Data Storage of Project Survey System Utilizing Android-Based Cloud Computing

Hamdan Fajril Haqiqie, Moh. Ali Romli

Abstract— **Data storage is a process or technology used to store digital information, including the methods used to store, manage, and access data. Cloud technology is a rapidly evolving information and communication technology in the current era, serving as a medium for data storage and data processing services. This application system is designed to streamline the process for administrators, technicians, and project managers when dealing with project survey document data, which so far they have relied on a manual reporting process and stored data on a computer server that is highly insecure for the survey data, Therefore, an effective application system is needed, enabling technicians to report and store data directly. As a result, the reporting and data storage processes, using cloud computing as the storage medium, will appear to be more secure and flexible, ultimately saving time. Through black-box testing of the application, the analysis and design of the developed system can be used to store both text and image data in Firebase Cloud, viewable on the main application page. Technicians have traditionally used this feature to report and store data, and the application functions well in this regard, although it still has security shortcomings. The conclusion of the system design for data storage application utilizing cloud computing, specifically Firebase, is that it can optimize the process for technicians, making data storage more time-efficient and secure for archiving survey data in cloud storage.**

Index Terms— **Android, Cloud, Computing, Firebase, Data, Telecommunications.**

I. INTRODUCTION

The construction of telecommunication towers in Indonesia has significantly increased, with 39,062 towers built in 2021 according to the Central Statistics Agency [1]. To ensure the success of the construction project or tower safety inspections, strict supervision is required, along with the collection of survey data and documentation of construction progress to be stored as records. At present, survey data reporting is conducted through WhatsApp groups, which is then transferred to Microsoft Excel and stored on a computer. However, this method is less than optimal because it requires a storage medium such as a database or cloud storage. Additionally, technicians face the issue of a time-consuming process for recording and reporting survey work progress to project managers if they do not make use of a that storage medium.

There is a study that presents a similar concept in reporting survey data [2]. However, that study has

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limitations in terms of data storage without using cloud storage. Therefore, this research aims to provide a secure and flexible Android application system. This system will facilitate the storage needs for documents related to telecommunication tower construction projects. With this system in place, the management and storage of project survey report data will become more efficient and flexible. The chosen operating system is Android, which is the fastest-growing and most widely used mobile operating system in the world [3]. The usage of Android OS as of September 2023 shows that Android remains the most widely used operating system globally [4]. [1].

Cloud computing is a solution that can assist companies in reducing costs by providing unlimited virtual storage. In this context, cloud storage services can be used to synchronize local folders with servers located in the cloud via the internet [5]. This research employs Software as a Service (SaaS), which applies the concept of an Application Service Provider (ASP). However, there are limitations in leveraging application features because this service is multi-tenant, meaning the provided features are generally used and cannot be customized to meet specific company needs [6]. Therefore, this research designs an Android mobile application to assist the needs of technicians, administrators, and project managers.

II. METHODOLOGY

A. Data Storage

Data storage system is the process of storing data in various forms, including numbers, letters, symbols, text, and images, which are stored on a related medium. Another definition of a data storage system is a collection of data that is mechanical, used collaboratively, formally defined, and controlled within an organization [12].

B. Cloud Computing

Cloud computing is a new model for organising and distributing information on the internet, and it is a mechanism where a collection of IT resources and data mining are interconnected and nearly limitless [7]. The term "cloud" has been in use for a long time, originally used in network diagrams to represent the Internet, cloud computing is often referred to as the provision of "Internet-based computing services" [8]. Based on this definition, it can be concluded that cloud computing refers to on-demand computing services available on computer/internet networks. Cloud computing services can be accessed by multiple users simultaneously, with all data stored centrally on a server.

Cloud computing offers benefits to users, including scalability, accessibility, and management [6].

C. Software as a Service (SaaS)

Software as a Service is one of the most widely developed service models for cloud computing systems. This service model consists of web-based applications or software provided to various users by service providers. Users do not need to possess the application themselves but require an internet connection to access and use it. As an example, a company that develops this service is Google, with an example application being Google Docs, which serves as a word processor, spreadsheet, and presentation maker [7]. It can be concluded that SaaS is the cloud computing technology service that is closest to end-user technology services. This service consists of software applications that can be run simultaneously with users. As a result, users no longer need to install or create applications; they simply use or rent software from the service provider. Software as a Service is a service designed to simplify users' computing activities [6].

