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Smart Building of TNI AU Headquarters Building in the Capital City of the Archipelago

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A B S T R A C T

This study aims to analyze the implementation of a smart building system at the TNI Air Force Headquarters in IKN as an effort to realize a smart city area in the new capital city. The research method used is qualitative, with data collection techniques through in-depth interviews, observations, and document studies. The results of the study indicate that the TNI Air Force Headquarters in IKN will implement an integrated smart building system, including energy management, security, and information systems. The implementation of this system aims to increase efficiency, effectiveness, and comfort for building users. This study concludes that the use of smart building technology at the Indonesian Air Force Headquarters in the IKN is a strategic step in realizing the concept of a smart city in the Capital City of the Archipelago.

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INTRODUCTION

The relocation of the National Capital to the Indonesian Capital City has strategic value for Indonesia's energy security and national development. The Indonesian Capital City is a milestone in achieving the vision of Advanced Indonesia 2045 which is supported by the Indonesia-centric development approach with the aim of creating inclusive growth. This relocation is not just a physical relocation of the capital city and government offices, but also an effort to build a new smart city that is able to compete globally. This city is expected to be the locomotive of Indonesia's transformation based on innovation, technology, and a green economy. In addition, the relocation of the capital city is also expected to encourage development in the Eastern Indonesia region, strengthen the agricultural sector, and support national economic transformation (RI, 2022).

The development of the Smart City concept in the Indonesian Capital is closely related to the implementation of Smart Buildings. This smart city concept includes various elements such as smart governance, smart living, smart buildings, smart mobility and transportation, smart nature conservation, and smart cultural and national transformation. Smart buildings are the main component in supporting this, including the use of energy-saving technology, renewable energy sources, improving air quality, and utilizing natural lighting. Therefore, the development of smart cities will be greatly supported by the existence of efficient, environmentally friendly, and sustainable buildings (Sari, 2022).

The relocation of the National Capital to the Indonesian Capital with a smart city approach has a direct impact on the development of government infrastructure, including the TNI Headquarters and the military headquarters which will adopt smart building technology. Smart buildings are buildings that integrate the concept of smart and environmentally friendly buildings through the application of automation in an integrated management system or Integrated Building Management System (IBMS), including the Building Automation System or Building Automation System (BAS) (Berawi MA, 2023). The construction of the IKN Headquarters is expected to support a smart city, different from conventional buildings that still rely on manual systems. This building will be equipped with smart technology, but still pays attention to security and supporting infrastructure such as energy, clean water, transportation, logistics, and telecommunications services.

The success of the construction of the IKN Mabesau smart building depends on the readiness of the infrastructure that is currently under construction. In addition, the competence of TNI AU personnel in operating smart building technology is also a crucial factor. However, the results of the study showed that the ability of TNI AU personnel in the fields of information technology, automation systems, and electrical energy management is still limited.

To overcome these obstacles, strategic and gradual steps are needed, both in the short, medium, and long term. The concept of the IKN Mabesau smart building will refer to the IKN smart city blueprint and includes the use of green buildings, energy efficiency, water and building material savings, improving air quality and health, and implementing smart grid technology that uses solar energy, smart meters, and fiber optic networks.

All efforts to develop smart buildings at the Indonesian Air Force Headquarters (Mabesau) in the Indonesian Capital City are directed to create an efficient, environmentally friendly, and sustainable environment, as well as supporting the realization of the Indonesian Smart City concept as a whole. In this context, research is focused on the utilization of smart building technology in the Mabesau environment as an integral part of the smart city development strategy. To understand in depth how this concept can be implemented effectively, this study examines three main aspects. First, the readiness of supporting infrastructure is a crucial element in the successful implementation of smart building systems. This includes the availability of energy supplies, clean water, transportation and logistics networks, and adequate digital connectivity. Mature infrastructure will be the main foundation in supporting the automation system and operational efficiency of the Mabesau building.

Second, the competence of the Indonesian Air Force personnel who will man and manage this building is another important aspect. Mastery of information technology, automation systems, and energy management and digital security are skills that must be possessed by the human resources involved. Without personnel readiness, no matter how sophisticated the technology is, it will not function optimally.

