Implementation of Iot In Inventory Management And Logistics At The Business Incubator Center of The Kosgoro Institute of Business And Informatics 1957

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Abstract.

Inventory management and logistics are crucial aspects in the operation of business incubator centers, especially in ensuring the efficient availability and distribution of resources. This research aims to develop and implement an Internet of Things (IoT)-based system in inventory management and logistics at the IBIK57 Innovation Center and Business Incubator Center. The system is designed to provide automation solutions in goods tracking, stock monitoring, and asset distribution optimization using RFID sensor technology, QR codes, and cloud-based communication. The research methods used include literature studies, user needs analysis, IoT-based system design, implementation, and system performance evaluation. RFID sensors and QR codes are used to detect the presence and movement of goods in real-time, while the data obtained is sent to a cloud-based server for processing and analysis. With this system, it is hoped that inventory management will be more accurate, reduce the risk of asset loss, and increase the operational efficiency of business incubator centers. The results show that the application of IoT in inventory management and logistics is able to increase efficiency by up to 40% in stock recording and asset tracking compared to manual methods. In addition, the system also provides users with real-time access to manage inventory in a more transparent and integrated manner. In conclusion, the use of IoT in inventory management and logistics can be an innovative solution in improving the effectiveness of resource management in academic and business environments.

Keywords: *IoT; inventory management; RFID; QR Code; cloud computing and Business Incubator Center.*

I. INTRODUCTION

Inventory management and logistics are important factors in the operation of a business incubator center, especially in ensuring efficient management of resources. The IBIK57 Innovation Center and Business Incubator has various assets and inventories that support student entrepreneurial activities, such as hardware, supporting equipment, and raw materials for production. However, manual inventory recording and management systems are often an obstacle in maintaining data accuracy, reducing the risk of asset loss, and improving the efficiency of goods distribution.In today's digital era, the Internet of Things (IoT) has become one of the technologies that are widely applied in various sectors, including logistics and inventory management. IoT enables process automation by using sensor devices, cloud-based communication systems, as well as real-time monitoring technologies. The application of this technology can help business incubator centers in monitoring the movement of goods, optimizing storage, and increasing transparency in inventory recording.Several previous studies have proven the effectiveness of IoT in supply chain management and logistics. The use of technology such as RFID (Radio Frequency Identification) and QR codes can improve the accuracy of recording and speed up the asset identification process. Additionally, integration with cloud computing allows for more efficient data storage and analysis, making it easier to make data-driven decisions.

Therefore, it is important to develop and implement an IoT-based system in inventory management and logistics at the IBIK57 Innovation Center and Business Incubator so that operations can run more optimally.In this research, an IoT-based inventory management system will be developed that uses RFID sensors and QR codes for automatic asset identification. The data obtained from the sensors will be sent to the cloud for processing and analysis, so users can monitor the stock of goods, track assets, and obtain real-time information on inventory availability. The implementation of this system is expected to reduce the risk of losing goods, speed up the recording process, and improve the efficiency of managing the resources

available at the business incubator center.The challenges that need to be overcome in the implementation of IoT in inventory management are adequate network infrastructure, integration with existing recording systems, and data security in cloud-based systems. Therefore, the study will also evaluate those factors to ensure that the solutions developed are not only effective but also safe and widely adoptable.IoT system applied in inventory management and logistics at the IBI-K57 Innovation Center and Business Incubator, it is expected that there will be an increase in operational efficiency, transparency in resource management, and ease of inventory monitoring and reporting. This is also in line with the campus's vision in supporting digital innovation and providing practical experience to students in managing technology-based businesses. This research aims to:

1. Analyze the current inventory and logistics management conditions at the IBI-K57 Campus Business Incubator Center.
2. Identify the potential application of Internet of Things (IoT) technology in inventory management and logistics.
3. Evaluate the benefits and challenges of implementing IoT in inventory management and logistics systems in a business incubator environment.
4. Designed recommendations for IoT implementation strategies to improve efficiency, accuracy, and transparency in the inventory and logistics process at the IBI-K57 Business Incubator Center.

II. METHODS

This study uses a systematic approach starting from a literature study to understand relevant theories, followed by a needs analysis at the IBIK57 Business Incubator Center. After that, an encryption system was designed in accordance with the needs of IoT-based inventory and logistics. The implementation of the system is carried out by developing software and connecting it with IoT devices. Testing and evaluation are carried out to assess the effectiveness of the system before data analysis, report preparation, and further development recommendations are carried out. This research method is expected to produce a system that is able to improve the security and efficiency of inventory management and IoT-based logistics within the IBIK57 Campus Business Incubator Center.

