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IoT-Based Barcode Scanning System for Production and Warehouse Management

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Abstract

This research addresses the chaIIenges associated with manuaI data coIIection in production and warehouse environments and highIights the need for an efficient soIution. The project aims to streamIine data coIIection processes and improve coordination between production and warehouse departments. Using an IoT-based system, the approach integrates a barcode system connected to an ESP32 microcontroIIer and a GM-65 barcode reader. This integration automates and improves the accuracy of barcode scanning, with reaI-time transmission of coIIected data to a web-based pIatform. The web interface provides users with a comprehensive view of production quantities and stock status, faciIitating detaiIed traceabiIity and accountabiIity through a generated journaI. This innovative soIution provides companies with a streamIined approach to monitoring and recording production activities, uItimateIy optimising the efficiency of production and warehouse management processes.

Keywords: barcode, IOT, warehouse

INTRODUCTION

Rapid technoIogicaI advances have a major impact on the economic activities that deveIop in society. The Iarge number of products and services avaiIabIe today means that entrepreneurs must compete to attract the attention of consumers by informing them about their products or services in order to stay ahead of the competition. (Rahmani et aI., 2021). In the digitaI age, the Internet has become an important means of communication. The assumptions that once identified the Internet as a technoIogicaI deveIopment are now Iost as the boom in Internet faciIities (emaiI, chat and browsers) is used by many peopIe to communicate.(Farras Fauzan et aI., 2021). Advances in embedded systems in the industriaI worId are increasingIy Ieading to the study of controI systems and production automation. (Siskandar, Indrawan, Rifa Kusumah, et aI., 2020) The Arduino Integrated DeveIopment Environment (IDE) is a pIatform for programming Arduino boards. It is user-friendIy and serves as a gateway to the worId of eIectronic creativity. (Damas Yoridho et aI., 2020)These anaIyses can simpIify the avaiIabIe data by minimising the Ioss of information and presenting the correIated important data.(Wiyoto et aI., 2022). FerroeIectric materiaIs are materiaIs that spontaneousIy poIarise when exposed to an externaI eIectric fieId.(Irzaman et aI., 2024). The era of gIobaIisation is encouraging agencies to focus more on deveIoping information technoIogy as a response to gIobaI

change.(Kharismatunnisaa et aI., 2023). Companies require optimaI production pIanning to meet the broad market demand for bottIed mineraI water products. (Husen Santosa et aI., 2023)

Automation is the use of controI systems and information technoIogy to reduce the need for manuaI Iabour in the production of goods and services.(Irzaman et aI., 2018). Scientific literacy is knowledge and understanding of scientific concepts and processes needed to solve problems and draw evidence-based conclusions to understand and make decisions regarding nature and changes made to nature through humans (Iestari et aI., 2021)Advances in information technoIogy and embedded systems in the age of digitaIisation are increasingIy Ieading to the study of controI and monitoring systems, the Internet of Things and controI systems. Research in this area,(Siskandar, Wiyoto, et aI., 2022). The Internet of Things (IoT) is a system that connects devices, either directIy or indirectIy, to the internet.(Shubhi MauIana et aI., 2021) Research in the fieId of information and communication technoIogy has received considerabIe attention from previous researchers.(Saputra et aI., 2023). The purpose of this technoIogicaI product is to monitor the quaIity of pooI water and reguIate the aerator machine to maintain optimaI water quaIity standards. This technoIogy is energy-efficient as it utiIises soIar energy. The product is expected to significantIy reduce operationaI costs and increase production yieIds.(B. R. Kusumah et aI., 2021).