Third, this study also highlights the main systems planned to be implemented in the Mabesau building. This includes the use of renewable energy such as solar panels, smart meters for monitoring energy consumption, natural and automatic lighting systems, to integration with smart grids and fiber optic networks. All of these systems will be controlled through the Integrated Building Management System (IBMS) framework that allows efficient and real-time cross-system communication and control. By examining these three aspects, this study aims to provide a comprehensive picture of how the smart building concept can be implemented in Mabesau, while supporting the development of the Indonesian Capital region as a globally competitive smart city.

The purpose of this study is to analyze the use of smart buildings in Mabesau in order to support the realization of a smart city area in the Capital City of the Archipelago. This study is expected to provide practical benefits as input for planning the development of Mabesau in the IKN, as well as provide theoretical contributions in the development of defense science, especially in terms of implementing high technology in military infrastructure.

LITERATURE REVIEW

Regulations and Legislation

a. Law of the Republic of Indonesia Number 3 of 2002 concerning National Defense.
   Article 6 emphasizes that national defense is implemented through efforts to build and foster the capabilities, resilience of the nation and state, and to overcome every form of threat.
b. Law of the Republic of Indonesia Number 34 of 2004 concerning the Indonesian National Army.
   Article 10 states that the Indonesian Air Force has the task of carrying out the role of the TNI in the development and advancement of air force strength.
c. Law of the Republic of Indonesia Number 3 of 2022 concerning the National Capital.
   This law is the operational legal basis for all ministries, government institutions, and the private sector in supporting the relocation of the national capital from Jakarta to North Penajam Paser.
d. Law of the Republic of Indonesia Number 21 of 2023 concerning Amendments to Law Number 3 of 2022 This law.
   Emphasizes legal certainty in the process of accelerating the preparation, construction, and relocation of the nation's capital, as well as the implementation of the special regional government of the Indonesian Capital City.
e. Decree of the TNI Commander Number Kep/545/V/2019 dated May 22, 2019 concerning the Indonesian Air Force Doctrine "Swa Bhuwana Paksa".
   This doctrine emphasizes that the development of the TNI AU's capabilities aims to realize professionalism in carrying out the task of maintaining the security of the national airspace.
f. Circular Letter of the Head of the Indonesian Capital Authority No. 009/SE/Head-of-IKN Authority/VIII/2023.
   This circular letter contains guidelines for the implementation of the smart building system in the IKN, including advanced technology that will be applied to the construction of the TNI AU Headquarters building.

Theoretical Basis

a. Development Theory by Deddy T. Tikson
   Tikson views national development as a planned economic, social, and cultural transformation through policies and strategies. He divides development theory into three paradigms: modernization, underdevelopment, and dependency, with the focus that development is a process of directed change for the progress of society (Tikson, 2005).
b. Core-Periphery Theory by John Friedman
   Friedman explains the existence of a core region that develops first and is surrounded by peripheral areas. Development occurs through market expansion, resource exploration, and technology dissemination. Infrastructure plays an important role as a motor of change from the center to the periphery (Friedman, 1979).

c. Collaborative Government Theory by Jhon and Richard
   This theory emphasizes the importance of collaboration between government, private sector, and society in policy making and development implementation. This approach aims to create inclusive and more effective development (Jhon and Richard, 2011).
d. Modernization Theory by RE Ahmad
   Modernization is defined as a process of change towards a more advanced condition, both in material and immaterial aspects. This process includes the transformation of values, the spread of knowledge, and the improvement of social and economic welfare. Ahmad also put forward five stages of modernization: psychological, intellectual, demographic, social, and economic (Ahmad, 2011).
e. Cyber Security Theory by Bruce Schneier
   Schneier introduced the concept of "The Security Mindset", which emphasizes that security is not just about technology, but also about mindset. He stated that security must be continuous, based on risk assessment, designed from the start, and involve openness and transparency. Security must also be seen as a process, not a finished product at one time (Schneier, 2008).

