PrintFlow: A Cloud-based Queue Management System for Automated Printing Services

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ABSTRACT

PrintFlow is an innovative automated inscription solution designed to streamline the printing process by enabling users to upload their documents remotely and retrieve high-quality printouts seamlessly from partnered xerox shops. This paper presents the architecture and implementation of PrintFlow, detailing its user-friendly interface, secure document transmission protocols, and integration with existing print infrastructure. By automating job scheduling and optimizing print workflows, PrintFlow enhances operational efficiency, reduces wait times, and minimizes human intervention. The system's scalability and adaptability make it suitable for diverse printing environments, offering a transformative approach to document printing services.

Keywords

Automation, remote document submission, print workflow optimization, xerox shop integration, PrintFlow

1. INTRODUCTION

With regard to the development an adult individual savors, queuing systems—not so intelligent ones either—which enable a buyer to choose an operator and wait for a chance have numerous shortfalls. Being accessible to an assortment of buyer populations, more economical deployment expenditures, ease to use, as well as diminished overhead and sluggishness related with unreasonable requests, are some significant impediments for the use of intelligent queuing systems. In addition, there is a physiological barrier for customers who fear that going out of the ready area will most likely leave them disconnected from the device, which would lead to more ready instances when they come back. In addition, even though it is feasible to enhance the customer experience of customers who prefer to stay in the ready place, not much attention has been given to doing so.

Certain programs contained inside the United Arab Emirates (UAE) have launched to enhance getting access to government services using smartphones and eliminate the necessity of being gift at service counters. However, waiting is still annoying customers of banks, hospitals, and government service counters to at least for now. Queue management systems implemented are faced with assistance of a phenomenon of clients attracting more than one carrier amount. This type of phenomenon causes numerous other clients as well as machines themselves overestimate wait time resulting in lack of enterprise.

Growing answers to the tedious project of watching for services is a vital necessity, in particular because of the growing demand as the populace of world keeps rising with no return. Considering the fact that cellular packages are now integrated inside truly any society, using this kind of the means to better queuing structures is intuitive. In various systems, from computer networks to customer service operations, queues are essential to managing tasks and ensuring orderly processing.

Queues help prevent system overload by regulating flow of tasks, maintaining efficiency, ensuring fairness in task handling. In computer networks, queuing mechanisms manage data packets to prevent congestion and optimize transmission, thereby enhancing overall performance.

Implementing effective queuing strategies is crucial for balancing resource utilization and service quality. By managing sequence/timing of task execution, queues help in minimizing delays and avoiding bottlenecks. In customer service scenarios, structured queues help in ensuring clients are attended in organized manner, improving satisfaction and operational efficiency.

Queuing theory offers a mathematical approach to studying and optimizing such waiting line systems. It allows organizations to forecast queue lengths and waiting times, enabling them to make informed decisions regarding resource utilization and process refinement. Through understanding and application of queuing principles, systems can be made to strike a balance between demand and service capacity, resulting in improved performance and user satisfaction.

The authors wish to enhance the buyer enjoy through all during ready time because from research, happiness and grade of a service do largely rely upon the ready durations that they prefer to experience. Therefore, queueing theories constitute an area of active interest [1], [2], [3] with realistic applications like in [4] and [5]. The research in [1] focuses on maximizing server availability the application of queuing theory for a distance or a time common assumed for emergency vehicles. Nevertheless, authors in [2] and [3] present purchaser pride through assuming outstanding theoretical processes for queuing systems. The authors of [2] investigate the influence a customer's perception of waiting time has on usual pride of the provider, while at the same time [3] examine how a waiting time guarantee influences the ready enjoyment of the consumer.

In another paper [6], the authors referred to the smart hospital waiting list management systems that consider the appointment of the patient, predict the appropriate time when the doctor is available to see the patient, and real-time notifications are sent to the user for leaving the domestic. The prediction takes into account the closeness of the individual with the doctor, time of the day, the rate of the physician in seeing the patients, and the number of patients.

2. FUNCTIONAL ASSESSMENT 2.1 Student Printing Behavior Analysis

In a university setting, students often experience delays due to high demand for printing services during peak times, such as before exam periods. A study analyzed printing tasks as random events with varying lengths and arrival times, revealing that with a printing rate of 5 pages per minute, the average waiting time ranged from 4 to 226 seconds. This variability can lead to inefficiencies and student frustration. Implementing a cloud-based queue management system could help in balancing the load and reducing wait times by allowing students to upload documents in advance, thus streamlining the printing process.

