

**A MOBILE-BASED SYSTEM FOR LOANS MANAGEMENT:
A CASE OF BANQUE DE GESTION ET DE FINANCEMENT**

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**A Project Report Submitted in Partial Fulfillment of the Requirements of the Award
the Degree of Master of Science in Embedded and Mobile Systems of the Nelson
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ABSTRACT

As technology has evolved and has embraced nearly all sectors of human daily life, bank processes are not left behind. Moreover, mobile technology penetration and internet access in Africa have increased a lot. In Burundi, internet users have increased by 452 thousand (+39%) between 2020 and 2021. Therefore, the introduction of a mobile system for the banking process would be in line with the region's digital trends. As for the case of the Burundian bank, the Banque de Gestion et de Financement (BGF) some processes are still done manually and the physical presence of the client is mandatory. This is the case in the loan application process. Existing studies have presented digital solutions for loan management but the studies are not tailored to Burundian banks' processes and regulations and there are security issues that are not addressed. To tackle the above challenges and enhance the loan management process, this study proposes a mobile-based system that manages the loan requests: the customer applies for a loan and is informed of the approval or rejection of the application online without reaching the banks' offices. The system provides feedback to the customer within fewer processes and in secure and reliable conditions. The proposed system does not incorporate the entire loan management process. The flow of information within BGF departments during the loan application analysis is not included in the proposed system. The system development process was based on the agile model methodology and the prototype was completed with the use of tools such as android studio, html5, css3, angular JavaScript, bootstrap for the front end, and PHP and MySQL for the back end. The system verification and validation included 10 participants from BGF (staff) and 15 BGF customers. The 25 participants evaluated the proposed system and gave positive feedback regarding the performance, ease of use, and usefulness.

DECLARATION

I, Armel Bizoza, do hereby declare to the Senate of the Nelson Mandela African Institution of Science and Technology that this project report is my original work and that it has neither been submitted nor being concurrently submitted for a degree award in any other institution.

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by The Nelson Mandela African Institution of Science and Technology, a project report titled “**A Mobile-Based System for Loans Management: A Case of Banque de Gestion et de Financement**” in partial fulfillment of the requirements for the degree of Master of Science in Embedded and Mobile Systems, Mobile Systems Specialty of the Nelson Mandela African Institution of Science and Technology.



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DEDICATION

To my late father Côme Minani, my daughter Abigaël and my son Mario I dedicate this work.

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LIST OF ABBREVIATIONS AND SYMBOLS

API	Application Program Interface
ATM	Automated Teller machine
BGF	Banque de Gestion et de Financement
BIF	Burundian label of currency. Burundian franc
BRB	Bank of the Republic of Burundi
COVID-19	Coronavirus disease of 2019
CSS	Cascading Style Sheets
DFD	Data-Flow Diagram
EMI	Equated Monthly Installment
GIZ	German International Cooperation
GSM	Global System for Mobile Communications
HTML	Hypertext Markup Language
ICT	Information and Communications Technology
IEEE	Institute of Electrical and Electronics Engineers
IFA	Alliance for Financial Inclusion
IntelliJ IDEA	An integrated development environment (IDE) written in Java for developing computer software. It is developed by JetBrains (formerly known as IntelliJ) and is available as an Apache 2 Licensed community edition
INTERPOL	International Criminal Police Organization
IT	Information Technology
MFI	Microfinance Institution
ONATEL	Office National des Télécommunications du Burundi
P2P	Peer-to-Peer

PHP	Hypertext Preprocessor
RDBMS	Relational Database Management System
REST API	Representational State Transfer - Application Programming Interface
SDK	Software Development Kit
SQL	Structured Query Language
SSD	System Sequence Diagram
UAT	User Acceptance Testing
UML	Unified Modelling Language

CHAPTER ONE

INTRODUCTION

1.1 Background of the Problem

Financial institutions such as banks offer money lending services to people and business organizations and these services are among the core functions which contribute significantly to the financial institutions' profit.

In traditional banks, it takes up to a month for the bank management to decide whether to give or not a loan to a particular person, a business, or a corporate. It might take nearly three months for the loan requester to receive the cash (Chappell *et al.*, 2018).

Currently, we are entering an era where advances in technology are changing financial and banking activities in the world: artificially intelligent assistants give financial advice, mobile apps are making people discover virtual reality, and process automation optimizes processes for higher productivity and costs savings. A user can set up automatic payments for regular service bills like power, gas, telephone, and credit cards (Jana *et al.*, 2021).

The future of each bank depends on how well it can adapt itself to these innovations and focus on the customer needs and behaviors.

The Banque de Gestion et de Financement (BGF Bank) is one of the commercial banks in Burundi. Founded in 1996, it has a current share capital of 27 126 799 200 Burundian francs (Burundian currency, abbreviated in BIF). The bank has incorporated digital services such as internet banking where customers can perform online key operations such as consulting their bank accounts, their bank balance, making a money transfer, send requests regarding their account (BGF Bank, 2021).

Besides, one of the bank's core functions is not yet digitalized. The loan management system. The current existing loan management process is time-consuming and requires the physical presence of the loan applicants to submit all requested documents to prove their trustworthiness and their credibility. As a result, some potential customers will not apply because of their inability to physically reach the bank offices. The time consuming has an impact on the productivity of the bank since the entire loan process involves the work of several employees and consumes a lot of effort.

Process automation is capable to enhance routine tasks and fastening the process for the benefit of both the bank and the customers. A loan management system will reduce and, in some way, eliminate human errors, several manual tasks will be dropped, the physical presence will no longer be mandatory and the automated report generation will be an advantage for decision-making based on analytical data (Kitsios & Kamariotou, 2021).

The automation of a part of the entire bank's loan management will streamline the process. The "time to decision" or "time to receive the cash" will be significantly reduced.

The proposed project intends to develop a system that will digitalize a part of the loan management process: loan origination. This refers to the process by which a customer applies for a loan, and the bank accepts or rejects the application.

The proposed system is mobile-based to enable access to the service through smartphones and is most suitable now to fight against the Coronavirus disease 2019 (COVID-19) pandemic.

1.2 Statement of the Problem

The current process at BGF Bank for a loan request application is as follows:

The loan applicant has to be physically present at the bank office or one of its branches to request a loan and submit all required documents. The applicant will then wait for some weeks for the analysis and decision of the bank management regarding his/her application.

The process takes time and resources for both the institution where the credit committee has to arrange regular meetings to state pending loan requests and for customers who need to travel regularly to the bank office/branch for follow-up. Moreover, manual procedures have a high risk of human errors, and the generation of reports takes a lot of time with no guarantee of data reliability. With the physical presence of customers, COVID-19 is likely to keep on spreading.

On the other side, the bank has the vision to stimulate a new dynamism of development based on adapted banking services for more sustained growth in Burundi and its mission is to apply its policy of innovating products adapted to all customer segments and its vast distribution network (BGF Bank, 2021).

To achieve its vision and mission, the BGF Bank needs to digitalize its processes such as the loan management process. This is possible especially when there are intuitive self-service digital banking solutions that provide a low-effort, fast, and pleasant user experience using the customer's device of choice (Suhaimi & Hassan, 2019).

With the advent of the fourth industrial revolution, internet/digital bank operations are offering alternative approaches such as online transactions and banking. This brings about satisfied employees who create satisfied customers as they work within a shorter time effectively and efficiently (Louw & Nieuwenhuizen, 2020; Sama, 2019).

Digitalization and automation of the loan request application process can contribute to solving the above-mentioned problems and hence drive a step forward to the BGF Bank's achievement of its vision and mission.

1.3 Rationale of the Study

The Banque de Gestion et de Financement aims at gaining a competitive advantage by innovating and adapting banking services for more sustained growth. A digital system implemented in one of its core functions, i.e., loan services, would positively impact the bank's productivity: customers will be able to request easily a loan and this will enhance customer relationships. The resources, i.e., time and staff, normally allocated to the manual process of loan requests will be reduced or shifted to other bank functions and significant cost savings will be achieved by the bank as a result. Credit management by the bank will be enhanced with data collected from customers within the loan request management system.

The proposed system is a mobile application that implies the use of smartphones or tablets to make loan requests and this can be done anywhere and at any time thanks to the portability of smartphones/tablets. This is good news for today's consumers who are more and more attracted by electronic services (e-services) and burdened by pandemic-related restrictions.

Therefore, the proposed mobile-based system for loans management will address the bank's credit department and customer needs by performing the following:

- (i) Self-registration from any place.

- (ii) Each customer will have access to a dashboard where one can apply for a loan, upload all requested documents, check the status of requested loans, check the history of equated monthly installment payments already made and update one's contact details.
- (iii) The credit department staff will have access to an admin dashboard where they would view all users' details, update client equated monthly installment (EMI) payments, generate EMI payment reports or view customers' loan request application files. After studying the files, the credit department staff would update the application status either as "On Progress", "Rejected" or "Approved".
- (iv) At this stage, the security of the process resides in the fact that you have to own a bank account before you can apply for a loan. Furthermore, once the loan application is approved, the applicant's physical presence, or the presence of a mandated person, is needed for loan agreement signing.

1.4 Objectives of the Study

1.4.1 General Objective

The main objective of this project is to develop a mobile-based system that would manage the BGF bank loan requests.

1.4.2 Specific Objectives

The specific objectives of this project are:

- (i) To identify the requirements for developing the mobile-based bank loan request management system.
- (ii) To design and develop the mobile application's frontend and backend.
- (iii) To validate the system's quality based on testing criteria.

1.5 Research Questions

- (i) Which requirements are needed to develop a loan management mobile-based system?
What are the features/functions to implement to make the users' experience efficient?
- (ii) How the loan management mobile-based system will be developed?
- (iii) How do validate and test if the system fulfills the requirements?

1.6 Significance of the Study

The proposed system is expected to contribute to the BGF Bank's achievement of its mission and vision which focus on innovative solutions adapted to all customer segments and that would increase productivity. The traditional loan management process currently used at BGF Bank is not convenient for both the bank employees and the bank customers: it is a long process, with a high risk of data loss, time, and financially costly for customers since they have to go to the bank offices for follow up. In addition, the existing solutions for loan management systems do not meet Burundian bank regulations.

As financial institutions all over the world are actively embracing technology innovations to meet the current customer needs and wants, BGF bank is not to be left behind. This proposed mobile-based system is a technological advancement for the bank's credit department. The system is expected to level up the bank's credit department efficiency and make employees' work and customer requests more user-friendly and convenient.

1.7 Delineation of the Study

The complete bank loan management process is made of multiple tasks and subtasks such as loan origination, loan agreement process, EMI payments and follows-up, and mortgage foreclosure in case of payment failure. This study focuses on loan origination whereby the customer applies for a loan and is informed of the approval or rejection of the application online without reaching the banks' offices. The system aims at enabling employees and customers to interact more efficiently and regarding avoiding unnecessary physical contact that would increase the spread of COVID-19.

