

# Smartphone Application for Support Library Operations in the Internet of Things Era

Eko Hadiano<sup>1)</sup>, Djarot Hindarto<sup>2)\*</sup>, Handri Santoso<sup>3)</sup>

<sup>1,3)</sup> Universitas Pradita, Serpong, Banten

<sup>2)</sup> Fakultas Teknologi Komunikasi dan Informatika Universitas Nasional, Jakarta

<sup>1)</sup>[eko.hadiano@student.pradita.ac.id](mailto:eko.hadiano@student.pradita.ac.id), <sup>2\*)</sup>[djarot.hindarto@civitas.unas.ac.id](mailto:djarot.hindarto@civitas.unas.ac.id),

<sup>3)</sup>[handri.santoso@pradita.ac.id](mailto:handri.santoso@pradita.ac.id)

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**Abstract:** The library can be referred to as a storage place for books and other references. The reference can be in the form of digital storage media. Libraries if not managed properly will cause chaos in the library organization. Many books were lost due to the entry and exit of books that were out of control. Currently, the library is not only a place to store books but can be maximized by managing and adding other digital devices. The use of Radio Frequency Identification (RFID) in libraries adds sophistication to the management of books and library items. In addition, currently many libraries have taken advantage of Internet of Things Technology, by adding various sensors and integrating with cloud-based storage devices. It provides a service that makes it easy for library members to find and track the current whereabouts of books. This research does not only create a library by providing hardware in the form of sensors to be installed in the library. This paper also proposes the use of smartphones as an alternative in replacing sensor hardware. This study uses a QR Code sensor to match the book you are looking for and simulates dancing a book in blocks and bookcases. with augmented reality. The purpose of this research is to make a smart library prototype to make it easier for library members to find books or other references. The results of the experiment to find books and DVDs that have been carried out achieve an accuracy of 83.33%.

**Keywords:** Camera; Internet of Things; RFID; Smartphone; System Application

## INTRODUCTION

Currently, library services have experienced many developments with the existence of technology and the increasingly diverse needs of users. Libraries are still the main source of access to various collections of books and literature, both in print and digital form. This service is generally available to library members with different types of membership cards. The library also provides book lending services, both online and at the library location. Some libraries also provide book delivery services to user addresses. The library provides a reading room for users who want to read books or find references on the spot. Some libraries also provide special reading rooms for children or reading rooms equipped with special facilities such as computers or Wi-Fi. Libraries provide reference services for users who need assistance in finding certain information or references. These services are generally available through websites or chat services. Some libraries provide programs of events such as seminars, training or workshops to increase user knowledge and skills. Libraries are starting to take advantage of technology in providing services, such as online book search systems, library applications, and the Internet of Things (IoT) (Verma et al., 2022) to facilitate access to available book collections and information. Some libraries provide special services such as disability services, research services, or

\*name of corresponding author



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certain community services. Library services are currently increasingly diverse and sophisticated with the available technology. These services provide added value for users to facilitate access to the information and literature needed.

The Internet of Things (IoT) (Rejeb et al., 2023), (Ding et al., 2023) or in Indonesian it is referred to as the Internet of Goods is a concept in which physical objects (such as electronic devices, vehicles, household appliances, etc.) are equipped with technology that allows them to be connected to each other and communicate via the internet network. By using technologies such as sensors, software and certain hardware, IoT enables these objects to collect and exchange data automatically without any human interaction. This enables integration between the physical and digital worlds and enables more effective decision-making based on data collected by various connected objects. Common examples of IoT uses include internet-connected household appliances, network-connected door security systems, vehicles that can be controlled remotely via apps, and more. On a larger scale, IoT is also being used in industry and manufacturing to monitor and regulate production, optimize supply chains and improve operational efficiency.

