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# The Use of Data Science and Big Data Analytics in Smart Environment forEnvironmental Quality Evaluation in Jakarta City

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## 1. Abstract

This research investigates the use of data science and big data analytics in smart environments to evaluate environmental quality in Jakarta City through a descriptive analysis of existing literature. The study examines resource management techniques, the application of machine learning models in simulations, edge data center deployment, and the integration of these technologies in smart city and energy management applications. By synthesizing findings from various studies, the research aims to identify how big data can improve environmental policies and resource management strategies in Jakarta, thereby addressing environmental challenges and promoting sustainable urban development.

**Keywords** : Big Data, Smart Environment, Jakarta, Resource Management, Environmental Quality, Machine Learning.

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## 2. Introduction

The quality of the environment in Jakarta is a critical issue that requires data-based solutions for its management. Various approaches and techniques in processing big data can be applied in urban contexts to address these challenges. In Jakarta, with a growing population and complex environmentalissues, this approach can provide deep insights and innovative solutions (Chen et al., 2012). The city faces numerous environmental challenges including air pollution, inefficient water management, and high energy consumption (Guttikunda & Jawahar, 2012). Utilizing big data in resource management and environmental quality evaluation can help design more effective and sustainable policies (Manyikaet al., 2011).

For instance, the simulation of the spread of pollutants in urban environments can assist in monitoringair quality and developing strategies to reduce pollution (Zhou et al., 2017). Machine learning models applied in the Domain Decomposition (DA) process enable more accurate predictions and faster responses to changes in air quality (Jordan & Mitchell, 2015). Additionally, the placement of Edge DataCenters (EDCs) can support smart city applications in Jakarta that require real-time responses, such assmart transportation systems and environmental monitoring. By considering the mobility of citizens and their spatial patterns, EDCs can be strategically placed to reduce network load and increase energyefficiency (Caragliu et al., 2011). Semantic data models can represent and analyze energy characteristics in data centers, improving the energy efficiency of buildings and public facilities in Jakarta. With the integration of a smart energy grid, energy use can be optimized and carbon emissions reduced (Kamel & Memari, 2019). This is particularly

relevant as buildings in Jakarta contribute significantly to energy consumption and carbon emissions (Gharaibeh et al., 2017). Monitoring systems for occupancy behavior in buildings using historical spatio-temporal data can enhance security monitoring and facilities management, which is
crucial for emergencies such as fires or earthquakes. By understanding occupancy behavior, evacuation strategies and space use can be optimized (Perera et al., 2014).

Furthermore, techniques for energy-efficient building and smart city applications can be applied to reduce energy consumption and CO2 emissions in Jakarta (Zanella et al., 2014). Research on plant datacan improve the planting process in Jakarta, helping select suitable plant species and reducing effort and time (Gandomi & Haider, 2015). By combining these techniques, a comprehensive approach to managing and improving environmental quality in Jakarta can be developed, significantly impacting environmental policy (Kitchin, 2014).

## 3. GOALS AND OBJECTIVES

The main objective of this article is to explore how the approaches and techniques discussed Data Science and Big Data Analytics in Smart Environments can be applied to evaluate and improve the quality of the environment in the City of Jakarta. We aim to:

1. Identify relevant techniques and methods data science and big data analytics that can be applied to the Jakarta environmental context.
2. Evaluate the potential impact of implementing these techniques on environmental policy andresource management in Jakarta.
3. Provides guidance for researchers and policymakers on how to leverage big data to address environmental challenges in Jakarta.
4. Assess the effectiveness of the approaches discussed data science and big data analytics inimproving the quality of life and sustainability in Jakarta.

With a focus on the Jakarta context, this review will provide in-depth insights into the practical application of big data in urban environmental management. We hope that this review can become a reference for developing better and more sustainable policies in Jakarta.

## 4. THE SCOPE OF RESEARCH

The scope of this research includes the city of Jakarta as the main case study. Jakarta, as the capital cityof Indonesia, faces various complex environmental challenges. This research will explore how the approaches and techniques discussed in scope Data Science and Big Data Analytics in Smart Environments can be applied in the Jakarta context to evaluate and improve the quality of the living environment.

The main focus will include:

1. Air Pollution : Air quality analysis and monitoring using machine learning models.
2. Energy Management : Using semantic data models to improve energy efficiency in buildings and public facilities.
3. Edge Data Center Placement : Optimizing EDC placement to support smart city applicationsin Jakarta.
4. Occupancy Behavior in Buildings : Monitoring and analyzing occupancy behavior for better facility management.
5. Water Management : A big data approach for more efficient planning and management ofwater resources.

By focusing on these aspects, this research will provide a comprehensive picture of how big data canbe used to improve the quality of the environment in Jakarta.

## 5. RESEARCH METHODOLOGY

This research uses a descriptive analysis by comparing the contents of Literatur Data Science and Big Data Analytics in Smart Environments with the quality of life conditions in the city of Jakarta. Methodsused include:

1. Literature Analysis : Reviewing various literature to identify relevant techniques and methods.

Comparing the results of this analysis with previous research and empirical data on environmental quality in Jakarta.

2. Case Study : Analyze the case studies in the literature and evaluate their relevance in the Jakarta context. This case study will provide an overview of how these techniques can be applied in Jakarta.
3. Secondary Data : Collect secondary data from relevant sources such as government reports, academic studies, and statistical data to understand environmental conditions in Jakarta.
4. Comparative Evaluation : Comparing the results and impact of applying the techniques in theliterature with existing policies and practices in Jakarta. This evaluation will assess the effectiveness of the approach proposed in this article.

This methodology will provide clear guidance on how big data can be used to improve environmentalquality in Jakarta and offer practical recommendations for implementation.

## 6. LITERATURE REVIEW

Data Science

Data science is a scientific discipline that uses statistical, mathematical and computational techniques to analyze large and complex data and extract valuable information from it. With the increasing availability of digital data from various sources such as sensors, social media, and business transactions,data science has become increasingly important in various fields, including business, health, and government (Provost & Fawcett, 2013). The data science process involves several main steps: data collection, data cleaning, data analysis, and interpretation of results. Data collection can come from internal and external sources of the organization. Data cleaning is an important stage to ensure data quality, remove anomalies, and fill data gaps. Data analysis uses various techniques, including machine learning, statistics, and predictive algorithms to find patterns and trends (Zhou et al., 2017).

One of the main applications of data science is in data-based decision making. In business, data scienceis used to optimize supply chains, improve customer experiences, and develop more effective marketing strategies. In the health sector, data science helps in disease prediction, genetic analysis, andpersonalization of medical care. In government, data science is used for policy analysis, crisis management, and improving public services (Chen et al., 2012). However, data science also faces significant challenges, such as data privacy and ethical issues, as well as data quality and integrity. Incomplete or biased data can result in inaccurate or misleading conclusions. Therefore, it is important to implement best practices in data management and comply with applicable regulations to protect individual privacy (Kitchin, 2014).

Technologies such as machine learning and artificial intelligence have expanded the scope and capabilities of data science. For example, deep learning has shown promising results in image recognition and speech analysis. Additionally, real-time data analysis allows organizations to respondquickly to changing market conditions or emergency situations (Jordan & Mitchell, 2015).

## 7. Big Data

Big data refers to very large and complex data sets that cannot be analyzed using traditional tools and techniques. Big data is characterized by three Vs: volume, velocity, and variety. Volume refers to very large amounts of data; velocity refers to high speed in data collection and processing; and variety indicates different types of data, including structured, semi-structured, and unstructured data (Gandomi & Haider, 2015).

Big data has opened up new opportunities for deeper analysis and better understanding of various phenomena. In business, big data is used to analyze customer behavior, identify market trends, and optimize operations. In the health sector, big data enables genomic analysis, personalization of care, and population health management. Governments use big data to monitor and manage infrastructure, analyze public policies, and improve services to citizens (Manyika et al., 2011). However, the challengesassociated with big data cannot be ignored. One of the main challenges is how to store, manage and process such large amounts of data efficiently. Technologies such as Hadoop and Apache Spark have been developed to address these challenges, enabling large-scale data processing in a parallel and distributed manner. In addition, issues of privacy and data security are becoming increasingly important when dealing with big

data, especially those involving personal or sensitive data (Zikopoulos et al., 2012).
Additionally, the ability to extract meaningful insights from big data requires sophisticated analytical skills and a deep understanding of statistical methods and machine learning algorithms. Big data analysis often involves techniques such as clustering, classification, and sentiment analysis to identify patterns and relationships in data (Chen et al., 2014). Big data has also driven the development of datascience and AI, with applications ranging from fraud detection to predictive analytics. For example, in the financial industry, big data is used to detect fraudulent activities by analyzing suspicious transaction patterns. In the marketing field, big data analysis enables more precise customer segmentation and more targeted marketing campaigns (Sagiroglu & Sinanc, 2013).