CHAPTER TWO

LITERATURE REVIEW

2.1 Bank Loans Management

One of the key services provided by banks is lending money to their clients. The borrower is required to repay the money with interest. Bank loan management is crucial and it is instrumental in ensuring the success or failure of any credit institution (Nazaj & Meka, 2014).

It has a positive impact on financial sustainability, profitability, financial efficiency, and productivity (Nsengiyumva & Harelimana, 2020).

2.2 Digital Banking Trends

Digital banking is the digitization of every level, from the front- to back-end, of banking. This allows users not only to make account deposits and transfers remotely; but also, to more easily apply for loans and access personalized money management services (Phaneuf, 2021).

The current state of pandemic and high-tech inventions leads to many changes in the processes of bank digitalization. The banking system has to switch to a remote work format and rebuild internal workflow (Nataliia, 2021) to meet customers' new behaviors and interests. There is a need for the banks to adopt a culture of continuous Customer Relationship Management, customer research, learning, and business innovation. Services such as Automated teller machines ATM's, smart cards home banking, telebanking, internet banking, and e-banking have enabled the bank to save time, increase storage capacity, save money, improve data accuracy, and maintain data security (Achimba *et al.*, 2014).

2.3 Mobile Banking in Africa

Mobile technologies penetration in Africa has increased a lot in the last few years, and according to Global System for Mobile Communications (GSMA) estimations, in 2020, 80% of the 800 million people living in Sub-Saharan Africa already have a mobile device, partly due to the advances mobile banking has had in the region. Smartphone use is also not left behind: according to Informa, Africa has gone from 79 million devices in 2012 to 412 million in 2018. Figure 1 shows how mobile financial services are popular in Africa, especially in Sub-Saharan Africa.

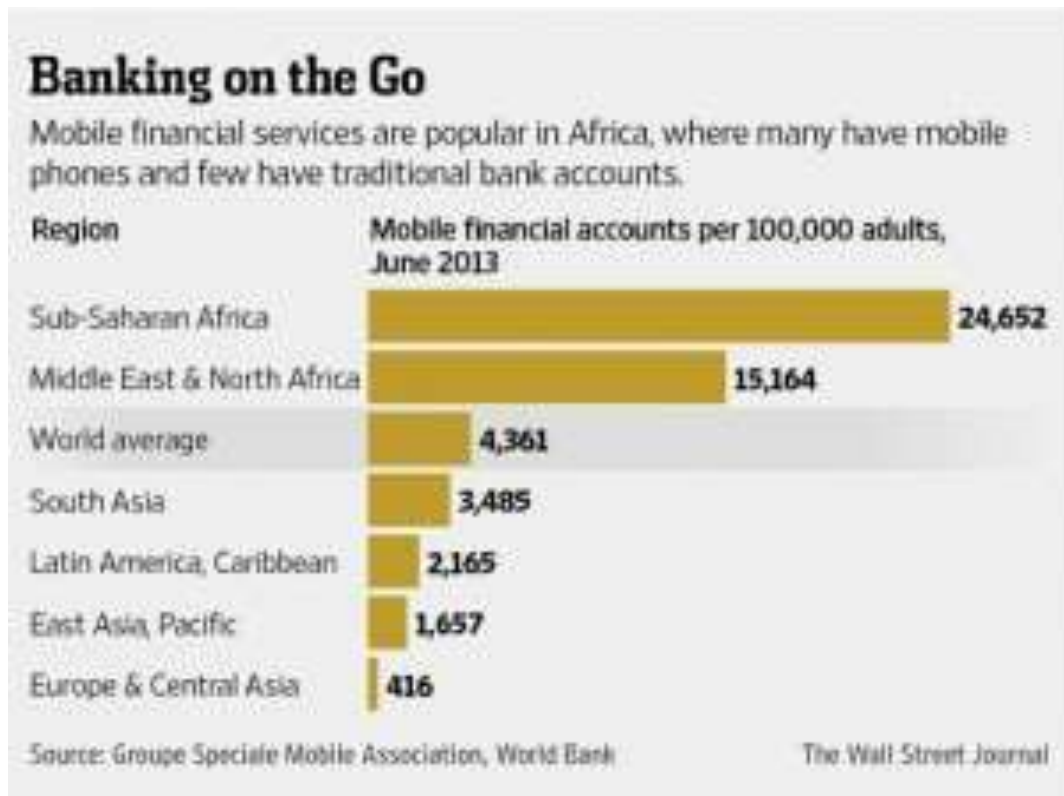


Figure 1: Mobile banking in Africa (Siedek, 2014)

2.3.1 Why Mobile banking is growing in Africa

Mobile banking is growing very fast in Africa. Figure 2 shows some of the reasons.

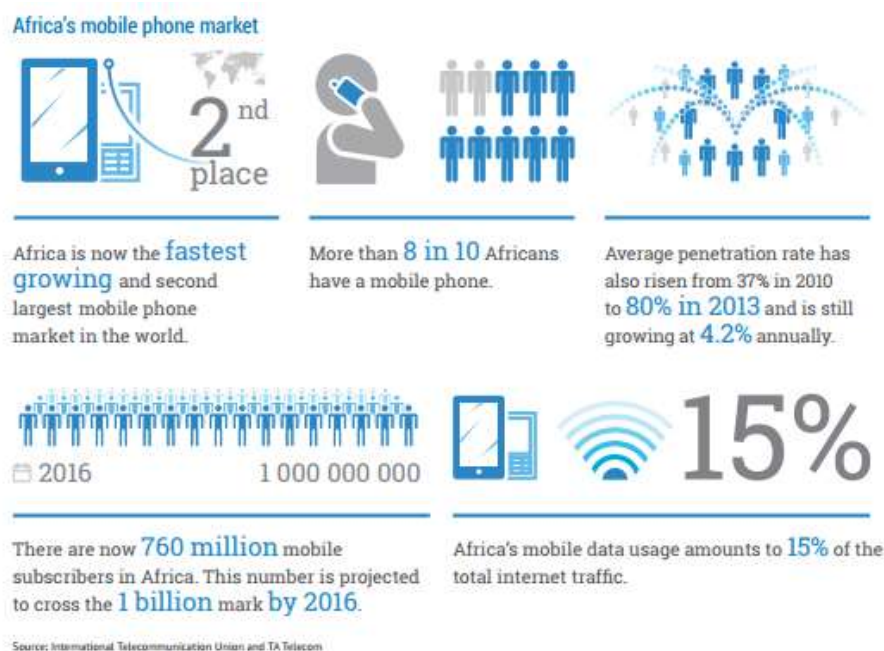
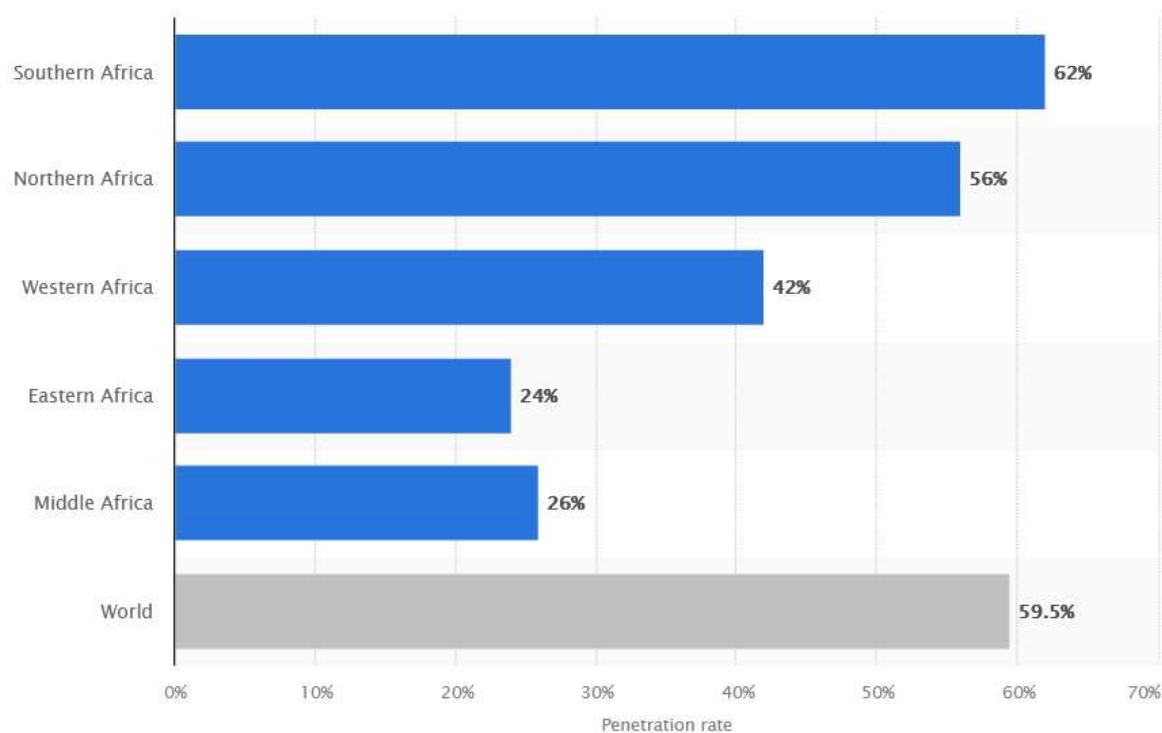


Figure 2: Why Mobile banking is growing in Africa (Sarah Nassiri, 2017)

2.4 Internet Access



Internet access across Africa is continuously growing as shown in Fig. 3.

Figure 3: Internet penetration rate in Africa (Faria, 2021)

2.4.1 Internet Access and Users in Burundi

The country is connected to undersea fiber-optic cables that run along the East African coast. The Burundi Backbone System, a company run under a public-private partnership has laid a fiber optic backbone in 17 of the country's 18 provinces, and that covers a distance of 1250 km. As of June 2016, mobile phone penetration stood at 47% of the population while the internet penetration rate was estimated at 7.2%. The state-owned Office National des Télécommunications du Burundi (ONATEL) and the Vietnamese company Viettel also offer landline services (OpenNet Africa, 2016).

Internet users in Burundi were 1.15 million in January 2020 while they were 1.61 million in January 2021. The number increased by 452 thousand (+39%) between 2020 and 2021. Internet penetration in Burundi stood at 13.3% in January 2021 (Kemp, 2021).

