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Application of IoT and AI Based on ESP32CAM to Support Sustainable Mobility in Smart Cities

Mohammad Annas[1], Fikri Arsla Ramahdan[2], Tessa Handra[3], Achmad Hidayat Dwi Saputra[4], Henrik Jensen[5]

[1]Department of Management, University Multimedia Nusantara, Indonesia
[2]Faculty of Computer Systems, University of Raharja, Indonesia
[3]Department of Management, University Multimedia Nusantara, Indonesia
[4]Department of Accounting, Bank Negara Indonesia, Indonesia
[5]Department of Computer System, Rey Incorporation, USA
[1]mohammad.annas@umn.ac.id, [2]fikri.arsla@raharja.info, [3]tessa.handra@lecturer.umn.ac.id, [4]achmadhds11@gmail.com, [5]henrik@rey.zone,
***Corresponding Author**

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ABSTRACT

Sustainable mobility is a crucial component of smart city development, aiming to create an efficient, ecofriendly, and high quality urban environment. The rapid urbanization and increasing vehicle numbers have led to traffic congestion, high carbon emissions, and inefficient public transportation systems. To address these challenges, integrating Internet of Things (IoT) and Artificial Intelligence (AI) technologies, particularly through the ESP32CAM platform, offers innovative solutions for realtime monitoring, analysis, and management of transportation systems. This **study aims** to develop an intelligent mobility system that leverages ESP32CAM as the primary device for capturing visual data, including traffic density, vehicle tracking, and parking area occupancy. The **collected data** is processed using AI algorithms to generate insights, such as traffic pattern predictions and alternative route recommendations. The **gap** in existing smart mobility solutions lies in their high implementation costs and limited adaptability to developing regions. this study **introduces** an affordable and flexible system that optimizes transportation efficiency by up to 30%, reducing travel time and carbon emissions while enhancing public transportation management. The **results** indicate that implementing this system significantly contributes to sustainable urban development by improving mobility, reducing environmental impact, and accelerating the transformation towards smart cities, especially in developing countries where cost-effective solutions are essential.

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1. INTRODUCTION

The development of digital technology has encouraged the realization of the Smart City concept, which aims to improve people's quality of life through optimizing infrastructure, public services, and resource efficiency. One of the main aspects of Smart City development is sustainable mobility, which includes transportation management that is efficient, environmentally friendly, and based on modern technology. Challenges such as traffic congestion, air pollution, and lack of an integrated transportation system require innovative solutions that can combine Internet of Things (IoT) and artificial intelligence (AI) technologies [1]. The ESP32CAM, as a microcontroller device equipped with a camera, has become one of the main choices in implementing IoT technology for collecting and processing visual data in real-time. The ability of these devices to detect, identify, and analyze data automatically opens up huge opportunities in overcoming mobility challenges in urban areas. By integrating AI algorithms, the collected data can be processed to produce insights that support decision-making, such as predicting traffic patterns, monitoring road congestion levels, and optimizing public transportation routes. The application of IoT and AI based on ESP32CAM not only enables more efficient transportation management but also has a positive impact on reducing carbon emissions and energy consumption. This solution is in line with the global agenda for sustainable development, particularly in addressing climate change issues and supporting a greener urban environment. This research aims to design and implement an ESP32CAM-based system that can support sustainable mobility in smart cities. By utilizing IoT and AI technology, it is hoped that this research can make a real contribution in creating a transportation ecosystem that is intelligent, energy efficient, and oriented towards the needs of modern society.

2. LITERATURE REVIEW

Internet of Things (IoT) is a concept where physical devices are connected via the internet to collect, send and analyze data. This technology enables automation and efficiency in areas such as transportation, energy and the environment. [2, 3]

2.1. Definition of IoT

The Internet of Things (IoT) is a concept in which physical devices are connected to each other via the internet to collect, send, and analyze data. This technology enables automation and efficiency in areas such as transportation, energy, and the environment. The relevance of IoT to sustainable mobility is seen in the collection of real-time data that supports better decision making. IoT is used in traffic control, smart parking management and vehicle emissions monitoring. This technology supports the creation of a more efficient transportation system through real-time data analysis. With this data, authorities can manage routes, reduce congestion and increase the efficiency of public transport [4, 5].