## 8. Smart Environment

Smart environment refers to an ecosystem that uses information and communication technology (ICT)to improve quality of life, operational efficiency and environmental sustainability. This concept involves the integration of various technologies such as the Internet of Things (IoT), sensors, and data analytics to create an environment that is more responsive and adaptive to the needs of its occupants (Perera et al., 2014). One of the main applications of smart environments is in smart cities. In the contextof smart cities, technology is used to manage resources efficiently, improve public services and reduce environmental impact. For example, sensors can be used to monitor air quality, energy consumption, and traffic conditions in real-time. The collected data is then analyzed to make better decisions and provide quick responses to problems that arise (Caragliu et al., 2011).
Smart environments also include smart buildings designed to improve energy efficiency and occupant comfort. Smart building management systems use IoT sensors and devices to monitor and control various aspects of a building, such as lighting, heating, ventilation and cooling. Thus, energy consumption can be optimized and operational costs can be reduced (Kamel & Memari, 2019). In the field of transportation, a smart environment involves developing intelligent transportation systems that can reduce congestion, improve safety, and reduce carbon emissions. Technologies such as adaptive traffic management systems, autonomous vehicles, and ride-sharing applications are some examples of how smart environments can be applied to create more efficient and environmentally friendly transportation systems (Gharaibeh et al., 2017).
However, smart environment implementation also faces challenges, including data privacy and security issues, system interoperability, and high implementation costs. To overcome these challenges,there is a need for a strong regulatory framework, clear technical standards and sustainable business models. In addition, collaboration between the public and private sectors is essential to ensure the successful implementation of a smart environment (Zanella et al., 2014). Nevertheless, the benefits offered by a smart environment are enormous. By using technology to increase efficiency and sustainability, smart environments can help address some of the biggest challenges faced by modern society, including climate change, rapid urbanization, and the decline of natural resources.

## 9. RESULT

1. Simulation of the Spread of Pollutants in Urban Environments

The use of machine learning models in simulating the spread of pollutants involves Domain Decomposition (DA) techniques, which enable more accurate predictions of pollutant distribution in urban environments. DA techniques applied with machine learning enable more accurate predictions of the distribution of pollutants in urban environments. By integrating real-time observational data with dynamic models, these simulations are able to provide a more realistic picture of how pollutants distribute in various environmental conditions.
In Jakarta, which has a serious air pollution problem, applying this technique could be very beneficial.Data from air quality monitoring stations can be used to monitor and predict the spread of pollutants across cities. This will allow authorities to take more rapid and targeted preventive measures, such as directing traffic or issuing health warnings to citizens.
In addition, this simulation can help in better city planning by considering pollutant distribution patterns.

For example, high risk areas can be identified for the implementation of green zones or motorvehicle restrictions. In this way, air quality in Jakarta can be improved overall, providing a healthier environment for residents.