Figure 4 shows the evolution of internet usage in Burundi from 1960 to 2019 and is evident

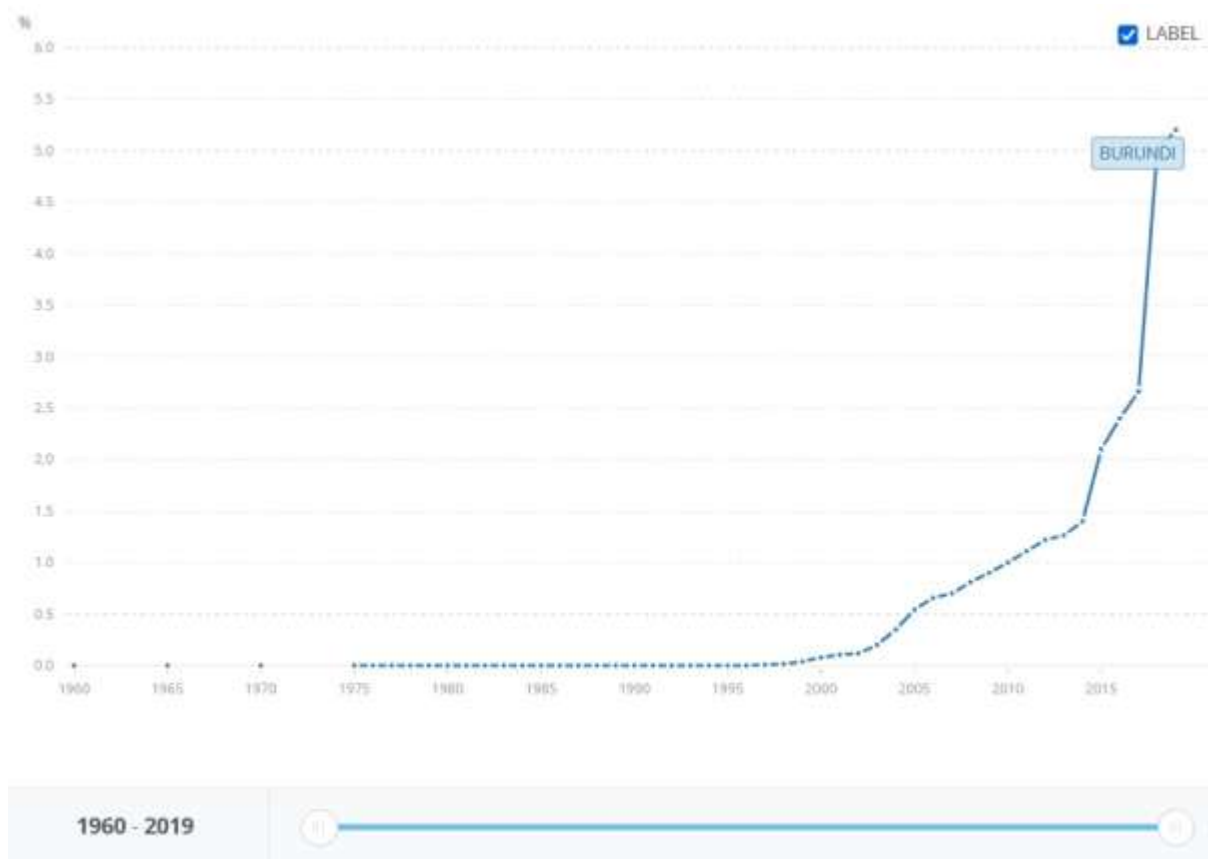


Figure 4: Evolution of internet in Burundi (The World Bank, 2021)

that individuals using the internet are rapidly increasing.

2.5 Cybersecurity Issues and COVID-19 Impact

Cybersecurity is important to trusted and sustainable digital transformation. This becomes evident during situations of crisis such as the COVID-19 pandemic, where many organizations' activities and communication move online and where cyber defenses might be lowered due

to the shift of focus to the health crisis. The COVID-19 pandemic has accelerated digital development across all regions. For example, the "Africa's Pulse, No. 22, October 2020" (World Bank, 2020) report states that during the lockdown, 25% of the firms in sub-Saharan Africa accelerated the use of digital technologies and increased investments in digital solutions in response to COVID-19. Therefore, there is an urgent need for universal digital

access to ensure that people can be reached, that they can stay informed and that they can work, communicate or buy/request goods and services. Here, security has to remain among the priority focuses. According to an assessment of the global landscape on COVID-19 cyberthreats conducted by the International Criminal Police Organization (INTERPOL), cyber threats have increased very much across all cybercrime domains, including online scams and phishing, data-harvesting malware, disruptive malware/ransomware, and vulnerability attacks on systems (networks, applications) used by businesses, governments and schools to enable working remotely (ITU, 2021).

2.6 State of Financial Systems in Burundi

The first national survey on financial inclusion in Burundi, conducted by the Bank of the Republic of Burundi (BRB) with support from German International Cooperation (GIZ) and the Alliance for Financial Inclusion (AFI) analyzed the services offered by the Burundian financial sector. The analysis shows that the banks and Microfinance Institutions (MFIs) should undertake a significant change to increase the scope of their services. The change should specifically deal with the following aspects: bringing services nearer the rural areas; smoothing the conditions of eligibility for savings and loans; greater transparency in the actual cost of services; developing products that meet better the needs of the majority of the population active in the informal sector of the economy.

Moreover, the analysis reveals that the Burundian population uses informal financial systems more than the services offered by formal financial institutions, whether to save, borrow or make money transfers. The recourse to the informal systems results from many factors including the lack of financial literacy and knowledge about financial institutions, the distance from the access points of the institutions as well as other socio-cultural factors (Burundi, 2012).

2.7 Related Works

Francisco (2021) proposed a web-mobile system for loan management of Technological University of the Philippines-Manila Multi-purpose Cooperative (TUPMMPC) that allows users to apply online for a loan and that involves the complete loan processing cycle from application, approval, voucher creation, check preparation, until ledger update. However, the admin panel is only accessed through the web portal and security issues are not addressed:

how do know if the loan requester is the one, he or she pretends to be before a loan is granted?

Sahota (2019) proposed an online loan management system where customers can apply for loans online and track their loan status, EMI details, and loan rate details. However, the system is only available through a web portal; there is no mobile app for the system. In addition, the system does not allow customers to upload documents related to their loan requests. They have to submit the documents to the office of the institution.

A research project was conducted by Ngugi (2017) to establish the effect of mobile-based loan management practices on the financial performance of commercial banks in Kenya. The result of the study concluded that mobile-based loan management practices influence the financial performance of commercial banks. Moreover, the study concluded that default patterns and risk profiles had a significantly negative influence on the financial performance of commercial banks (Ngugi, 2017). However, this study focused on the general perception of mobile-based loan management systems; specifically on how the financial performance of commercial banks in Kenya would be affected by mobile-based systems. The study provided results for only Kenyan commercial banks and from a general perspective.

Another research on the effect of loan management on the performance of banking institutions was published in May 2020 by graduate students at the University of Science and Technology of China and the case study was the Bank of Kigali Headquarters. The researchers undertook the study on Loan management as one of the factors that increase the financial performance of banking institutions even though banks differ on the methods and how they organize the way to manage problem-related with loans. Based on the findings of the study, the researchers concluded that there is a significant relationship between loan management and the performance of Bank of Kigali Ltd. Loan is the lending of money by a bank to another party with the agreement that the money will be repaid along with interest or other financial concerns is what brings performance to the banks (Nsengiyera, 2020).

In the paper “Evaluation of Mobile Application in User’s Perspective: Case of P2P Lending Apps in FinTech Industry” published by S.Lee in February 2017, the study was focused on the user acceptance of mobile Peer-to-Peer (P2P) lending apps. P2P lending is a method of borrowing or lending money to individuals through online services without the use of an official financial institution as an intermediary. The P2P lending companies operate their

services entirely online or mobile environment. The study concluded that the users' acceptance of mobile P2P lending apps is significantly influenced by perceived ease of use, perceived usefulness, and user satisfaction (Lee, 2017).

Considering the above studies, it is clear that loan management systems have a significant impact on the performance of banks and other financial institutions. Furthermore, users are attracted by mobile applications depending on the efficiency of the apps.

However, it is important to note that online services and mobile services are more likely to encounter security issues such as data theft, data fraud, or data validation difficulties.

The proposed system is developed to fill the gaps and enhance the previous studies. It is a mobile-based system that will allow customers and BGF staff to complete in a more secured, fast, and simple way the loan origination process, i.e., from loan application to loan approval or denial; including the EMI follow-up feature. The proposed system is completely mobile-based: the user interfaces, as well as the admin interface, will be accessible on smartphones. Moreover, for security reasons, once the loan is approved, the customer or the mandated person is requested to go to the Bank office to the signature on the loan agreement documents. That will be an opportunity to verify the identity of the customer. Last but not least, a mobile-based system for loan management is an innovation for the Burundian financial institution's environment. Up to this date, bank loan management processes in Burundi are in a large part manually processed. The success of the proposed system would therefore benefit not only the BGF bank and its customers but also other financial institutions that would look forward to implementing a similar system for competitive purposes.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

This study was carried out at BGF Bank's main office located in Bujumbura city, Burundi. The BGF Bank is a limited company founded in 1996. With the following main functions: deposit, withdrawal, credit, foreign exchange, investment, cash flow, bill discount, commission, and share buyback operations, the institution has now expanded and has now eight counters in Bujumbura city and 15 branches in various provinces of Burundi.

Bujumbura, the economic capital of the Republic of Burundi, is located in the west of the country, on the shores of Lake Tanganyika, one of the great lakes in East Africa. Burundi is a landlocked country in the African Great Lakes region of East Africa, bordered by Rwanda to the north, Tanzania to the east and south, and the Democratic Republic of the Congo to the west (Kamga, 2019). The map shows the location of BGF Bank in Bujumbura city (Fig. 5).

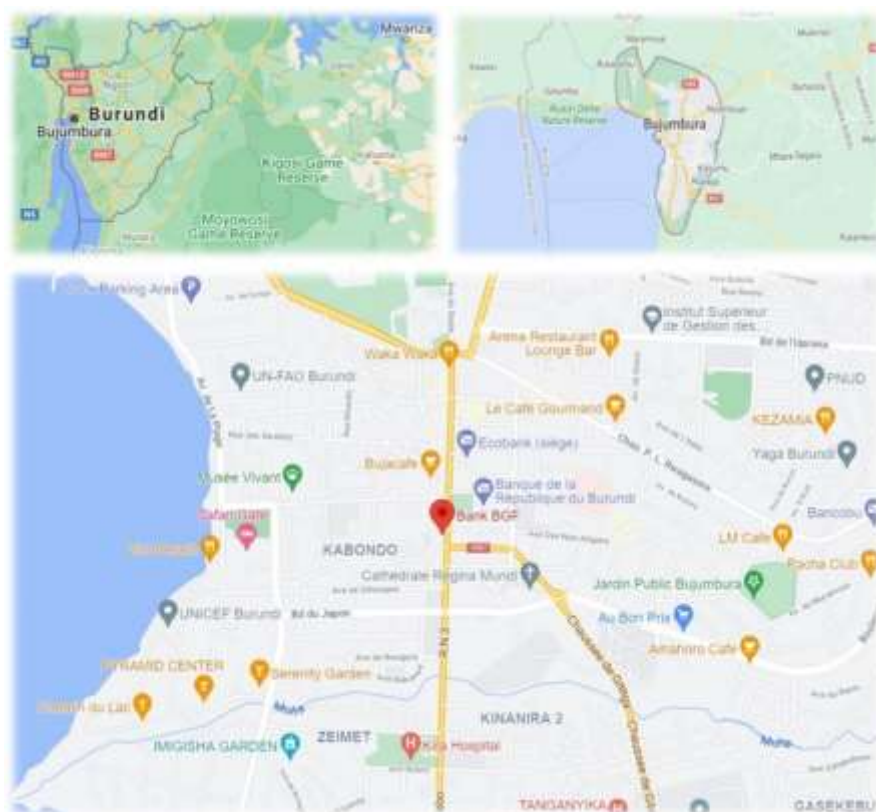


Figure 5: Study area (Google, 2021)

3.2 Sampling Techniques

A purposive non-probability sampling method was used to select participants of the study. The research focused on BGF staff that were working in the credit department, the information technology (IT) department, and BGF management. On the customer side, the focus was directed to company managers, businessmen, and public/private sector employees. The selection was done based on the availability and willingness to participate in the study. A total of 21 participants took part in the study.