D. Firebase

Firebase is a platform that can support your projects with features such as data storage, user authentication, static hosting, and more. You can easily create mobile and web applications that scale from one to millions of users. These features also enable you to develop more robust, secure, and scalable applications. Firebase uses a Global NoSQL document database to store, sync, and access mobile and web application data across Web, iOS, and Android platforms [10]. Firebase is also a cloud service and backend service provider owned by Google. As a solution, Firebase offers ease in connecting devices and exchanging information between devices via an online network [11].

E. Research

In this research, the methodology used will be descriptive using a qualitative approach. The descriptive method aims to address issues by describing the condition of the subjects or objects in the current study based on observable facts [12] [13]. The research steps can be seen in Figure 1.
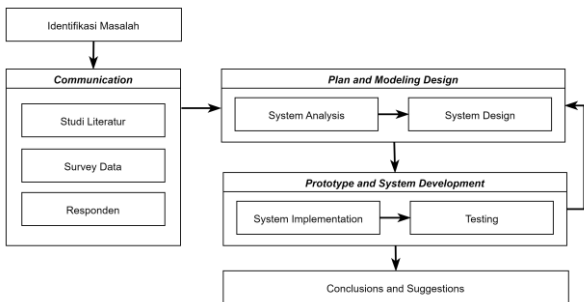

Figure 1. Research Steps

The stages in this research follow a prototype model, which is then adapted to the research requirements, resulting in stages such as a) Problem Identification, b) Communication, c) Planning & Rapid Design Modeling, and d) Prototype Construction & Development Delivery.

F. Data Collection Procedure

The data collection method is carried out by obtaining information that aligns with the research objectives, and the steps are as follows:

1) Observation

The researcher observes the company's activities directly by conducting observations at PT. Tricomindo Cipta Mandiri in Jakarta.

2) Interview

The data collection method is highly effective as it allows the researcher to meet and directly question individuals related to the company's operational activities, specifically the administrators and technicians at PT. Tricomindo Cipta Mandiri.

3) Literature Study

The data collection method is highly effective as it allows the researcher to meet and directly question individuals related to the company's operational activities, specifically the administrators and technicians at PT. Tricomindo Cipta Mandiri.

III. PROPOSED SYSTEM

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A. Architecture

The data storage system is designed for Android and comprises two entities: administrators and technicians. Report results in the form of documents can be managed by administrators, while the Android-based application is intended for administrators. A representation of these two entities can be seen in the following diagram.
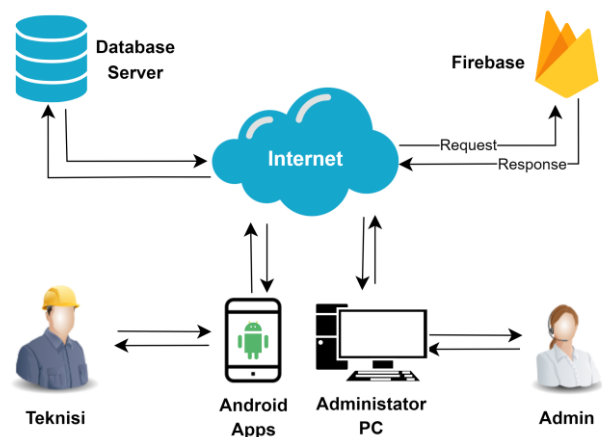

Figure 2. System Architecture Diagram

The system architecture diagram for the telecommunication tower survey data storage application can be found in Figure 2. The stages include application registration, technician registration, survey data input, data storage in cloud storage, and the reporting process. In the registration stage, the company needs to submit a complete profile document to be handled by the administrator. The technician can subsequently register and enter personal information such as name, email, company, and a password

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for account security. Afterward, the technician can log into the application and input survey data in various forms such as text, numbers, jpg, or png. This data is then saved to cloud storage in PDF format. The administrator can view and download these documents, while the technician can review the survey results. By storing data in cloud storage, the process of reporting from technicians to administrators becomes more efficient, and survey documents remain secure as part of the company's archive.

B. Context Diagram

The Context Diagram is essential for providing an overview of the system. The level of the Data Flow Diagram (DFD) begins with the context diagram to illustrate the system in a general sense, encompassing several external entities outside the system. Ensure that technical terms' abbreviations are explained when first used and adhere to a consistent citation style and format.
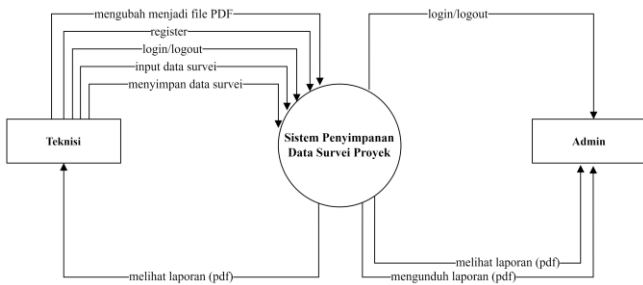

Figure 3. Context Diagram

Figure 3 above illustrates how data is exchanged within the application. Admin receives account creation requests that include personal and technician company information, and the system receives feedback after admin approval of this information. Technicians can input report documents and data into the system as personal data before entering the application. The data flowing from the system consists of PDF documents and data input by technicians. Specifically, this data relates to the results of telecommunication tower surveys.