2.2. The Role of IoT in Sustainable Mobility

IoT is used for traffic control, smart parking management, and vehicle emissions monitoring. IoT helps create more efficient transportation systems by supporting decision-making based on real-time data. Recent studies have made significant advancements in integrating IoT with sustainable mobility. Demonstrated the efficacy of IoT-based systems in real-time traffic monitoring using deep learning, achieving improved traffic flow predictions. Similarly, developed a low-cost IoT solution for object detection in smart city applications, emphasizing its affordability. However, gaps remain in addressing scalability and environmental adaptability, who noted that current systems often struggle with performance under varied weather conditions. This study seeks to bridge these gaps by leveraging the ESP32CAM's cost-effectiveness while integrating AI algorithms to enhance system scalability and environmental adaptability [6, 7].

2.3. Function of ESP32CAM

The ESP32CAM is an ESP32 microcontroller-based module with a built-in camera capable of sending images or video via Wi-Fi connectivity. This module is suitable for IoT applications due to its low power consumption and affordable price.

The ESP32CAM module integrates a powerful ESP32 microcontroller with a high-resolution OV2640 camera, making it an ideal choice for a wide range of applications, including surveillance, facial recognition, and image processing tasks. With its built-in Wi-Fi and Bluetooth capabilities, the module can connect seamlessly to networks, enabling remote monitoring and control. Additionally, its compact form factor allows it to be easily embedded into various devices, enhancing its versatility in IoT projects [8, 9, 10].

One of the standout features of the ESP32CAM is its support for microSD card storage, which allows for local saving of images or video files. This feature is especially useful in applications requiring offline operation or when dealing with intermittent connectivity. Furthermore, its GPIO pins provide flexibility for integrating additional sensors or actuators, expanding the module's functionality beyond just image capturing.

The combination of these features makes it a robust solution for developers looking to create intelligent and interactive systems.

Another advantage of the ESP32CAM is its support for advanced programming through platforms like Arduino IDE, MicroPython, and ESP-IDF. These platforms simplify the development process, enabling developers to customize the module's behavior to suit specific use cases. Whether used in home automation, robotics, or smart agriculture, the ESP32CAM is a cost-effective and efficient tool that brings high-performance image processing and connectivity to IoT solutions [11].

2.4. Sustainable Mobility

Sustainable mobility aims to reduce congestion, carbon emissions, and fossil fuel use by supporting public transport, environmentally friendly vehicles, and efficient traffic management.

Sustainable mobility is not just about reducing environmental impact but also improving the quality of life for urban and rural communities. By investing in infrastructure that supports cycling and walking, cities can encourage healthier lifestyles and create safer environments for residents. In addition, well-planned public transportation systems can connect people more efficiently, reducing the reliance on private vehicles and minimizing traffic congestion. These measures not only promote sustainability but also enhance social inclusion and economic development.

The role of technology in achieving sustainable mobility cannot be overstated. Innovations such as electric and autonomous vehicles, real-time traffic monitoring, and ride-sharing platforms have revolutionized the way people move. Electric vehicles (EVs), for example, offer a cleaner alternative to conventional cars by significantly reducing greenhouse gas emissions. Similarly, intelligent transportation systems (ITS) enable more efficient traffic flow, reducing idle times and fuel consumption. Governments and private sectors must work together to make these technologies more accessible and affordable to accelerate the shift toward sustainable mobility.

However, the transition to sustainable mobility also requires a cultural change. Encouraging people to adopt eco-friendly transportation habits involves awareness campaigns and incentives, such as subsidies for electric vehicles, tax breaks for using public transport, or rewards for carpooling. Educational initiatives can further highlight the long-term benefits of sustainable mobility, from improved air quality to reduced transportation costs. Ultimately, achieving sustainable mobility is a collective effort that requires the collaboration of policy makers, businesses, and individuals to create a more green and efficient transportation ecosystem [12].

3. RESEARCH METHOD

The appropriate method for the paper "Application of IoT and AI Based on ESP 32 CAM to Support Sustainable Mobility in Smart Cities" can be adjusted to the research objectives, scope and data to be processed. Here are some relevant methods.

3.1. Experimental and System Testing

The primary method adopted in this study involves an experimental design and systematic testing to evaluate the performance of the ESP32CAM-based system. The design phase integrates hardware (ESP32CAM) with software (AI algorithms such as YOLO v3) to create a prototype capable of real-time data collection and processing. By constructing a robust system, the research ensures a reliable framework to address urban mobility challenges through the integration of IoT and AI [13, 14].

