# Optimizing Data Management in Web Applications through Google Drive API Integration and Synchronization

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## Abstract

The rise of Web-based applications has created a demand for streamlined data management and automatic data synchronization. Even manually stored local data is often insufficient to meet these requirements, necessitating a solution that can efficiently manage data access and storage through Cloud technology. This study advocates for utilizing the Google Drive API to resolve these issues. By leveraging the benefits of Google Drive's Cloud storage, Web applications can seamlessly synchronize user-uploaded data to the Cloud. To initiate this integration, a Google account is required to authenticate the process and serve as a mediator for data exchange. This approach employs secure authentication and authorization mechanisms to ensure data privacy. The system is developed using an iteration-based approach starting with user requirements analysis, followed by interface design and API integration. Pilot tests were then conducted to validate system performance under various usage scenarios. The findings revealed a noteworthy advancement in the synchronization and administration of data through the Web-based application with a data transmission duration of under 60 seconds, contingent on internet speed. Google Drive's API integration enables users to access files and manage them in real-time, surpassing prior limitations. To meet the demands of progressively intricate Web-based applications, future research can concentrate on enhancing data security and optimizing performance.

## Keywords

API, Cloud, Google Drive, Google Drive API, Integration, Web Application

## I. Introduction

Increasingly developing digital era today, efficient data management and precise, even automatic, synchronization are very important aspects for the success of increasingly complex web-based applications [1]. In almost every application, data is a crucial component where the application system could access, store, and share data safely and efficiently [2]. The data processed in the system includes text, images, and documents[3].

Google Drive technology, as a cloud storage service provider [4], has become a popular solution for data management needs [5], [6]. Therefore, integrating the Google Drive API is an efficient solution to face this challenge. This study aims to implement the role of the Google Drive API in optimizing data management and synchronization processes in web-based applications. Data synchronization management is used to automatically update newly uploaded data [7]. Additionally, it is necessary to measure data optimization to determine the speed of data transmission so that data sharing and synchronization processing is faster and less time-consuming when cloud storage systems are applied [8], [9]. Google Drive is a cloud storage platform known for its reliability, scale, and ability to provide storage that can be accessed from anywhere [10]. By using the Google Drive API, web-based applications can easily integrate storage, synchronization, and file-sharing features, enhancing the functionality and appeal of the application. This technology is also referred to as cloud storage, which can facilitate various data exchanges that can be done anytime [11],[12]. In its implementation, the private cloud storage system created can synchronize data from the computer device to the cloud storage server with two seconds [13], [14].

This study will focus on integrating the Google Drive API as a solution to overcome challenges in data management and synchronization in web-based applications. It discusses the basic concepts of integrating the Google Drive API and its potential benefits in improving data management. It also

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explores how web-based applications can utilize the storage, synchronization, and sharing features offered by the Google Drive API. Furthermore, this study will include practical usage examples with case studies that demonstrate the implementation of Google Drive API integration in web-based applications. These case studies will illustrate how this API can be used to synchronize data between devices, access data securely, and provide a better user experience [15]. In its implementation on the Google Drive administration website, it can accommodate real-time data quickly and without problems.

## II. Related Work

In previous studies, the integration of the Google Drive API had advantages such as centralized storage and team collaboration, but also encountered issues such as connection stability and data management [16],[17]. This study will show an in-depth understanding of previous results, emphasizing the importance of good data management factors in creating an information system based on Google Drive integration [18],[19]. This research is expected to provide insights for developers, students, researchers, and interested parties in understanding the potential of integrating the Google Drive API in improving data management and synchronization of web-based applications [20]. With a better understanding of this potential integration, developers can leverage Google Drive as a useful tool to optimize data management in the applications they create.

Research by [21] explain the data exchange service using Google Drive API. The results of this study discuss the data exchange service using Google Drive API for the purpose of this service is to help the business process of an organization and provide an alternative way of communication if there is a problem with the main system by utilizing Google Drive API technology. The advantages of this study are in the system that can transmit data using the API. However, this study does not discuss whether the data received in the system has been synchronized or not directly. The study conducted by [19] about web-based college student assignment file collection application using Google Drive API. Explains the collection of web-based student assignment files with Google Drive API which aims to utilize Google Drive as the main storage media for collecting student assignments. However, in this study, there was no real-time notification if someone submitted an assignment and there was no measurement of the transmission speed carried out by students using the Google Drive API.