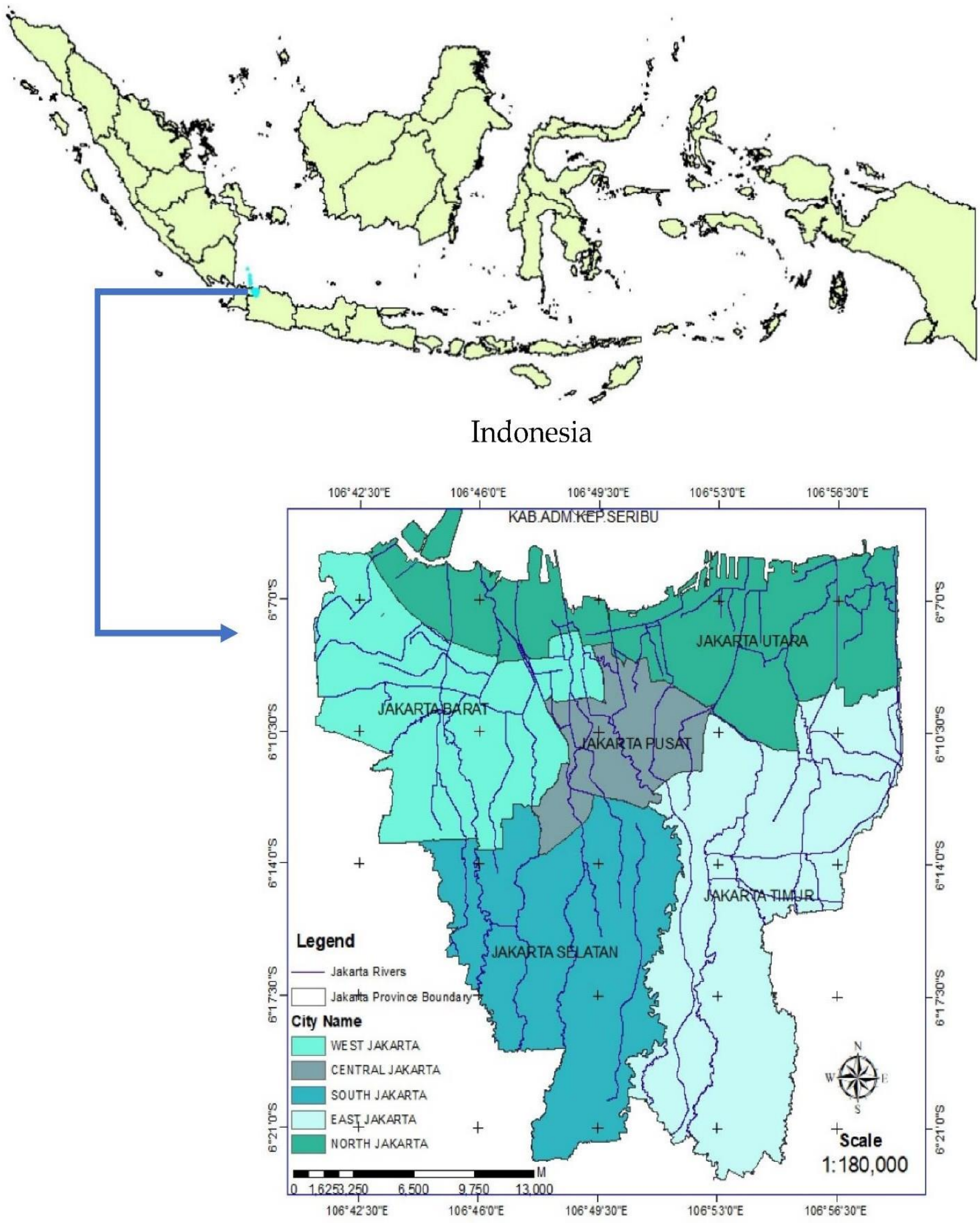


**Figure 1. Research Area: Jakarta Metropolitan City, Indonesia.**

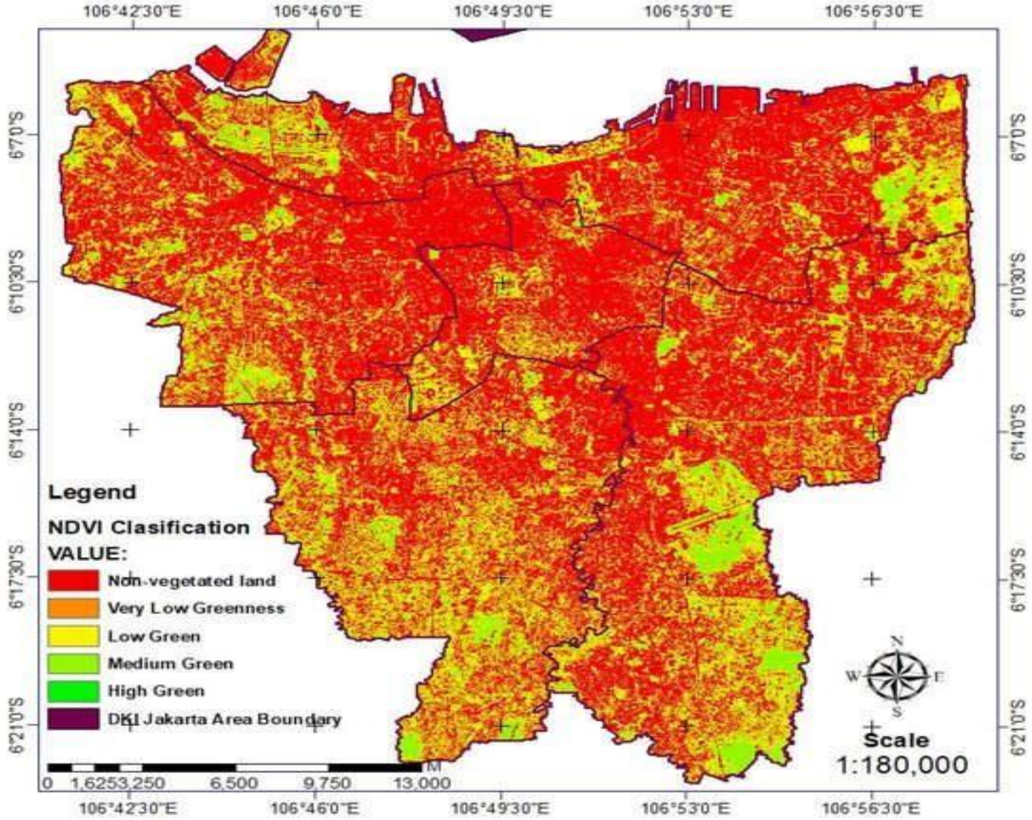
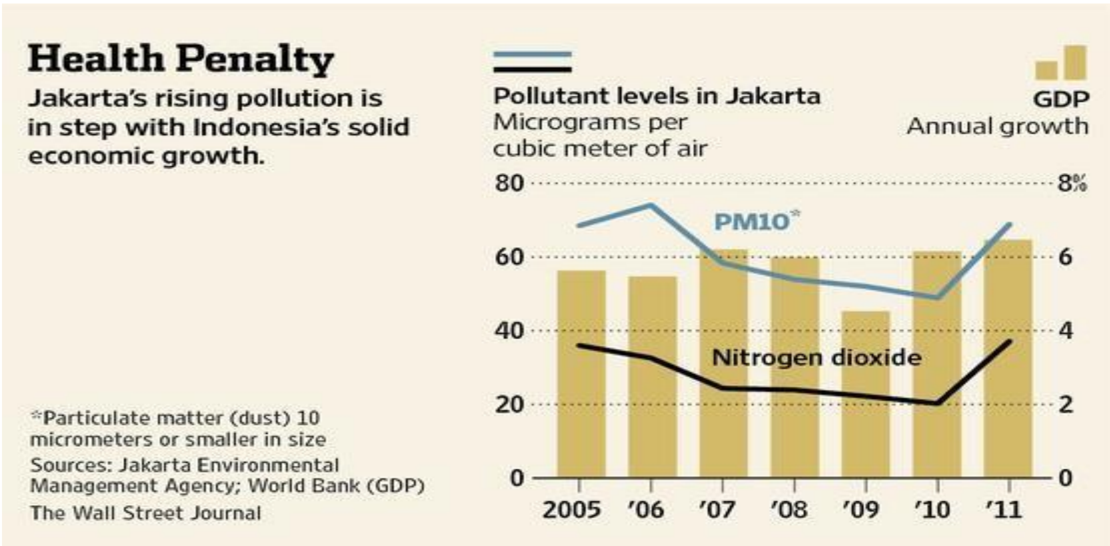
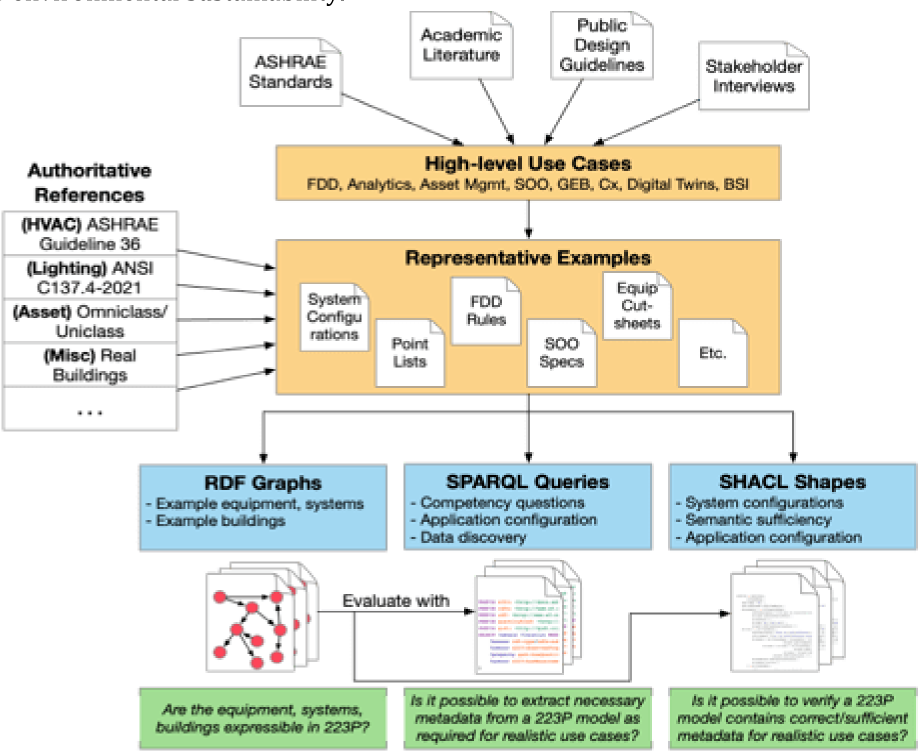