METHODOLOGY

This study uses a qualitative method to analyze the use of *smart buildings* in the Mabesau building to realize a *smart city area* in the Indonesian Capital City. This method was chosen because it allows researchers to gain a deep understanding of the concept of *smart buildings* and how their implementation can support the development of a sustainable and environmentally friendly *smart city area*. The analysis was conducted descriptively, aiming to provide a detailed and comprehensive picture of various aspects related to the implementation of *smart buildings* in Mabesau IKN.

The data sources for this study come from primary and secondary data. Primary data were obtained directly from related agencies, namely the Indonesian Air Force Construction Service (Diskonsau), through in-depth interviews with key informants. These interviews were designed to obtain information about:

a. Readiness of supporting infrastructure in the application of the smart building concept.
b. The competence of the Indonesian Air Force personnel who will man the building.
c. The systems that will be implemented to make the Mabesau building a smart building.

Information from the interviews was analyzed to understand the challenges and opportunities in implementing the *smart building concept* at Mabesau IKN.

Meanwhile, secondary data was obtained from documents related to the planning and development of the Indonesian Capital City and references regarding *smart buildings*. This includes the IKN master plan, policies and regulations related to *smart city development*, as well as scientific journals and relevant articles. Document analysis was conducted to complement primary data and provide a broader context.

The qualitative approach and descriptive analysis allow for in-depth exploration of various relevant aspects, considering that the development of the IKN was still ongoing when this research was conducted, so statistical measurements were not yet possible.

The focus of this research includes three main questions:

1. How is the readiness of the supporting infrastructure in applying the *smart building concept* to the Mabesau building in the Indonesian Capital City?
2. What are the competencies of the personnel who will man the Mabesau building with the *smart building concept*?
3. What systems will be applied to the Mabesau building to make it a building with a *smart building concept*?

RESEARCH RESULTS AND DISCUSSIONS

Readiness of Supporting Infrastructure in the Application of the Smart Building Concept in the Mabesau Building in the Capital City of the Archipelago

The smoothness of a development is largely determined by the readiness of supporting infrastructure that plays a crucial role in ensuring that each stage of the development process runs efficiently and on time. Referring to the Core Region/Area theory by John Friedman, the concept of *core-periphery is explained*, namely the existence of a core or central area surrounded by a peripheral area (*periphery region*). This theory emphasizes that a good relationship between the core and the periphery can be realized through adequate infrastructure.

Smart building is a building that utilizes advanced technology to create an environmentally friendly, efficient, and sustainable environment. In this context, the readiness of supporting infrastructure is a key factor in the success of implementing the *smart building concept* in Mabesau IKN. Currently, infrastructure development in the Indonesian Capital City is still in its early stages. In order for the implementation of the *smart building concept* to run optimally, support is needed from infrastructure such as:

a. Roads and bridges.
b. Transportation system.
c. Energy.
d. Telecommunication.

All these elements enable the distribution of materials, labor, and information to take place quickly and efficiently, so that obstacles in the project can be minimized.

Based on the results of an interview with Colonel Sus Yusrizal, ST, Head of the Sarpras Sub-dept. of the Cilangkap Air Force Base, the author groups the readiness of supporting infrastructure into three main phases:

1. Initial or Preparation Stage.
2. Implementation Stage, namely regional development and development activities.
3. Maintenance Stage.

These three stages are interrelated. For example, **road access** is needed from the preparation phase to maintenance to support sustainable accessibility to the IKN Mabesau *smart building*.

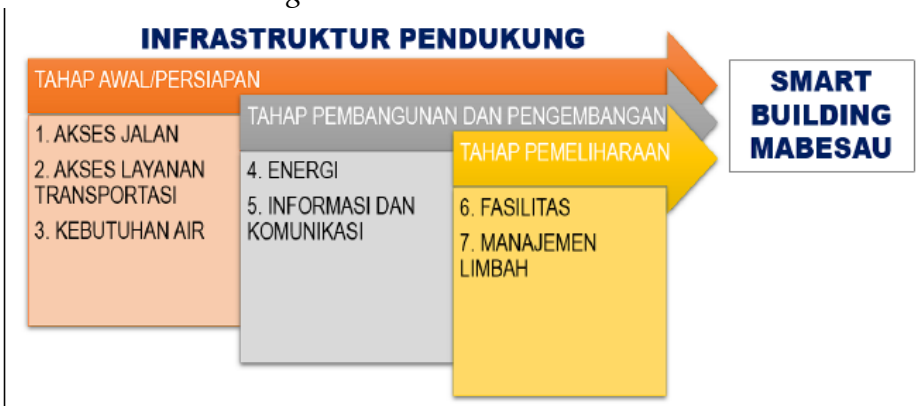

Figure 1. Priority of Infrastructure Support for *the Smart Building* of IKN Headquarters.