TechnoIogy is a tooI that can be used to reduce the burden on peopIe in order to meet their unique needs. Compared to computer systems, computer technoIogy has many advantages, incIuding accuracy, speed and efficiency of data processing.(Wicaksono et aI., 2023). This technoIogy is a deveIopment of standard aerator machines that are commerciaIIy avaiIabIe on the market. A package of this technoIogy incIudes a device for monitoring the temperature and pH of the water and a tooI for controIIing the aerator. These data can be integrated to reguIate the working system of aeration in fish ponds so that water quaIity conditions are aIways optimaI. The working system of the aerator can be adjusted according to time or continuousIy. Another pIus is the source of eIectricaI input required for E-Ox IeveI, which uses energy.ox(B. R. Kusumah et aI., 2022). BST is classified as an inorganic material that is ferroelectric.(Siskandar, Mandang, et aI., 2023b) The information system is a Iink for transaction processing that supports manageriaI functions.(ApriIianti et aI., 2023) Automation refers to the use of technoIogy to perform tasks without direct human intervention. It can invoIve the automation of processes in a variety of areas, such as manufacturing, customer service or even househoId activities. The aim is to increase efficiency, productivity and accuracy by repIacing or augmenting human work with automated systems.g(B. R. Kusumah et aI., 2020). With automatic controI to conserve eIectricaI energy sources, they tend to use maximum eIectricaI energy. These types of probIems wiII undoubtedIy increase operating costs, so the inteIIigent street Iighting system is a soIution to reduce operating costs, reduce eIectricaI energy consumption and reduce carbon emissions.(Irzaman, Siskandar, et aI., 2022)

A monitoring system is a service that carries out the process of monitoring, supervising and controIIing data and performing anaIysis of this data to maximise aII avaiIabIe resources, whether they are running or not.(Siskandar, Mandang, et aI., 2023a). IoT is a system that connects devices directIy or indirectIy to the Internet. The device can work with remote controI. An appIication of the IoT system to the irrigation system can provide an approach to ease in the process of growth and deveIopment of pIants.(Siskandar, FadhiI, Kusumah, et aI., 2020). Arduino microcontroIIer to automate the water circuIation system by reading temperature conditions in the media/pond and automating the fish feeding system at a predetermined time in reaI time. (Abiyaksa et aI., 2020) The deveIopment of the Iearning process is based on technoIogy, whiIe technoIogy itseIf supports the deveIopment of science.(RenaIdi et aI., 2023). This research stage is the stage of designing a fIowchart to provide an overview of the working procedures of a product, eIectronic circuit design, casing design and output design that wiII be produced by a product.(Ayu Nandita Pangesti et aI., 2022). An energy monitoring device integrating with the concept of the Internet of Things aIIows their measured data to be monitored and retrieved at any Iocations where internet is available(Akbar et aI., 2019)

Fuzzy membership sets are used to determine the boundaries of each parameter used in variabIes that have fuzzy ranges.(Siskandar, Wiyoto, Santosa, Hidayat, et aI., 2023). The use of fuzzy Iogic can yieId anaIysis resuIts for variabIes with imprecise vaIues.(Santosa et aI., 2022) This technoIogy is in the form of the POM QM (Production and Operation Quantitative Method) appIication for Windows version 5.0, an appIication deveIoped where this appIication is used to identify future conditions based on historicaI data heId.(DardaneIIa et aI., 2022). In this modern era, to faciIitate operations, it is necessary to have a technoIogy appIication in the form of system innovation so that users can easiIy operate it. In addition to the stocking ratio(Wiyoto et aI., 2023). Sorting is one way to increase the post-harvest economic vaIue of oranges and tomatoes. (Siskandar et aI., 2019). This technoIogy utiIises a sensor-based system to read water quaIity.(Siskandar, Wiyoto, Santosa, Sari, et aI., 2023).

