2021-10

Mobile application development for university students management system: the case of Pwani University in Kenya

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NM-AIST

http://doi.org/http://doi.org/10.58694/20.500.12479/1573

MOBILE APPLICATION DEVELOPMENT FOR UNIVERSITY STUDENTS MANAGEMENT SYSTEM: THE CASE OF PWANI UNIVERSITY IN KENYA

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A Project Report Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in Embedded and Mobile Systems of the Nelson Mandela African Institution of Science and Technology

Arusha, Tanzania

October, 2021

ABSTRACT

Universities in Kenya have demonstrated a great increase of mobile gadget users to access university-related information. In Pwani University, the Information Management System is currently accessible through a local area network connection on laptops and desktop computers, which are fixed in offices. In addition, the working hours of the office between Monday to Friday limit access to services to many students especially those who are out of the main campus. The objective of this project is to develop a mobile application and integrate it with the existing university Information Management System for improving access and user experience for services to be accessed anytime, anywhere through connected smartphones. An online survey, interviews, and observations to collect the system requirements were gathered and analyzed essential requirements for the design and development of the mobile application. Agile software methodology was used because of its flexibility to accommodate changes. The integration architecture was based on Representational state transfer (RESTful) Application Programming Interface. The System Usability Scale methodology assessed the user's perception and usefulness of the mobile application. The developed mobile app successfully connected with the current system. Unit, integration, and system testing were performed to ensure the intended specifications were met. The key findings from the survey show that smartphones, are the most owned and used mobile devices among students and staff. The majority of students 97% agreed that the justification for developing the app was valid. The study indicated that 68% of students want access to course information, fees balance, and their profile via their mobile gadgets. The usability and acceptance testing were successful with 90% of users liking the app and 80% did not need any assistance to use the app and did not find it cumbersome. Universities can provide seamless services by integrating their current management systems with mobile apps and this research contributes to the knowledge on mobile app design, usability, and acceptance testing.

DECLARATION

I, Amrani Athumani Hassan do hereby declare to the senate of the Nelson Mandela African Institution of Science and Technology that this project report titled "*Mobile Application development for University students management System: The Case of Pwani University in Kenya*" is my original work and that it has neither been submitted nor being currently submitted for degree award in any other institution.

Amrani Athumani Hassan

A.A.H — 15/11/2021

Name and Signature of Candidate — Date

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Name and Signature of Supervisor 1 — Date

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CERTIFICATION

The undersigned certifies that he/she has read and hereby recommend for acceptance by the Nelson Mandela African Institution of Science and Technology a Project report titled "An Integrated Programs Information System for the Inter-University Council for East Africa" in fulfillment of the requirements for the degree of Master of Science in Embedded and Mobile Systems of the Nelson Mandela Institution of Science and Technology.

Dr. Edith Talina Luhanga		25-10-2024
Supervisor (1)	**Signature**	**Date**
Dr. Kisangiri Michael		22/10/2024
Supervisor (2)	**Signature**	**Date**

ACKNOWLEDGEMENTS

Glory be to Allah for the good health, strength, and patience throughout the course. This work is financed by the Centre of Excellence for Information Communication Technology (ICT) in East Africa (CENIT@EA project), funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the German Academic Exchange Service (DAAD), I will be forever grateful for the master's scholarship and funding for the project.

Special thanks to my academic supervisors, Dr. Devotha Nyambo, Dr. Shubi Kaijage, and industrial supervisor Mr. Newton Andebe for their great support, guidance, and advice throughout the research.

Many thanks to Dr. Dina Machuve, Dr. Neema Mduma, Dr. Stefan Wundelich, and Prof. Helmut Faasch, who together taught me the foundations of mobile applications, especially Android programming.

I am grateful to Pwani University management for granting me study leave and approval to conduct an industrial internship and the final project at the institution. My sincere appreciation to the ICT department staff, members of staff, and the students for participating in the project, for their great support and cooperation.

Lastly, to my parents, my wife, and children, for standing with me throughout the course. Their contribution is immeasurable.

DEDICATION

This project report is dedicated to my parents, wife, and children, who kept me going during the entire course.