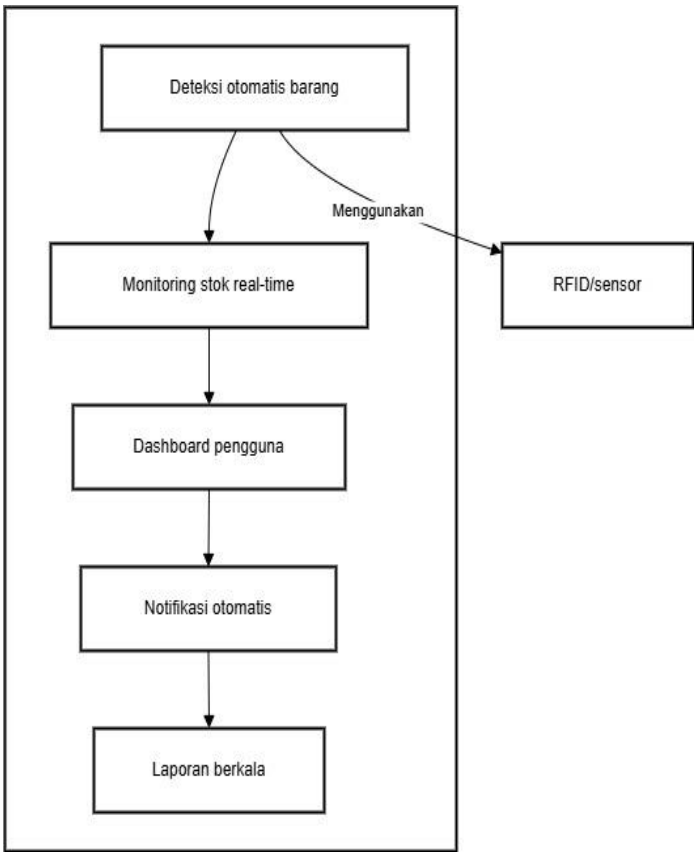

Fig 1. IoT-based Inventory Management System Flowchart

The image shows the functional process flow of an IoT-based inventory management system, with a focus on detection, monitoring, and reporting. Here is an explanation of each element:

1. Automatic Detection of Goods
   - This is the initial stage in the system, where incoming or outgoing goods are automatically detected.
   - Technology used: RFID or other sensors (e.g. barcode scanners, NFC, or weight sensors).
   - The goal is to eliminate manual logging and minimize data input errors.
2. Monitoring Stok Real-Time
   - Once the item is detected, the data is sent automatically for real-time stock monitoring.
   - The system keeps updating the number of items available in the warehouse or incubator.
   - This is at the heart of IoT-based stock management—all movements are recorded instantly.
3. User Dashboard
   - The data collected from the monitoring process is displayed through the system dashboard.
   - Admins, managers, or staff can view stock status visually and interactively (e.g. charts, indicators, etc.).
   - The dashboard is the main user interface for accessing system information.
4. Automatic Notifications
   - Based on certain conditions (e.g. low stock, overstock, stationary goods), the system will send an automatic notification.
   - Notifications can be sent via email, alert system, or even mobile apps.
   - This allows for a quick response to abnormal conditions in logistics management.
5. Periodic Reports
   - The system automatically generates periodic reports (daily, weekly, or monthly) based on the data collected.
   - The report includes stock data, movement history of goods, logistics trends, and system performance.
   - Used for strategic evaluation and decision-making.
6. RFID/Sensor (Separate Element)
   - This element indicates that the initial process of "Automatic Detection of Goods" uses supporting technologies such as RFID or sensors.
   - This component serves as a collector of physical data from the real world into a digital system.