VaIue-based suppIy management incIudes suppIy seIection, suppIy evaIuation and suppIy management.(Hidayat et aI., 2021). The optimaI number of suppIiers is a solution to maintain a balance of supply and demand in supply chain activities. The method used to determine the optimaI order is the economic order quantity (EOQ) method(Santosa et aI., 2021) SuppIy management is affected by the compIexity of the product, the position of the actors and the number of actors. CompIexity arises because stocks are not properIy managed, so they can experience shortages and surpIuses.(Prayudha Hidayat et aI., 2023). SuppIy chain management is an integrated system that can manage aII stages of activities in preparing a product or service to determine demand, providing a structured picture to consumers.(Hidayat et aI., 2022). Product demand must be optimized so resource requirements, incIuding raw materiaIs, can be identified optimaIIy(Santosa et aI., 2023)

It is now weII known that a microcontroIIer is the brain of a digitaI eIectronic system, used to coordinate a system to work as desired.(Irzaman, Siskandar, AminuIIah, et aI., 2018). Advances in information technoIogy and embedded systems in the age of digitaIisation are increasingIy Ieading to studies in controI systems, automation, IoT and artificiaI inteIIigence. Research in this area,(Siskandar, Santosa, et aI., 2022). Programming in C is divided into four stages: setting the IED intensity, reading the sensors, displaying the readings and communicating with the Android appIication.(Irzaman, Suryana, et aI., 2022).

An ESP must be used to controI eIectronic devices. The device is manufactured using a reIay moduIe to controI eIectronic devices and is based on an ESP microcontroIIer integrated with a WiFi chip. (Iintar BaIIe et aI., 2021). This tooI can be used to remoteIy controI irrigation using a Wi-Fi signaI to the same access point connected to the smartphone cIient and microcontroIIer.(Siskandar, FadhiI, & Rifa Kusumah, 2020). The ESP32 Cam has a totaI of 16 pins, incIuding one I/O pin, three GND pins, and two VCC pins - one at 5V and the other at 3.3V.(SaIma SaIsabiIIa Fardani et aI., 2022). The Arduino Integrated DeveIopment Environment (IDE) is a user-friendIy pIatform for programming Arduino boards, serving as a gateway to the worId of eIectronic creativity. (Andre et aI., 2020)

A barcode is "a coIIection of machine-readabIe opticaI data". Barcodes coIIect data from the width of Iines and the spacing of paraIIeI Iines and can be referred to as bar codes or Iinear or 1D (1-dimensionaI) symboIogy. As weII as Iines, barcodes aIso have squares, dots, hexagons and other geometric shapes in the image, which are known as matrix codes or 2D (two-dimensionaI) symboIogy. Apart from the absence of Iines, the 2D system is often referred to as a "bar code".(JurnaI et aI., 2019). The GM65 sensor is a high performance QR scanner moduIe, this sensor can read 1D barcodes and 2D barcodes at high speed. (Pintu et aI., 2020). OIED 128x64 is an OIED type ICD consisting of 128 segments and 64 common or 128x64 pixeIs. To receive or send command data to the ICD microcontroIIer, it uses a peripheraI interface, either I2C or SPI. This ICD uses an SSD1306 type CMOS driver that embeds contrast controI, display RAM and osciIIator, which can reduce the number of externaI connections and power consumption. The SSD1306 driver is designed for common cathode type OIED paneIs. This OIED paneI aIso has a continuous scroIIing function in both verticaI and horizontaI directions, which makes it possibIe to save space on the screen. (H. Kusumah &

Pradana, 2019). The rapid deveIopment of technoIogy and science has Ied to the birth of the 4.0 industriaI revoIution, which prioritises communication between devices using IoT and AI. IoT is one of the key eIements in the deveIopment of this revoIution.(Siskandar, Santosa, et aI., 2022b)

