a Global City for All", respectively. The development of IKN is targeted at the concept of a forest city [6]. This is stated in the "Nusantara Net Zero Strategy 2045" prepared by the Deputy for Environment and Natural Resources Nusantara Capital Authority (OIKN) as a unique work unit.

The forest city is a new concept implemented in Indonesia. Therefore, several challenges are experienced in achieving the Nusantara Net Zero Strategy 2045, such as environmental [2] financial [7], and socio-economic issues [8]. Additionally, there are no policies or standards regulating the construction and operation of buildings, areas, and cities to support net zero strategies [2, 6]. In 2039, the IKN development was dominated by physical infrastructure activities, where several built assets were operated with adequate maintenance. The OIKN needs to create policies and standards related to physical construction activities, operations, and maintenance through level of service to minimize the issue of challenges. Therefore, this city becomes a world-class prioritizing environment to be liveable and lovable.

2. RESEARCH AIMS AND SCOPE

Capital city relocation reduces the burden on Jakarta and provides a better quality of life for the community through a sustainable and environmentally friendly city. Therefore, this research aims to provide standards for construction, operations, and maintenance activities in the development of IKN Forest City to achieve net zero strategy through Level of Service (LoS) Standard. In construction phase, the LoS Standard is expected to guide the design, material specification, and the methods to be sustainable and environmental friendly. In operations and maintenance stage, the LoS Standard is a tool to monitor performance and asset management. The scope of this research is limited to level of service criteria of building infrastructure.

3. LITERATURE REVIEW

3.1 Development of sustainable and environmental-friendly Indonesia new capital Nusantara

IKN is a plan for capital city of Indonesia to replace Jakarta by carrying the concept of a forest and a sponge city. An important principle of a sponge city is the traditional green through city parks and forests, as well as "blue infrastructure" such as wetland drainage channels with bioretention functions

[9]. Sustainable city has superior capabilities in providing facilities, infrastructure, and other elements to ensure the quality of life in the future [10]. The characteristics are the orientation of nature and environment towards the balance of physical, socio-economic, cultural, and other aspects [11].

IKN is a form of government realization that provides a city with world-class spatial planning, as explained in the Master Plan for the Development of the IKN. The policy of changing the status of Jakarta is a strategic step in organizing a good and adequate center of government. The relocation of the capital city emphasizes the current condition of Jakarta. With 60% of the population living on the islands of Java and Jakarta, this city is considered dense [12]. The Vision of Golden Indonesia 2045 is oriented towards a transformation strategy in terms of economy, infrastructure, state governance, and human resources. IKN is a form of urban transformation that promotes economic growth through the optimization of government activities while stimulating the development of other major cities.

IKN has a master plan showing all manifestations and transformations of urban planning through 8 (eight) types of principles and 24 (twenty-four) KPIs. The target emphasizes that the goal of the IKN becoming a livable city can be realized. A friendly city is a part of the principles and KPI in responding to the challenges of extreme climate change. The issuance of the IKN principles and KPI explains that different factors are guided by the principle of sustainability in the context of the development, operation, and maintenance of capital city.

The development of IKN that occurred previously was already in the first stage, namely building a city ecosystem, which focused on the development of basic infrastructure, development of initial residential infrastructure, development of government offices, and initiating priority economic sectors. Currently, the development of the IKN is in a transition period to enter the next stage, namely strengthening the core area of Nusantara by preparing the operation and maintenance of all assets that have been built, as well as developing other facilities needed in the development of infrastructure in the IKN. In order to promote sustainable building management in IKN, an understanding of sustainable building criteria is required.

Firstly, a sustainable building has to create benefits for public health [13, 14], such as improving air quality, providing adequate clean water and sanitation services, etc. Public health is a key factor in achieving the Sustainable Development Goals (SDGs). Good health is an important enabler of positive community and family life. Secondly, a sustainable building the contributes to the quality of life [13], where the infrastructure development or operations improve the well-being of citizens in the respective area and their satisfaction with living, working, or studying through convenience, accessibility, and cleanliness.