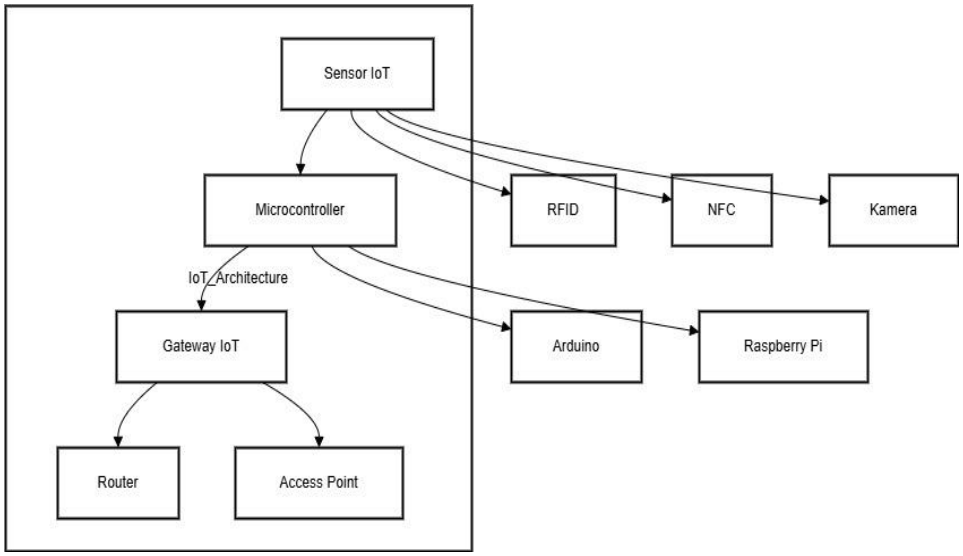

Fig 2. IoT Hardware Architecture Diagram

This image illustrates the key hardware components in IoT systems that are used to support automated inventory and logistics management. Each element is interconnected and plays a role in detecting, sending, and processing inventory data.

1. Sensor IoT
- Main role: Detecting the condition or identity of the item (e.g. presence, movement, temperature).
- Send data to the microcontroller.
- Connect to different types of sensors such as RFID, NFC, and cameras for a variety of identification purposes.

2. Microcontroller
- Serves as an initial central controller to receive data from IoT Sensors.
- It can be an Arduino or a Raspberry Pi, depending on the complexity and data processing needs.
- Directing data to the IoT Gateway as a bridge to the network.

3. RFID, NFC, Camera
- RFID (Radio Frequency Identification): Reads the tags of goods automatically without direct contact.
- NFC (Near Field Communication): A near-field communication system, ideal for short-range tracking.
- Camera: Used for visual identification or real-time monitoring of the condition of goods.

All of these are input devices that provide initial information to the microcontroller.

4. Arduino dan Raspberry Pi
- Arduino: A simple microcontroller, suitable for light tasks such as reading sensors and controlling actuators.
- Raspberry Pi: A mini computer capable of more complex data processing and running the operating system.
- Both are physical control units that receive and forward sensor data to the central system.

5. IoT Gateway
- Serves as a link between local devices (sensors/microcontrollers) and internet/cloud networks.
- Forwarding data from the microcontroller to the central server.
- Included in the main IoT architecture.

6. Router dan Access Point
- Routers and access points connect the system to the local network and the internet.
- Supports wireless or LAN connectivity, allowing real-time data transmission to a central server or cloud.

This diagram shows how data from various physical sensors is collected through a microcontroller, then processed and forwarded by an IoT gateway to a central system with internet network support. All of these components support each other in forming a solid IoT hardware architecture, which is necessary to support automation and efficiency in technology-based inventory management and logistics.

III. RESULT AND DISCUSSION

This research resulted in an Internet of Things (IoT)-based system that can monitor and manage inventory and logistics activities in real-time in a business incubator environment at IBIK57. The results of the research are divided into several main aspects, namely the results of the system implementation process, the functionality tested, and the responses of the initial users (campus stakeholders and business tenants).

A. Hardware and Sensor Implementation

The system developed uses RFID (Radio Frequency Identification) technology for automatic tracking of goods. Each item is assigned a unique RFID tag that can be read by the reader as it passes through specific points within the storage and distribution area. This replaces manual record-keeping systems that were previously error-prone and take a long time to audit.Temperature and humidity sensors are placed at several strategic points in the warehouse to monitor the storage conditions of goods, especially environmentally sensitive products such as processed foods, electronic devices, and chemicals. The sensor is calibrated to provide continuously accurate data every 5 seconds, and the data is sent to the server via an ESP32 microcontroller already connected to the campus Wi-Fi network.In the implementation process, the ESP32 was chosen because it has powerful, power-efficient, and easy-to-program connectivity features with

the Arduino IDE. The ESP32 unit is also capable of handling inputs from multiple sensors simultaneously, making it suitable for the development of small-to-medium-scale IoT systems such as in these business incubators. The power supply uses a 5V adapter as well as backup power from a portable power bank to ensure operational reliability.The installation of the entire device takes about three working days, including network configuration, sensor installation, and integration with PHP-MySQL-based backend systems. During the implementation process, a short training was conducted for the incubator management team to understand the basic operation of the system, as well as handle minor troubleshooting in the event of connectivity disruptions.