**Figure 2 . NDVI Map of Jakarta Province in 2021. (Source: Researcher Processed with ArcGIS Desktop10.8).**

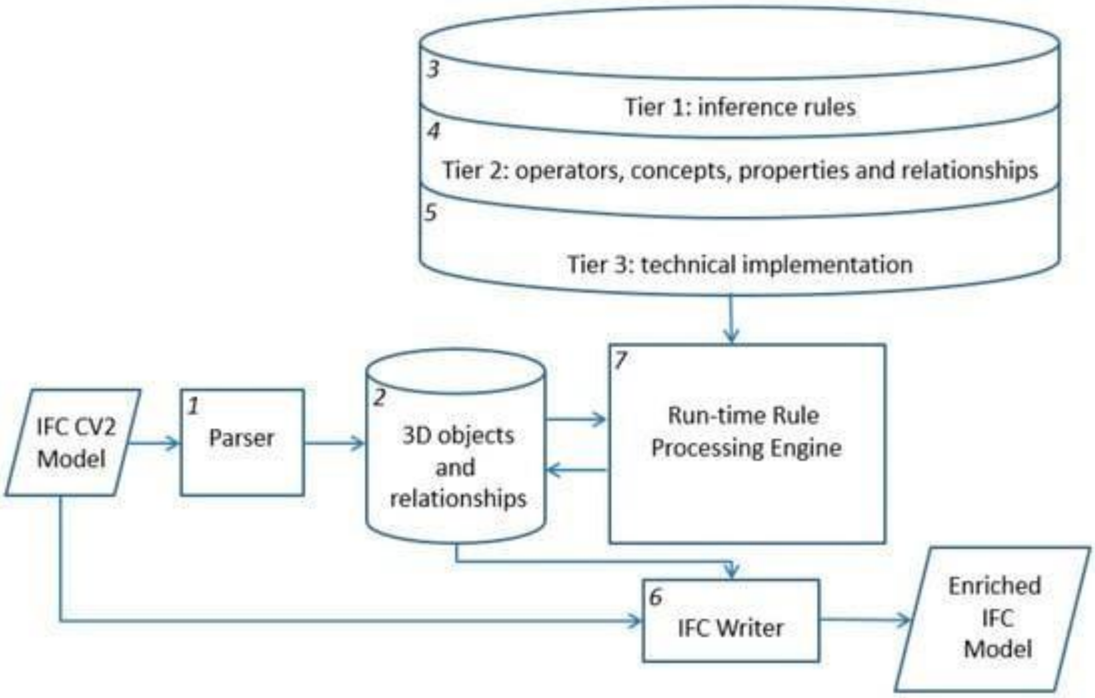


2. Placement of the Edge Data Center (EDC) in Jakarta
Efficient Edge Data Center (EDC) deployment is crucial for supporting low-latency applications in urban environments. EDCs play a key role in Multi-access Edge Computing (MEC) by bringing storage and computing capabilities closer to the end user, which is critical for applications such as autonomousvehicles, virtual reality, and environmental monitoring.
In Jakarta, strategic EDC placement can improve the performance of various smart city applications. For example, in smart transportation systems, well-placed EDCs can process real-time traffic data, reducing congestion and improving transportation efficiency. By considering the mobility of Jakarta residents and their spatial patterns, EDC locations can be optimized to reduce network load and maximize energy efficiency.
Furthermore, effective deployment of EDCs can also help in crisis management. In emergency situations such as floods or earthquakes, EDC can provide reliable and fast communications services, which is critical for coordinating emergency responses. Thus, implementing the EDC placementstrategy discussed in this article can make a significant contribution to improving the quality of life in Jakarta.

3. Semantic Data Models for Energy Efficiency
Semantic data models are used for the representation and analysis of energy characteristics in data centers. These models enable deeper analysis of energy consumption and operational efficiency, whichis critical in resource management in commercial buildings and public facilities.
In Jakarta, the application of this semantic model can help improve energy efficiency in various buildings. Using operational data from the building, the model can identify areas that need improvement and provide recommendations for reducing energy consumption. For example, these models can identify inefficient equipment and recommend replacement or maintenance to reduce energy use.
Integration of semantic models with smart energy grids can also optimize energy distribution and use across cities. This will not only reduce carbon emissions but also reduce energy costs for governmentsand residents. By implementing this technique, Jakarta can achieve higher energy efficiency targets and contribute to environmental sustainability.




*Semantic models represent building systems, their components, properties and interconnections in a standardizedqueryable way. In doing so they make it easier to install and configure building analytics and* *control software.*

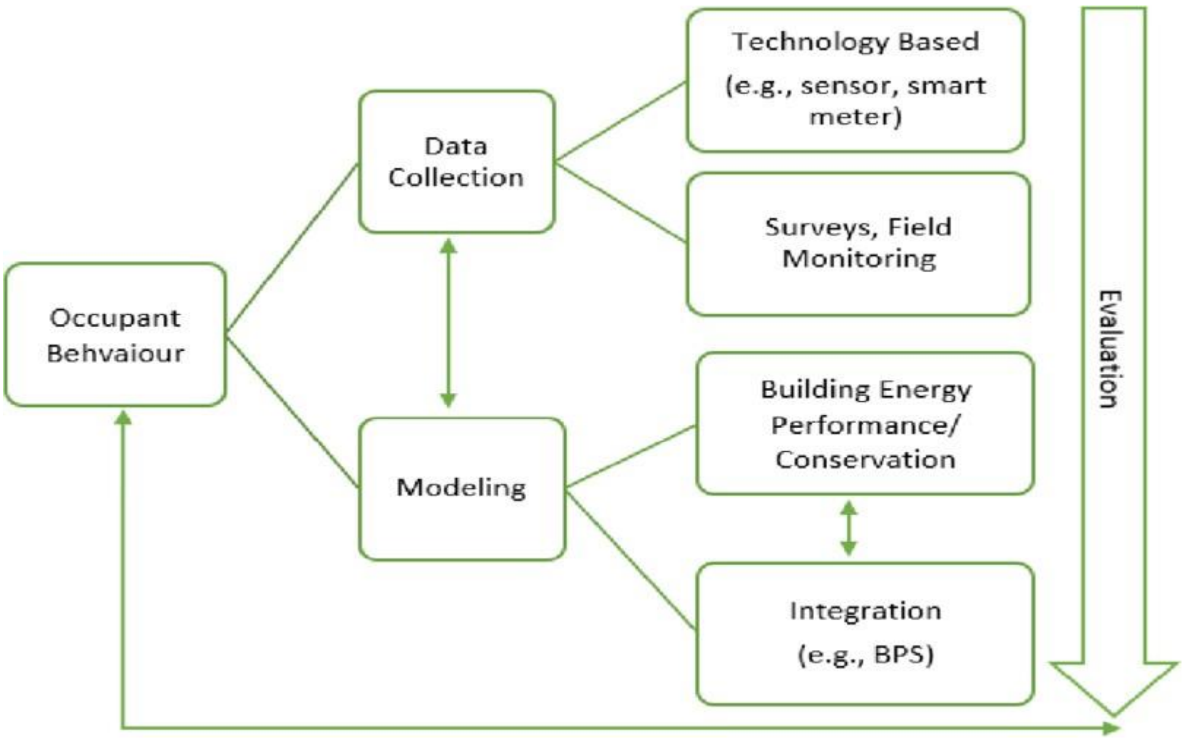



*Semantic Enrichment Engine (SEE) architecture*

**4.** Monitoring Occupancy Behavior in Buildings

The OBIDE (Occupant Behaviors in Dynamic Environments) system monitors occupancy behavior in buildings using spatial-temporal historical data. This system enables more accurate monitoring of space usage, leading to more efficient and responsive facility management.

In Jakarta, the OBIDE system can be applied for a variety of applications, from security monitoring to better space management. For example, in commercial and public buildings, understanding occupancypatterns can help in managing energy use, optimizing resource deployment, and improving safety. In emergency



situations such as fires or earthquakes, information about occupancy behavior can be used for more effective evacuation strategies.

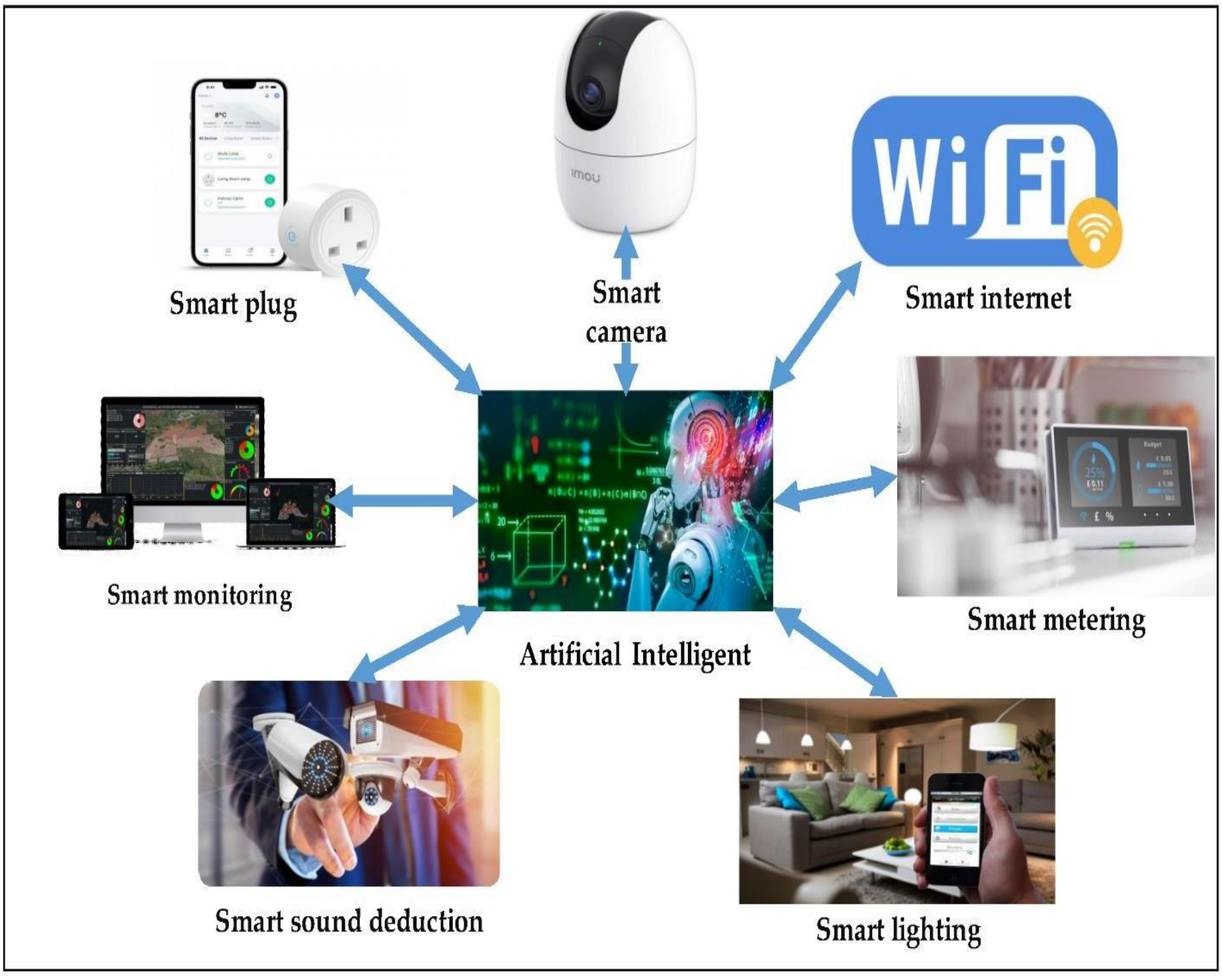
Apart from that, this system can also help in planning future facilities. With the data collected, developers and facility managers can design spaces that are more efficient and responsive to user needs. This will increase comfort and productivity, as well as reduce operational costs.