Libraries have become an important resource for people to gain access to various types of literature and information. However, with the development of technology, libraries also need to keep abreast of these developments so that they remain relevant and easily accessible to users. One of the latest technologies that can be utilized by libraries is the Internet of Things (IoT). IoT is a network of devices that are connected via the internet and can communicate with each other to simplify the decision-making process and provide accurate data. In the context of libraries, IoT can be used as a book search tool that makes it easier for visitors to find the books they need. In a book search system using IoT, every book in the library is equipped with an RFID (Radio Frequency Identification) sensor that can read information about the book. This sensor is connected to the IoT system in the library and can send information about the location of books to users through applications or websites that can be accessed by visitors. With a book search system using IoT, library visitors can easily find the books they need without having to search for these books manually. In addition, visitors can also obtain information about books, such as the number of book stocks, availability of books, and the exact location of books.

RFID (Radio-Frequency Identification) (Qasim Mohammed et al., 2023) is a technology that uses radio waves to identify and track objects equipped with RFID tags. An RFID tag consists of a microchip and antenna attached to the object to be identified. The tag will send a radio signal to the RFID reader, and then the data contained in the tag will be forwarded to the connected system. RFID is often used in applications such as inventory, logistics and manufacturing to track the movement of goods and optimize supply chains. For example, a warehouse can use RFID to monitor product movement, reduce product loss, and increase shipping efficiency. RFID technology is also used in various security applications such as door access cards, public transportation tickets, identity cards, and others. In addition, RFID is also used in medical applications such as tracking medical equipment, drugs, and patients in hospitals.

A smartphone is a type of cell phone that has more capabilities than just calling and texting. Smartphones are equipped with more sophisticated features, such as cameras, music players, applications and internet connections that allow users to access various services and information in the form of text, images and videos. In addition, smartphones also have an operating system that allows users to install and run various applications. With these features, smartphones are very useful and popular devices in today's digital era. Smartphones can support the Internet of Things (IoT) because they have the ability to connect to the internet network and communicate with other IoT devices. Using the appropriate apps, smartphone users can control and monitor connected IoT devices, such as smart lights, smart thermostats, surveillance cameras, and other devices. In addition, smartphones can also receive notifications from IoT devices when certain changes or events occur, such as motion detection or temperature changes. In some cases, a smartphone can also serve as a central control or gateway for IoT devices, allowing users to manage and control multiple devices from one place. Therefore, smartphones are very important in the development and implementation of IoT technology.

In this digital era, the use of technology such as IoT can be a solution to improve the quality of library services and make it easier for visitors to obtain the information they need. With a book search system using IoT, libraries can provide a better experience for their visitors and make it easier to access literature and information available in the library. From the description of Internet of Things Technology

\*name of corresponding author



for libraries, it can be broken down into questions for research. The following are Research Questions that can be used as follows:

1. How does smartphone-based internet of things tool with qr code help to find position in book? (Research Question 1)
2. How to make an internet of things device, not using external sensors or just using a smartphone. (Research Question 2)

Researchers will discuss "Smartphone Application Supports Library Operations in the Internet of Things Era" complete with Literature review, Methodology, Results and discussion, as well as complete conclusions in a written paper.

### LITERATURE REVIEW

Research that discusses the Internet of Things has been carried out by many researchers around the world. Much research has also been done on libraries that use internet of things and smartphones. The following are several articles discussing the Internet of Things: First, a discussion of research entitled "Investigating the impact of the Internet of Things services from a smartphone app on grocery shopping" has impacted the use of the Internet of Things in the wholesale sales industry (Fagerstrøm et al., 2020). The advantage of this research is being able to carry out investigations for the use of internet of things devices in the wholesale smartphone sales industry. The drawback of this research is that it does not provide technical details regarding the design of internet of things devices. So, it's only limited to investigations from the internet of things.

The second research, entitled "Applications of the Internet of Things in university libraries of Pakistan: An empirical investigation", is the application of IoT devices to library needs. This research implements IoT-based appliances including smart air conditioners, automatic fire alarms, smart hand sanitizers and smart security doors. In addition, the university library uses limited IoT-based services, namely automatic check-out notifications, reading material check-in, check-out and self-check-in systems, user card recognition, and the use of Radio Frequency Identification Tags (RFID) for a security perspective (Asim et al., 2022). Weaknesses of this research, to implement IoT applications found a lack of network and integrated environment, budget problems, unavailability of policies and strategic plans, and lack of technical personnel.