Source: Processed By the Author, 2024.

The readiness of supporting infrastructure in the application of the *smart building concept* in the Mabesau building in the Indonesian Capital City is a crucial factor in ensuring smooth development efficiently and on time. The government has built a 47.63 km toll road connecting the IKN Core Government Center Area (KIPP) with Sepinggan Airport, so that the travel time is around ±30 minutes. In addition, the IKN VVIP Airport is also planned to be connected to Balikpapan via a toll road that passes through the Pulau Balang Bridge. Transportation service infrastructure is also an important concern, including the readiness of air routes through Balikpapan Sepinggan Airport and IKN VVIP Airport, sea routes through Balikpapan Port, and land routes that rely on transportation systems such as ART, BRT, and MRT. In terms of water supply, the Sepaku Semoi Dam and Sepaku Intake have been prepared to meet the water supply needs in the IKN area for the next hundred years.

In the energy sector, PLN has completed the construction of a 50-Megawatt Solar Power Plant (PLTS) in Sepaku, East Kalimantan, and is planning to build a 70 MW Wind Power Plant (PLTB) in Tanah Laut in the initial stage and a Hydroelectric Power Plant (PLTA) with a capacity of around 1,000 MW in the long term. Information and communication technology (ICT) infrastructure is another important foundation, with the main focus on the development of fiber optic networks and 5G technology by the Ministry of Communication and Informatics to support *smart city- based governance*. Supporting facilities such as transportation systems and health services based on the Internet of Things (IoT) are also being built to support the operationalization of smart areas. In waste

management, the Moving Bed Biofilm Reactor (MBBR) technology concept is used to treat domestic wastewater connected to the Wastewater Treatment Plant (IPAL) and Integrated Waste Treatment Facility (TPST).

Related to the manning of the Mabesau building which adopts the *smart building concept*, competent and trained human resources are needed. The theory of people-centered development put forward by Deddy T. Tikson emphasizes that humans are the center of the development process. In this context, TNI AU personnel who will be tasked with managing the *smart building* must have skills in the fields of information technology, automation systems, and energy management. Currently, there are still limitations in terms of both quantity and quality of TNI AU personnel in mastering the technology used to operate and maintain smart systems in buildings. Smart building management requires the integration of various complex systems, ranging from energy management, security, to automation systems, which require technical skills and analytical abilities to interpret data from various sensors and monitoring systems.

To overcome these challenges, several strategic steps need to be taken. First, improve special training and education programs for TNI AU personnel in the fields of *smart building technology*, energy management, and automation systems that cover theoretical and practical aspects. Second, recruit personnel with information technology and automation backgrounds, and provide career development opportunities through advanced training and certification. Third, establish cooperation with educational institutions, technology companies, and *smart building service providers* to accelerate knowledge transfer and technical support. Fourth, build a knowledge management system that facilitates the exchange of information, experience, and best practices between personnel through a digital platform that can support continuous learning.

The systems that will be implemented in the Mabesau building refer to the Circular Letter of the Head of the Indonesian Capital Authority Number 009/SE/Head of the IKN Authority/VIII/2023 concerning the Guidelines for the Indonesian Smart Building. These systems are designed to improve the efficiency, sustainability, and security of buildings, and all will be managed through an automation framework called the *Integrated Building Management System* (IBMS). Some of the main systems planned include an HVAC system for automatic temperature and air quality control, a fiber optic and 5G-based communication system, an energy system connected to *the smart grid* and using solar energy, and a touchless access control system equipped with digital-based visitor management. In addition, an energy-efficient smart lighting system, a camera-based and biometric security system, and a resource system that manages water and waste efficiently will be implemented. This facility is equipped with an automatic safety system and internal mobility systems such as smart lifts and automatic parking management. With all these systems, the Mabesau building in IKN is expected to become a prototype of a military *smart building that supports the realization of the Indonesian Capital as the leading smart city* area in Indonesia.