**5.** Smart City and Energy Efficiency Applications

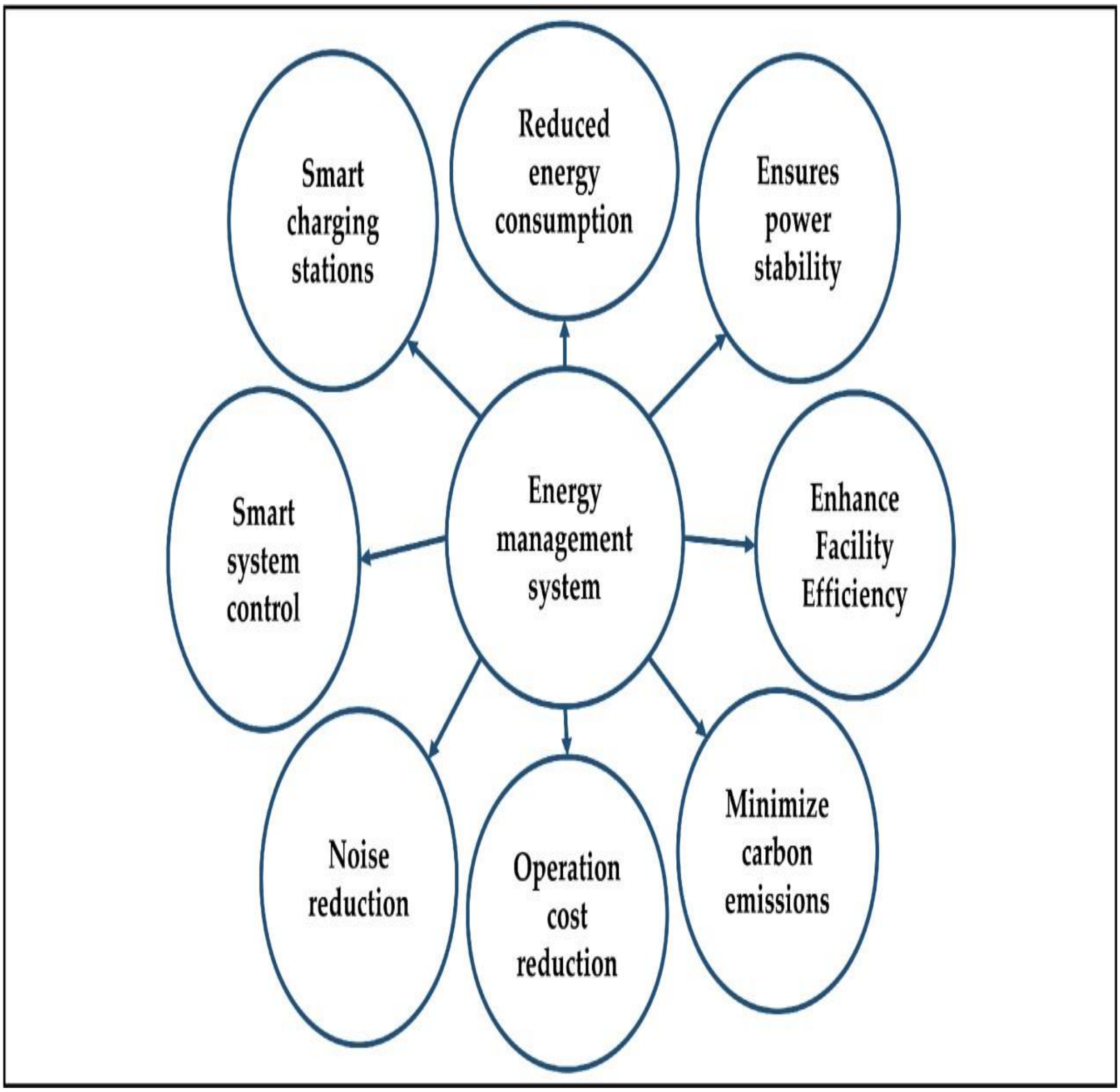
The applications of energy-efficient buildings and smart cities are highly relevant in the Jakarta context.The city, like many other large cities, faces major challenges in reducing energy consumption and CO2emissions. The technologies discussed in this article can help Jakarta overcome these challenges by implementing energy-saving solutions.

One of the technologies discussed is an integrated energy management system that can monitor and control energy use in buildings in real-time. Using sensors and data analytics, the system can identify areas where energy is used inefficiently and provide recommendations for improvement. Implementation of this technology in public and commercial buildings in Jakarta could result in significant energy savings.

Additionally, smart city applications such as smart street lighting, efficient waste management and connected transportation systems can also contribute to reducing energy consumption and improving quality of life. This technology not only reduces operational costs but also improves environmental sustainability, making Jakarta a cleaner and greener city.