C. Physical Design

Physical design is essential for clarifying the proposed process or operational process for the new system. In the physical design stage, application activities are depicted using an Entity Relationship Diagram (ERD), as shown in Figure 4.
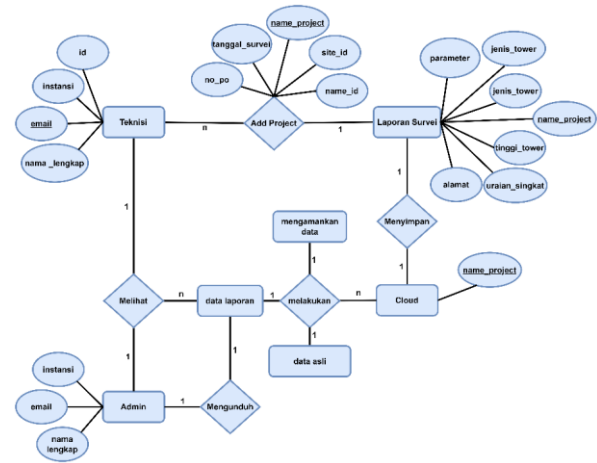
Figure 4. Entity Relationship Diagram

By modeling the physical data from the entities previously modeled in the logical design. In physical data modeling, each attribute in the entities is given a data type, and the attribute names are adjusted to meet the database system's needs using table relationships, as seen in Figure 5.
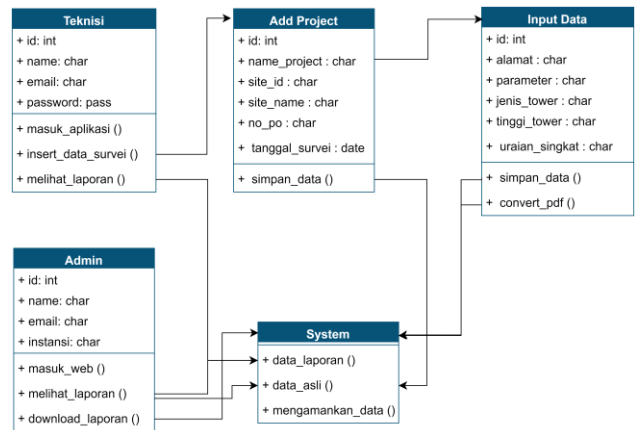
Figure 5. Relations Table Design

D. Interface Desain

The application framework is developed using Figma software to create low-fidelity prototypes and interface designs for the Android application used by technicians, encompassing various perspectives as shown in Figure 6. Technicians have the ability to input survey data and save it to cloud storage. All interfaces to be used are optimized for user comfort to the greatest extent possible.
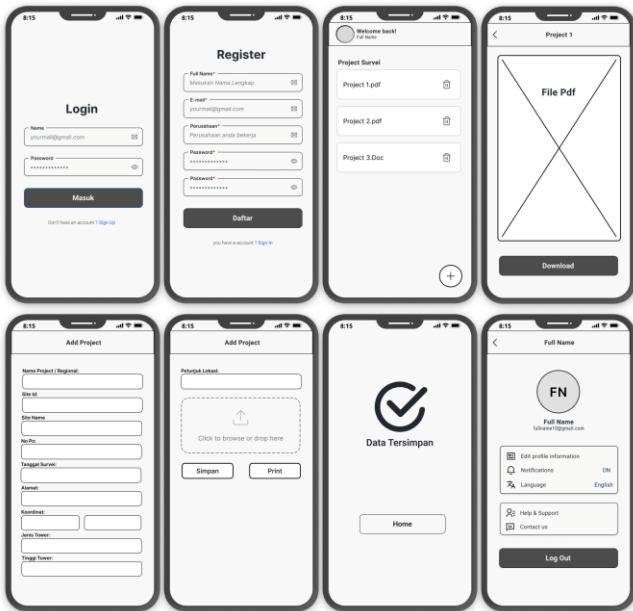
Figure 6. Wireframe Interface Design

IV. EXPERIMENT RESULT AND DISCUSSION

This system has been designed as an Android-based application for storing survey data related to telecommunication tower projects. The application is built using the Java programming language through the Android Studio IDE and utilizes Cloud Computing processed using Firebase services. The following are the results of testing for the application.