Other researcher in implementation of Google Drive API for uploading, Sharing, and downloading data on Web-Based applications aims to develop a web-based application that utilizes API technology and Google Drive data storage to assist the data exchange process and function as a replacement for free data storage. This application uses Google Drive Cloud Storage to exchange and store data. However, this study has not included the speed or latency of data transfer input by students through the web system [22]. Then research [18] file management application for proposals and assessment of thesis defense using google Drive API Services. This used the Rapid Application Development (RAD) development method with Black Box testing techniques. This system produces a file management system related to proposals and assessments of thesis defense using the Google Drive API service. Where the system aims to facilitate the process of filing, file approval, assessment, and publishing seminar minutes using the application. Application testing was also carried out on the main function using black box testing, namely the file upload process, file approval, and assessment. The results of the application test showed that the main function of the system was running well. However, this study does not explain how optimal the implementation of the system that was created and carried out was, both in terms of data transmission speed and synchronization of existing files to facilitate data management.

Integration of google drive storage in the development of project monitoring applications using pyDrive [16]. In developing this system using the Agile Software Development method using the Flask Python framework and Black Box testing. Integration is carried out using the pyDrive library which can facilitate developers in the authentication process and use the functions contained in the Google Drive API. So that it produces monitoring application software with Google Drive API storage integration as a storage medium which of course files related to the project can be centralized and make it easier for users to share drive access rights to other team members.

Based on the description of the five related studies above, a study was conducted google drive API integration for synchronization and optimization of data management in web-based applications. This study examines the use of API features from Google Drive, including uploading, downloading, and sharing data. These features can be used as a new means of exchanging data or as a storage option in the system. The results of this study are in the form of a web-based application that uses the Google Drive API as a means of storing data.

## III. Methodology

The research methodology is outlined in Figure 1 and includes the following stages: Define Problem, Data Collection, System Design, Implementation, and Testing.

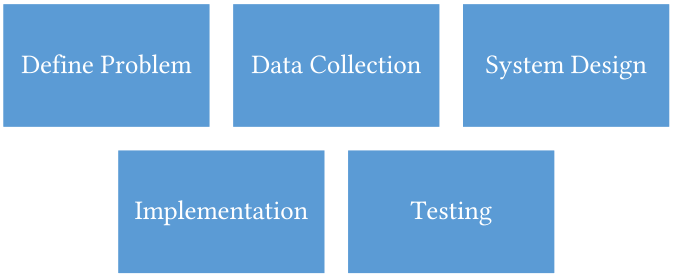


**Fig. 1. Methodology**

### *A. Define Problem*

Formulation is carried out by determining the problem by identifying deficiencies and evaluating needs and alternative data storage solutions in an information system.

### B. Data Collection

The data collection method begins with problem identification and needs planning before developing the data management system, through literature review and interviews with relevant parties. The literature review is conducted by examining various reference sources related to the research topic, including books, journals, websites, conferences, and other sources. Meanwhile, interviews are conducted by posing various questions to the research team and the administrative staff of the informatics department at the faculty of engineering, as informants, to gather the necessary information and data for system implementation.

### C. System Design

This design phase is carried out after completing the literature review, which serves as a foundation for understanding system requirements. In this phase, the process involves creating a comprehensive overview of the system, covering key aspects such as architecture, user interface, workflow, and functional structure. This design process provides a clear, organized, and systematic framework that will guide the system's implementation phase. Additionally, technical specifications are determined to ensure that all system components can operate optimally and integrate seamlessly. The design follows the waterfall model, emphasizing a linear and sequential approach where each phase must be completed before moving on to the next, allowing for thorough evaluation at each step of development.

### D. Implementation

The implementation phase of system development involves key steps in building both the user interface and functionality to ensure optimal performance and user experience. HTML is used for the web page structure, CSS for layout and design, and PHP for managing system logic and user interactions. The Laravel framework is chosen for PHP development due to its efficiency, security, and structured code management, offering built-in features that protect against. This combination creates a visually appealing, interactive interface that enables users to input, process, and view data seamlessly, while also enhancing system scalability, facilitating external API integration, and providing a responsive experience across devices.

### E. Testing

System testing is conducted using the black box method, focusing on evaluating the functionality of the storage media. Each feature, including upload, download, and data sharing processes, is tested individually to ensure optimal performance. The primary goal of this testing is to verify that these features operate smoothly and without significant issues, ensuring that the system meets user expectations and requirements.