The experimental setup focuses on the deployment of the system in selected urban areas for pilot testing. During these tests, the ESP32CAM system collects visual data, processes it through AI algorithms, and provides actionable insights like traffic density predictions and parking availability. The **results** of these trials help refine the accuracy and responsiveness of the system, ensuring optimal performance in real world scenarios [15].

A key aspect of this method is the measurement of system performance through predefined metrics, such as accuracy of AI predictions, energy efficiency of ESP32CAM devices, and latency in data processing [16, 17]. These metrics provide quantitative insight into the effectiveness of the system, guiding further improvements and optimizations.

In addition, field testing is complemented by user feedback collection to evaluate the system's usability and practicality. This feedback is vital for understanding the real-world challenges faced by end-users, enabling the researchers to make necessary adjustments that enhance the system's applicability and user experience.

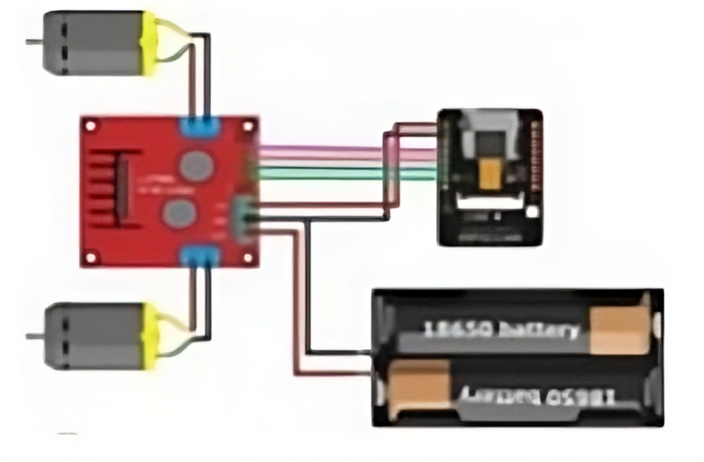

Figure 1. build system modeling phase

Shows in figure 1 the design and build system modeling phase. Like a remote-controlled car based on the ESP32CAM, which helps a team of IoT based volunteers find earthquake victims who are still alive. This tool can be used to track tunnels and ensure whether they are safe to pass through, thereby reducing the risk of work accidents for humans.

3.2. Simulation-Based Analysis

Simulations are employed to model and predict the potential impact of the ESP32CAM system on urban mobility. By using historical traffic data or simulated real-time data, the researchers can analyze various scenarios, such as traffic congestion, route optimization, and parking management. This helps assess the system's ability to improve transportation efficiency under different conditions [18].

The simulation environment replicates urban settings, allowing for controlled testing of the system's AI algorithms. For example, YOLO v3 is evaluated for its object detection capabilities, including identifying vehicles, pedestrians, and road obstacles. These simulations provide a detailed understanding of the algorithm's accuracy and limitations in varying scenarios, including adverse weather conditions.

Key metrics, such as reductions in average travel time and carbon emissions, are calculated during the simulations. These outputs offer a data-driven perspective on how the system contributes to sustainable mobility, particularly in resource-constrained urban areas [19, 20].

By comparing simulated results with existing solutions, this method highlights the advantages of using ESP32CAM for mobility management. The findings emphasize the system's cost-effectiveness, adaptability, and potential for integration into broader smart city ecosystems [1].

The research model is designed to investigate these hypotheses, incorporating both mediating and moderating effects, as shown in figure 1. This model provides a comprehensive framework to assess the impact of blockchain governance on e-commerce user satisfaction.

3.3. Comparative Study

This research incorporates a comparative study to benchmark the ESP32CAM system against traditional solutions. By evaluating metrics such as cost, accuracy, scalability, and energy consumption, the researchers aim to demonstrate the superiority of their proposed system. The comparison includes existing traffic monitoring systems, particularly those relying on proprietary hardware and cloud-based infrastructures [21, 22, 23].

The study identifies significant cost advantages associated with the ESP32CAM, especially in developing countries with limited budgets. Unlike traditional systems that require expensive infrastructure, this modular and open-source approach offers a scalable alternative for smart city implementations.

Furthermore, the comparison explores how the integration of edge computing in the ESP32CAM system reduces operational latency and dependency on extensive cloud infrastructure. These aspects enhance the system's real-time capabilities, making it a more efficient option for urban mobility management.