The third research, with the title "Smart monitoring solution through internet of things utilization to achieve resilient preservation". A new framework for heritage buildings that integrates resilience techniques with historical building information modeling. The internet of things device serves as a tool for practical implementation of resilience in process preservation. The framework attributes as a solution applying theory with high accuracy and efficiency (Mohamed El Abd, 2023). The weakness of this implementation is that it requires very high costs, if used for monitoring all cultural heritage areas to be protected.

Previous research has discussed a lot about Internet of Things devices that are used for library systems to improve services. So that in carrying out the implementation requires additional hardware. So that the three studies above show that the procurement of equipment requires money. This research completes the shortcomings of the three studies that have discussed Internet of Things devices in library systems. The state of the art in this research is building a library system with smartphone-based internet of things. Because smartphones have many sensors that can be used as a substitute for external hardware sensors.

### METHOD

This study uses an Android-based smartphone. Android is an operating system based on the Linux operating system. The architecture of the Android smartphone in figure 1, is the hardware and software structure that allows the Android operating system to run on the device. In general, the architecture of an Android smartphone consists of four main components:

1. The kernel is the lowest layer of the Android (Hindarto & Handri Santoso, 2021), operating system that connects hardware and software. The Android kernel is the Linux kernel that has been modified to support mobile devices. The Android kernel is based on the Linux kernel, which has been modified and enhanced to support specific features on mobile platforms. The

\*name of corresponding author



Android kernel provides an interface between hardware and software at the system level, and also provides many of the system functions and services used by applications and layers above them. The kernel is responsible for managing hardware resources, such as CPU, memory, and input/output (I/O), and for providing security and power management services.

2. Libraries are a set of code that facilitate the performance of the Android operating system. Some of the important libraries include the Surface Manager, which manages displays, and the Media Framework, which enables multimedia applications. A library is a collection of code written in a specific programming language, which can be used by applications to extend or simplify their functionality. Libraries usually consist of a collection of functions or procedures that have been written and optimized to perform a particular task. In the Android context, there are various libraries that can be used by developers to extend the functionality of their applications. Android libraries (Hindarto & Santoso, 2022) can be written in Java or Kotlin, and can be included in Android applications as separate modules or as JAR or AAR files.
3. The Application Framework (Hindarto, 2022) is a set of components that enable the development of Android applications. This framework consists of various features such as network management, database management, and window management. The Application Framework is not only used for developing Android applications, but also for developing applications on other platforms such as iOS, web and desktop. An Application Framework is a set of components that provide a framework or basic structure for building applications in a consistent and efficient manner. These components can include APIs (Application Programming Interfaces), libraries, modules, and other tools that make it easier for developers to build, test, and distribute their applications. Examples of some well-known Application Frameworks include React Native, Flutter, Angular, Laravel, Ruby on Rails, and Spring.
4. Applications are the application layers installed on an Android device. Some of the default apps on Android devices include Phone, Messages and Browser. An application is a software layer on the Android operating system that is used to perform certain tasks on an Android device. Apps can be installed on Android devices via the Google Play Store, or they can be installed manually via APK files. Every Android app runs in a sandbox environment, which means it's isolated from the operating system and other apps on the device. This means that each application can only access the resources and information provided by the operating system through its defined interface. Android applications can be built using various technologies and programming languages, such as Java, Kotlin, and C++. Android applications can also take advantage of various system services and frameworks provided by Android, such as the Android SDK, Android NDK, Android Support Library, Google Play Services, and more. Android apps can perform a variety of tasks, such as accessing the network, storing data, displaying the UI, sending and receiving messages, performing computations, and more. Android apps can also use various hardware features on the device, such as the camera, GPS, sensors, and more.
5. Android runtime (Shankar & Somani, 2016) which contains the core library and Dalvik virtual machine. Dalvik Virtual Machine (DVM) is a virtual machine used on the Android operating system to run applications. DVM is designed specifically for mobile devices and is an integral part of the Android architecture. Every Android app runs in a sandbox environment, which means it's isolated from the operating system and other apps on the device. Every time the user opens the application, the Dalvik Virtual Machine will create a virtual environment in it to run the application. Dalvik Virtual Machine uses a file format called Dalvik Executable (.dex) to run applications. This file format was designed to optimize memory usage and to support mobile platforms by enabling lighter code and faster running applications.