2.2 Cloud Resource Allocation in Printing Services

Efficient resource allocation is vital in cloud-based printing systems to handle varying workloads. Research on cloud computing clusters has shown that optimal resource allocation algorithms can improve throughput and reduce queue lengths, even under heavy traffic conditions. Applying such algorithms to a cloud-based printing service can ensure that resources are utilized effectively, minimizing delays and maintaining service quality during peak usage times. [9]

2.3 Print Job Queue Management

Effective print job queue management is essential to ensure timely printing and minimize bottlenecks. Implementing intelligent scheduling and prioritization can optimize the order in which print jobs are processed. Incorporating predictive analytics and AI can further enhance the system's ability to foresee and address potential issues before they arise, leading to a more efficient and user-friendly printing experience. The developers are obliged to offer streamlined experience to users for their enhanced satisfaction. Print queue job is, you can assume the most critical aspect as it can be crucial to also manage the files effectively if not only to just print.

2.4 PubLayNet for Document Layout Analysis

For the effective processing of student-uploaded documents, it's crucial to accurately interpret various document layouts. The PubLayNet dataset, comprising over 360,000 document images annotated with layout elements, can be instrumental in training models to understand and process diverse document formats. Utilizing such a dataset can enhance the system's ability to handle different file types, ensuring high-quality print outputs. [10]

2.5 Google Cluster Workload Traces

Understanding the workload characteristics of cloud systems can aid in better resource management. The Google Cluster

Trace dataset provides extensive data on job failures, resource usage, and task resubmissions across multiple clusters. Analyzing this dataset can offer insights into user behaviors and system performance, informing the development of more resilient and efficient cloud-based printing services. [11]

2.6 Print Job Data for Scheduling Optimization

To refine print job scheduling, access to detailed print job data is necessary. Such data can include information on job sizes, submission times, and user priorities. Analyzing this data can help in developing algorithms that efficiently manage print queues, ensuring that urgent tasks are prioritized and resources are allocated effectively. [12]

3. PROPOSED SYSTEM

Students experience a hectic and tedious job for taking prints of their documents while waiting in a crowded queue at the xerox shop. This creates chaos at the shop, leaving a frustrating environment for students as well as the shop owner. This project focuses on making a queue management system for files to get uploaded onto a cloud space which will be shown at the admin portal provided to the xerox shop owner. This will make students demand and the xerox shop owners' job much less hectic and easy.

The solution is to provide a web-based system which will allow students to upload their files which are supposed to be printed on a cloud space which will be managed by the admin portal provided to the xerox shop owner.

The time for both the student and the operator will be utilized more for productivity, creating havoc free and less disrupting environments which will also make the job of the operator easier to fulfill student demands.

3.1 File Uploading

Student will be offered a UI with all the options required or mandatory so that they will be able to give pretty much all details about how the file must be printed, number of copies required, color print or black and white print. This UI is all what is required to be filled by users in order to take the service of automated printing.

One thing that if the user has not yet registered on the platform, they will not be able to upload any file for printing and will get the prompt to register on the platform in order to avail the service, but not only registered but the user must be logged in also as these processes are very important to confirm the identity of users using the service.

An android showing an Upload option to upload their files for printing, but it will be necessary to create an account and logged in on the system to actually upload the files. They will get a login prompt if they open the application anonymously and will need to login to further use the system.

As the user clicks on the upload button, they will get a dialogue box where user can upload their files which must not exceed 10mb of size. It is mandatory to make sure that the uploaded file is in pdf format and not any word document or any other extension file. The user will be allowed to select the number of copies which will vary from the range >0 to ≤ 10 .

Further a radio button option will be there to specify the color of the print either B/W or original color scheme. And lastly a description box will be available to further notify or give any other instructions to the xerox operator.

In order to complete this project, the authors will make use of various websites development tools and technologies including front-end and back-end frameworks. The core focus would be on building a responsive website using HTML, CSS, and PHP as primary tools. Html will be used to place the content, while CSS guarantees a smooth user experience and aesthetically pleasing design.

PHP will manage the server-side processes in regard to controlling dynamic content, database communication, and instant responses generation. He will manage the form submissions; user log ins and other interactions made with the server.

Also, the authors will add other web technologies such as JavaScript which are needed to add interactivity as well as the dynamic features to the site. JavaScript will be responsible for managing real time updates and animations, user input validation at the front end which makes the site not only appealing but also easy to use.

When it comes to mobile development, the authors will compile and run Java code using Android Studio for a mobile version of the project. The app is primarily written in Java to ensure performance and functionality on all android devices.