Various advanced technology systems will be implemented in the construction of the Mabesau building in the Indonesian Capital City to support the concept of an efficient, safe, and sustainable *smart building*. *First, the HVAC (Heating, Ventilation, and Air Conditioning*) system will be used to automatically regulate temperature, humidity, and air quality inside the building. This system is supported by intelligent sensors and algorithms that allow real-time adjustment of environmental conditions to improve comfort and energy efficiency (Carli, 2020; Zhou et al., 2023; Merabet et al., 2021).

Second, the communication system will be supported by high-tech telecommunications infrastructure in the form of a fiber optic network embedded in underground channels, to ensure fast and stable connectivity. This infrastructure will support various smart technology applications such as the Internet of Things (IoT), internal communication systems, and integrated data management.

Furthermore, the energy system will rely on integration with *smart grids* to optimize electricity usage and distribution. Renewable energy such as solar power will be utilized through the installation of solar panels on the roofs of buildings. *Smart grids* will help in the efficient management and storage of the energy generated (Orikpete et al., 2023; Kataray et al., 2023; Sharma, 2024). Access control systems will also be implemented in the form of a touchless system that allows personnel or visitors to enter certain areas without physically touching the device. In addition, a high-tech visitor management system will be used to simplify the process of welcoming, monitoring, and controlling access to the building (Berawi, 2023).

For lighting efficiency, smart lighting systems will optimize the use of natural light and energy-saving LED lights. Light and motion sensors will automatically adjust lighting to suit needs, without wasting energy (Soheilian et al., 2021; Vaidya, 2021; Ramadhani, 2022). In terms of security, the building will be equipped with an intelligent surveillance system that includes high-resolution surveillance cameras, motion sensors, and a biometric-based access control system. All of these components are connected to a security control center to enable rapid response to potential threats (Zhang, 2016; Ciholas et al., 2019; Li, 2023).

The building resource system will include intelligent water and waste management. The use of low-water technology taps and toilets, as well as wastewater recycling systems, will reduce water consumption. The waste management system will include source separation, recycling processes, and organic waste treatment to support a clean and sustainable environment (Krishnan et al., 2022; Shahanas et al., 2016; Singh, 2021). The building safety system will be equipped with automatic safety devices such as intelligent fire extinguishing systems, emergency buttons, and animal hazard protection systems. All of these are integrated into the building safety network that supports rapid reaction in emergency situations (Berawi, 2023).

Finally, the mobility system in the building will include smart transportation technology such as automatic elevators and digital parking management systems. This system is designed to improve the comfort and efficiency of mobility for all users of the Mabesau building in the Indonesian Capital area.