*Features and technologies used in the smart cities.*



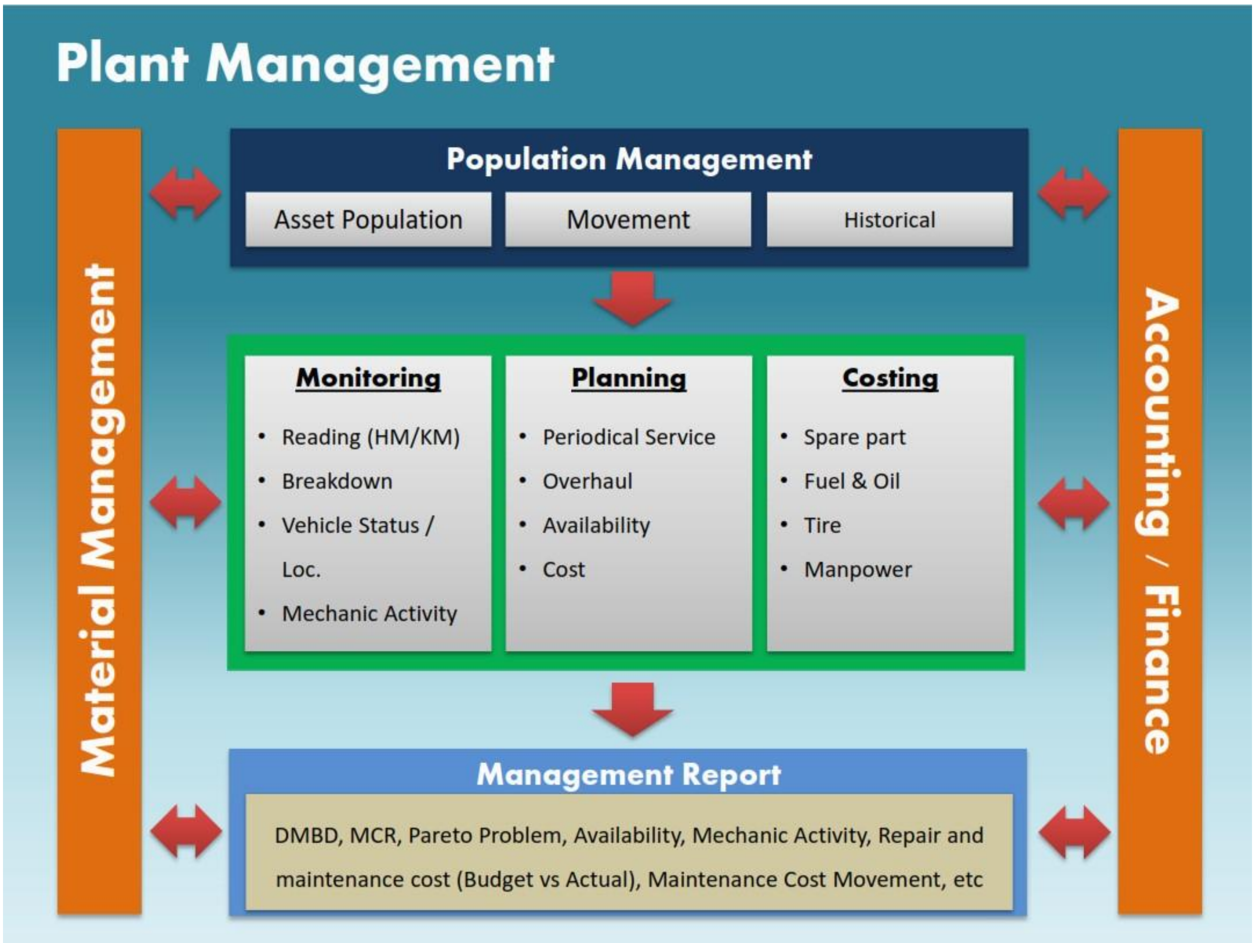

*Energy-management-system-based renewable energy in smart cities.*

**6.** Plant Data Management

The analysis of plant datasets helps in selecting the most suitable species for a particular area. Jakarta, with its climate and urbanization challenges, needs appropriate greening solutions to improve the quality of the environment and the welfare of its residents. The approaches discussed in this article canhelp in this process.

By analyzing data about soil conditions, climate and plant species, this technology can provide precise recommendations regarding the types of plants that are most suitable for planting in various areas in Jakarta. This will ensure that the selected plants not only grow well but also contribute to improving the air quality and aesthetics of the city.

In addition, this technology can reduce the time and effort required in the process of greening cities. By providing accurate data and evidence-based recommendations, city managers can make better, faster decisions. This will accelerate greening efforts and increase the effectiveness of environmental programs in Jakarta.




7. Vehicle Safety Verification and Validation

An ontology-based vehicle safety verification and validation model can be highly beneficial for Jakarta's complex and congested transportation system. In Jakarta, which has a complex and congested transportation system, this model can be very useful for ensuring the safety of public and private vehicles. By creating a knowledge representation that covers all aspects of the vehicle, the model can identify potential threats and ensure that safety standards are met.

This model can be integrated with Jakarta's transportation management system to monitor and validate vehicle safety in real-time. This will provide additional safety for public transport users and reduce therisk of accidents. In addition, this model can also help in preventative maintenance by identifying components at risk before failure occurs.

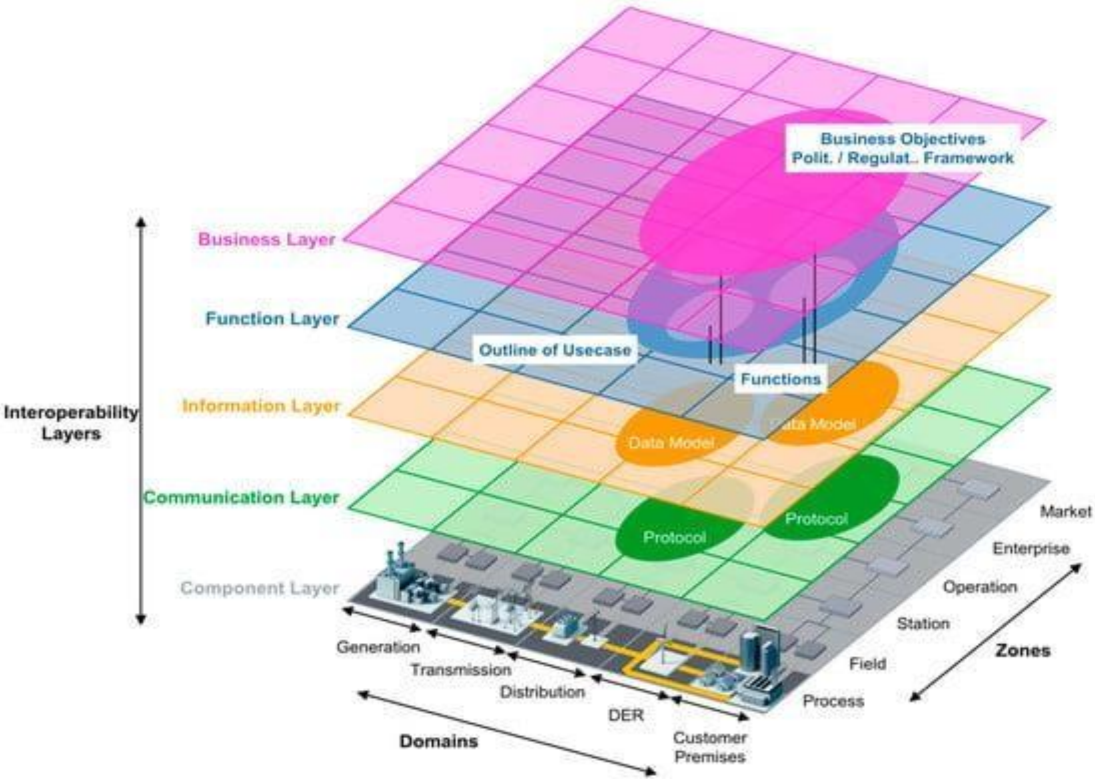
Furthermore, this model can contribute to better transportation policies. The data collected andanalyzed can provide insight into trends and patterns that can be used to develop policies that improvethe safety and efficiency of the transportation system in Jakarta.

8. Dynamic Resource Provisioning in Smart Grids

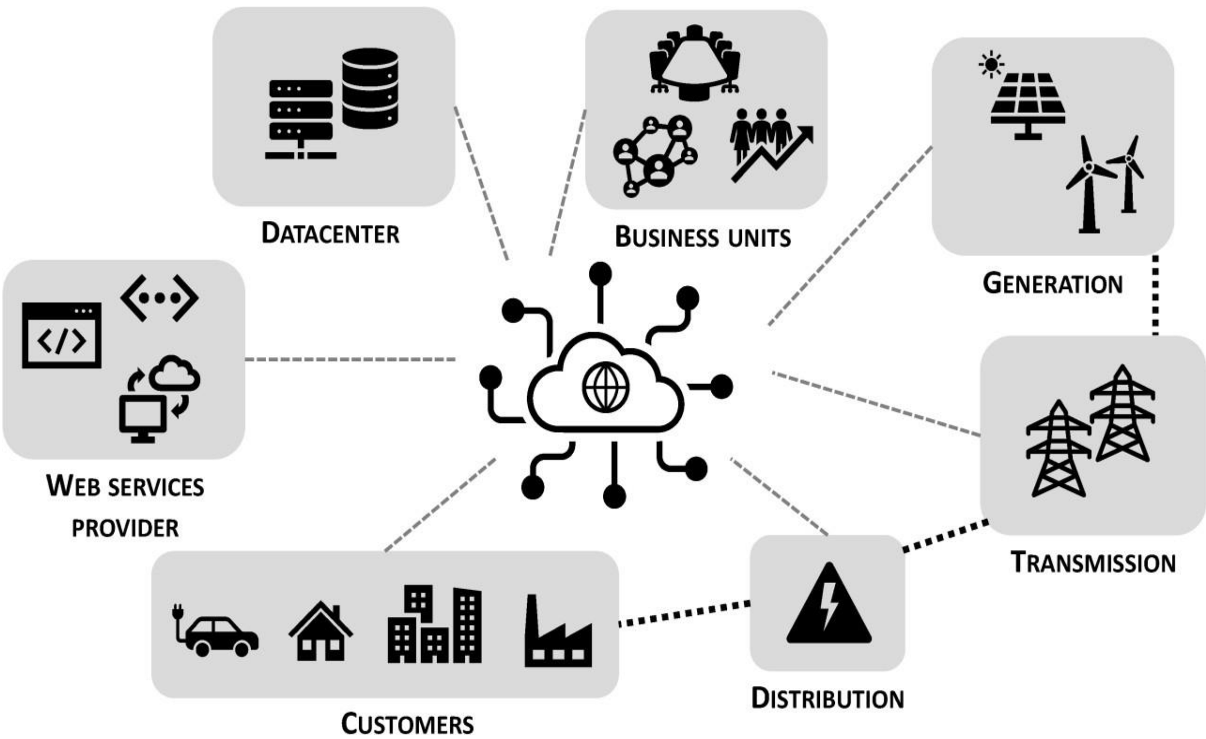
Dynamic resource provisioning methods using intelligent networks based on Markov decision processes can enhance system efficiency and stability in Jakarta's complex electricity and telecommunications networks. By using intelligent algorithms, resources can be allocated dynamicallyaccording to network needs and conditions.