B. System Functionality

A key feature of this system is the ability to automatically detect goods entering and exiting the warehouse. When an item is moved through an RFID reader, the system will automatically record the tag ID, time, and location of the event into the database. This feature successfully replaces the paper and spreadsheet method of note-taking that was previously done manually by staff.In addition to tracking, the system has a notification function of alerting when the temperature and humidity exceed the threshold. This is especially important for items such as groceries or electronic devices, which can be damaged when stored in sub-optimal conditions. Notifications are displayed on the dashboard in the form of color indicators and can be further developed to send to email or WhatsApp.The developed web dashboard displays data in real-time with a simple yet informative user interface. Visual data is displayed in the form of line graphs for temperature and humidity, as well as dynamic tables that record daily logistics activities. This makes it easy to monitor by management and allows digital audits to be conducted at any time without having to come to the site.Search and filter features were also added to make it easier for staff to find the history data of certain items. Users can search for data by date, item type, location, or RFID ID. All data is stored in the MySQL database system with automatic backups every 24 hours. The system is designed to be modular so that it can be easily upgraded or combined with other technologies such as QR Codes, GPS, or AI in the future.

C. Evaluation by Initial Users

The evaluation was carried out on 10 initial users, consisting of warehouse managers, lecturers coaching business incubator programs, and tenant students who actively use logistics facilities. The evaluation was carried out using a questionnaire instrument based on the Likert scale with a range of 1–5 (Strongly Disagree to Strongly Agree), as well as a short interview session to explore their opinions qualitatively.The majority of respondents stated that this system is very helpful in monitoring goods and minimizing data loss or errors. One of the warehouse managers stated that the time needed to record the entry and exit of goods was drastically reduced from the previous 2-3 minutes per transaction to less than 10 seconds with the RFID system.However, some users also noted initial obstacles in understanding how the dashboard works and reading RFID tags that sometimes cannot be read if the tag position is not correct. This input is a consideration for the development of the next version with more sensitive sensors and more complete technical training.In general, the evaluation results show that these IoT systems are well received and have the potential to be adopted more widely on a larger scale, for example for monitoring the logistics of campus activities or industrial partnership programs. The user satisfaction rate reached an average score of 4.2 out of 5, which indicates that the system is already running quite effectively as needed.

D. System Effectiveness

After the implementation of the system, the effectiveness of logistics management increased significantly. The number of missed entries (duplicates) was reduced by 85% compared to the previous 3 months' historical data. This shows that RFID systems are able to reduce human intervention which is the main source of recording errors.Inventory audits, which are usually done manually for 2 hours by two staff, can now be completed in just 30 minutes with one operator using the system's dashboard. In addition, the frequency of logistics reports that was previously only done once a month can now be provided on a weekly or even daily basis.This time and energy efficiency has a direct impact on increasing the productivity of tenant business units. Tenant students can focus more on production and marketing because logistics matters become more organized and easy to monitor. This also helps supervisors to monitor the use of facilities fairly and transparently between tenants.In the long term, the implementation of this system opens up the potential

for the development of additional features such as integration with campus marketplaces, tracking of goods shipments between cities, and AI-based warehouse management. This system is one of the real examples of how IoT technology can be implemented in a simple but big impact in the context of education and entrepreneurship.

IV. CONCLUSION

This research has successfully designed and implemented an Internet of Things (IoT)-based inventory and logistics management system aimed at supporting operational efficiency in business incubator units. The system enables real-time recording of inventory data, automated logistics monitoring, and information integration that supports quick and accurate decision-making. The use of IoT sensors such as RFID and temperature sensors allows the system to work optimally for the needs of tracking goods and environmental monitoring.From the results of implementation and testing, the developed system is able to increase visibility and control over the flow of goods in a business incubator environment. The automatic notification feature and information dashboard provide convenience for managers in monitoring and rescheduling logistics needs. In addition, the integration between IoT devices and web-based applications makes this system flexible for online and offline use. It is suggested that further research add the integration of IoT systems with artificial intelligence (AI), so that it not only functions as a monitoring system but is also able to provide predictions of logistics needs, early warning of potential problems, and automatic optimization of the distribution of goods.

V. ACKNOWLEDGMENTS

The author would like to express his deepest gratitude to all parties, especially the Head of the Business Incubator Center, the Chairman of the Kosgoro Institute of Business and Informatics 1957 who have provided support and contribution in the completion of this research.

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