Lastly, a sustainable building has the ability to address the climate change through efficient energy consumption, adequate waste management, and use of innovations including smart technologies and eco-materials [11, 13]. The use of ICT-managed intelligent systems in infrastructure projects enable resource optimization, and efficiency energy improvements, and extends the building lifespan by providing adequate maintenance [14, 15]. These sustainable building criteria are then used as the basis for developing a Level of Standard framework that will be integrated with the Nusantara Net Zero Strategy 2045.

3.2 Indonesia's new capital Nusantara net zero strategy 2045

IKN has five strategies to achieve net zero city, namely: 1) Forestry and Other Land Use (FOLU), 2) energy efficiency, 3) Industrial Process and Product Utilization (IPPU), 4) waste management, and 5) agriculture. This strategy is divided into two masterplan scenarios, including Counter Measure 1 (CM1) and Counter Measure 2 (CM2). CM 1 was set in 2022, and CM2 was reported as an enhanced scenario with a more aggressive mitigation commitment to achieve net zero emissions by 2045. CM1 and CM2 emissions are calculated and compared with business-as-usual emissions. The calculation of the emission method has been examined extensively in several research [16, 17].

Forestry and Other Land Use (FOLU) refers to activities including the management and use of forests, woodlands, and other types of land, such as agricultural land, wetlands, and urban spaces. The application of FOLU to IKN includes avoiding deforestation, using IKN land for industrial eucalyptus forests, forest restoration, mangrove protection, fire control, and community-based forest management. Strategies including OIKN, market/private actors, and communities have been shown to achieve implementation efficiency, livelihood improvement, carbon sequestration, and biodiversity conservation. This is the latest effort to address climate change and improve socioeconomic and ecological conditions at local, subnational, national, regional, and global levels [18]. The management can increase CO_2 emissions from 0.19 $MtCO_2$ eq/year to -1.79 $MtCO_2$ eq/year for CM1 and -1.93 $MtCO_2$ eq/year for CM2.

In terms of energy, OIKN has adopted a stringent strategy, which includes achieving 100% renewable energy sources by 2030, implementing a 10-minute city design, attaining 80% mobility via public transport, and ensuring the use of 100% electric vehicles by 2045. The CM1 scenario will be 100% EV by 2040 and there is still city gas for limited household needs (for cooking). Meanwhile, CM2 100% will be achieved 10 years earlier without the provision of city gas network. In this scenario, CO_2 emissions increase from 10.07 $MtCO_2$ eq/year to 0.28 $MtCO_2$ eq/year for CM1 and 0.00 $MtCO_2$ eq/year for CM2.

The third strategy to achieve zero net energy for IKN in 2045 is the management of Industrial Process and Product Use (IPPU). The sector refers to emissions arising from industrial activities that are not related to energy consumption. These emissions occur during the physical or chemical transformation of raw materials in industrial processes or from the use of GHG in products. The IPPU sector is responsible for the majority of global GHG emissions. Even though the contribution varies by country and industrial activity, the sector contributes 5-10% of total global GHG emissions [19]. There are no emissions from IPPU sector in the IKN. Carbon dioxide is typically released during the production and use of certain materials with the energy consumed in the manufacturing process. These materials include cement, iron, steel, and certain chemicals. Since IKN does not have the industries, emissions from IPPU sector will be zero. Based on Nusantara Net Zero Strategy 2045 document, the construction material production process is not in Nusantara, given that IKN does not have the industries and the emissions are not counted as Nusantara emissions. But if the cement factory is built in Nusantara, then these emissions will be calculated as Nusantara emissions. To eliminate these emissions, the

government through Nusantara Net Zero Strategy 2045 regulates that the cement factory is built with the latest low-carbon technology, so that the emissions will drop to 0.5 MtCO2 in 2045.

The fourth strategy is waste management carried out through the 3R system and a circular economy. Approximately 60% of the waste generated in the IKN is recycled, while 40% is processed into energy and products. In this context, 10% - 12% of non-recyclable residues are disposed in landfills. This method has proven successful in contributing to reducing emissions produced [20, 21]. IKN reduces waste management emissions from 0.35 $MtCO_2$ eq/year for business-as-usual operations to 0.18 $MtCO_2$ eq/year for CM1 and 0.13 $MtCO_2$ eq/year for CM2.