A. Database Connection

In this stage, testing and implementation are carried out on all data storage applications using Firebase as cloud storage. The features that can be utilized include Firestore, Real-time, and Storage, ensuring that the data in the application is well-preserved on the cloud server. Here is an overview on the Firebase website with Apps Check (API) as shown in Figure 7.
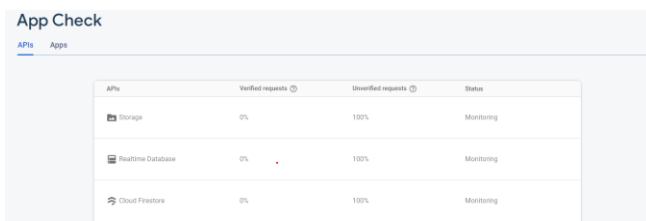

Figure 7. Database Connection in Firebase

B. Analisis Simulasi Skenario

The analysis of scenario simulations is the result obtained after a series of functional accessibility tests on the data storage application. The results of each scenario are described as follows.

1) Login dan Register

In this simulation, there are several variables for user login and registration, and both simulation results utilize Firebase as a storage medium. Table 1 contains the list of variables required for user registration in this data storage application, and Figure 8 shows the Firebase Auth interface on the Firebase website.

Table 1. Variable Register and Login

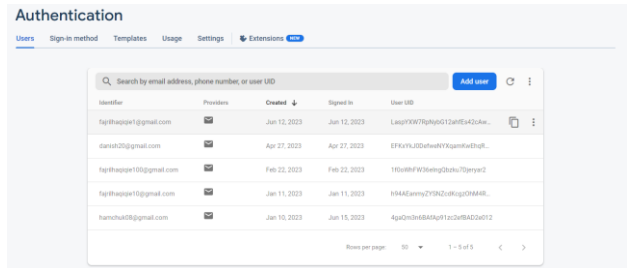| Variable	Description
editName	Fill in with Full Name.
editEmail	Fill in with User Email.
editPass	Fill in with a secure password.

Figure 8. Simulasi Firebase Auth

2) Penyimpanan Data

This simulation involves various variables to input survey data that will be securely stored in Firebase cloud storage. Firebase Storage provides a storage solution for survey result reports in PDF format, while Firebase Firestore and Real-Time serve as records during the data input process in the application. Table 2 summarizes the variables needed in the data recording process in the application

Table 2. Data Storage Variables

String	Description
nameproject	The name of the surveyed project
siteid	The Site Id of the tower
sitename	The Site name of the tower
noPo	The Purchase Order number from the relevant party
tglsurvei	The survey date
lattitute, longtittude	The tower's coordinates
Jtower	The tower's distance
Ttower	The tower's height
plokasi	A brief description of the tower's location

Therefore, the variables listed in Table can be used as data classes in Android Studio, serving as actions to store data and documents in Firebase

C. Application Features

There are various system features available to enhance the reporting and document storage process for technicians and administrators. The following is Table 2, which shows the distribution of features for each entity.

Table 3. List of Feature

| Actor	Description
Admin	Admin login page, profile page, technician approval page, technician profile page, technician deactivation, and survey result document page.
Technician	User login page, registration page, profile page, project home page, data input page, and file viewing page.

The application features described in Table 3 above indicate that the admin plays a crucial role in this application. The admin has access rights that allow them to determine whether technicians can use the application or deactivate them.

D. Implementasi

The implementation of the system that has been designed and completed is in the form of an Android application. Here is the design of the application.

1) Login Page and Register Page

The initial page when running the application is the login page. Technicians are required to enter their email or username, along with their password, to access the application. If a technician doesn't have an account, they must open the register page and wait for approval from the company's admin. On the registration page, there is a form to be completed, which includes Full Name, Email, Company, and Password to gain access to the application.
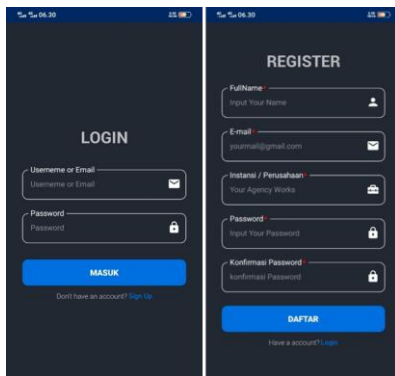
Figure 9. Login Page and Register Page