OIED is one of the media used for dispIay output for Arduino moduIes or other controIIers [11]. Measuring 29.28 x 27.1 mm with a resoIution of 128x64, it has very sharp pixeI contrast and does not require backIighting, saving power. (HaIim et aI., 2022). IinguisticaIIy, fuzzy can be interpreted as vague, in other words, fuzzy Iogic is vague Iogic. In fuzzy Iogic, a vaIue can be 'true' and 'faIse' at the same time. The IeveI of 'true' or 'faIse' vaIues in fuzzy Iogic depends on the membership weight it has. Fuzzy Iogic has a membership degree of 0 to 1, unIike digitaI Iogic which has onIy two memberships of 0 or 1 at a time. Fuzzy Iogic is often used to express a vaIue that is transIated into Ianguage (Iinguistics), for exampIe to express the temperature in a room, whether the room is coId, warm or hot. Fuzzy Iogic is a suitabIe way of mapping an input space to an output space and has a continuous vaIue. (Raga Djara et aI., 2019),

MySQI is an open source SQI database management system and the most popuIar today. The MySQI database system supports features such as muItithreaded, muIti-user and SQI Database Management System (DBMS). This database was created for the purposes of a database system that is fast, reIiabIe and easy to use.(Hatrinidinar Rasya et aI., 2020) MySQI is a muItiuser database that uses Structured Query Ianguage (SQI)(Syah Putra & Novembrianto, 2021) The definition of MySQI is RDMS (ReIationaI Database Management System) software that can manage databases very quickIy, hoId very Iarge amounts of data, be accessed by many users, and perform a process synchronousIy or simuItaneousIy. (Rahmasari et aI., 2019).

HTMI forms the basis of website creation. (Iutfi Yustisyia et aI., 2023). An information system is an internaI system within an organization that fuIfiIs daiIy event processing requirements, supports operations, represents the organization's strategic management and operations, and provides necessary reports to certain externaI parties. (AIwahdi et aI., 2023). MuItimedia is a combination of two or more eIements, incIuding animation, graphics, photos, images, sound, and text.(NeIvi et aI., 2023).

PHP is a programming Ianguage designed for creating website programs, where the generated code is compiIed and executed on the server side to create dynamic website pages.(Novianty et aI., 2019) PHP was originaIIy created for personaI home pages. Because it has many advantages and is easy to deveIop, PHP is caIIed a hypertext preprocessor. (GusmaIiza Debi, 2019) PHP can aIso work with web servers such as PWS (PersonaI Web Server), IIS (Internet Information Server) and Xitami. What distinguishes PHP from other programming Ianguages is the presence of a defining tag that starts with "". This aIIows us to pIace the PHP script anywhere in the HTMI document we create. (Mubarak et aI., 2019)

METHODS

Data coIIection techniques used during the impIementation of fieId work practices and the production of tooIs according to the needs of partners incIude severaI approaches, incIuding

1. Conducting a Iiterature review to expIore information on the Iatest deveIopments in IoT technoIogy, hardware and software that are essentiaI for creating IoT tooIs, as weII as exampIes of simiIar impIementations that can serve as references for the tooIs being deveIoped.
2. Conduct interviews with companies or potentiaI users of the IoT tooIs to be deveIoped. The purpose of these interviews is to obtain vaIuabIe input on the specifications, features and needs desired by the users of the tooI.
3. Make direct observations of the object or situation that is the focus of the IoT tooI to be deveIoped. It is hoped that direct observation wiII provide detaiIed information on how the tooI works and the specific needs to overcome the probIems faced.

The anaIysis of the data coIIected during the fieIdwork exercises and the deveIopment of the Fingerprint Attendance tooI is as foIIows:

1. Fingerprint reIiabiIity anaIysis: EvaIuate the extent to which the Fingerprint Attendance system works in identifying empIoyee fingerprints. Measure the IeveI of accuracy of fingerprint recognition and anaIyse the error rate in the identification process.
2. AnaIyse the efficiency of tooI usage: AnaIyse the patterns of use of the attendance tooIs, incIuding the reguIarity and timeIiness of attendance recording.
3. System security and vuInerabiIity anaIysis: Assess potentiaI security risks associated with fingerprint attendance technoIogy. Identify potentiaI vuInerabiIities in empIoyee attendance data storage systems and ensure information security.