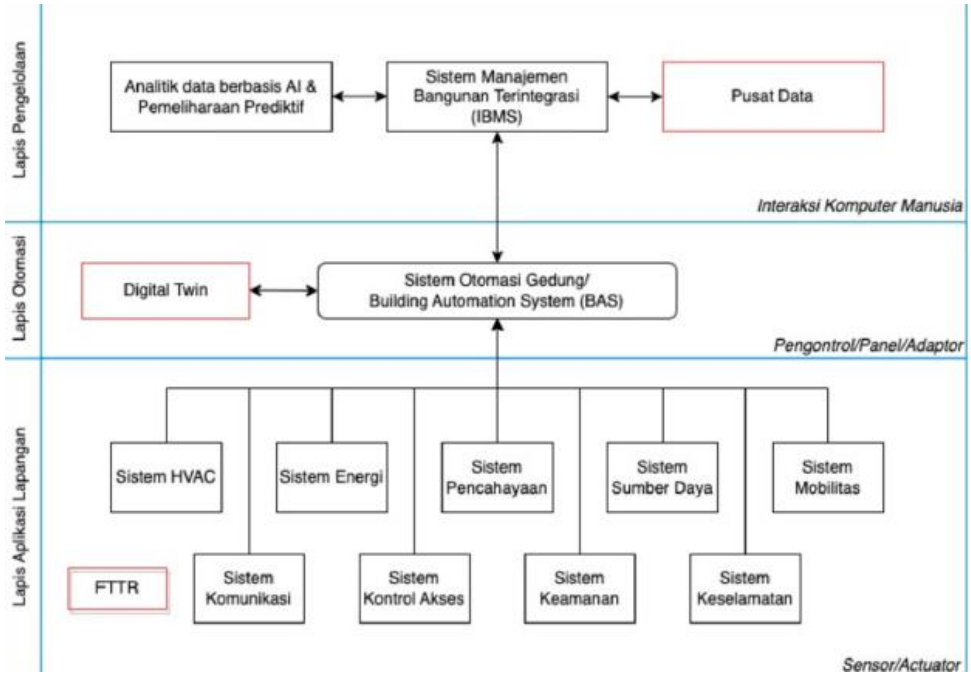

Figure 2. Automation Layer on the IBMS Framework of the IKN Headquarters Building.

Source: Smart Building Guidelines for the Indonesian Capital, 2023.

By implementing an automation system in the Indonesian Air Force Headquarters (Mabesau) building in the Indonesian Capital City (IKN) based on the Integrated Building Management System (IBMS), various problems that have occurred in Mabesau Cilangkap such as high electricity consumption, uncontrolled lighting systems, suboptimal HVAC systems, no waste processing, and chaotic parking conditions can be controlled in real time through the use of sensors and actuators. In order for the IBMS system to function optimally, adequate infrastructure support is needed, especially strong and stable internet connection services in the Mabesau IKN environment.

The implementation of the smart building concept at Mabesau in IKN requires comprehensive and structured planning that includes short, medium, and long-term stages. The following are the planning stages:

a. Short Term Planning (1–2 Years)
    1. Needs and Readiness Assessment
       Conduct a comprehensive analysis of infrastructure, technology, and human resource (HR) readiness needs required to support smart building implementation.
    2. Initial Personnel Training
       Conducting basic training for Indonesian Air Force personnel on smart building technology, automation systems, and energy management and efficiency.

3. Basic Infrastructure Development
   Building initial technological infrastructure such as high-speed internet networks, installing IoT (Internet of Things) sensors, and digital security systems as the foundation of smart buildings.
4. Initial Collaboration with External Parties
   Establish cooperation with technology companies for the procurement of basic smart building hardware and software, and collaborate with educational institutions to support initial personnel training.

b. Medium Term Planning (3–5 Years)
   1. Core System Implementation
      Performing installation and integration of core systems such as Building Energy Management System (BEMS), Building Automation System (BAS), and Integrated Building Management System (IBMS).
   2. Advanced Competency Development
      Conducting advanced training and certification for personnel to improve data analysis, problem solving, and energy management optimization and smart building system maintenance capabilities.
   3. Advanced Infrastructure Development
      Integrating smart grids for intelligent electrical energy management, automating building operations, and using analytical software for monitoring and optimizing building performance.
   4. Advanced Development Collaboration
      Continue cooperation with energy and technology service providers for the development of smart grid systems, as well as establishing partnerships with research and educational institutions to support research and development of automation and data analytics technologies.

c. Long Term Planning (6–10 Years)
   1. Continuous Evaluation and Improvement
      Conduct periodic evaluations of the performance of smart building systems and infrastructure and implement continuous improvements based on the results of these evaluations.
   2. Special Skills Training
      Organizing advanced skills training for personnel related to Artificial Intelligence (AI)-based systems, cutting-edge technology, and sustainable development planning capabilities.
   3. Sustainable Infrastructure Development
      Developing AI-based technology to support system updates, managing the use of renewable electricity, and strengthening adaptive cybersecurity systems to ensure the resilience and sustainability of building operations in the long term.
   4. Sustainable Collaboration with External Parties
      Expanding cooperation with research institutions and technology companies for the development of AI and renewable energy technologies, as well as organizing sustainable training programs with educational institutions to improve HR competencies sustainably.