## IV. Result and Discussion

The results and discussion of this research encompass three main aspects: system design, system implementation, and system testing. The design phase details how the system was constructed based on the established requirements and specifications. The implementation phase covers the actual development of the system, including the creation of the interface and integration of core functions. Finally, the testing phase evaluates the system's performance and reliability to ensure that all features function correctly and meet the intended objectives.

### A. System Design

System design is carried out to define and visualize how the developed system will function. This design process outlines the system's flow based on functional requirements, providing a general overview of the system architecture. It helps to understand how the implementation process will unfold and ensures that the system's design aligns with the intended operational goals.

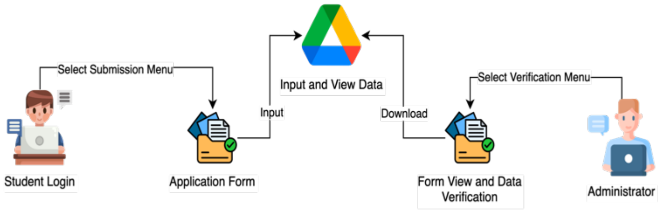


**Fig. 2. System Architecture Design**

Based on Figure 2, the system architecture allows users to access the system from either a laptop or computer, using the internet as the primary means of communication with Google Drive. This architecture demonstrates the integration between hardware and software, enabling users to easily access input pages and share or upload data. The system is designed to combine web technology with Google Drive API integration, facilitating efficient information sharing.

The system utilizing Google Drive API technology is designed with three main actors: the admin, who has the highest level of management rights; the operator, who acts as the verifier for student submissions; and the student, who is the end user. Each actor has specific access rights, represented using UML use case diagrams. The operator's use cases include managing users, handling various academic submission processes such as internship and thesis proposals, extensions, and seminars, as well as managing the upload and verification of internship and thesis reports, diploma collection proofs, and transcripts.

The system is designed with the primary users in mind, namely students and admins. Students can access the submission form menu to input and upload data. Meanwhile, the admin has access to all operator menus and additional menus for managing information. This design ensures that each user has functionality appropriate to their role. Figure 3 illustrates the use case visualization for this system.

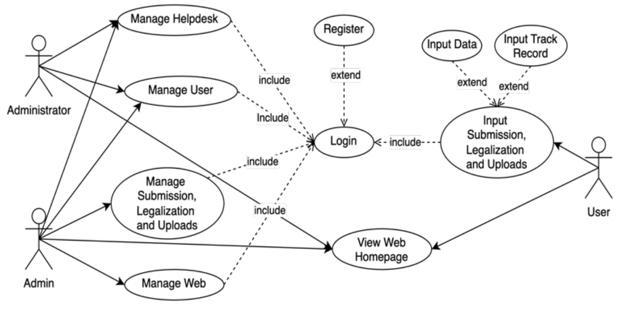


**Fig. 3. Use Case Diagram**

The next step in the research is to design the file upload process flow for students. This process will enable them to upload files to Google Drive. The design of the upload process flow must be clear and easily understandable for students to use effectively. Figure 4 will provide an illustration of the planned process flow.

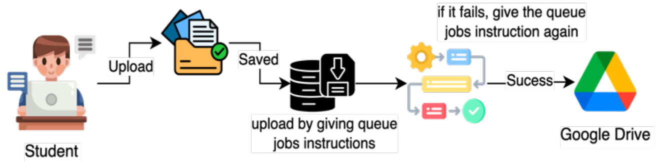
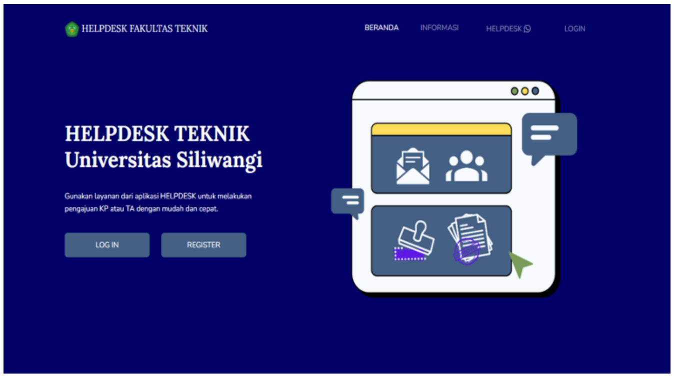

Student
Upload
Saved
upload by giving queue jobs instructions
if it fails, give the queue jobs instruction again
Sucess
Google Drive

**Fig. 4. Process Flow Design Upload to Google Drive**

Figure 4 illustrates that when a student uploads a file to the system, the file is initially stored temporarily on the server. Subsequently, the system initiates the process of transferring the file or data to Google Drive using a Queue Worker. In the event of a failure during this transfer process, the system will automatically retry the process. In other words, the system continuously attempts the transfer until the file is successfully moved to Google Drive. This ensures that the upload process is robust and reliable, handling failures gracefully and ensuring that files are properly stored in Google Drive.