Overall, the architecture of an Android smartphone is a combination of hardware and software designed to work with the Android operating system. Each component plays an important role in keeping Android devices running smoothly and providing a good user experience.

\*name of corresponding author



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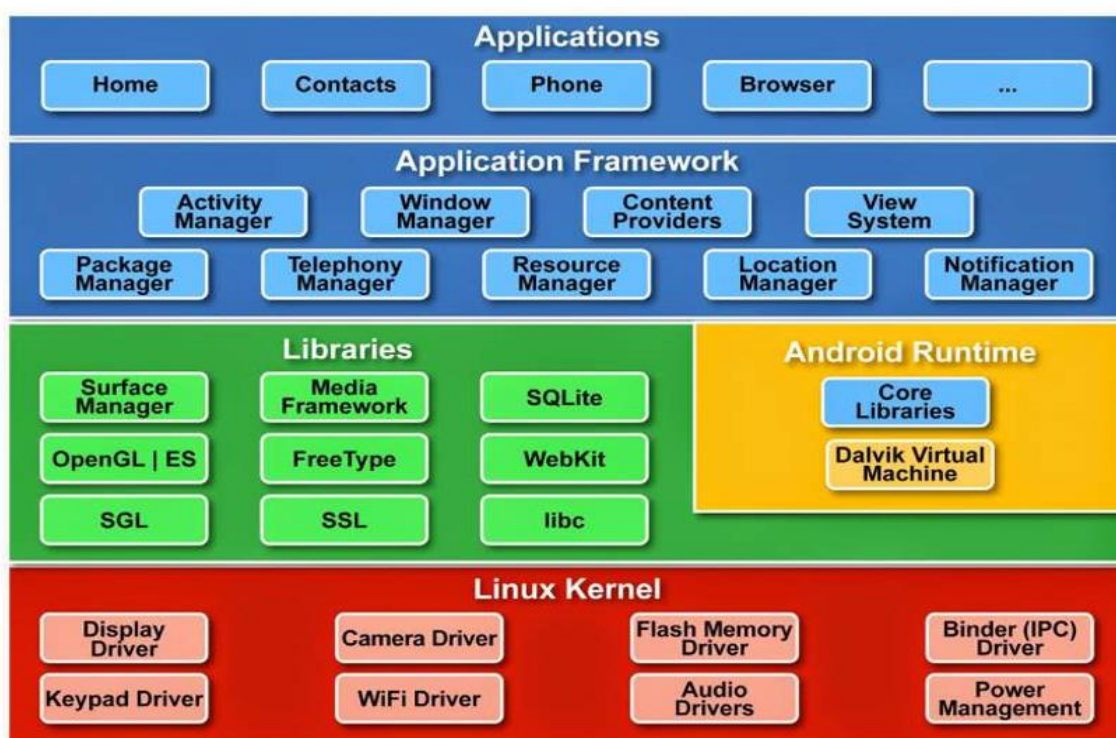


Figure 1. Android Architecture Kernel Linux  
Source: Google Image

### Programming Language on Android

In developing application systems for libraries, it is necessary to use the Android programming language. The programming languages used to develop Android applications are Java, React, Flutter and Kotlin. Java is the main programming language used to develop Android applications from the very beginning. Android SDK (Software Development Kit) provided by Google, supported by the Java programming language. The Java programming language has a syntax that is easy to understand and easy to learn, so many developers choose to use this language in developing Android applications. React Native uses the JavaScript programming language (Bosse, 2018), (Ashrov et al., 2015) and allows developers to develop Android (and iOS) apps using the same code for both platforms. React Native uses native APIs from mobile operating systems and provides a fast and responsive native app experience. React Native can more easily integrate with existing applications and has a large user base.

Meanwhile, Flutter uses the Dart programming language developed by Google. Flutter uses consistent widgets and provides powerful tools for building rich and interactive user interfaces. Flutter also allows developers to build Android and iOS apps using the same code. Flutter is more focused on developing beautiful and responsive user interfaces. Kotlin is a relatively new programming language and started being supported by Android Studio in 2017. Kotlin provides modern features and a syntax that is easier to read and write compared to Java. In a short time, Kotlin became one of the most popular programming languages among Android developers.