3.3 Data Collection

This activity was undertaken at the BGF Bank headquarters as well as approaching selected individuals all residing in Bujumbura city. The data collection technique included a qualitative research method to have a closer and clear picture of the problem faced, the needs, and the requirements for developing the mobile-based bank loan request management system.

3.3.1 Interview

The interview consisted of three parts:

- (i) The first part was made of identification information. This would help to categorize respondents based on gender, age, residence, and whether the respondent is an employee or a customer (Appendix 2).
- (ii) The second part was made of questions about the existing loan processing system. The objective was first to identify the challenges faced by both BGF staff and BGF customers and second, to understand the data/information flow within the loan processing system (Appendix 2).
- (iii) The third part was made of questions about expectations and needs from the stakeholders regarding an enhancement of the existing system. The aim was to understand the technical requirements for a successful implementation of the proposed system (Appendix 3).
- (iv) The fourth part was made of questions that would provide a picture of the impact that the developed system will have on the credit department and the bank. The objective was to understand the proposed system's quality validation criteria (Appendix 3).

3.3.2 Observation

This technique was used at BGF's main office, specifically in the credit department and in the information and communications technology (ICT) department. The observation activity was conducted for two months, from 15 June 2021 to 17 August 2021. The aim was to observe the loan management process to gather information on behaviors and interactions between customers and staff.

Figure 6 shows BGF customers in the queue waiting to be received one by one at the BGF credit department office.



Figure 6: BGF customers at the credit department office, BGF headquarter

3.3.3 Document Review

The procedures manual was reviewed. Samples of loan application letters, loan analysis files, loan agreement files, and loan amortization schedules were also examined. This activity aimed to qualitatively analyze the different steps of the loan application process to ensure that the developed system complies with the standards.

3.3.4 Data Quality Control

To ensure the quality and accuracy of data being collected, data collection tools were selected in consultation with key stakeholders. Regular meetings with the BGF IT Project Manager, Credit department staff, and other key stakeholders were maintained and feedback/comments were taken into consideration.

3.4 Data Analysis

After gathering data, the next task was to analyze them, structure and organize them (removing duplicates, identifying those that overlap or conflict with others) to meet the objectives of the project.

How do analyze qualitative data? Qualitative data describes qualities or characteristics. It is collected using questionnaires, interviews, or observation, and frequently appears in narrative form (Albertson, 2021). Therefore, the preferred method to analyze the data collected was narrative analysis. This method involves the reformulation of stories presented by respondents by taking into account the context of each case and the different experiences of each respondent.

Results from the analysis were then compared with other resources to select suitable methods for developing the proposed system.

3.5 Ethical Consideration

The research ensured adherence to research ethical standards. Confidentiality during data collection was observed. Participants in meetings or interviews were informed in advance and gave their consent to participate in the research. Respect for the privacy of participants was observed together with the fact that participants' roles in the institution differ from one

another. All data involving individual identity or confidentiality is not to be shared with the public by the researcher.

3.6 System Development Approach

The development methodology chosen for this project was the Agile development methodology which involves a cycle of planning, requirement analysis, designing, building, and testing (Fig. 7). This methodology allows for the development and test of the system in different stages called iterations until the whole system is completed. That way, there is room for risk evaluation, adjustments, and evolutionary development concerning stakeholders' requirements. A specific Agile development framework, Scrum, was used in this study. In Scrum, the project progress is made via a series of iterations called sprints (Altameem, 2015).

In scrum, three core roles ensure the project objectives are met:

- (i) **The scrum owner:** For this system development, the scrum owner refers to the BGF bank which is the product customer. BGF bank management is entitled to verify and validate the proposed system and give remarks and recommendations at the end of each sprint.
- (ii) **The scrum master:** who is the project supervisor. For the case of this project, there are two academic supervisors and one host supervisor. Their role has been to facilitate, motivate and coach the scrum team.
- (iii) **The scrum team:** is the development team normally made of 6 to 10 members. For the case of this project, the team consisted of one member who is the author of this project report.

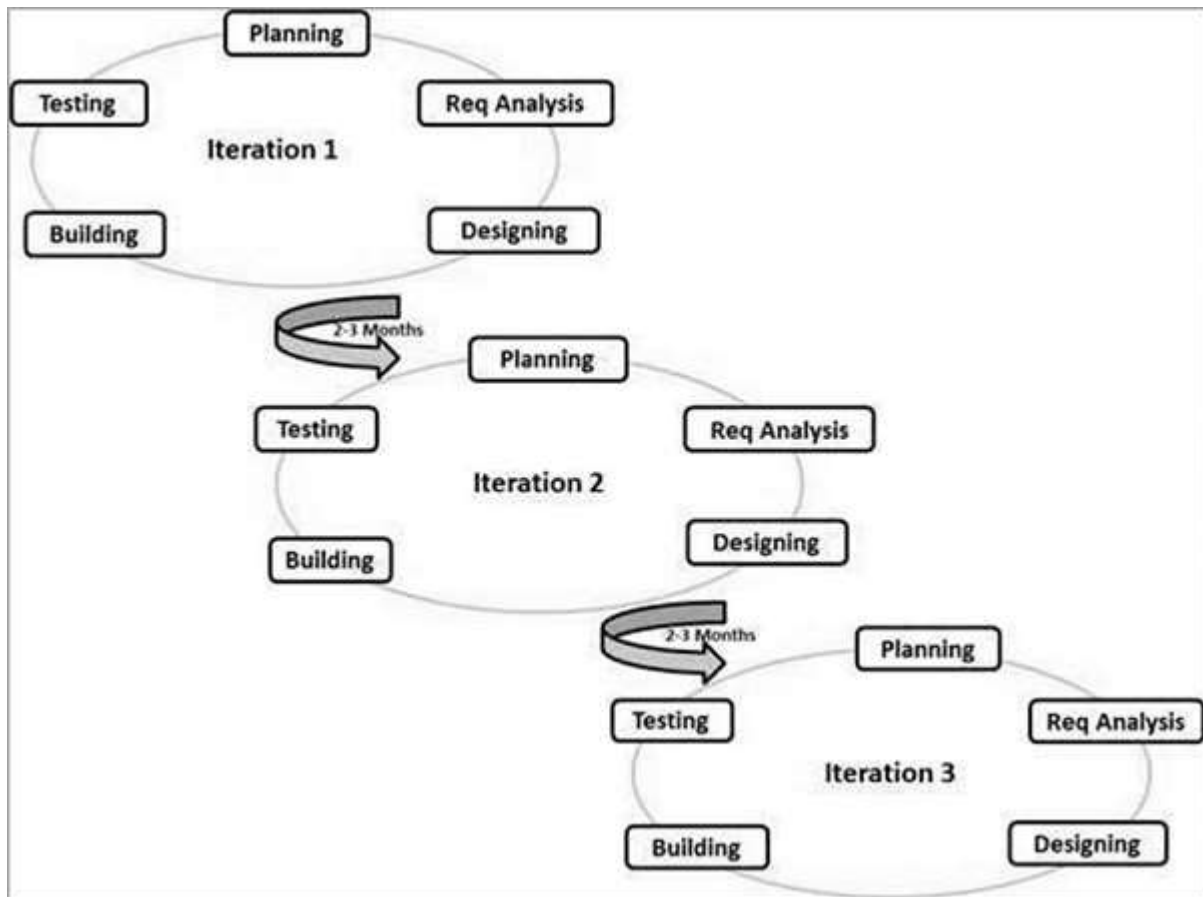


Figure 7: Agile model (SDLC - Agile Model - Tutorialspoint, 2020)

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Results

After collecting and analyzing data and all requirements to build the proposed system, the system was modeled and developed. This section is meant to present the results.

4.1.1 Requirements for the Proposed Mobile-Based System for Loan Management

According to the Institute of Electrical and Electronics Engineers (IEEE) standard 729, a requirement is defined as a condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed documents (Geeks for Geeks, 2021).

(i) Functional Requirements

The functional requirements represent functionalities that the system has to perform. It is what the end-user expects to get from the system.

Table 1: Functional requirements – First part

Requirements	Description
Mobile-based system	The system should be accessible and allow users to request all available services online from any location and at any time using one's smartphone
Apply for loan	The system should allow users to apply for a loan and upload all required documents online without reaching the bank's offices. The applications would be accessed and managed by BGF staff.

Table 2: Functional requirement - Second part

Requirements	Description
Provide feedback and notification	Bank staffs have to be notified whenever a loan request is submitted and on the other side, bank customers have to be able to check for feedback regarding their loan requests.
User profile	Every customer using the system has to create a personal profile in the system and be able to update it when it is necessary.
Equated monthly installment payment	The system should allow BGF staff to update the records on EMI payments and BGF customers would view their status.
Generate reports	The system should be able to generate reports for both BGF staff and customers.
Search option	The system will allow users to search for a given record

(ii) Non-functional requirements

The non-functional requirements are the requirements that are quality constraints that the system has to satisfy. Issues like security, maintainability, reliability, scalability, efficiency, and performance are non-functional requirements.

Table 3: Non-functional requirements

Requirements	Description
Security	The system should be secured and allow only authorized access to the system and data
Reliability and scalability	The system shall provide accurate service and adapt regularly to users' needs and trends.
Simple, available, and easy to use	The system should be accessible anytime and provide services to users in simple and few steps.

4.1.2 System Modeling

System modeling is the process of developing abstract models of a system, with each model presenting a different view or perspective of that system (Central Connecticut State University, 2016). The system modeling represents the proposed system using diagrams and other design models to describe the system's functionalities and interfaces. In this project, unified modeling language (UML) was used to model the system.

The following UML diagrams were used:

(i) Use Case Diagram

The Use case diagram shows the interactions between the system and its environment, also referred to as actors. It represents the system functionalities from the user perspective (Fig. 8).