Figure1. User Portal Flow Chart

3.2 Cloud Storage Implementation

To implement Firebase Cloud Firestore for managing user login credentials securely, the authors will design a system where Firestore serves as the primary database for storing and organizing user data. Firestore will act as a central repository for critical user details, such as usernames, email addresses, hashed passwords, and any other essential information needed for authentication purposes. The Firestore database will be designed to allow easy and secure access to user credentials during the login process. Passwords will be hashed before being stored and sensitive data will be encrypted. When a user logs into the system, the necessary user details will be retrieved from Firestore. The password provided will be checked against the password stored in Firestore for hashed values. System access will be granted if the credentials entered are valid.

In addition, Firebase Cloud Firestore allows data to be both read and written, giving Firestore administrators the power to manage user credentials. This means that administrators can change user information when needed by resetting passwords, changing user's details, or even deleting the user from the system. The flexible design of Firestore makes it easy to perform queries, ensuring the security of user authentication and the speedy retrieval of data. Furthermore, the real time updates of Firestore ensures deletion or updates of users information is done instantly, allowing the system to have the most current user information

The authors will incorporate Firebase Cloud Storage into the system for the purpose of storing and managing uploaded files like documents/PDFs. Users conveniently upload files without limitations as Firebase Cloud Storage provides dependable and easily expandable solution for storage of large files.

As users upload files, they will be stored with a uniquely generated link accessible through Cloud Storage. Using the link provided will simplify file retrieval and address content management challenges. Such distinct links will be appended to the user's personal information in Firebase Cloud Firestore, thus establishing an easily navigable system to accessing files.

This bond between Firestore and Cloud Storage facilitates fast and easy file access for the users whenever they wish. By generating access links to the files kept in Cloud Storage, users will be able to view or download the files as they desire. Additionally, the admin will have unrestricted access to file management functions which may include file updates or deletions. With regards to system operations, a high standard of file and user data protection will be maintained to safeguard user account details and the files affiliated with them. This reinforces the system's framework while providing a highly secure environment to context-sensitive information. Enhanced security alongside smooth user interaction with the file management system brings adds to value of this approach.



Figure2. Admin Portal Flow Chart

3.3 Cloud Storage Working

The admin program controls the printing process of student files, which are usually in PDF format and stored in a Firestore database. The files accessible to the admin portal come from Firestore database storage. Admin program retrieves these files using access link in Firestore. As soon as it gets that link, PDF file respective to this document is downloaded and pushed into print queue awaiting processing.

The print queue works on LIFO (Last In, First Out) so the first file that was added to the queue prints first. This ensures that all student files are processed in the order of their upload. Here, system is configured in such a way that it automatically prints each file after a gap of 5 minutes which keeps the organization and timetable of printing intact. This 5-minute interval gives sufficient time for handling print queue so that system is not overpowered with many tasks at one time.

To make the whole process easy, all information typed by the user (like student info, file details and extra metadata) is combined into one JSON format. This JSON file has all the info needed by admin to do the print job. JSON format helps that all related details are caught in an ordered way which can then be easily reached and used by admin portal.

Once the Firestore has stored the JSON file, it will be fetched back at admin portal and the data decrypted. Decryption here means turning JSON data into readable information so that all details required by the software to print can be known beforehand. This will guarantee that the admin will have a clear and comprehensive overview of each file queued for printing, including any metadata that may affect the printing process such as formatting preferences, file size, or other specifications. The automatically processed, orderly printed queue coupled with obvious data makes workflow for both students and administrators smooth.

3.4 User Experience

By leveraging this technology and implementation, users can efficiently have their documents printed without the hassle of waiting at a print shop. Upon document upload to Firestore by the user, the system initiates full automation of the printing process. When the document upload is complete the admin program retrieves it automatically then downloads the file and places it in the print queue. Users can now enjoy a hassle-free experience because they no longer have to go to the print shop or line up while printing documents.

The automated printing system utilizes a LIFO (Last In, First Out) algorithm to maintain upload order while printing files with a 5-minute interval between jobs. The designated time interval maximizes printing resources utilization while simultaneously avoiding system delays and bottlenecks. Users can leave print shop while their documents are being printed because the system manages the entire process on its own.

The document information required for administration storage is saved as structured JSON and later decrypted for display on the admin portal. The admin receives all pertinent information in an easily accessible format which enables them to perform necessary modifications prior to printing. Users can expect their documents to be printed quickly because all processes occur in the background thus eliminating usual printing service delays and uncertainties.

This system improves the efficiency of the overall printing process, creating quick, effective, and seamless time saving experience for users. They will not have to spend time waiting on their printed items or managing issues associated with the printing of their document. This system gives users the ability to print their document in their own time, while saving them the trouble of driving to a print shop.