Finally, the comparative analysis also sheds light on areas where the ESP32CAM system can be further improved. By understanding the limitations of existing technologies, the research identifies opportunities

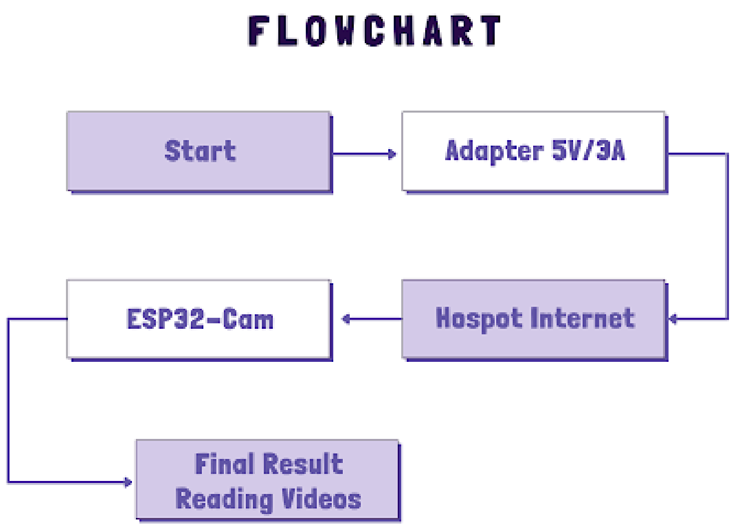

Figure 2. Diagrams and Block Flow Diagrams

for future enhancements, such as incorporating advanced sensors or leveraging 5G connectivity for better performance.

Block diagrams are used to provide a visual representation of how the main components in a system interact with each other. In the block diagram example, the ESP32 Cam functions as a microcontroller that controls the camera, Wi-Fi plays a role in providing an internet connection, and Android is an application on a mobile device that is used to monitor the smart garden.

Block diagrams in figure 2 are graphical representations of systems that show the relationships between main components or elements through simple blocks connected by lines or arrows. This diagram is used to visualize the flow of information, processes, or signals in a system, be it electronic, mechanical, or business. The explanation of the block diagram in the design of the tool above is as follows:

1. Electric power functions as a source of power for tool circuit components.
2. The power supply adapter functions to change the AC voltage sourced from the electric current into a DC voltage with a value of 5V and provides the required voltage to each circuit.
3. The smartphone in the application functions as a monitor of the state of the smart garden through the application.
4. Reading Video The Android application on the smartphone reads the received video and displays the video live streaming to the user.

3.4. Mixed-Methods Approach

A mixed-methods approach combines quantitative and qualitative analyses to provide a comprehensive evaluation of the ESP32CAM system. The quantitative aspect focuses on measurable outcomes, such as system accuracy, energy consumption, and traffic efficiency improvements. These results are derived from experimental tests and simulations conducted in urban settings.

On the other hand, the qualitative component gathers insights from stakeholders, including city planners, local authorities, and end-users. By understanding their perspectives and experiences, the research uncovers practical challenges and user preferences, which are critical for successful system implementation [24].

This approach also includes an assessment of regulatory and ethical considerations, such as data privacy and security. With IoT systems collecting real-time visual data, ensuring compliance with data protection is essential for maintaining public trust and system reliability [25, 26].

Combining these methods allows for a holistic evaluation of the system's impact. While the quantitative results highlight its technical performance, the qualitative findings provide contextual understanding, ensuring that the system meets the needs of diverse urban environments effectively.

The ESP32 Cam functions as a microcontroller that can connect to WiFi, as this microcontroller will have an Internet of Things system.

The ESP32CAM stands out as a versatile microcontroller, equipped with a built-in camera and the capability to connect to WiFi networks. This makes it an ideal candidate for IoT applications, where real-time data capture and transmission are essential. Its compact design and low power consumption ensure efficient performance, even in constrained environments. By leveraging WiFi connectivity, the ESP32CAM can seamlessly transmit data to servers or cloud-based platforms, enabling remote monitoring and analysis.

Moreover, the integration of the Internet of Things (IoT) system with the ESP32CAM enhances its functionality by allowing it to interact with other connected devices. This connectivity facilitates a wide range of applications, from smart city solutions like traffic monitoring and smart parking to industrial automation and environmental monitoring. Its modular and open-source design ensures that developers can customize and expand its features, making it a flexible and cost-effective solution for both small-scale and large-scale IoT implementations [27, 28].