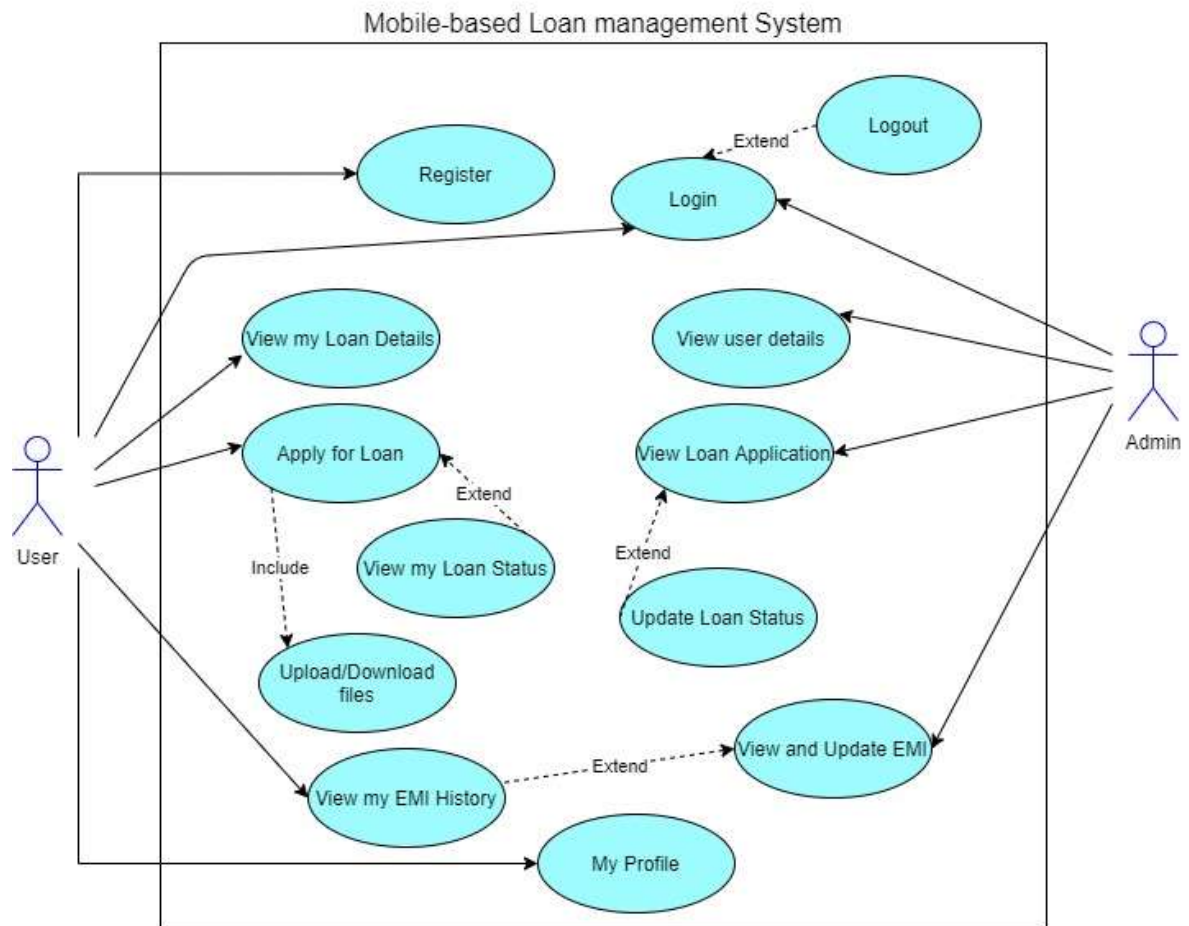


Figure 8: Use case diagram

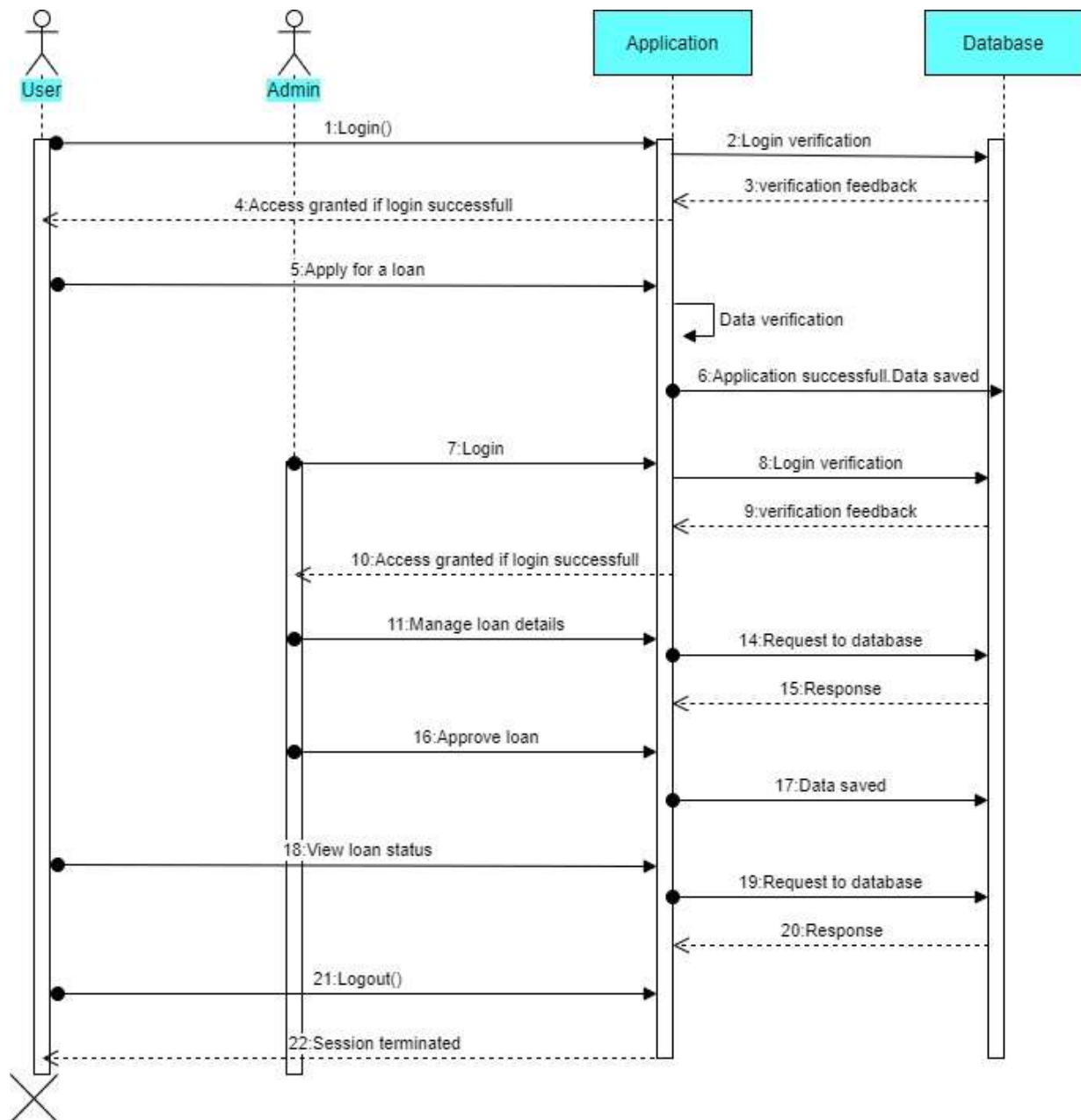
On the other side, the admin is a BGF bank staff who has been appointed to manage loan

applications and has the login credentials to access the admin panel of the application. The main functions of the admin area are to review loan applications submitted by users and to update their status. The admin has also the role of updating the EMI payment history every time a customer makes a payment. Moreover, the admin has also access to all users' details.

(ii) Sequence Diagram

A sequence diagram or system sequence diagram (SSD) shows object interactions arranged in a time sequence. For a particular scenario of a use case, the diagram shows how events generated by objects (the actors interacting with the system) are ordered and processed.

A sequence diagram shows different processes or objects that live simultaneously as parallel vertical lines (lifelines), and, as horizontal arrows, the messages exchanged between them, in the order in which they occur. The main actors of the proposed system are the user and the admin, interacting with the system materialized by two core objects: the application and the database (Fig. 9).



(iii) Data Flow Diagram

A data-flow diagram (DFD) is a way of representing a flow of data through a process or a system (Wikipedia, 2020). Below is the DFD for the proposed loan management system (Fig. 10).

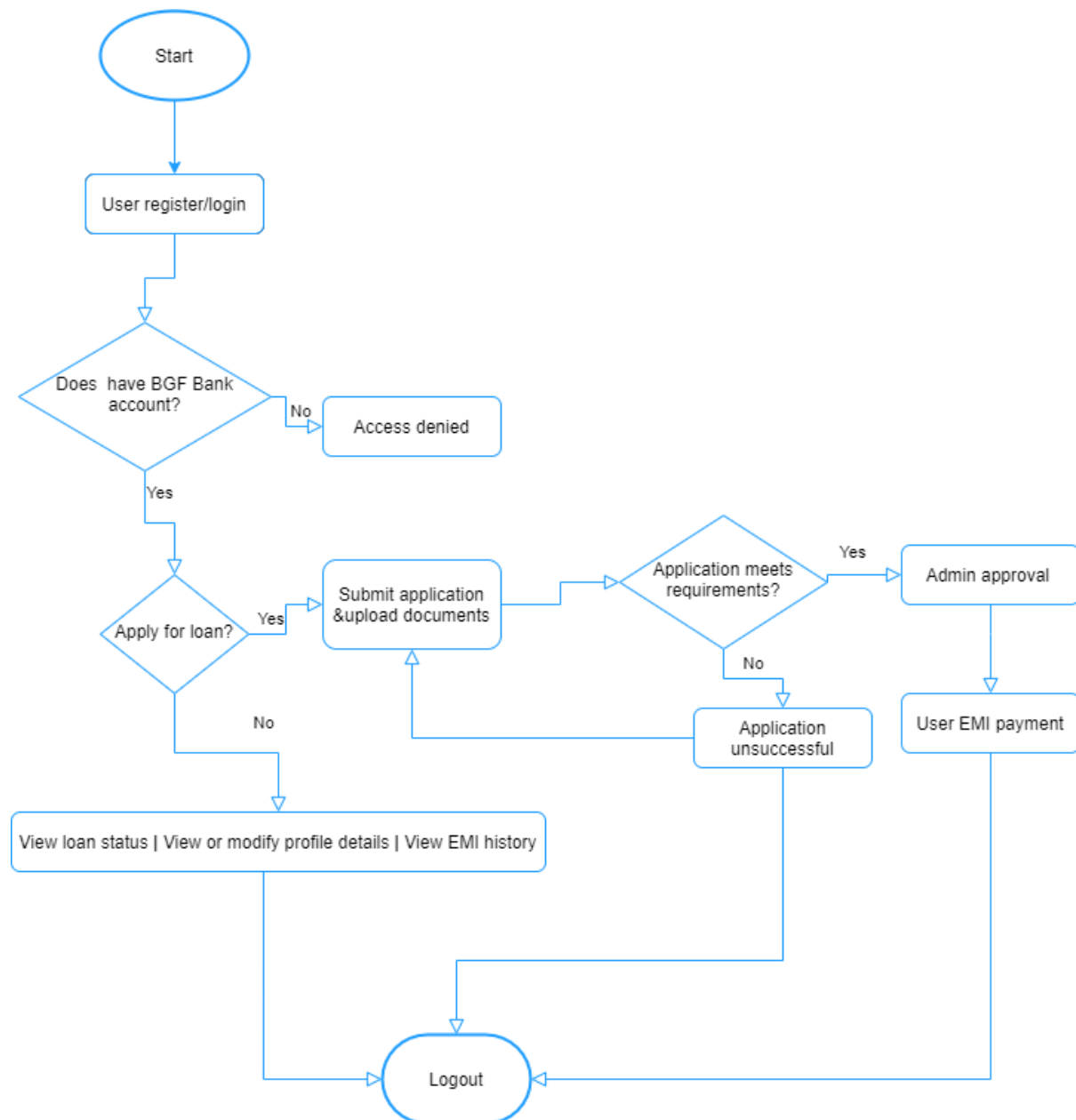


Figure 10: Data flow diagram

4.1.3 System Implementation

The implementation of the system involved designing and building the front-end and back-end which are the two parts of the mobile application. The front-end is what a user sees and interacts with (user interface). The back-end is the part of the application that is hidden from the user (Flyaps, 2020). More specifically, the back-end means the server, the database, and the application that works behind the scene to process and deliver information. The programming languages, software, and hardware components used to implement the system are described in the following subsections:

(i) Hardware Components

The hardware components used for the application are :

- A laptop is used for designing, coding, and building a mobile application. It is the support on which the required software and programming language were installed.
- An android smartphone was used to test the application.