Table 1. Plan for Staging the Implementation of the *SMA Concept*

No.	Short Term (1–2 Years)	Medium Term (3–5 Years)	Long Term (6–10 Years)
1.	Needs And Readiness Assessment	Implementation Of Core Systems (Bems, Bas, And Ibms)	Continuous Evaluation and Improvement
2.	Basic Training for Air Force Personnel	Advanced Competency Development for Personnel Managing Smart Building Systems	Specialized Skills Training for Air Force Personnel
3.	Basic Infrastructure Development	Development Of Advanced Infrastructure (Integration of Smart Grid and Automation Systems)	Development Of Sustainable Infrastructure (Ai and Cybersecurity)
4.	Initial Collaboration with External Parties	Ongoing Development Collaboration with External Stakeholders	Development Of Long-Term Collaboration with External Parties

CONCLUSIONS AND RECOMMENDATIONS

The implementation of the smart building concept in the Indonesian Air Force Headquarters (Mabesau) building in the Indonesian Capital City (IKN) is a strategic step in supporting the development of an efficient, sustainable, and environmentally friendly smart city area. However, a number of major challenges need to be faced, especially related to the readiness of supporting infrastructure and the competence of human resources who will manage the system.

Through comprehensive and structured planning, it is expected that smart building-based buildings can operate optimally and provide real contributions to national development goals. To achieve this, here are some recommendations that can be applied:

a. Realizing Infrastructure and Technology Investment
   Focus investment on the development of digital and energy infrastructure. Prioritize the development of fiber-optic telecommunications networks and the implementation of 5G technology to ensure fast and reliable connectivity. In addition, it is also important to invest in the development of smart grids and renewable energy storage technologies as the foundation for building energy efficiency.
b. Organizing the Indonesian Air Force Personnel Training and Development Program
   Conduct structured training for TNI AU personnel in the fields of information technology, automation systems, and energy management. Collaboration with educational institutions and technology providers is

essential to accelerate the transfer of knowledge and skills needed to manage smart buildings professionally.

c. Implementing Cross-Sectoral Coordination
   The formation of a cross-sector working team is necessary to ensure synergy between agencies in overseeing project development, while also ensuring the integration and harmonization of all aspects involved in the implementation of smart buildings.
d. Develop and Implement Supportive Regulations
   It is necessary to prepare and implement special regulations that support the development, operation, and management of smart buildings so that each process runs according to the expected safety, efficiency, and sustainability standards.
e. Implementing a Strict Cyber Security System
   Given that smart buildings rely heavily on digital systems, developing robust and adaptive cybersecurity protocols is a must. This is to protect systems from potential cyber threats and ensure data security and smooth operations.

ADVANCED RESEARCH

Further research on the implementation of smart buildings in the Indonesian Air Force Headquarters (Mabes TNI AU) building in the Indonesian Capital City (IKN) needs to expand the analysis through an integrative approach that includes the dimensions of technology, organization, human resources, and national security. Future studies should explore in depth the readiness of digital infrastructure and building management systems based on the Integrated Building Management System (IBMS) integrated with 5G communication networks, smart grids, and Artificial Intelligence (AI)-based technologies to support operational efficiency and resilience.

In addition, it is necessary to study cross-institutional synergy, including the Indonesian Air Force, the Ministry of PUPR, the IKN Authority, and technology providers in the planning, development, and management of smart buildings in a sustainable manner. Evaluation of the competence of human resources, especially Indonesian Air Force personnel, is important to ensure the successful operation of automation and energy management systems. The construction of this smart building must also consider energy sustainability through the use of renewable energy, environmentally friendly waste management, and the integration of adaptive cybersecurity systems.

Furthermore, a research approach based on data-driven management and predictive maintenance is worthy of being a focus to support the responsiveness, efficiency, and security of military facilities in strategic environments such as the IKN. By integrating digital technology, visionary policies, and personnel readiness, the results of this study are expected to provide a basis for policy-making for the construction of modern, efficient future military buildings that optimally support the country's defense mission in the digital and smart city era.

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