The final strategy to achieve net zero energy by 2045 is climate-friendly agriculture. The agriculture sector is projected to be the one of main sources of GHG emissions in the agricultural sector even if with the implementation of carbon-reducing technologies [22, 23]. To achieve net zero emissions, the agriculture in IKN has to adopt the regenerative agriculture practices. If it is well implemented, it will enable Nusantara to sequester significant amounts of carbon [24, 25]. All agricultural waste, including poultry and livestock manure, crop residues, and other agricultural waste products, should be converted into biochar and used as soil amendments to improve fertility and store carbon in an inert form. Centralized biochar facilities can also be developed through public-private partnerships (PPP) with farming communities [26]. The agriculture strategy can also be integrated with FOLU strategy where green open spaces are planted with agriculture crops [18, 27]. Based on Nusantara Net Zero Strategy 2045, these regenerative agriculture practices are projected to sequester amounts of carbon in about 30 tCO_2/ha/year.

3.3 Indonesia new capital Nusantara level of service

There are no specific standards governing the development and management of infrastructure in the IKN that support net zero strategies [6]. Therefore, it is necessary to create standards [2] through level of Service. This standard assesses the "current level" against the "required level" both qualitatively and quantitatively. In this context, the achievement of service level can take place sustainably [28]. Level of Service standard is prepared based on the organizational values contained in the 8 IKN Principles to ensure that infrastructure assets meet quality standards, criteria, and service parameters.

3.3.1 Level of service in Forestry and Other Land Use (FOLU) strategy

To support the first net zero strategy, Forestry and Other Land Use (FOLU), land preparation for green open spaces can be done to maintain biodiversity and ecosystems in order to increase environmental, economic, and social sustainability [18, 29, 30]. Various types of plants can be planted in green open spaces, including parks, forests, street trees, and agriculture [27, 31, 32]. Besides FOLU, green open spaces can also support the fifth net zero strategy, agricultural strategies. According to the Regulation of the Minister of Public Works Number 05/PRT/M/2008 concerning Guidelines for the Provision and Utilization of Green Open Spaces in Urban Areas, the area of green open space is 30% of the site area. The provision of adequate greenery in buildings such as vertical [33-35] and roof gardens [36] can be an option. Based on previous results, the presence of greenery in buildings can save energy by an average of 20% - 30% and able to reach up to 50% [34].

3.3.2 Level of service in energy efficiency strategy

Energy efficiency in buildings, which constitutes the second strategy in net zero method can be achieved through effective building ventilation design, including the use of sufficient natural ventilation [37-39]. Good ventilation design in buildings has a significant impact on energy savings and reducing CO_2 emissions [37]. The use of natural ventilation reduces energy use and CO_2 carbon by 11% - 26% and 31% - 49%, respectively [38]. In Indonesia, this ventilation specification has been regulated as a building operational requirement through Sertifikat Laik Fungsi (the Building Function Suitability Certification). In the construction of IKN building, ventilation parameters refer to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), where the maximum CO_2 level is 1000 ppm, and ventilation meets the fresh air needs of 5 liters per second per person. However, the application of natural ventilation is highly dependent on the condition of the land and the area, hence not all buildings can conduct the implementation. A heating, ventilation, and air conditioning (HVAC) system may be required. To mitigate excessive energy consumption from artificial HVAC systems, the implementation of a smart HVAC system can be an effective solution [40-42]. The use of technology in the HVAC system reduces HVAC energy by 13.5% - 29.2% [41, 42].

Smart building automation systems can be applied to lighting systems [43-45]. Energy savings reach 68% on normal days when the application of smart lighting in buildings is carried out properly [45]. The efficiency is achieved more optimally through the implementation of automatic meter and sub-meter reader systems. Smart meters allow users or building managers to monitor electricity, water, or gas usage in real-time [46, 47]. This allows users to implement energy-efficient consumption to reduce CO_2 emissions [48] and implement electrical load balancers [49, 50]. The implementation of the Smart Building system in IKN refers to the Circular Letter of the Head of OIKN No. 09/2023 concerning Guidelines for the Development of Smart Buildings, Regulation of the Minister of Public Works and Public Housing Number 10/2023 concerning Gedung Cerdas, Cetak Biru Kota Cerdas Nusantara (Smart Buildings, Blueprint for the IKN Smart City).