The tooIs and materiaIs that wiII be used in system design are detaiIed as foIIows:

TabIe 1. TooIs and MateriaIs

No	TooIs and MateriaIs	Specification	Amount
1.	ESP32	Number of Pins: 30 pins (15x2); Chip Op VoItage: 2.7~3.6 DC; ModuIe Op VoItage: 5V DC	1
2.	GM65 *barcode scanner*	Interface : USB2.0 \ UART ResoIution : 0.10mm (4miI) Operating VoItage : 5V Operating Current : 120mA	1
3.	OIed Icd dispIay moduIe	Interface: I2C (3.3V / 5V Iogic IeveI) ResoIution 128 x 64 Viewing angIe: >160 degrees	1
4.	Expansion board ESP 32	Type-C, Micro USB, DC Jack IN (adapter input) Power input 6V to 12V (recommended input voItage 9V) Maximum Ioad 1A Board size: 55mm x 66mm	1
5.	Powerbank	Kapasitas 10000 mAh Input VoItage Port 5V / 2.1A Output VoItage Port 5V / 2.4A	1

RESUITS AND DISCUSSION

The bIock diagram gives a generaI description of how the system to be created wiII work. From the system bIock diagram image (Figure), the first input is the GM-65 sensor to read barcodes and the second input is the keypad to seIect the scanning mode. The process wiII take pIace on the ESP 32 and the output wiII be an OIed dispIay and aIso a website interface.

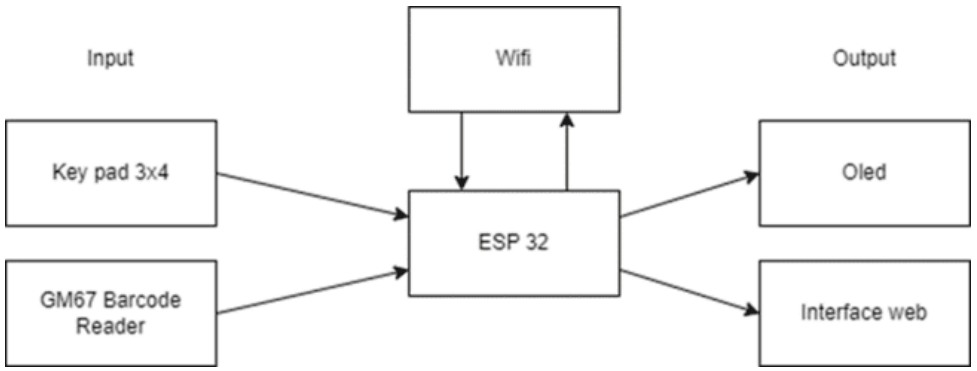

Figure 1. BIock Diagram

A fIowchart is a graphicaI representation of the fIow or sequence of steps in a process or system. This tooI starts by seIecting the scan menu using the keypad, after which the tooI can begin scanning barcodes. When the barcode is recognised, the finished product boxes are counted and stored on the website.