(ii) Front-end

The front end was developed using the following programming languages:

- (a) Android Software Development Kit (SDK) is an SDK that provides the application program interface (API) libraries and developer tools necessary to build, test, and debug apps for Android.
- (b) Java programming language, the official language for Android development. Large parts of Android are written in Java and its APIs are designed to be called primarily from Java.
- (c) Android Studio is the official integrated development environment (IDE) for Android app development, based on IntelliJ IDEA (an IDE written in Java for developing computer software).
- (d) Extensible Markup Language (XML), is a markup language created as a standard way to encode data in internet-based applications. Android applications use XML to create layout files.

- (e) Angular Java Script (commonly referred to as "Angular JS" or "Angular.js"), is an open-source JavaScript framework that is used to build the front-end of web applications. It is maintained mainly by Google and a community of individuals and corporations. It aims to simplify both the development and the testing of the developed applications (Kotaru, 2016).
- (f) HTML, Bootstrap, and CSS were used to make the web app version of the system. The web app was used for testing the prototype on the localhost before hosting the database on the cloud. Hypertext Markup Language (HTML) provides the structure of the page, and Cascading Style Sheets (CSS) is responsible for the design or style of the front-end part, including the layout, visual effects, and background color. Bootstrap is a free and open-source front-end development framework for the creation of websites and web apps.

(iii) Back-end

The back-end was developed using the following tools:

- (a) MySQL Server, one of the most popular relational database management systems (RDBMS) based on structured query language (SQL). Originally an open-source solution, MySQL now is owned by Oracle Corporation. It is used in this project to store and manage data in the database. Its name is a combination of "My", the name of co-founder Michael Widenius's daughter, and "SQL", the abbreviation for structured query language (MySQL, 2020). It is estimated that over 100 million copies of MySQL servers have been downloaded worldwide by individuals, corporate companies, and small-scale organizations (ByteScout, 2019).

MySQL is free and open-source software under the terms of the GNU General Public License and is also available under a variety of proprietary licenses. It provides numerous advanced database functionalities. Google, Yahoo, Facebook, Nokia, Wikipedia, and several famous organizations have employed MySQL for data processing. MySQL's main advantages are that it is cost-effective, open-source, a cross-platform database server, very performant, enables rapid development, and provides continuous updates. Moreover, MySQL server databases are extremely secure and all the data access scenarios are protected via encrypted connections (ByteScout, 2019).

- (b) PHP programming language Hypertext Preprocessor (PHP), a server-side scripting language used to manage dynamic content, databases, session tracking, and even build entire e-commerce sites. It is integrated with some popular databases, including MySQL, PostgreSQL, Oracle, Sybase, Informix, and Microsoft SQL Server. PHP is being widely utilized in developing web applications and become one of the main languages for developers to make new applications (GeeksforGeek, 2021).
- (c) REST API is used to make the android app communicate with the MySQL database. It is a Representational State Transfer (REST) API created using PHP. REST API is a set of rules that define how applications or devices can connect to and communicate with each other. A REST API is an API that conforms to the design principles of the REST, or representational state transfer architectural style (Framework & Tips, 2010).

4.1.4 Database Schema

A database schema is the skeleton structure that represents the logical view of the entire database. It defines how the data is organized in the database and how the relations among them are associated (W3Schools, 2019). It is a relational model of how the tables in the database are structured (Fig. 11).

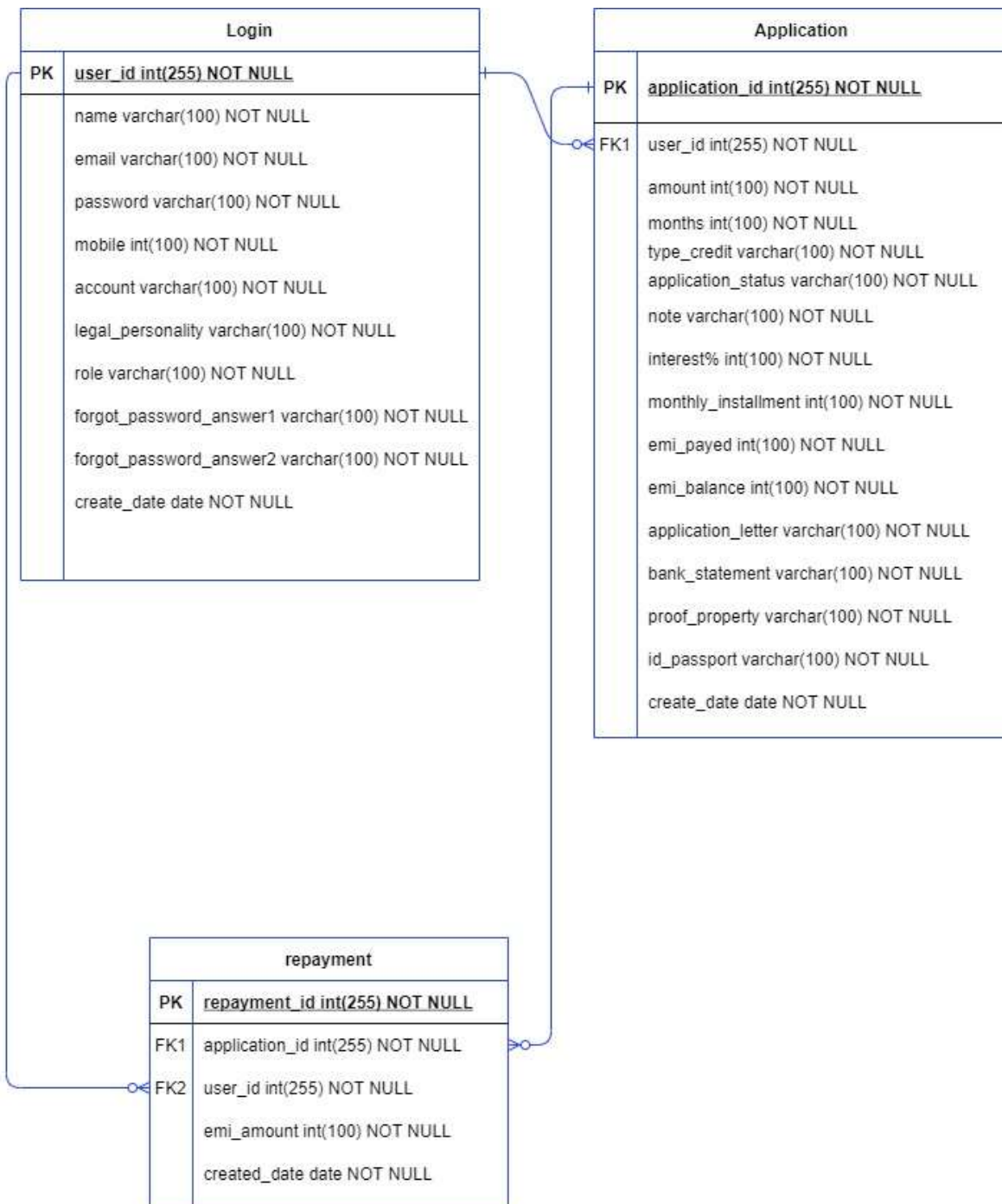


Figure 11: Database schema

4.1.5 System Architecture

An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system (Wikipedia, 2021). The system architecture shows how system components work together to accomplish the task for which the system is built. It primarily concentrates on the internal interfaces among the system's components or subsystems, and on the interfaces between the system and its external environment, which are the user and the admin. Figure 12 shows the planned comprehensive architecture of the proposed system.

The interface between the mobile-based system and the user/admin is the mobile application installed on the user's and/or the admin's android smartphone. When a BGF customer or a BGF staff connects to the system, an API request is sent to the REST API engine which transfers the request to the database (MySQL). The database processes the request and sends data (response to the request) to the REST API engine which transfers this time to the android smartphone of the user/admin.

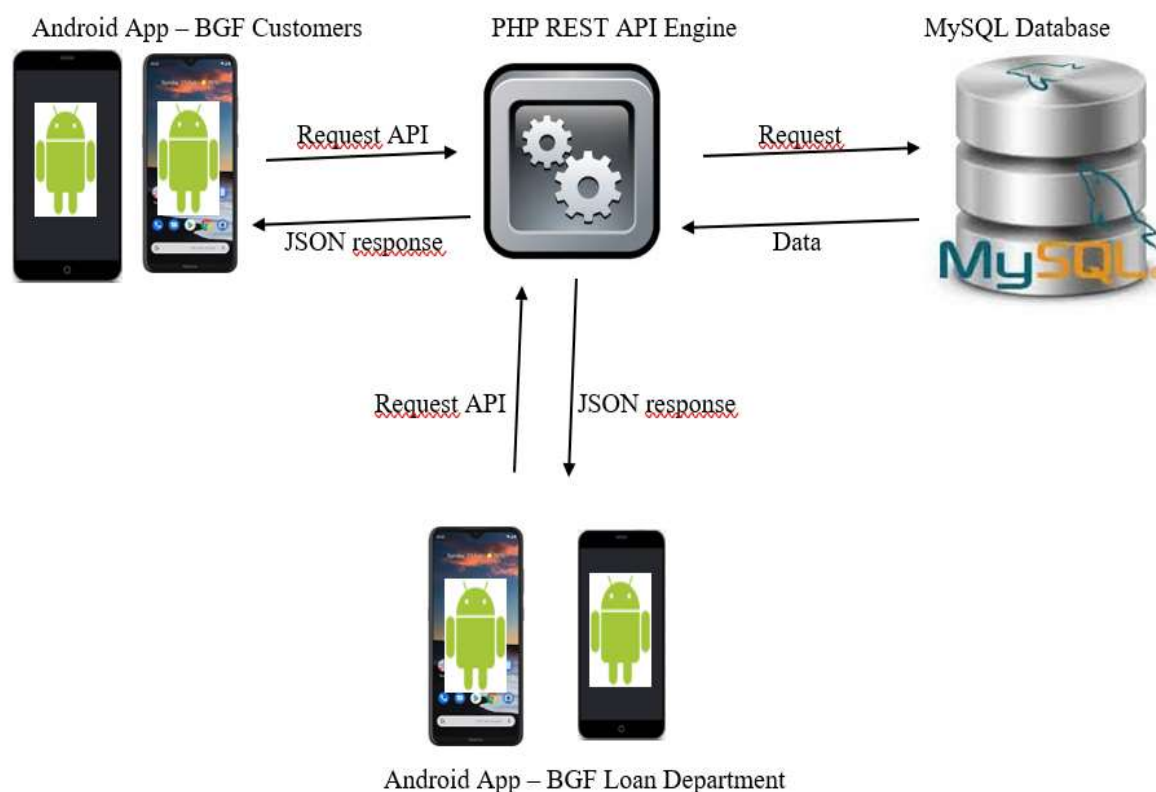


Figure 12: System architecture

4.1.6 System Features

The designed mobile-based system has three main features: registration, client-side, and administration side.