### Internet of Things

Internet of Things (IoT) (Sze et al., 2022) is a concept where physical objects connected to the internet can communicate with each other and exchange data without human intervention. In other words, IoT refers to a network consisting of various devices, vehicles, and sensors that are connected to the internet and can interact and exchange information automatically. IoT can be used in a variety of contexts, such as in smart homes, transportation, healthcare, agriculture, manufacturing and many more. With IoT, devices can be controlled and monitored remotely, and the resulting data can be used to make smarter and more effective decisions.

\*name of corresponding author



IoT devices, this includes sensors, actuators, controls (Pantelic et al., 2023), (Hadianto et al., 2023) and other equipment that is connected to the internet and can communicate with each other. The devices need a network to communicate. Network is the infrastructure used to connect IoT devices to the internet and also connect IoT devices to each other. In some cases, IoT requires cloud computing as its operations. Cloud computing is a technology used to process and store data from IoT devices in remote data centers. This involves using technology to analyze data from IoT devices (Thouti et al., 2022) to gain insight and a better understanding of how the system operates. Security is very important in IoT because data sent between devices must be protected from threats such as hacking or identity theft. Communication protocols govern how IoT devices communicate and exchange data with each other. Some of the common protocols used in IoT are MQTT, CoAP, and HTTP. When all of these components work well together, the Internet of Things can provide great benefits in various fields.

Smartphones can be used to control smart devices at home such as lights, fans and thermostats. This is done by connecting the smartphone to the smart device via a Wi-Fi or Bluetooth network. Smartphones can also function as sensors to detect the surrounding environment such as temperature, humidity and noise. This can be used to monitor conditions inside the house or to measure air quality. By using sensors on smartphones, users can monitor their health, such as heart rate and sleep quality. Smartphones can be used as GPS and can assist in navigation, especially when driving. Currently, many payments use digital transactions, smartphones can be used as digital payment instruments and can be used to make transactions without the need to carry cash or credit cards. Internet of Vehicles (IoV), Smartphones can connect to cars and function as smart keys, unlock cars, and manage navigation systems. To use a smartphone as an IoT device, special applications and software that can connect smartphones to other devices in the IoT network must be installed. That way, users can take advantage of the potential of smartphones as IoT devices to access information and control various devices around them.

### Proposed method

In this study, the author proposes to create an application system for libraries using Internet of Things devices, which in this case are Smartphones. Because smartphones now have a lot of sensors embedded in the Android smartphone system. As in figure 2. The proposed method is very simple, but very powerful when combined with the arrangement of books or library items. In terms of cost and a simple system, it can serve library members optimally. Of course, making a library system does not need to use expensive devices. Adding a QR Code scan to books can also help in finding books arranged on a bookshelf. In searching for books, augmented reality technology is also used which functions as a simulation in searching for bookshelves. Search simulation is used for members who can quickly find the position of the book. In addition to saving costs in making the system, this simple system is very fast to implement in the library. Thus, saving time, both in developing and in saving time in implementation.

Quick Response Code (QR Code) (Kjeldsen et al., 2023) technology is a form of two-dimensional matrix code that stores information in the form of black and white patterns. QR codes can store a larger amount of information than traditional barcodes and can be read quickly using a smartphone equipped with a camera and QR code scanner software. QR Code was first developed by a Japanese company, Denso Wave in 1994. The use of QR Code is very popular in Japan and has been used in various applications, such as sending text messages, member registration, payment in stores, and many more. Identification of goods, QR Code (Lau et al., 2022) can be used as a tool to identify goods or products by displaying information such as product name, serial number, expiration date, and other information. In the library system, the QR code can be used to identify the books on the shelves. Information from the QR code can contain the code for the title of the book, the author, the position of the book on the shelf. In recent years, QR codes have become increasingly popular around the world and many companies have started using them as a way to improve customer experience and operational efficiency.