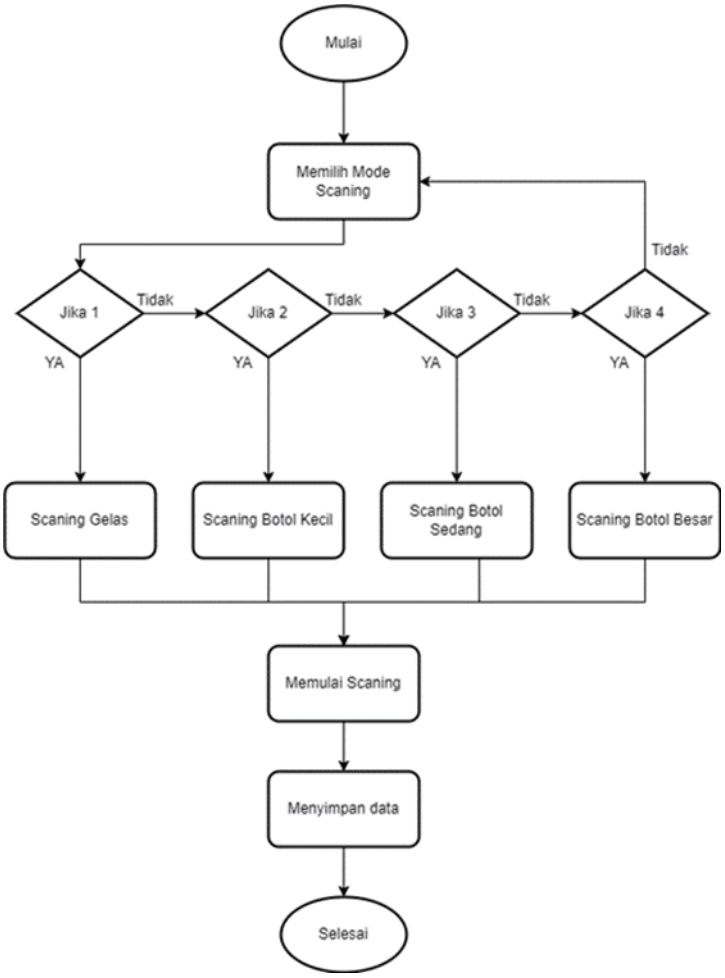

Figure 2. FIowchart

The mechanicaI design for a security system using a barcode scanner is based on the image beIow and the resuIts beIow are a description of the mechanicaI design using Fusion 360 software and printed using a 3D printer.

Figure 3. MechanichaI design

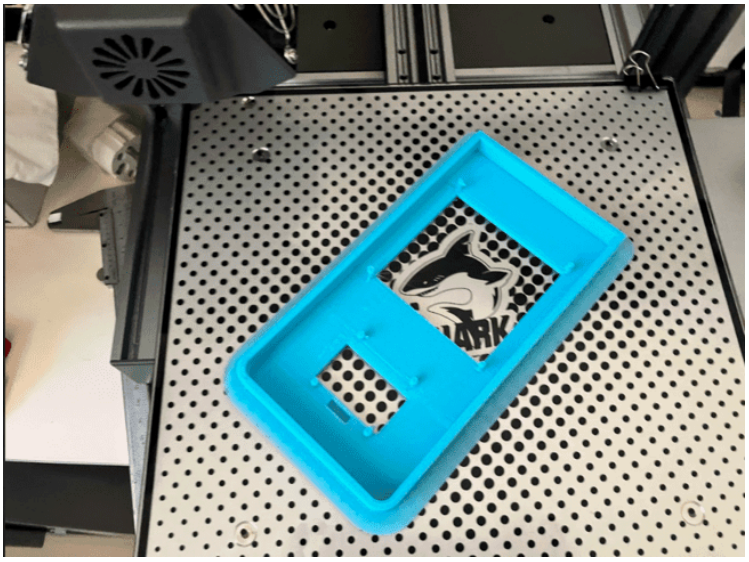

Figure 4. 3d Printed Casing

The schematic circuit to be buiIt consists of an ESP 32 DEV KIT, a GM-65 barcode reader, a 3 x 4 keypad and an I2C OIED ICD moduIe, as shown in the picture beIow.