## *B. System Implementation and Google Drive API Integration*

The results of the system implementation are presented in Figure 5, illustrating the main interface of the platform. At this point, students are restricted from submitting any requests. Submission functionality becomes available only after students have completed the registration process and successfully logged into the system. This design ensures proper user authentication and data security, allowing the system to maintain control over submissions and preventing unauthorized access. Additionally, this step improves the overall integrity of the process by verifying the identity of each student before any submissions are accepted.

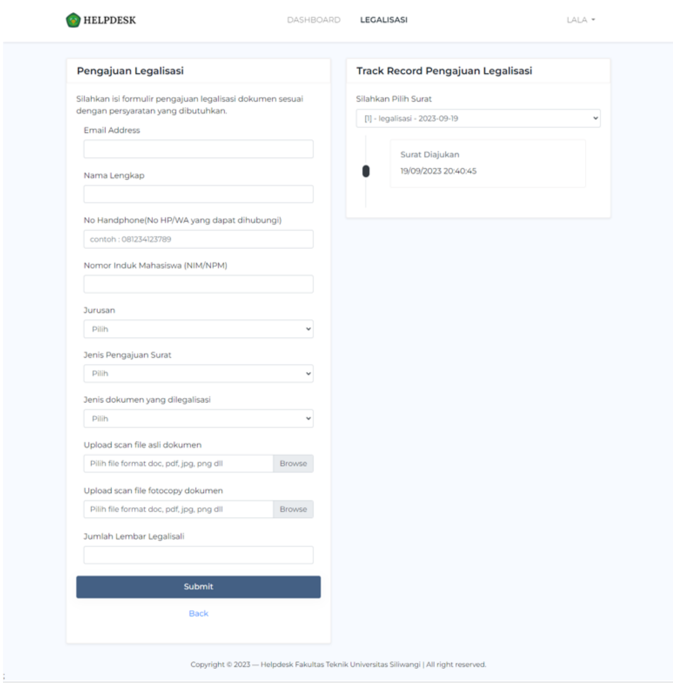


HELPDESK TEKNIK
Universitas Siliwangi

Gunakan layanan dari aplikasi HELPDESK untuk melakukan pengajuan KP atau TA dengan mudah dan cepat.

**Fig. 5. Helpdesk Submission System**

If a student successfully logs in, they will gain access to various submission menus, one of which is the document legalization request. Students are required to provide their personal details and upload the necessary documents, including both the original and photocopy of the document they wish to have legalized. Additionally, students can check the status of their submissions on each submission page to view their track record, such as whether the request is approved, in process, or rejected. The submission form and status tracking interface are shown in Figure 6.



Pengajuan Legalisasi

Silahkan isi formulir pengajuan legalisasi dokumen sesuai dengan persyaratan yang dibutuhkan.

Email Address

Nama Lengkap

No Handphone(No HP/WA yang dapat dihubungi)
contoh : 081234123789

Nomor Induk Mahasiswa (NIM/NPM)

Jurusan
Pilih

Jenis Pengajuan Surat
Pilih

Jenis dokumen yang dilegalisasi
Pilih

Upload scan file asli dokumen
Pilih file format doc, pdf, jpg, png dll | Browse

Upload scan file fotocopy dokumen
Pilih file format doc, pdf, jpg, png dll | Browse