4. RESULTS

By utilizing this technology, it simplifies and improves the printing process, making it much faster and easier for users to have their documents printed. Users no longer have to visit a print shop or wait in a queue as everything is processed and uploaded automatically and awaits their approval. The technology used runs in the background, printing their documents automatically.

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Password		Password			
Forgot password?		Confirm password			
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Figure3. User Login/Signup Form

LIFO (Last In, First Out) algorithm eliminates delay in print queue by guaranteed print in the order exactly as they were uploaded. Add a 5-minute break after each print job to allow the printing system some breathing room rather than risking overload and jammed printer. The developers' used unique timed approach will allow each user's document to be printed in a timely manner so consecutive users do not need to be delayed, avoiding the long wait times seen with regular printing services.

Upload File Upload File Number of Copies: 1 Color Mode:	
Upload File Number of Copies: 1 Color Mode:	
1 Color Mode:	
Color Mode:	
Black and White	
Print Side:	
Single-sided	
Pages to be Printed:	
1	
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Figure4. Uploaded File Details Panel

Moreover, the system stores all the data in a JSON format which ensures that every single print is served with all the data required and is easy for the admin to access it whenever he/she wants. Checking Decrypted JSON Data on Admin Portal, the decrypted JSON data shown on the admin portal provides a clear overview of the print job, ensuring that everything is properly set up and that the right settings and preferences have been applied before printing.



Figure5. Uploaded File Current Status

That is how the process becomes automated and efficient, enabling a notably faster turnaround time for users who no longer need to hang around the print shop waiting for their documentation.

🕌 PrintFlow		-	×
	PrintFlow		
	Start Service		
	Stop Service		
	Status:Service Running		
	Exit		

Figure6. Admin Service Definition Portal

5. CONCLUSION

In conclusion, this technology revolutionizes the traditional printing process by offering a seamless, automated experience that benefits both users and administrators. With the ability to upload documents, manage print queues, and handle everything remotely, users are freed from the need to visit print shops and wait for their documents to be processed.

The efficient use of the LIFO algorithm and the structured management of print jobs ensure that each document is printed in a timely and organized manner. This results in significant time savings for users while also providing administrators with a streamlined system for managing print tasks. Ultimately, the implementation of this system not only enhances the convenience and speed of document printing but also ensures a smoother, more efficient operation overall.

This project demonstrates an efficient and user-friendly approach to managing document printing through an Androidbased application. By integrating Firebase services, it will ensure secure storage of user credentials and uploaded files, along with streamlined data handling via JSON formatting. The system enforces key constraints—such as file type, size, and copy limits—to maintain order and consistency. Automated queue management using the LIFO principle enhances operational flow for the admin. Overall, the application simplifies the printing process for students while equipping shop owners with an organized, digital interface to manage requests efficiently and accurately.

By minimizing manual queuing and enabling remote file uploads, it improves efficiency, reduces congestion, and enhances the experience for both students and xerox shop owners. This solution not only saves time but also reduces operational stress, paving the way for smoother interactions and better service management.

By eliminating the need for physical queuing and enabling cloud-based file uploads, the project enhances operational efficiency while reducing delays, confusion, and unnecessary crowding. The centralized admin portal gives shop owners full control over the incoming requests, allowing them to process prints in an organized and timely manner. This improves productivity on both ends—students can continue with their tasks while their files are being handled, and operators can manage workloads without feeling overwhelmed.

Looking ahead, PrintFlow has the potential to expand its utility with additional features such as live queue tracking, real-time notifications, automated billing and payment integration, and compatibility with multiple printing centers. Further enhancements could include mobile application support and integration with institutional login systems for increased security and ease of access. With growing digitization, this system could serve as a foundation for transforming conventional printing shops into smart, tech-enabled service hubs.

Admins can be provided with dashboards to track peak hours, frequent users, types of documents printed, and usage trends. These insights can help improve service planning and business decisions.

The system can be scaled to manage multiple xerox centers across a college campus or educational network. Students could choose the least busy shop based on real-time queue data, optimizing footfall distribution.

In the future, sensitive documents can be protected using user authentication methods like OTP verification, student ID linking, or QR code-based retrieval to ensure confidentiality and controlled access.

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7. ACKNOWLEDGEMENT

The authors would like to express their much sincere gratitude towards their mentor, institute and university for their valuable guidance, constant support and encouragement throughout the duration of this project and will always be thankful for this gesture.

The authors hope that even they were able to be sincere and also show their sincerity throughout the project tenure and hope that the university will remember their gratitude as well.