This method can be used to optimize electricity distribution in Jakarta, ensuring that energy supply is always available in areas that need it. This will reduce the risk of power outages and increase the reliability of the city's power grid. In addition, this method can also be used in telecommunications network management to ensure consistent service quality.

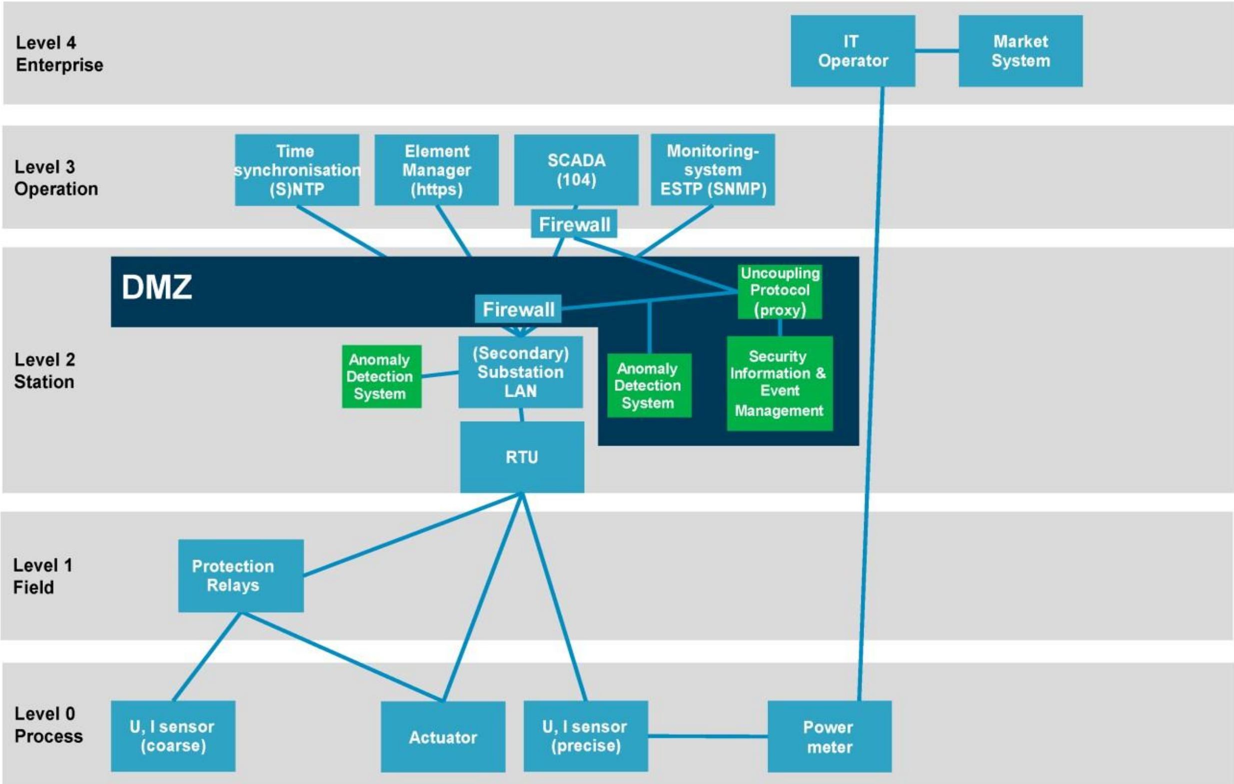
The application of this technology can also support other smart city initiatives in Jakarta. With a more efficient and stable network, smart city applications such as environmental monitoring, traffic management and digital health services can function better. This will improve the quality of life of residents and support the city's sustainability.



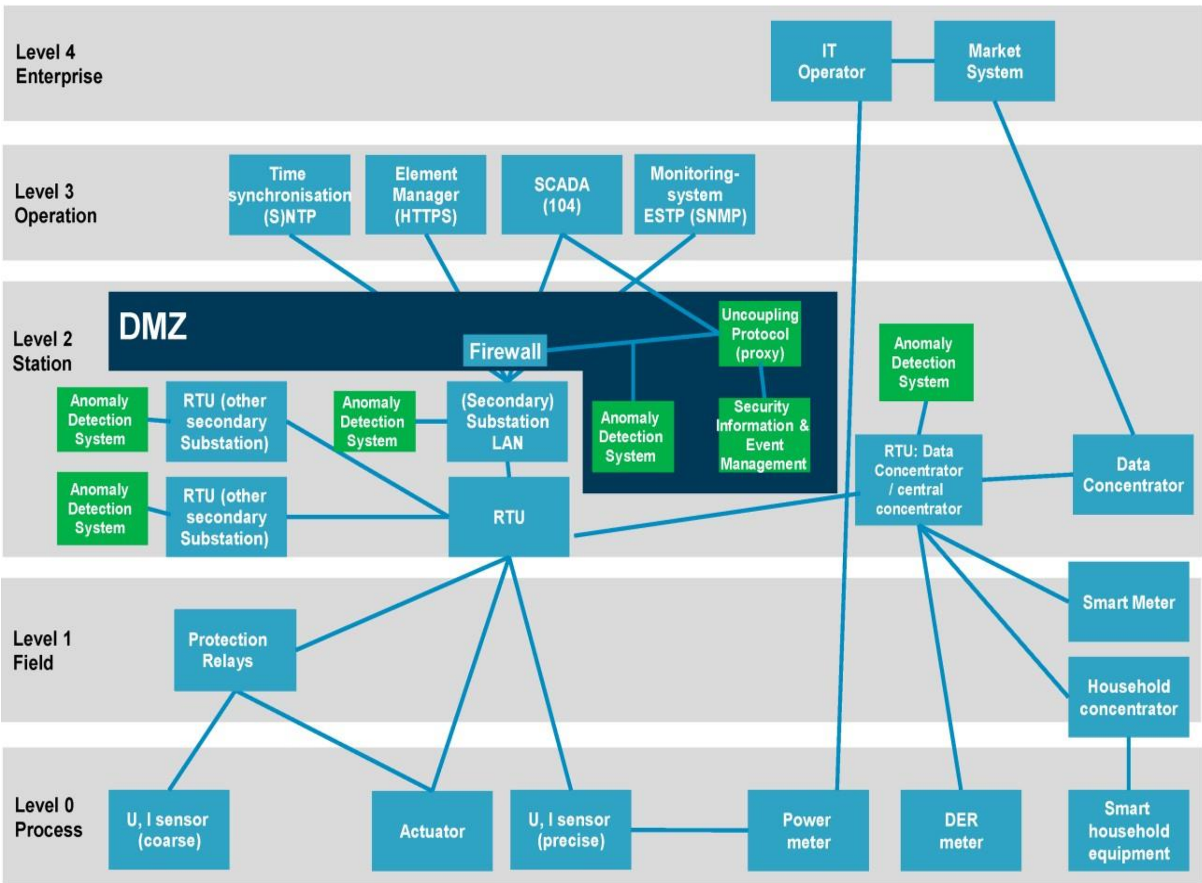

*High level representation SGAM ( Smart Gird Architecture Model)*



*Smart Grid energy market.*




*Smart Grid overview.*



*Future secure Smart Grid.*

9. Water Management and Resource Planning

Big data approaches can enhance water resource planning and management. In Jakarta, water management is a critical issue, with challenges including seasonal flooding and limited supplies of clean water. The approaches discussed in this article may provide better solutions to overcome these problems.