Jumlah Lembar Legalisali

Track Record Pengajuan Legalisasi

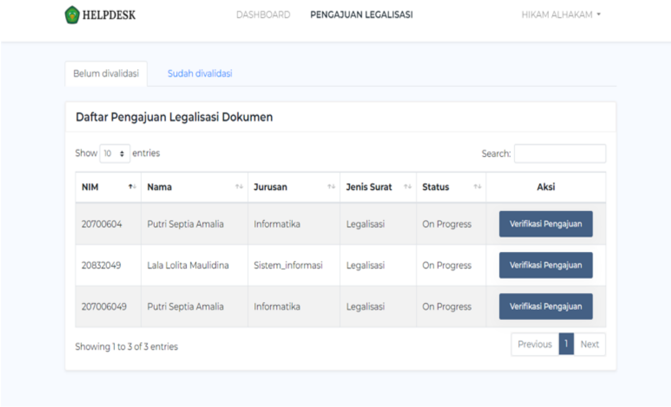
Silahkan Pilih Surat
[1] - legalisasi - 2023-09-19

Surat Diajukan
19/09/2023 20:40:45

Copyright © 2023 — Helpdesk Fakultas Teknik Universitas Siliwangi | All right reserved.

**Fig. 6. Document Legalization Submission**

Based on the submissions made by students shown in Figure 6, the uploaded data will be directed to the "Document Legalization Management" menu for operators and administrators, as illustrated in Figure 7. In this interface, the operator can either approve or reject the request depending on the data and requirements uploaded by the student. The system allows operators to review submissions, ensure that all necessary documents are provided, and make decisions on the approval or rejection of each request.



Daftar Pengajuan Legalisasi Dokumen

Show 10 entries  Search:

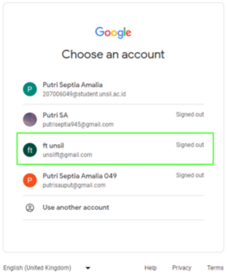
| NIM | Nama | Jurusan | Jenis Surat | Status | Aksi |
|---|---|---|---|---|---|
| 20700604 | Putri Septia Amalia | Informatika | Legalisasi | On Progress | Verifikasi Pengajuan |
| 20832049 | Lala Lolita Maulidina | Sistem_informasi | Legalisasi | On Progress | Verifikasi Pengajuan |
| 207006049 | Putri Septia Amalia | Informatika | Legalisasi | On Progress | Verifikasi Pengajuan |

Showing 1 to 3 of 3 entries

**Fig. 7. Document Legalization Request Verification**

The next step involves integrating the Google Drive API. To facilitate this integration, researchers must first prepare a Google account that will serve as the storage medium for data. This preparation includes setting up the Google account, enabling the Google Drive API, and configuring necessary credentials and permissions for secure and efficient data handling.

In Figure 8, the preparation for integrating Google Drive begins by logging into the Google account selected for integration. As shown in Figure 9, a Google account is already set up and ready to be used for data storage. This step ensures that the account is properly configured for managing and storing data through the Google Drive API.



Choose an account

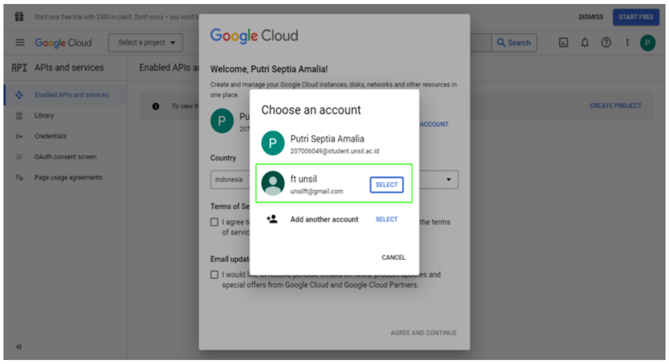
Putri Septia Amalia
207006049@student.unsil.ac.id

Putri SA — Signed out
putriseptia945@gmail.com

ft unsil — Signed out
unsilft@gmail.com

Putri Septia Amalia 049 — Signed out
putrisauput@gmail.com

Fig. 8. Google Account Preparation



Google Cloud

Welcome, Putri Septia Amalia!

Create and manage your Google Cloud instances, disks, networks and other resources in one place.

Choose an account

Putri Septia Amalia
207006049@student.unsil.ac.id

ft unsil
unsilft@gmail.com

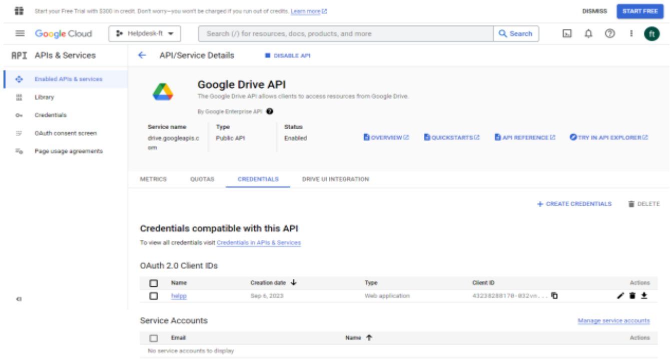
Add another account

☐ I agree t… the terms of servic…

☐ I would l… es and special offers from Google Cloud and Google Cloud Partners.