In supporting energy efficiency on an urban scale, IKN is built with the concept of "10 minutes city design where 80% of motorized mobility is served by public transportation" [36, 51, 52] and bicycle paths [36, 52]. Based on reference [36], a walking city has 50% lower GHG residue than a city that uses cars. This is because CO_2 emissions from walking and cycling can be reduced by 100% [52]. In Indonesia, the construction of pedestrian and bicycle paths refers to Regulation of the Minister of Public Works and Public Housing No. 14/2017 concerning Building Ease Requirements, and Circular Letter No. 05/2021 concerning Design of Bicycle Facilities. Energy efficiency on an urban scale is pursued by using renewable resources [36, 48, 53], as well as electric vehicles and the supporting infrastructure [36, 54]. According to the study [53], renewable energy consumption has a significant impact on reducing carbon emissions, with a 1% increase per capita from 0.280% - 0.396% globally. In Europe, the application of renewable energy through electric vehicles reduces CO_2

emissions by 7.46% - 46.40% [54]. In Indonesia, the application of renewable resources refers to the Nusantara Net Zero Strategy 2045 as well as the Minister of Public Works and Public Housing Regulation 21/2021 concerning the Assessment of Green Building Performance.

3.3.3. Level of service in Industrial Processes and Product Use (IPPU) strategy

The third net-zero strategy, Industrial Processes and Product Use (IPPU) is carried out by using environmentally friendly materials, such as low-carbon cement, iron, and steel [36, 55] reducing CO_2 emissions by 22% [56]. The use of environmentally friendly materials is applied starting from the materials production, construction, operation, maintenance, dismantlement/disposal, and introduction of the eco-architectural method stage [55]. The measurement reference for environmentally friendly materials in Indonesia refers to the Nusantara Net Zero Strategy 2045 and the Minister of Public Works and Public Housing Regulation Number 21/2021 concerning the Assessment of Green Building Performance.

3.3.4 Level of service in waste management strategy

In the fourth strategy, waste management in net zero strategy is carried out by processing clean water [57, 58] as well as solid waste [59, 60]. Rainwater management can be a solution to saving drinking water by 39.2% - 42.7% [58]. The management has been regulated by the Minister of Public Works and Public Housing Regulation Number 11/2014 concerning Rainwater Management in Buildings and Lands. Additionally, wastewater management for reuse in toilet flushing can save clean water use by 28.7% - 34.8% [58]. In Indonesia, the concept is regulated by the Minister of Environment and Forestry Regulation Number 68 of 2016 concerning Domestic Wastewater Quality Standards. Besides wastewater treatment, based on reference [59], the concept of solid waste treatment has reduced GHG by 73% in the past 30 years in the UK. However, good management is needed to achieve net zero emissions, such as on-site sorting [60]. In this context, on-site waste sorting is efficient when integrated with existing technology from waste channels to smart trash bins [61]. Solid waste management in IKN refers to the Nusantara Net Zero Strategy 2045, the Minister of Public Works and Public Housing Regulation Number 21/2021 concerning the Assessment of Green Building Performance, the Head of IKN Authority Instruction Number 1/2023 concerning Waste Sorting and Plastic Waste Reduction in the IKN Authority Office Environment and IKN Development Project Locations, as well as Code of practice on environmental health, National Environment Agency of Singapore.

3.3.5 Level of service in agriculture strategy

Agricultural strategy is used to increase water use efficiency in irrigation systems [36, 62, 63]. According to reference [62], 70% of water in a country is distributed to the agriculture sector. Therefore, special attention is needed to develop smart water management, such as irrigation systems, track usage, detect leaks, and optimize water use [63]. Based on the research, smart water management reduces 28% of use in irrigation systems.