By collecting and analyzing data from various sources, water resource planning can be carried out more accurately and responsively. For example, data on rainfall, water use and river conditions can be usedto predict and manage floods more effectively. This will reduce the impact of flooding on residents andcity infrastructure.

Apart from that, this approach can also help in managing clean water supplies. By understanding use patterns and conditions of water sources, city managers can make better decisions about waterdistribution and conservation. This will ensure that a clean water supply is always available to residents and reduce dependence on unsustainable water sources.

## 10. Discussion

Data science has become an important foundation in modern urban environmental management, offering powerful tools and methods for analyzing large data sets generated by various sources. Thesesources include sensors, social media, and public records that provide valuable insights into urban dynamics. In Jakarta, which is one of the largest and most densely populated cities in the world, data science can help address pressing environmental issues, such as air pollution, traffic congestion, energyconsumption and water management.

The integration of machine learning models into domain decomposition simulations, as discussed in Result 1, highlights the potential of data-driven approaches to improve environmental monitoring and management. By leveraging real-time data, the model can accurately predict pollution distribution patterns, enabling timely intervention. This capability is especially important for a city like Jakarta, where air quality is a major problem due to high vehicle emissions and industrial activity.

Result 2 focuses on optimizing edge data center (EDC) placement, which is critical for supporting low-latency applications in urban environments. Solutions that take into account citizen mobility, such as those proposed in this chapter, can determine optimal locations for EDCs. Strategic placement of EDCsin Jakarta can improve the efficiency of various smart city applications, from traffic management systems to emergency response services. Implementing EDC in Jakarta requires in-depth analysis of mobility data, including traffic flow, public transportation use, and pedestrian movements. By optimizing the placement of these centers, cities can reduce network congestion, minimize outages, andimprove energy efficiency.

Result 3 presents a semantic data model designed to analyze the energy characteristics of data centers.This model can be used to assess energy efficiency and support data-based decision-making processes.In Jakarta, where energy consumption in buildings is a major contributor to environmental degradation, this kind of semantic model could play an important role in optimizing energy use and reducing carbon emissions. By integrating this model with a smart energy grid, Jakarta can achieve significant improvements in energy management. The model's ability to provide detailed insight into energy use patterns enables the identification of inefficiencies and the implementation of remedial measures. This approach not only improves the sustainability of the building but also contributes to the city's overall environmental goals.

The OBIDE framework discussed in Result 4 offers a system for monitoring occupant behavior in buildings using spatial-temporal data. These systems can be very useful in managing building operations more efficiently and ensuring occupant safety. In Jakarta, implementing the OBIDE systemcan help in a variety of applications, from security monitoring to better facility management. Understanding occupancy patterns can help manage energy use, optimize resource deployment, and improve safety. Additionally, in emergency situations such as fires or earthquakes, information about occupant behavior can be used for more effective evacuation strategies.

Restult 5 of this article highlights the applications of energy efficient buildings and smart cities that are relevant in the Jakarta context. The city faces major challenges in reducing energy consumption and CO2 emissions. The technologies discussed in this article can help Jakarta overcome these challenges by implementing energy-saving solutions. One of the technologies discussed is an integrated energy management system that can monitor and control energy use in buildings in real-time. Using sensors and data analytics, the system can identify areas where energy is used inefficiently and provide recommendations for improvement. Implementation of this technology in public and commercial buildings in Jakarta could result in significant energy savings.

Result 6 discusses the analysis of plant datasets to select the most suitable species for a particular area. Jakarta, with its climate and urbanization challenges, requires appropriate greening solutions to improve the quality of the environment and the welfare of its residents. By analyzing data about soil conditions, climate and plant species, this technology can provide precise recommendations regardingthe types of plants that are most suitable for planting in various areas in Jakarta. This will ensure that the selected plants not only grow well but also contribute to improving the air quality and aesthetics ofthe city.

Result 7 introduces an ontology-based vehicle safety verification and validation model. In Jakarta, which has a complex and congested transportation system, this model can be very useful for ensuringthe safety of public and private vehicles. By creating a knowledge representation that covers all aspectsof the vehicle, the model can identify potential threats and ensure that safety standards are met. This model can be integrated with Jakarta's transportation management system to monitor and validate vehicle safety in real-time, providing additional safety for public transportation users and reducing therisk of accidents.

Result 8 discusses dynamic resource provisioning methods using intelligent networks based on Markov decision processes. In Jakarta, which has complex electricity and telecommunications networks, this method can improve system efficiency and stability. By using intelligent algorithms, resources can be allocated dynamically according to network needs and conditions. This method can be used to optimize electricity distribution in Jakarta, ensuring that energy supply is always available in areas that need it.This will reduce the risk of power outages and increase the reliability of the city's power grid.

Result 9 outlines big data approaches for more efficient water resource planning and management. In Jakarta, water management is a critical issue, with challenges including seasonal flooding and limited supplies of clean water. The approaches discussed in this article may provide better solutions to overcome these problems. By collecting and analyzing data from various sources, water resource planning can be carried out more accurately and responsively. For example, data on rainfall, water useand river conditions can be used to predict and manage floods more effectively.

## 11. ESSENCE OF DISCUSSION AND RESULTS

Data science and big data analytics have brought a revolution in various aspects of urban management, including the environment. The use of data science and big data analytics in smart environments offers valuable insights into how data-driven approaches can be used to overcome various environmental challenges in big cities like Jakarta. From simulating the spread of pollution to deploying edge data centers, each chapter in this article presents innovative solutions that can be adapted to improve the quality of life in urban environments.

The pollutant spread simulations discussed in Result 1, for example, show how the integration of machine learning can improve the accuracy of pollution spread predictions. In Jakarta, which faces serious air pollution problems, this model can be used to monitor and predict the spread of pollutantsin real-time, allowing authorities to take timely preventive action. This is very important considering the negative impact of air pollution on public health and quality of life.

The edge data center (EDC) deployment discussed in Result 2 offers a solution for supporting low- latency applications in urban environments. In Jakarta, strategic EDC placement can improve the performance of various smart city applications, such as traffic management systems and emergency response services. By optimizing EDC placement based on citizen mobility data, Jakarta can reduce network congestion and improve energy efficiency, in line with the city's goal of becoming smarter andmore connected.

The semantic data models discussed in Result 3 can be used to analyze the energy characteristics of data centers, helping in optimizing energy use and reducing carbon emissions. In Jakarta, applying thismodel can help improve energy efficiency in buildings, identify inefficiencies, and implement appropriate remedial measures. This is especially important in the context of cities committed to reducing energy consumption and achieving environmental sustainability.

The OBIDE framework discussed in Result 4 provides a system for monitoring occupant behavior in buildings, which can be used for more efficient and responsive facility management. In Jakarta, implementing this system can help in security monitoring, space management and more effective emergency evacuation strategies. Information about occupancy patterns can be used to manage energyand resource use more efficiently, and improve occupant safety.

The energy-efficient building and smart city applications discussed in Result 5 are particularly relevantfor Jakarta, which faces major challenges in reducing energy consumption and CO2 emissions. Technology such as an integrated energy management system can monitor and control energy use in abuilding in real-time, identify inefficiencies, and provide recommendations for improvements. Implementation of this technology can result in significant energy savings and support sustainability goals

## 12. Conclusion

The research investigates various approaches and techniques relevant for evaluating and improving the environmental quality in Jakarta City using data science and big data analytics. From air pollution simulation to edge data center deployment and energy management, each chapter offers insights and solutions that can be applied in an urban context.

Implementing these techniques in Jakarta could help overcome the various environmental challenges it faces, including air pollution, energy efficiency and water resource management. By leveraging big data and analytics, environmental policies can be designed more effectively and sustainably, which willultimately improve the quality of life for Jakarta residents.

This research shows that by integrating big data approaches in environmental management, Jakarta can become a smarter and more sustainable city. This article is a valuable guide for researchers, policymakers and practitioners in their efforts to create better and more sustainable urban environments.

## 13. Acknowledgments

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