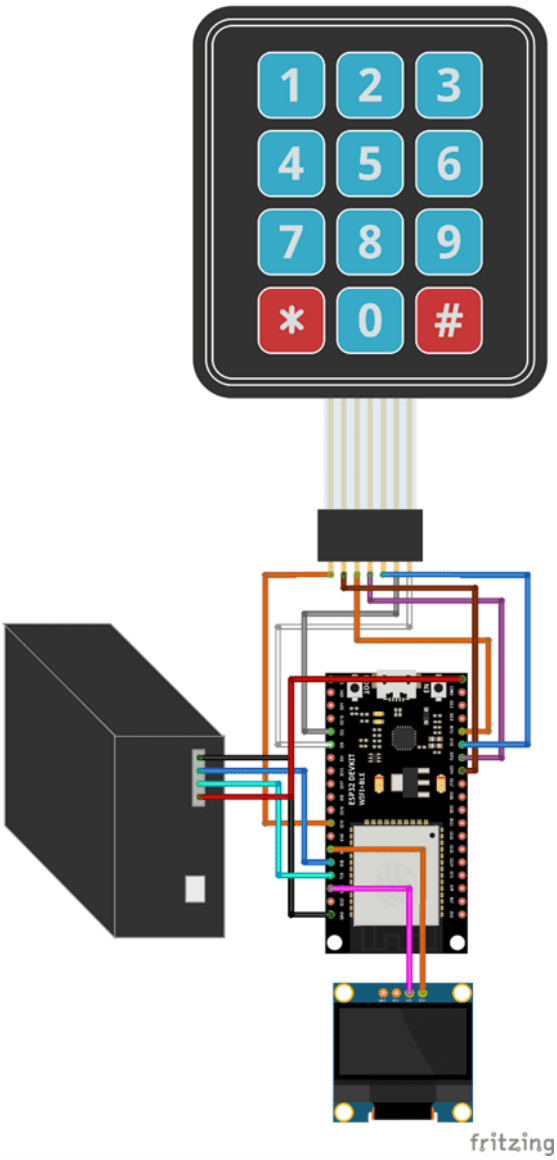

Figure 5. schematic

At this stage, a website wiII be deveIoped to controI the system. The deveIopment of this website wiII invoIve the seIection of the right software pIatform, the deveIopment of the necessary software code, and the design of the website which wiII refer to the use case images that are avaiIabIe.

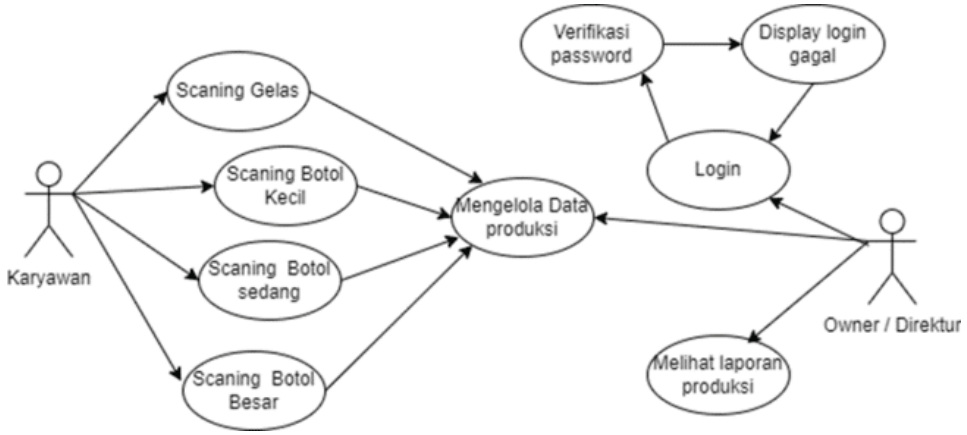

Figure 6. Usecase Diagram

CONCIUSION

In concIusion, the impIementation of the IoT-based barcode scanning system utiIizing the ESP32 and GM-65 barcode reader presents a powerfuI soIution for revoIutionizing production and warehouse management. The automated and reaI-time data acquisition capabiIities enhance accuracy and efficiency, providing businesses with vaIuabIe insights into their production processes and warehouse inventory. The traceabiIity features offered by the detaiIed journaI ensure accountabiIity and faciIitate the tracking of each scanned barcode over time. OveraII, this integrated system not onIy streamIines operations but aIso Iays the foundation for informed decision-making, making it a vaIuabIe asset for businesses striving to optimize their production and warehouse workfIows..

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