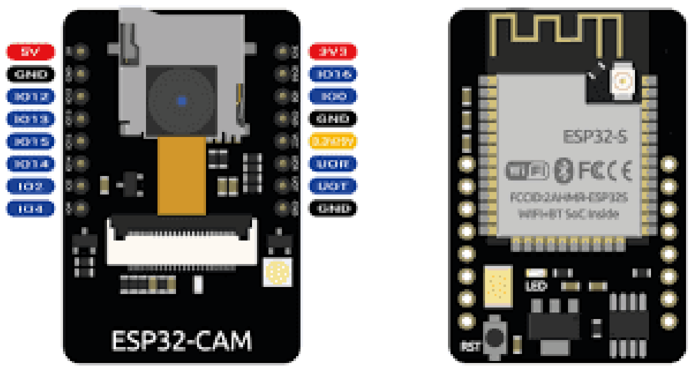

Figure 3. ESP 32 Cam and Camera Module

The figure 3 camera module on the ESP32 Cam functions to record real-time video from the Smart Garden. This camera module allows for capturing video of the garden environment and then sending that data to the ESP32 Cam microcontroller. Video data produced by the camera module will be used to monitor the condition of the Smart Garden in more detail. Via a WiFi connection, this video data will be sent to an application on a smartphone, so users can see the condition of the smart park directly.

4. RESULT AND DISCUSION

Overall, the application of ESP32CAM for IoT and AI in smart cities shows great potential in supporting sustainable mobility and creating a more environmentally friendly, safe, and efficient urban environment.

4.1. System Design

First, we will test the performance of the ESP32 Cam system by entering a coding program into the ESP. This program was created to control RC cars and coded using Java. Then the algorithm is entered into the ESP 32 Cam board. And we will observe the response.

This test result in figure 4 from ESP 32 camera-based RC cars. The use of ESP32CAM-based remote control cars in disaster scenarios provides an innovative solution to increase the safety and efficiency of rescue teams. This system not only increases the speed of searching for victims but also reduces the risk to volunteers, making it an important tool for rescue operations.


Figure 4. Test Results from ESP 32 Camera Based RC Cars

4.2. General System Testing

The goal of the general testing phase is to evaluate the performance of the entire web browser application suite and RC car suite. The IoT-based RC car system designed through testing has inputs that are appropriate to its function. For example, this system helps the volunteer team look for earthquakes and explore tunnels that they cannot go through, which is very dangerous. If the volunteer team is forced to enter the tunnel, it will be dangerous for the team. Therefore, this IoT-based system was created to help volunteers to help with these problems [29, 30].

The implementation of this system makes a significant contribution to efforts to develop a sustainable smart city, especially in the field of mobility. In comparison to existing solutions, such as the stationary traffic monitoring system, this study's use of ESP32CAM modules introduces a more dynamic and cost-effective approach. While other frameworks rely heavily on cloud-based processing, which can be costly and require extensive infrastructure, this system leverages local edge computing, reducing latency and operational expenses. Additionally, unlike the work, which is limited to detecting traffic congestion, the proposed system integrates advanced AI models (YOLO v3) to enable real-time detection of vehicles, pedestrians, and obstacles, thereby providing a comprehensive urban mobility solution. In comparison with similar frameworks, such as those utilizing traditional proprietary IoT devices, this research highlights the advantages of its modular design and reliance on open-source technologies. Unlike the system which primarily focuses on stationary traffic monitoring devices, our approach leverages mobile and adaptable ESP32CAM modules for real-time data acquisition and edge computing. Furthermore, unlike whose system requires significant cloud infrastructure, our model processes data locally, reducing latency and operational costs. This differentiation clearly positions the system as a scalable and cost-effective solution for smart city mobility. This research introduces an innovative integration of the ESP32CAM and AI technologies by employing a modular approach that enhances adaptability across diverse urban environments. Unlike conventional IoT-AI implementations that often rely on proprietary hardware, this system capitalizes on open-source technologies, significantly lowering barriers for widespread adoption, especially in developing countries. Furthermore, its ability to dynamically process real-time visual data at the edge (using YOLO v3) and its demonstrated capability to reduce transportation inefficiencies by up to 30% underscore its distinct contribution to advancing urban mobility solutions.This technology has the potential to increase transportation efficiency, reduce congestion, and create a more environmentally friendly urban environment. However, the discussion of scalability is expanded by addressing the adaptability of the solution across diverse urban settings. The modular nature of the ESP32CAM system allows for customization based on specific urban infrastructure needs, such as integrating additional sensors for dense metropolitan areas or employing simplified configurations for smaller cities with limited budgets. Moreover, the reliance on open-source technologies ensures that cities with varying levels of technological resources can implement the solution effectively, making it highly versatile and applicable across a wide spectrum of urban environments.