Fig. 9. Google API Account Integration

In the integration process, researchers are required to create an API project aimed at connecting the website system with Google Drive on the Google Developer Console. The process begins with linking the Google Drive API in the library menu. Next, configure the OAuth Consent Screen to define the type of user and input various information. Create credentials as shown in Figure 10 to establish the OAuth Client ID, specifying the application type and entering the required information.



Google Drive API

The Google Drive API allows clients to access resources from Google Drive.

By Google Enterprise API

| Service name | Type | Status |
|---|---|---|
| drive.googleapis.com | Public API | Enabled |

Credentials compatible with this API

To view all credentials visit Credentials in APIs & Services

OAuth 2.0 Client IDs

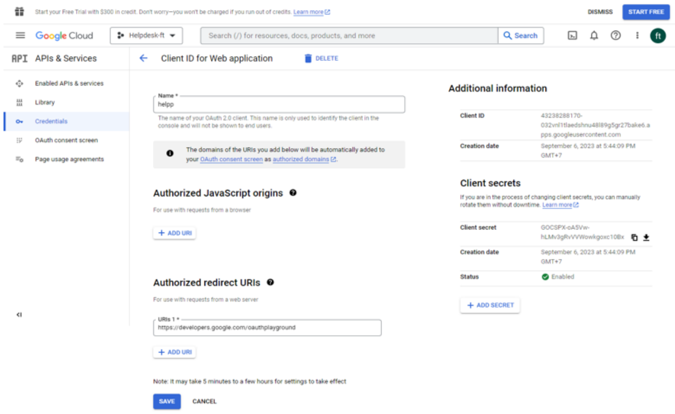
| ☐ | Name | Creation date | Type | Client ID | Actions |
|---|---|---|---|---|---|
| ☐ | helpp | Sep 6, 2023 | Web application | 43238288170-832vn... | |

Service Accounts

| ☐ | Email | Name | Actions |
|---|---|---|---|
| No service accounts to display | | | |

Fig. 10. Determining OAuth Client ID

In Figure 11, you can see the detailed result of the Credential creation process. This step involves generating essential credentials, including the Client ID and Client Secret. These credentials are crucial for the next steps in the authorization process. Specifically, they will be used to authorize access and configure the integration with Google Drive API v3, ensuring secure and authenticated interactions between your application and Google Drive.


Start your Free Trial with $300 in credit. Don't worry—you won't be charged if you run out of credits. Learn more
DISMISS
START FREE
Google Cloud
Helpdesk-ft
Search (/) for resources, docs, products, and more
Search
APIs & Services
Client ID for Web application
DELETE
Enabled APIs & services
Library
Credentials
OAuth consent screen
Page usage agreements
ADD URI
ADD URI
ADD SECRET
SAVE
CANCEL

Name *
helpp

The name of your OAuth 2.0 client. This name is only used to identify the client in the console and will not be shown to end users.

The domains of the URIs you add below will be automatically added to your OAuth consent screen as authorized domains.

Authorized JavaScript origins

For use with requests from a browser

Authorized redirect URIs

For use with requests from a web server

URIs 1 *
https://developers.google.com/oauthplayground

Note: It may take 5 minutes to a few hours for settings to take effect

Additional information

| | |
|---|---|
| Client ID | 43238288170-032vnl1tlaedshnu48l89g5gr27bake6.apps.googleusercontent.com |
| Creation date | September 6, 2023 at 5:44:09 PM GMT+7 |

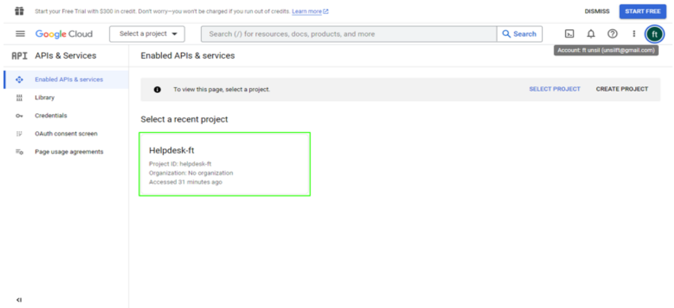
Client secrets

If you are in the process of changing client secrets, you can manually rotate them without downtime. Learn more

| | |
|---|---|
| Client secret | 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 |
| Creation date | September 6, 2023 at 5:44:09 PM GMT+7 |
| Status | Enabled |