4. METHODOLOGY

This research consisted of two stages, namely 1) literature review and 2) producing level of service for construction, operations, and maintenance activities in the development of IKN Forest City. In the first stage, a literature review was conducted by searching for the following keywords in article titles: 'Sustainable Building', 'Green Building', 'Net Zero Building', and 'Sustainable City'. The research scope was limited by only English literature research, reviews, and articles that were published in the period of 2005-2024 and Scopus indexed. The resulting documents were filtered in a systematic methodology as seen in Figure 1, which consists of excluding irrelevant subject areas, removing duplication, reviewing the titles and abstracts, and thorough reading. A further comprehensive screening was conducted through the full documents which yielded 55 articles.

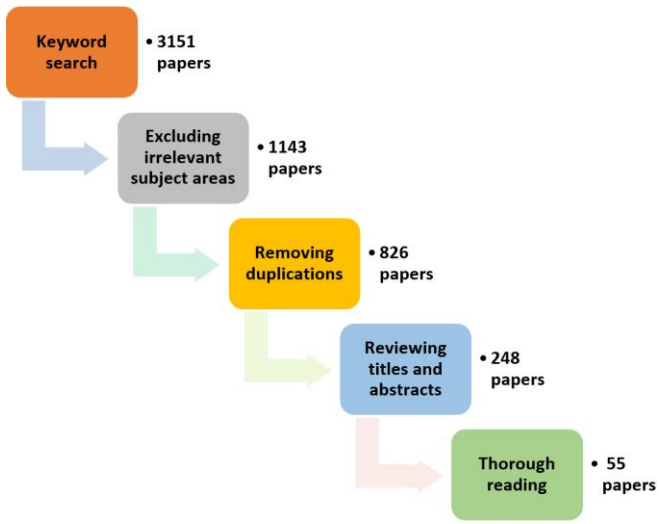

Figure 1. Systematic literature review process

The literature review that had been conducted is then tabulated into a draft Level of Service Standard. In this part, the author studied the standards or regulations that apply in Indonesia to each criterion parameter.

In the second stage, level of service was developed through FGD with the experts based on previous literatures related to the Nusantara Net Zero Strategy 2045, as well as service level standards for building infrastructure that apply in Indonesia. The experts in this FGD consist of five experts, including three local experts (i.e., an expert in green building area and two experts in project management area) and two international experts (i.e., an expert in green building area and an expert in smart building area).

5. DISCUSSIONS AND RESULTS

Greenhouse gas (GHG) emissions are a global issue, both in developing and developed countries [64]. The emissions gap report [65] explained that greenhouse gas (GHG) emissions hit new highs in 2023, implying temperature records tumble and climate impacts intensify. This problem needs special attention from all countries throughout the world. In Indonesia, greenhouse gas (GHG) emission issues have been attempted to be accommodated through the Nusantara Net Zero Strategy 2045 that will be applied in Nusantara Capital City first. However, the standards and policies are required to achieve those strategies [2, 6], one of which is the level of service (LoS) which will later be a KPI standards for built

assets in Nusantara Capital City (IKN).In this study, the development of the LoS Standard framework was carried out by integrating building level of service parameters with Nusantara Net Zero Strategy 2045 (i.e., FOLU strategy, energy efficiency strategy, IPPU strategy, waste management strategy, and agriculture strategy) and sustainable indicators criteria obtained from the literature review. The LoS parameters obtained from the results of the literature review were then validated with experts through the FGD process, resulting in one additional parameter related to the criteria for green building. The international standards were also added through discussion input based on best practices that can be applied in this proposed LoS standard framework.

The final results of the development of level of service framework that can support the achievement of net zero strategies in the IKN are classified into 6 (six) criteria based on sustainable building criteria (i.e., health, convenience, accessibility, cleanliness, sustainability, and intelligence) and 19 (nineteen) sub-criteria as shown in Table 1.