\*name of corresponding author



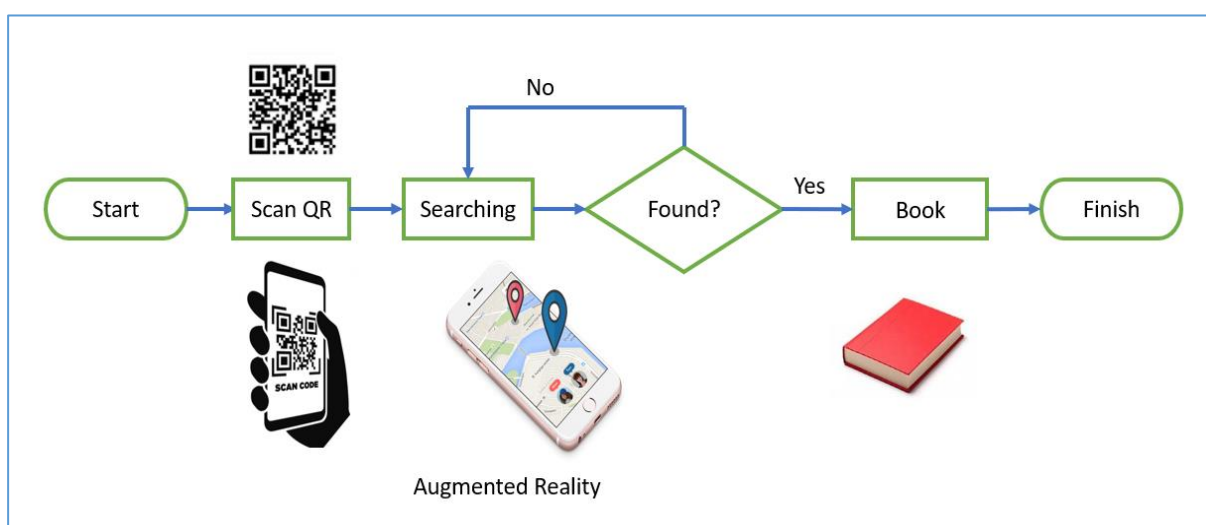


Figure 2. The proposed research method  
Source: Researcher Property

Augmented reality technology in figure 2, is used to help users determine directions in finding a book in the library. Augmented reality applications can display the camera view of a smartphone and place a user-defined direction visually on a live image on the screen. Users can point the camera at a bookshelf in the library and the app will show directions to the shelf containing the book they are looking for. This can help users to find books more quickly and easily without having to ask other people or search for books manually.

### RESULT

The results obtained are in the form of a prototype model to simulate a book search using Augmented Reality. Experiment on figure 3, using augmented reality software that has been widely circulated on the internet with free mode or paid mode. Augmented reality does not require coding, it only simulates arrow directions (arrow movement, left, right, straight and up), as well as book direction arrows.

Table 1. Test results for the smart library prototype

No	Location Testing	Actual location	Result
1	Book D are in block A rack 1	Book D are in block A rack 1	Valid
2	Book D are in block B rack 1	Book D are in block B rack 1	Valid
3	Book D are in block C rack 1	Book D are in block C rack 1	Valid
4	Book D are in block A rack 1	Book D are in block A rack 1	Valid
5	Book D are in block A rack 1	Book D are in block A rack 2	Wrong
6	DVDs are in Block B1 rack 3	DVDs are in Block B1 rack 3	Valid
7	DVDs are in Block A1 rack 2	DVDs are in Block B1 rack 3	Wrong
8	DVDs are in Block B1 rack 3	DVDs are in Block B1 rack 3	Valid
9	DVDs are in Block B1 rack 2	DVDs are in Block B1 rack 2	Valid
10	Book D are in block A rack 1	Book D are in block A rack 1	Valid
11	Book D are in block A rack 1	Book D are in block A rack 1	Valid
12	Book D are in block A rack 3	Book D are in block A rack 3	Valid
13	Book E are in block A rack 1	Book E are in block A rack 1	Valid
14	Book D are in block C rack 2	Book D are in block C rack 2	Valid
15	Book D are in block A rack 1	Book D are in block A rack 1	Valid

\*name of corresponding author



From the results of the experiment 10 times, there are 2 that are not in the right location for the book and the location of the DVD. The results of the accuracy of the experiment showed 83.33%