2) Home Page and Profile Page

The home page serves as the main interface of the application after login, displaying documents stored in PDF format that can be deleted or viewed. In addition, users can upload data either by submitting original documents or by entering information directly through the "Add Data" button. At the top of the page, there is the user technician's profile filled out during registration, accompanied by an action to go to the profile page. On the profile page, personal information is displayed for each user's data, and this page is equipped with various features such as profile updates, notifications, and language settings. Additionally, there is a log out button available if the user wishes to exit the application.
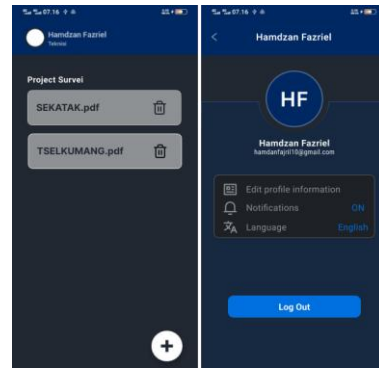
Figure 10. Home Page and Profile Page

3) Add Project Page and Succes page

The Add Project page is the primary function of this project survey data storage system. Its purpose is to allow technicians to enter project data instantly, reducing the need for manual input. This page displays a form with fields for Project Name, Location ID, Location Name, Purchase Order Number, Survey Date, Address, Tower Coordinates, Tower Type, Tower Height, Detailed Location Directions, and an option to upload an image of the project location layout. Technicians can directly save or convert this information into a PDF format while the survey process is ongoing, and then a page is displayed indicating that the data has been saved in the cloud storage.
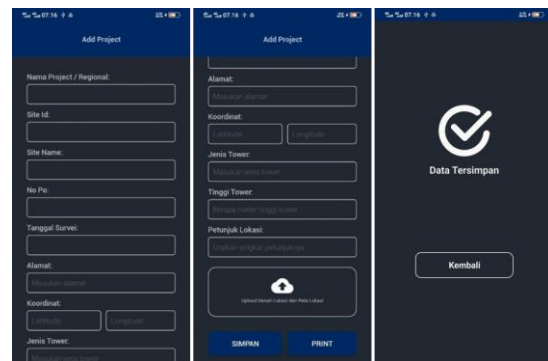
Figure 11. Add Project Survey Page

4) Document page (pdf)

This page serves as an action from the main interface, displaying survey result reports in PDF format that can be viewed by technicians and used as files for reporting to the company's admin. There is a download button to obtain the document.
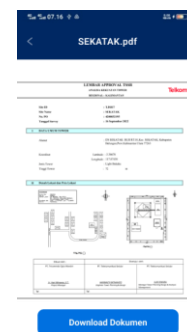
Figure 12. Document page (pdf) and success page

E. Application Testing Discussion

Tahap selanjutnya adalah pengujian, yang berfungsi untuk memastikan sistem berfungsi secara optimal. Black box

testing adalah pengujian yang digunakan dalam tahap ini. The next stage is testing, which aims to ensure that the system functions optimally. Black box t testing is used in this stage. Black box testing focuses on the software's functional specifications. Black box testing allows software developers to establish a set of input criteria that will meet all the functional requirements in a program [14]. Black box testing offers advantages such as not requiring the tester to have knowledge of a specific programming language, testing from a user's perspective to identify ambiguities or inconsistencies in requirement specifications, and a separation of roles between programmers and testers [15].

Table 4. 2 Black Box Testing

Data Menu	Expected Outcome	Conclusion
Login Page	Displays the login form	Successful
Register Page	Displays the Register Page	Successful
Home Page	Displays a list of previously worked on projects	Successful
Profile Page	Displays technician's personal data, features, and logout button	Successful
Add Project Page	Displays a survey form with input fields and the ability to save or convert data into a document	Successful
Document Page	Displays a report in PDF format with a download button	Successful
Success Page	Displays a notification that the data has been saved	Successful

V. CONCLUSION

Based on the research conducted on the Android-based survey data storage application using Firebase cloud computing for telecommunication tower projects, it can be concluded that this application is expected to assist survey technicians in addressing the issues they faced in the past during the survey process. By utilizing Cloud storage in the form of Firebase, which provides real-time and regular storage, it helps prevent the loss of essential company documents. This application can also make real-time data changes if the data has not been converted into PDF format yet. However, further research is required to enhance this data storage system application, focusing on data management concepts. This data storage system application can be developed by implementing security features for the application and user data. Based on the results of black box testing, it can be concluded that the application operates accurately according to the implemented design. Therefore, users can use it effectively and understand the applied application design.

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