(i) Registration

This is the function that any new user has to access in the first place (Fig. 13). The reason is that you cannot log in to the user dashboard without being registered. For registration, the user is requested to provide the following information:

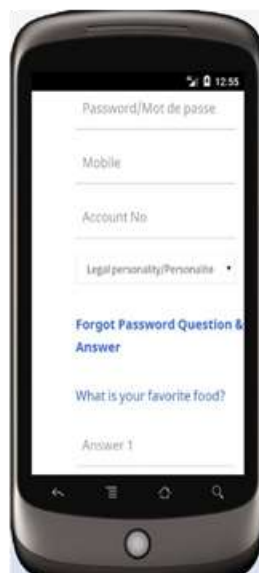
- (a) Name
- (b) Email
- (c) Create a password
- (d) Phone number
- (e) BGF account number
- (f) Set forgot password question and answer



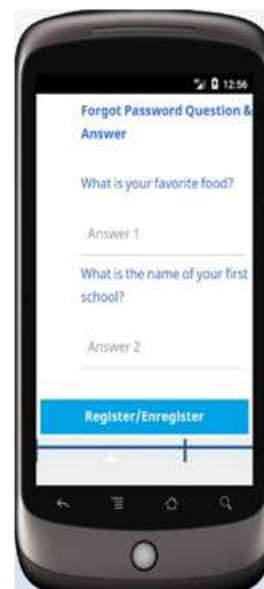
1



2



3



4

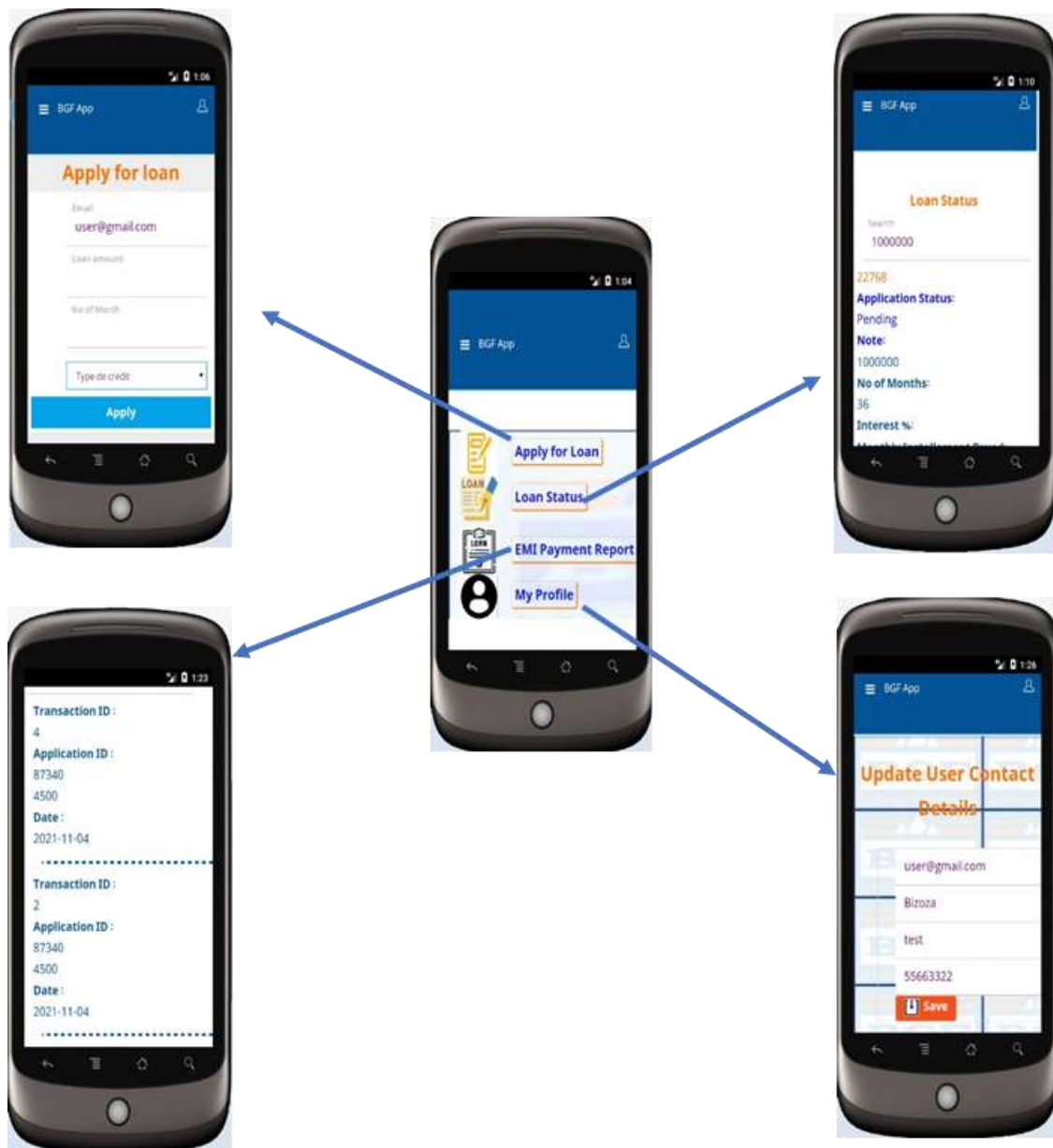
Figure 13: Registration

(ii) Bank customer side

This part of the system helps the customer to interact with the system, whether for applying for a loan, checking loan status and EMI payment, or for reviewing and updating the personal profile (Fig. 14 and Fig. 15).



Figure 14: Bank customer side



4

Figure 15: Customer's dashboard

(iii) Administration Side

This part of the system is exclusively accessed by BGF loan department staff. The system provides access to all loan applications, and all user details for management purposes. Moreover, the system enables BGF staff to regularly update equated monthly installment payments (Fig. 16 and Fig. 17).



Figure 16: Administration side



4

Figure 17: Administration dashboard

4.1.7 Validation and Verification of the System

Verification and validation are the processes of checking that a software system meets specifications and requirements so that it fulfills its intended purpose (Fries, 2012).

System verification is the process to ensure whether the developed product achieves its goal and modules are integrated and respond correctly. Here, the question to answer is: “ Are we building the product, right?”.

System validation is the process to ensure that the developed product is the expected product. Here, the question to answer is: “Are we building the right product?”

(i) Participants in the system verification and validation

The selected participants included all BGF management, BGF staff, and BGF customers. The selection was intended to include all stakeholders of the proposed project.

Responses and comments from five staff working in the credit department, five staff from the ICT department, and 15 BGF customers were collected and considered in the verification and validation process of the proposed system.

(ii) System Verification

The process of verification included the following steps :

- (a) Unit testing was performed on each module of the system, i.e., the loan application module, the user profiles module, and the EMI payment module.
- (b) Integration testing was performed to test each module’s effect on the entire mobile application.
- (c) System testing was performed to check how the entire application was working as a whole. This test was performed by the BGF ICT department.

The test results were successful as indicated in Table 4, Table 5, and Table 6.

Table 4: Unit testing

	Requirement	Description	Test result
Phase 1: Unit testing	Loan application module(user side)	The customer should be able to apply for a loan and upload the required documents	Successful
	Loan application module(administration side)	The administrator should be able to view loan applications, add comments and update status(pending, in progress, approved, rejected)	Successful
	Registration	The customer has to create a personal profile before accessing the system	Successful
	EMI payment	The administrator should be able to update EMI payments and the user should be able to view the updates	Successful
	User management	The customer should be able to update one's profile and the administrator should be able to access all customer profiles	Successful

Table 5: Integration testing

	Requirement	Description	Test result
Phase 2: Integration testing	Loan application management	The customer should be able to check on one's profile the feedback from the system administrator. A change by the administrator on any system module shall have an impact on the data displayed on the customer's interface	Successful

Table 6: System testing

	Requirement	Description	Test result
Phase 3: System testing	Security check before access	User authentication	Successful
	Search option	The system should allow both the customer and the administrator to search for specific records	Successful
	Mobile-based system	The process of applying for a loan should be completed and managed digitally using a smartphone	Successful
	Reports	The system should be able to generate and display reports for both the customer and the administrator	Successful
	System notification	The system should send a notification whenever a new application is submitted	Successful for emails

(iii) Non-functional requirements evaluation

The non-functional testing focused on security, reliability, and scalability and involved the ICT department.

- (a) **Security:** An important challenge of system digitalization is security. Online systems are more exposed to integrity, privacy, and data attacks than manual/traditional systems. For this reason, measures were taken to mitigate potential cyberattacks and other computer crimes:
 - A user needs to have a valid BGF bank account before creating one's profile in the system. The perspective is to connect the proposed mobile-based loan management system with the core banking system so that the bank account number provided by the user during registration may be verified and validated.
 - Once a loan request is approved, the customer needs to reach out physically or send a mandated person to the BGF office for a loan agreement signature. The mandated person shall present a notarized letter of attorney.
- (b) **Resource cost evaluation:** Comparisons were made to evaluate resources needed for a customer to apply for a loan using the traditional way on one side and using the proposed mobile-based application on the other side. Results in Table 7 showed that an average of 50% of the current resources allocated to the loan application process would be saved with the use of the proposed system.