Table 1. Level of service to expedite net zero

Criteria	Parameter	Measurement Code	Net Zero Strategy	References
		A. Health		
Ventilation	Carbon Dioxide level and the fresh air needs per person	•ASHRAE •SLF Building Indoor Air Comfort Building	Energy Efficiency	[37-39]
Rainwater Management	Availability and functionality of rainwater management facilities	•Minister of Public Works and Spatial Planning Regulation No. 11/2014	Waste Management	[57, 58]
Wastewater Management	Availability of wastewater management facilities and standard parameters for domestic wastewater quality	•Wastewater Engineering Treatment and Reuse (4th Edition), Metcalf & Eddy, Inc. •European Union (EU) Urban Waste Water Treatment Directive (91/271/EEC) •Minister of Environment and Forestry Regulation No. 68/2016	Waste Management	[57, 58]
Waste Management	Use of equipment and drinks, polybags, paper, and reusable containers	•Instruction of the Head of the OIKN No. 01/2023	Waste Management	[59, 60]
		B. Convenience		
Greenery in Buildings	Having greenery in buildings such as parks and/or vertical gardens and/or roof gardens	•FGD Experts and Related Stakeholders	Forestry and Other Land Uses (FOLU)	[33-35]
Green Open Spaces	Green Open Space must constitute at least 30% of the site area	•Minister of Public Works and Spatial Planning Regulation No. 05/PRT/M/2008	•Forestry and Other Land Uses (FOLU) •Agriculture	[18, 28-30]
		C. Accessibility		
Pedestrian Paths and Shade Paths	Conditions and ease of use of Pedestrian and Shade Paths	•Accessibility code 2019 Singapore •Global Street Design Guide, NACTO •Minister of Public Works and Spatial Planning Regulation No. 14/2017	Energy Efficiency	[36, 51, 52]
Bicycle Paths	Conditions and ease of use of Bicycle Paths	•Global Street Design Guide, NACTO •Bicycle Design Guidelines, Ministry of Public Works and Spatial Planning (05/BM/2021)	Energy Efficiency	[36, 52].
Trash Bins	Number of trash bins available, conditions, and placement of trash bins	•Code of practice on environmental health, National Environment Agency of Singapore	Waste Management	[59-60]
		D. Cleanliness		
Parks	Clean park conditions and maintained	•Turf And Horticulture •Practice Note 10.3 Parks Management, IPWEA •ISO 10004-2018 Quality Management - Customer Satisfaction	Forestry and Other Land Uses (FOLU)	[33-35]
		E. Sustainability		
Energy Use Efficiency	Use of electric vehicles and provision of supporting infrastructure	•Minister of Public Works and Spatial •Planning Regulation No. 21/2021 •Nusantara Net Zero Strategy 2045	Energy Efficiency	[36, 54]
	Using renewable energy or electricity sources		Energy Efficiency	[36, 48, 53]
	Implementing energy-efficient energy consumption		Energy Efficiency	[48]
Water Use Efficiency	Consumption of water use	•Minister of Public Works and Spatial Planning Regulation No. 21/2021	Agriculture	[36]
Use of environmentally friendly materials	Level of use of low carbon cement, iron, and steel	•Nusantara Net Zero Strategy 2045 •EN 15804 •ISO 14025:2006	Industrial Processes and Product Use (IPPU)	[36, 55, 56]
	Level of use of environmentally friendly materials	•Minister of Public Works and Spatial Planning Regulation No. 21/2021	Industrial Processes and Product Use (IPPU)	[36, 55, 56]