Fig. 11. Creating Credential Details

Here is the display when the Google API project is successfully created with the name Helpdesk-ft, as shown in Figure 12. Afterward, a dedicated Google Drive folder is created to store the system's data, ensuring organized data management. The next step involves configuring the system by updating the .env file using a text editor. This configuration includes adding the necessary API keys, client ID, and other credentials required for secure communication between the web application and Google Drive. Proper configuration in the .env file ensures smooth integration, enabling efficient data uploads and synchronization between the system and Google Drive.


Start your Free Trial with $300 in credit. Don't worry—you won't be charged if you run out of credits. Learn more
DISMISS
START FREE
Google Cloud
Select a project
Search (/) for resources, docs, products, and more
Search
Account: ft unsil (unsilft@gmail.com)
APIs & Services
Enabled APIs & services
Enabled APIs & services
Library
Credentials
OAuth consent screen
Page usage agreements
SELECT PROJECT
CREATE PROJECT

To view this page, select a project.

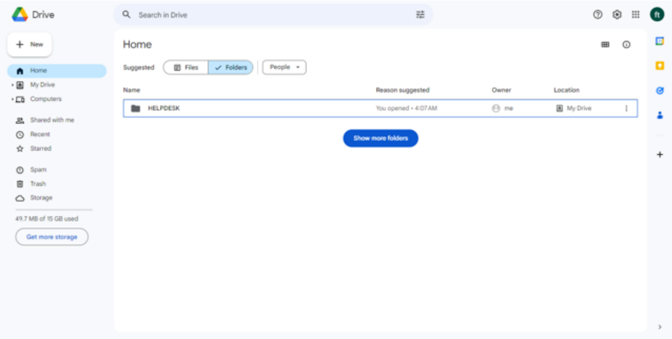
Select a recent project

Helpdesk-ft
Project ID: helpdesk-ft
Organization: No organization
Accessed 31 minutes ago

Fig. 12. Helpdesk Project Successfully Created

## *C. System Testing*

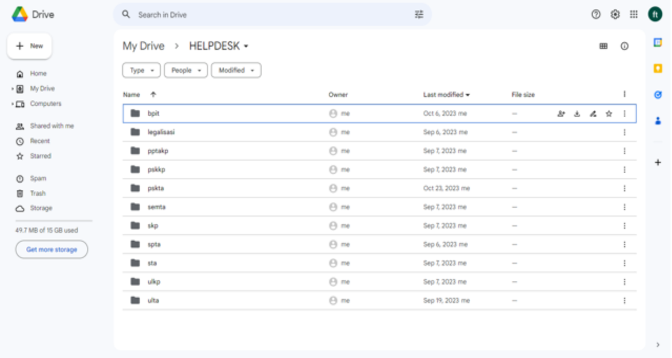
Based on the system testing, the integration was fully successful. Out of 10 data upload attempts through the system, all were successfully processed, with each submission appearing on both the operator and admin pages. Furthermore, the uploads were optimally synchronized with the designated Google Drive account. As shown in Figure 13, the "helpdesk" folder, which was previously created for data storage, now contains the uploaded files, demonstrating seamless integration and synchronization. This outcome confirms the reliability of the system in managing uploads efficiently, while also validating the Google Drive API's role in streamlining file organization and access.



| Name | Reason suggested | Owner | Location |
|---|---|---|---|
| HELPDESK | You opened • 4:07 AM | me | My Drive |

**Fig. 13. View of the successfully created Helpdesk Folder**

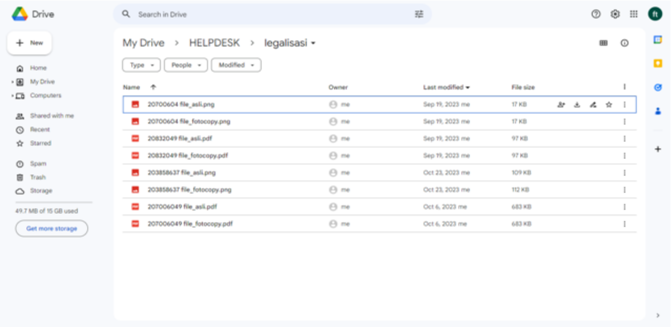
In this folder there are many other folders according to those in the system being built, as shown in Figure 14.