Activity	Traditional system	Proposed system
Number of actors needed for application letter and supporting documents submission	The customer, the receptionist, the archivist, the head of the credit department, the credit analyst. → 5 actors	The customer, the credit analyst and occasionally the head of the credit department (for monitoring reasons). → 2 to 3 actors
Need of physical storing space	Physical storing space needed	No need for physical storing space

Table 7: Resource cost evaluation

- (c) **Time cost evaluation:** An evaluation of the time needed for a bank customer to apply for a loan and get a notification was made. As indicated in Table 8, results from interviews and observation showed that the use of the proposed system saved time for both the customer and the bank employees.

Table 8: Time cost evaluation

Activity	Traditional system	Proposed system
Loan application submission	Need for a customer to reach the bank's office, queue for five to ten minutes, and submit an application to the receptionist. <p>→ Average of three to four hours.</p>	The customer applies online using a mobile application installed on a smartphone <p>→ Average of five minutes.</p>
Application moves from the receptionist to the credit analyst	All loan applications submitted per day are transferred to the loan department in one batch at the end of the day.	Loan applications reach the loan department in real-time just after the customer submits the application through the mobile app.
Credit analyst gives feedback to the customer	The bank staff waits for the customer to come back and inquire about the loan application status.	The bank staff is required to update the loan application status in the proposed system which will automatically be displayed on the customer's profile.

- (d) **Scalability:** the proposed system can be adapted for various local banks and micro finances since loan activities are key functions of financial institutions. The main features are similar. Specific characteristics such as type of loan, and interest rate vary on the financial institution.
- (e) **Simple, available, and ease of use:** The number of steps required for loan application submission is reduced with the proposed system (Table 9). Moreover, the system is online and once it is hosted in the cloud, it will be accessible anytime and from everywhere.

Table 9: Availability and ease of use evaluation

Activity	Traditional system	Proposed system
Number of steps required when a customer applies for a loan	<ul style="list-style-type: none"> - Reach the bank office, - Submit the physical application to reception, - Physical application is transferred to the credit department, - Physical application is transmitted to credit analyst for analysis - The loan application is presented during a meeting with BGF management for approval - The customer comes back to the Bank office for inquiries on the status of the loan application - The credit department employee gives updates to the customer <p>→ 7 steps</p>	<ul style="list-style-type: none"> - The customer submits a loan application through the mobile application - The digital application reaches credit analysts who analyze it - The loan application is presented during a meeting with BGF management for approval - The credit department employee gives updates to the customer through the mobile application. <p>→ 4 steps</p>
Availability	Customers can submit loan applications during working days and working hours: from Monday to Saturday and from 8:00 am to 5:00 pm.	Customers can submit loan applications anytime.

(iv) System Validation: User Acceptance Testing

User Acceptance Testing (UAT) is performed by the end-user to verify/accept the software system before moving the software application to the production environment. This validation testing was performed by selected BGF staff working in the credit and ICT departments. A few customers also accepted to test and give their views on the system. They tested the proposed system which was deployed in a test environment at BGF headquarters.

After testing, participants accepted to answer a short questionnaire (Appendix 4) intended to give a general evaluation of the proposed system regarding its performance, ease of use, and usefulness. The answers were recorded in Table 10:

Table 10: User acceptance results

Questions	Frequency and Percentage of Responses				
	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
The system works according to the requirements	10 (40%)	15 (60%)	-	-	-
System reliability and scalability	13 (52%)	10 (40%)	2 (8%)	-	-
System efficiency	18 (72%)	17 (28%)	-	-	-
System is ease of use	20 (80%)	5 (20%)	-	-	-

4.2 Discussion

A comparison between the time to complete the loan application process using the existing manual system and using the proposed mobile-based system has highlighted the efficiency and enhanced speed of the proposed system. When using the mobile-based system, the process (including application submission, application analysis, and approval or rejection of application) does not require the physical presence of customers. Therefore, there are no queues in the credit department office. The loan processing time and resources get much reduced as the reception of customers one by one is suppressed.

The customer will benefit from the use of the proposed system: the possibility to apply from any location and whenever one wishes. The BGF staff will also benefit from the use of the application: loan applicants' information reaches the loan department digitally with all the advantages of digitalization (automated order of data, data storage in the database, ease of data retrieval for processing). The BGF bank as a whole will benefit from the application which is a new way of managing loans application. The User Acceptance Testing results show interest and appreciation from BGF staff and customers towards the performance, ease

of use, and usefulness of the mobile-based system. The probability of success of the system, once it is launched in BGF bank loan processes, is therefore growing high.

However, for better efficiency of the system, there is a need for a connection between the core banking and the proposed system. This will enable security checking based on the bank account and automatic updates of EMI payments.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The purpose of this project is to propose a mobile system that will enhance loan application process routine tasks and fasten the process for the benefit of both the BGF bank and the customers. Nevertheless, the proposed system does not incorporate the entire loan management process. It focuses on loan origination when a customer applies for a loan and gets notified whether the loan application is rejected or approved. The customer will also be able to check the EMI status once the loan is granted. The flow of information within BGF departments during the loan application analysis is not included in the proposed system. The loan origination process is done completely online, from any location, and at any time using one's smartphone.

Results have shown that the proposed system is useful, easy to use, reliable, scalable, and would contribute to driving a step forward to the BGF Bank's achievement of its vision and mission.

5.2 Recommendations

Security is a key factor for financial institutions. Improving the system's security by incorporating geolocalization and camera features will increase the reliability of the system.

- (i) Geolocalization: this feature will give the exact location of the loan applicant at the time of submitting the loan application.
- (ii) Camera: This feature will take a profile picture of the loan applicant at the moment of applying for a loan.

In addition, the system would be improved in future works by adding the following features and making a more complete loan management system: loan agreement process and automatic EMI payments updates.

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APPENDICES

Appendix 1: Questionnaire used during the interview – page1

A questionnaire was prepared for collecting the requirements for developing the mobile-based system for loan management. It was prepared using Microsoft Word, printed out, and distributed to interviewees for them to fill it manually.

Introductory note from the researcher:

Je m'appelle Armel Bizoza, étudiant en Systèmes embarqués et mobiles à l'Université Nelson Mandela African Institution of Science and Technology à Arusha, en Tanzanie . Je travaille actuellement sur un projet académique qui propose de mettre en place un système mobile de gestion des prêts dédié aux clients BGF et au personnel du service Crédit.

Je vous demande par la présente de remplir le questionnaire ci-dessous et vos réponses clarifieront les exigences et les besoins pour une mise en œuvre réussie du système proposé. Je vous assure d'utiliser les informations fournies à des fins strictement de recherche et de respecter la confidentialité.

My name is Armel Bizoza, a student in Embedded and Mobile Systems at Nelson Mandela African Institution of Science and Technology in Arusha, Tanzania. I am currently working on an academic project that proposes to implement a mobile-based system for loans management dedicated to BGF customers and Credit department staff.

I hereby request you to fill the below questionnaire and your responses will clarify the requirements and needs for a successful implementation of the proposed system. I assure you to strictly use information provided for research purpose and observe confidentiality.

Appendix 2: Questionnaire used during interview – page2

Questions	Answers
Section 1: Background information	
1. Sexe du répondant / <i>Gender of respondent</i>	Male <input type="checkbox"/> Female <input type="checkbox"/>
2. Age du répondant / <i>Age of respondent</i>	Under 35 <input type="checkbox"/> Between 35 and 50 <input type="checkbox"/> <input type="checkbox"/> Above 50
3. Relation avec la banque BGF / <i>Relation with BGF bank</i>	Employee <input type="checkbox"/> Customer <input type="checkbox"/> Other <input type="checkbox"/>
3.1. Si autre, merci de préciser / <i>If other, please specify</i>	
4. Adresse / <i>Address</i>	
Section 2: Existing loan processing system	
1. Êtes-vous satisfait du système de traitement des prêts de BGF ? <i>Are you satisfied with the loan processing system at BGF?</i>	
2. Quels sont les avantages du système de gestion de prêt BGF si vous le comparez à d'autres systèmes de gestion de prêt que vous connaissez ? <i>What are the advantages of BGF loan management system if you compare to other loan management systems you know?</i>	
3. Quels inconvénients voyez-vous du système de gestion de prêt BGF si vous le comparez à d'autres systèmes de gestion de prêt que vous connaissez ? <i>Which disadvantages do you see of BGF loan management system if you compare to other loan management systems you know?</i>	
4. Quelles étapes sont nécessaires pour qu'une personne soumette une demande de prêt ? <i>What steps are needed for someone to submit a loan request?</i>	
5. Comment et quand savez-vous si la demande de prêt a été approuvée ou rejetée ? <i>How and when do you know if the loan request has been approved or rejected?</i>	

Appendix 3: Questionnaire used during interview – page3

Section 3: Expectations and needs from customers and staffs	
1. À votre avis, qu'est-ce qui devrait être modifié dans le système actuel de gestion des prêts de BGF ? <i>What do you think should be changed in the current BGF loan management system?</i>	
2. À votre avis, qu'est-ce qui ne devrait pas être modifié dans le système actuel de gestion des prêts de BGF ? <i>What do you think should not be changed in the current BGF loan management system?</i>	
3. Utilisez-vous régulièrement des smartphones ? <i>Do you use smartphones regularly?</i>	
4. -En tant que client, que ressentiriez-vous si vous pouviez faire une demande de prêt en ligne, sans vous rendre dans les bureaux de la banque ? <i>As a customer, how would it feel if you could apply for loan online, without reaching bank offices?</i> -En tant qu'employé de BGF, quels défis ou avantages voyez-vous si les clients pouvaient demander un prêt en ligne, sans se rendre dans les bureaux de la banque ? <i>As a BGF employee, what challenges or advantages do you see if customers could apply for loan online, without reaching bank offices?</i>	<p>Vous pouvez répondre à l'une ou aux deux questions.. <i>You can answer one or both.</i></p>
Section 4: Impact of the developed system for the bank	
1. Selon vous, un système mobile de gestion des prêts peut-il être une amélioration pour le service crédit et pour l'ensemble de la banque ? 1.1 Si non, veuillez expliquer 1.2 Si oui, quelles fonctionnalités pensez-vous être nécessaires pour que le système soit la solution appropriée pour le processus de demande de prêt BGF ? <i>According to you, can a mobile-based system for loan management be an enhancement for the credit department and for the whole bank?</i> 1.1 If not, please explain 1.2 If yes, what features do you think are necessary for the system to be the suitable solution for BGF loan request process?	

Appendix 4: User acceptance evaluation form

Mobile-based system for loan management: User acceptance testing

➤ Gender/Genre:

➤ Address:

➤ Profession:

Question	Tout à fait d'accord <i>Strongly agree</i>	D'accord <i>Agree</i>	Pas sûr <i>Not sure</i>	Pas d'accord <i>Disagree</i>	Fortement en désaccord <i>Strongly disagree</i>
Vous utilisez régulièrement le smartphone <i>You use smartphone regularly</i>					
Le système fonctionne selon les exigences <i>The system works according to the requirements</i>					
Le système est viable et évolutif <i>System is reliable and scalable</i>					
Le système est efficace <i>System is efficient</i>					
Le système est facile à utiliser <i>System is ease of use</i>					

Appendix 5: Poster Presentation