Waste Control	Waste control conditions	•Minister of Public Works and Spatial Planning Regulation No. 21/2021 •Nusantara Net Zero Strategy 2045	Waste Management	[59, 60]
Wastewater Control	Level of wastewater recycling	•Minister of Public Works and Spatial Planning Regulation No. 21/2021	Waste Management	[57-58]
		F. Intelligence		
Resource Systems	Availability and functioning of smart water management system to monitor water quality, detect leaks, track water usage, and optimize water usage and irrigation	•Circular Letter of the Head of OIKN No. 09/2023 •Regulation of the Minister of Public Works and Public Housing No. 10/2023	Agriculture	[36, 62, 63]
	Availability and functioning of smart waste chute & smart trash bin	•Blueprint of the Smart City of Nusantara, Deputy for Green and Digital Transformation	Waste Management	[59-61]
Energy Systems	Availability and functioning of Energy System Automatic meter reader & sub-meter for efficient energy management	•Circular Letter of the Head of OIKN No. 09/2023	Energy Efficiency	[46, 47]
	Electric load balancer	•Blueprint of the Smart City of Nusantara, Deputy for Green and Digital Transformation	Energy Efficiency	[49, 50]
	Availability and functioning of Public Electric Vehicle Charging System (SPKLU)	•IEC TS 60364-8.2:2018 •IEC TS 60364-8.3: 2020	Energy Efficiency	[36, 54]
Lighting Systems	Availability and functioning of Automatic Lighting System	•Circular Letter of the Head of OIKN No. 09/2023 •Regulation of the Minister of Public Works and Public Housing No. 10/2023 •Blueprint of the Smart City of •Nusantara, Deputy for Green and Digital Transformation	Energy Efficiency	[43-45]
Heating, Ventilation, and Air Conditioning (HVAC) System	Availability and functioning of Heating, Ventilation, and Air Conditioning System (HVAC System)	•Circular Letter of the Head of OIKN No. 09/2023 •Regulation of the Minister of Public Works and Public Housing No. 10/2023 •Blueprint of the Smart City of Nusantara, Deputy for Green and Digital Transformation	Energy Efficiency	[40-42]

Note: The 'Criteria' column explains the aspects and sub-aspects of level of Service assessment, the 'Parameter' column describes the elements that will be measured in level of Service assessment, the 'Measurement Code' column explains the standard guidelines that will be used as a reference for the value in level of Service assessment benchmark, the 'Net Zero Strategy' column explains the categories in Nusantara's net zero strategy that will be supported by related aspects and sub-aspects, and the 'References' column contains sources of previous literature research.

6. CONCLUSIONS

Indonesia's New Capital City, Nusantara or IKN, is expected to be a model city, especially in Indonesia. The establishment of this Building Level of Service Standard are not only to achieve the Nusantara Net Zero Strategy in IKN but can also be applied in other cities in Indonesia or even other countries with similar climate and conditions to achieve net zero. this The Level of Service Standard framework was compiled based on previous research using regulations and related standards as a reference for measurement parameters. The limitations of this study only cover the level of service indicator components related to the net zero strategy for building infrastructure. Based on the previous researches, the utilization of green open spaces and renewable energy (including electric vehicles) are the most significant indicators in reducing carbon dioxide emissions, which can reach up to 50% if implemented optimally.

This proposed standard framework not only supports the Nusantara Net Zero Strategy 2045 but also supports the government, especially the Nusantara Capital City Authority (OIKN), in ensuring that building management in IKN can provide optimal services to the public as per the 8 (eight) principles and 24 (twenty-four) KPIs of IKN. As well as for the investors, while development of IKN is a fairly massive project that requires a lot of funds, the government is also holding the option of procuring infrastructure in IKN with Public Private Partnership (PPP) scheme. The establishment of this Level of Service Standard can be used as a basis for the government and investors in formulating Service Level Agreement (SLA) in PPP scheme cooperation agreements. Thus, it is expected that the public will gain equal services where there is no gap between building management by the government or by investors.

The scope of this research only covers the level of service standard for building infrastructures in general, while there are still several other types of infrastructure that need to be considered to achieve net zero. Then, according to Law Number 28 of 2002 concerning Building, in Indonesia, buildings are classified based on their class and function. It is very possible that each type of building has different characteristics, thus it requires special parameters to achieve certain services. This research also has not reviewed the extent of readiness to adapt to this level of service standard, where there are possibility of the resource limitations both in terms of quality and quantity. Given the gaps, the following potential future directions are clear:

•Providing details of building level of standards based on the type of building

•Providing the level of service standards for other types of infrastructure, such as roads, bridges, water structures, etc.

•Attempting to find the readiness needs in implementing the

proposed level of services standard, as well as the roadmap journey that may be needed to achieve Nusantara Net Zero Strategy 2045.

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