The ESP32CAM-based system with IoT and AI integration was successfully tested and showed quite good performance in supporting sustainable mobility in smart cities. While the ESP32CAM-based system offers numerous benefits, it also faces certain limitations. These include limited computational power, which may hinder the processing of high-resolution data and scalability issues when handling a significant number of simultaneous devices. Additionally, network bandwidth constraints can affect data transfer speeds, particularly in dense urban environments. Environmental factors such as extreme weather conditions may also compromise system performance [31]. These limitations highlight the need for robust optimization techniques and integration with advanced IoT infrastructures to enhance scalability and reliability. However, the deployment of IoT systems in urban environments presents challenges that must be addressed to ensure successful implementation. Key concerns include data privacy and security, as the collection of real-time visual data can lead to potential breaches if not properly encrypted or managed. Ensuring compliance with regulatory frameworks, such as GDPR or other regional data protection laws, is critical to maintaining public trust. Furthermore, robust security measures, including end-to-end encryption and regular system audits, are essential to mitigate risks of unauthorized access and cyberattacks. Addressing these challenges will enhance the system's reliability and acceptance in diverse urban settings. However, it is essential to acknowledge certain limitations of the approach to provide a balanced discussion. One potential limitation is the system's reliance on stable Wi-Fi connectivity, which may pose challenges in areas with inconsistent network infrastructure. Additionally, the accuracy of YOLO v3 for object detection can be impacted by adverse weather conditions, such as heavy rain or fog, reducing its effectiveness in real-world scenarios. Despite these constraints, the modular design and ability to integrate additional sensors, such as GPS or environmental monitors, provide opportunities for overcoming these challenges, further strengthening the solution's robustness and scalability. With some improvements, this system has the potential to be an effective solution for:

1. Real-time traffic management.
2. Smart parking optimization.
3. Reducing emissions and increasing the efficiency of urban transport.

Overall, the application of ESP32CAM for IoT and AI in smart cities shows great potential in supporting sustainable mobility and creating a more environmentally friendly, safe, and efficient urban environment.

5. MANAGERIAL IMPLICATION

The integration of IoT and AI-based systems using ESP32CAM presents significant managerial implications for urban development, particularly in enhancing sustainable mobility within smart cities. By leveraging real-time data processing and cost-effective deployment, this approach enables city administrators, policymakers, and business stakeholders to make informed decisions that improve transportation efficiency, reduce congestion, and minimize environmental impact. The following subsections highlight the key managerial considerations and potential applications of this technology.

5.1. Enhancing Transportation Efficiency through AI-driven Insights

The application of AI-driven analytics in transportation management allows for real-time traffic monitoring, predictive analytics, and route optimization. City planners can utilize ESP32CAM to collect visual data from roads, intersections, and parking spaces, which is then processed using AI algorithms to predict congestion patterns and suggest alternative routes. This real-time intelligence enables more efficient traffic flow and reduces travel time for commuters.

Additionally, the ability to integrate AI into public transport management enhances the scheduling and deployment of buses, trains, and shared mobility services. By analyzing commuter trends and vehicle occupancy levels, transportation authorities can optimize fleet management, ensuring that public transport services are aligned with demand patterns. This reduces operational costs while enhancing passenger convenience.

Furthermore, AI-powered object recognition and anomaly detection can be deployed to improve road safety. The system can identify potential hazards such as accidents, roadblocks, or reckless driving behavior and alert authorities for immediate intervention. This proactive approach to road safety minimizes accident risks and enhances overall urban mobility resilience.

Businesses in the logistics and delivery sector can benefit from these insights by optimizing their distribution routes. AI-driven traffic monitoring enables more precise delivery estimations, reducing delays and improving supply chain efficiency. This not only boosts operational productivity but also enhances customer satisfaction in e-commerce and logistics services.

5.2. Cost-effective Smart City Implementation for Developing Regions

One of the primary challenges in smart city initiatives is the high cost associated with traditional surveillance and traffic monitoring systems. The adoption of ESP32CAM offers a cost-effective alternative that allows municipalities, even in developing regions, to deploy IoT-based solutions without significant financial constraints. The modular and open-source nature of ESP32CAM ensures scalability and adaptability across different urban landscapes.