Figure 3. One of the models for augmented reality with the help of AR Makar software  
Source: Property Researcher

Figure 4. is the source code for reading QR Code, using the web-based Kodular.io software. Kodular.io is a web-based visual application development platform for Android, which allows users to create Android applications with a drag-and-drop interface without the need for in-depth programming knowledge. Kodular.io provides a wide variety of components and blocks that can be used to build applications, including cameras, storage, image processing, networking, and more. Kodular.io uses a visual programming language that is, a programming language that does not require knowledge of programming syntax and a deeper understanding of programming languages. Apps created using Kodular.io can be downloaded and installed on Android devices, and can also be uploaded to the Google Play Store. Kodular.io can be used by users of all backgrounds, from beginners to experienced developers who want to create Android apps quickly and easily without having to master more complex programming languages.

```

when QR_Code1 .Got Response
  success url
do
  if
  then
    set global picture to get url
    set Lqr_label . Text to Tqr_text_enter . Text
    set Vqr_text . Visible to false
    set Vqr_code_show . Visible to true
    set Image1 . Picture to get url
  else
    call QR_Code1 .Generate Qr Code
  
```

Figure 4. Source code visual block Kodular  
Source: Property Researcher

\*name of corresponding author





## DISCUSSIONS

How does smartphone-based internet of things tool with QR code help to find position in book? (RQ1). In the context of finding a position in a book, smartphone-based Internet of Things (IoT) tools with QR Codes can help in a number of ways. First, books can be labeled with a QR Code on each page which can be scanned with a smartphone. QR Code labels can contain information about page numbers and book titles, so that when a user scans a QR Code label with their smartphone, that information will appear on the smartphone screen. In this way, users can easily know the position of the page being read and can continue reading from that page on their next visit. Second, if the book is equipped with a QR Code label, users can use third-party applications that support QR Code scanners to help find a position in the book. Such apps can help users bookmark the last page they read and allow them to quickly return to that page on their next visit. However, keep in mind that users must have a smartphone that supports QR Code technology and a QR Code scanner application to be able to use these features. Additionally, books must come with a QR Code label on every page, which can require additional cost and effort to apply to each copy of the book.

How to make an internet of things device, not using external sensors or just using a smartphone? (RQ2). To make Internet of Things (IoT) devices using only smartphones, you can use built-in sensors on smartphones and IoT development platforms that have been designed to be operated via smartphones. Determine the type of sensor to be used and the data to be collected. For example, if you want to create an IoT device to measure temperature and humidity, you can use temperature and humidity sensors on your smartphone. Choose an IoT development platform that suits your needs. Some popular platforms include Blynk, ThingSpeak, and Kodular.

1. Download and install the IoT application associated with the platform you have chosen. If you are using the Blynk platform, download and install the Blynk or Kodular app on your smartphone.
2. Program code to connect the sensors on your smartphone with the IoT platform you are using. You can use a programming language such as C, C++, Python, or another programming language, depending on the platform you are using.

To create an IoT device using only a smartphone, Use the built-in sensors on the smartphone and an IoT development platform such as Blynk, ThingSpeak, or Kodular. Program code to connect sensors on your smartphone with the IoT platform used and monitor data collected through the IoT application on smartphones.

## CONCLUSION

In the Internet of Things (IoT) era, libraries can improve their operations by utilizing a smartphone application that supports them. By using a smartphone application, libraries can manage books, monitor book availability, provide book return notifications, and make it easier for visitors to search for books. Smartphone applications can also assist libraries in improving services to visitors. For example, by using a library application, visitors can easily find information about books, view borrowing history, and extend the period of borrowing books. In addition, smartphone applications can assist libraries in increasing operational efficiency. By using the library application, library staff can easily track the availability of books, monitor the number of loans, and perform data analysis to improve library services. However, the library needs to ensure that the smartphone application used is safe and meets privacy standards. Libraries also need to provide training to staff and visitors in using library applications. In conclusion, smartphone applications can assist libraries in improving operations and services to visitors. However, libraries need to ensure that the applications used are safe and meet privacy standards, as well as provide training to staff and visitors in using library applications.

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\*name of corresponding author