| Name | Owner | Last modified | File size |
|---|---|---|---|
| bpit | me | Oct 6, 2023 me | — |
| legalisasi | me | Sep 6, 2023 me | — |
| pptakp | me | Sep 7, 2023 me | — |
| pskkp | me | Sep 7, 2023 me | — |
| pskta | me | Oct 23, 2023 me | — |
| semta | me | Sep 7, 2023 me | — |
| skp | me | Sep 7, 2023 me | — |
| spta | me | Sep 6, 2023 me | — |
| sta | me | Sep 7, 2023 me | — |
| ulkp | me | Sep 7, 2023 me | — |
| ulta | me | Sep 19, 2023 me | — |

**Fig. 14. Folder View in Helpdesk Folder**

Within this folder, there are several subfolders Figure 14 displays the data synchronized into the legalization file when a student submits a document legalization request by entering the required information and clicking the submit button. This demonstrates the successful integration and data synchronization between the system and Google Drive.



| Name | Owner | Last modified | File size |
|---|---|---|---|
| 20700604 file_asli.png | me | Sep 19, 2023 me | 17 KB |
| 20700604 file_fotocopy.png | me | Sep 19, 2023 me | 17 KB |
| 20832049 file_asli.pdf | me | Sep 19, 2023 me | 97 KB |
| 20832049 file_fotocopy.pdf | me | Sep 19, 2023 me | 97 KB |
| 203858637 file_asli.png | me | Oct 23, 2023 me | 109 KB |
| 203858637 file_fotocopy.png | me | Oct 23, 2023 me | 112 KB |
| 207006049 file_asli.pdf | me | Oct 6, 2023 me | 683 KB |
| 207006049 file_fotocopy.pdf | me | Oct 6, 2023 me | 683 KB |

**Fig. 14. Data Display Synchronized into Drive**

The data obtained regarding the optimization and synchronization of data from the website system to Google Drive is summarized in Table 1 below. This table offers a comprehensive overview of the system's performance in managing data uploads, highlighting key metrics such as upload speed, data transfer efficiency, and synchronization accuracy. Additionally, it provides insights into potential bottlenecks observed during the process, including instances where network speed or device limitations affected upload times. By analyzing these metrics, the table helps identify areas for further optimization, such as improving system resilience during high-traffic periods or enhancing compatibility with a wider range of user devices for consistent performance.

TABLE I. Data Upload Speed Measurement

| Methods | Requests | Errors | Avg Latency | Latency (%) |
|---|---|---|---|---|
| Create | 213 | 0 | 0.630 sec | 2.075 sec |
| Get | 4 | 0 | 1.012 sec | 4.110 sec |
| Delete | 165 | 0 | 0.236 sec | 0.512 sec |
| Update | 14 | 0 | 0.700 sec | 2.024 sec |

From the testing conducted, which involved evaluating each function of the system and the integration with the Google Drive API, the results have been positive regarding optimization and synchronization. The data tested were synchronized automatically and even in real-time to Google Drive. Once a submission is successfully processed, the uploaded data is placed into the respective submission folders within the "helpdesk" folder. With transmission speeds of under 5 seconds, it can be concluded that the data management integration using the Google Drive API has been successfully achieved.

## V. Conclusion

Based on the research findings, student data submissions via the web application have been successfully synchronized with Google Drive, demonstrating the seamless integration of the Google Drive API. This integration not only ensures reliable storage but also proves to be an efficient alternative for managing web application data. The API enables swift data transmission, typically completing uploads in under 60 seconds, though occasional delays were observed due to varying network speeds and device performance. Importantly, the use of Google Drive helps mitigate storage limitations of both free and paid hosting services. Future improvements could incorporate real-time notifications to enhance user experience by instantly alerting students upon successful submissions or uploads, further streamlining the process. The integration of Google Drive API also enhances data security by utilizing Google's robust encryption and access control features, ensuring that sensitive student information is protected during storage and transmission. Additionally, the system's scalability allows for seamless expansion as the volume of submissions grows, making it a sustainable solution for long-term use in academic environments.

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