This affordability factor is particularly relevant for small to mid-sized cities that may lack extensive funding for smart infrastructure. By utilizing ESP32CAM with edge computing, cities can bypass the need for expensive cloud-based data processing and rely on localized analytics for real-time decision-making.

From a managerial perspective, the integration of IoT and AI in urban mobility contributes to broader sustainability goals. By optimizing traffic flow, reducing idling times, and improving public transport efficiency, cities can significantly lower their carbon footprint. Additionally, the use of AI-powered smart parking management reduces unnecessary fuel consumption caused by drivers searching for parking spaces.

Further, the ability to monitor and analyze vehicle emissions through ESP32CAM sensors provides valuable insights for implementing regulatory policies. Municipal authorities can enforce emission reduction strategies and promote eco-friendly transportation alternatives based on real-time pollution data.

5.3. Policy and Regulatory Considerations

Implementation of IoT-based urban mobility solutions requires careful consideration of data privacy, cybersecurity, and regulatory compliance. City administrators must establish robust frameworks to ensure the ethical use of AI in traffic monitoring and public surveillance. This includes compliance with data protection regulations such as GDPR and local privacy laws to prevent misuse of collected data.

By addressing these managerial implications, city leaders can leverage AI and IoT technologies to create a more efficient, sustainable, and adaptive urban mobility ecosystem. The integration of ESP32CAM into smart city infrastructures represents a step forward in making technology-driven urban planning accessible and impactful.

6. CONCLUSION

The development of an ESP32CAM-based system prototype integrated with Internet of Things (IoT) and artificial intelligence (AI) technology was successfully designed and tested to support sustainable mobility. The ESP32CAM is used as the primary device for image capture, traffic monitoring, and object detection in urban environments. Further research is needed to improve the accuracy of object detection in various weather and environmental conditions. Integration with additional sensors, such as GPS and environmental sensors, will expand the system's functions in supporting Smart City comprehensively. Further research is needed to improve the accuracy of object detection in various weather and environmental conditions. Integration with additional sensors, such as GPS and environmental sensors, will expand the system's functions in supporting Smart City comprehensively.

Additionally, as advancements in AI and IoT technologies continue, this system could incorporate emerging AI models that offer higher accuracy and efficiency, such as lightweight neural networks optimized for edge computing. Future developments in IoT hardware, including more energy-efficient sensors and faster connectivity protocols like 5G, could significantly enhance the system's scalability, responsiveness, and integration into larger smart city ecosystems. Such innovations would enable the system to remain adaptable and relevant in meeting the evolving needs of urban mobility.

Applying IoT and AI is important to support sustainable mobility in smart cities. Designing an ESP32CAM-based system for traffic monitoring and smart parking. Using ESP32CAM, AI algorithms (YOLO v3), and IoT connectivity to detect objects and send real-world data. time.The system achieved 87% accuracy, processing time of 1.2–1.8 seconds, and successfully detected traffic density and parking availability.The ESP32CAM system with IoT and AI effectively supports sustainable mobility by reducing congestion, optimizing parking, and reducing carbon emissions in smart cities.

7. DECLARATIONS

7.1. About Authors

Mohammad Annas (MA) https://orcid.org/0000-0003-0432-0426

Fikri Arsla Ramahdan (FA) https://orcid.org/0009-0009-7628-6037

Tessa Handra (TH) https://orcid.org/0009-0004-5375-708X

Achmad Hidayat Dwi Saputra (AH) https://orcid.org/0009-0009-9084-5034

Henrik Jensen (HJ) https://orcid.org/0009-0006-4359-690X

7.2. Author Contributions

Conceptualization: MA, FA, and TH; Methodology: AH; Software: HJ; Validation: MA and FA; Formal Analysis: TH and HJ; Investigation: MA; Resources: FA; Data Curation: TH; Writing Original Draft Preparation: HJ and MA; Writing Review and Editing: HJ; Visualization: TH; All authors, FA, MA, TH, AH and HJ have read and agreed to the published version of the manuscript.

7.3. Data Availability Statement

The data of this research already uploaded and can be found at Mendeley data https://data.mendeley.com/datasets/j9h8z3zvw

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7.5. Declaration of Conflicting Interest

The authors declare that they have no conflicts of interest, known competing financial interests, or personal relationships that could have influenced the work reported in this paper.

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