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LIST OF ABBREVIATIONS AND SYMBOLS

API	Application Programming Interface
APP	Smartphone/Mobile Application
CAK	Communications Authority of Kenya
CASE tools	The Computer-Aided Software Engineering Technologies
COVID-19	Corona Virus Disease of 2019
CRUD	Create, Read, Update, Delete
DFD	Data Flow Diagram
DVC-ARI	Deputy Vice-Chancellor for Academic, Research, and Innovation
ERD	Entity Relationship Diagram
ERP	Enterprise Resource Planning
GSMA	Global System for Mobile Communications
HLT	Higher Learning Institutions
HTTP	Hypertext Transfer Protocol
ICT	Information Communication Technology
IDE	Integrated Development Environment
IMS	Information Management System
iOS	IPhone based operating System
IoT	Internet of Things
ITU	International Telecommunication Union
KENET	Kenya Education Network
Mobile apps	Mobile Application
NAV	Microsoft Dynamics Navision
NM-AIST	Nelson Mandela African Institution of Science and Technology
OS	Operating System
OTP	One Time Password
PDF	Portable Document Format
PHP	Hypertext Preprocessor
PU	Pwani University
PU APP	Pwani University Mobile Application
RAD	Rapid Application Development

RDBMS	Relational Database management System
REST	Representational State Transfer
SDK	Software Development Kit
SDLC	Software Development Life Cycle
SOAP	Simple Object Access Protocol
SQL	Structured Query Language
SRS	Simple Random Sampling
SSL	Secure Sockets Layer
UI	User Interface
UML	Unified Modeling Language
UX	User Experience
WI-FI	Wireless Fidelity
XML	Extensible Mark-up Language

CHAPTER ONE

INTRODUCTION

1.1 Background of the Project

The penetration rate of mobile phones across the African continent is nearly 79% mark, out of which close to 25% of the users use the internet (Wyche *et al*., 2019). Advances in technology have led to more widespread use of mobile technology in education, especially at the university level (Ahmad, 2020; Kaliisa & Picard, 2017). This new reality is forcing universities, both private and public to consider how to integrate phones into educational settings (Aguirre *et al*., 2019). In a study by Ahmed *et al*. (2017) 67% of students were found to be using their smartphones and tablets for academic purposes. Mobile applications (Mobile apps) have a lot of potential for educational use, particularly in university studies (Wai *et al*., 2018). These Mobile apps administer small, separate, and basic features such as sports, office suites, calculators, and file managers (Aggarwal *et al*., 2019). Technologies have taken center stage, especially in education, health, the economy, and commerce (Oyelere *et al*., 2018). When everybody uses the same content, sharing educational resources becomes instantaneous, resulting in immediate input and guidance (Ligi & Raja, 2017). The rising need for Enterprise Resource Planning (ERP) systems to be accessed via mobile devices (mobile ERP) like smartphones, tablet computers, and mobile portable computers has been fueled by the proliferation of mobile devices, ongoing developments in mobile computing (Omar & Gómez, 2017).

Nowadays people have many commitments with movements due to their busy schedules, hence they need to access real-time information on issues relating to their day-to-day life. Students use sophisticated gadgets and portable devices on campus, however, most of the time these devices are not used for learning purposes (Hinze *et al*., 2017). A survey conducted by Kenya Education Network (KENET) found that 53% of the students owned smartphones (Kashorda, 2013). In another study by Ahmed *et al*. (2017) 67% of students were found to be using their smartphones and tablets for academic purposes.

Towards the end of 2019, just over half of the world's population was online, but among teenagers, this figure rises to over 69% (International Telecommunication Union [ITU], 2020). In addition, 477 million people in Sub-Saharan Africa subscribed to mobile services, accounting for 45% of the population. Smartphone use continues to grow rapidly in the region, with the region's total connections were expected to hit 50% by 2020 as cheaper devices become available (Global

System for Mobile Communications [GSMA], 2020a). In Sub-Saharan Africa, the average annual growth rate in smartphone connections has been 28% since 2015, and smartphones now account for almost half of total connections (GSMA, 2020b). All stakeholders in the value chain can be linked thanks to the widespread use of mobile phones in Sub-Saharan Africa (Kabbiri *et al*., 2018).

Smartphone ownership and usage have increased in Kenya. According to the Communications Authority of Kenya (CAK) Kenya's level of mobile penetration continued to be above the African performance levels. Mobile telephony subscriptions in Kenya were recorded as 45.6 million, which represents a 97.8% rate of penetration (Annual Report For the Financial Year 2017-2018, 2018). With 97% of respondents having access to a smartphone in 2018, compared to 49% in 2015, smartphone usage has reached a pinnacle (Nicholas & Silvere, 2019).

1.2 Statement of the Problem

Higher Learning Institutions (HLTs) mainly have student management systems and other independent systems for day-to-day operations. In Pwani University (PU) the Information Management System (IMS) is currently accessible through a local area network connection on laptops and desktop computers, which are fixed in physical offices. In addition, the working hours of the office are between Monday to Friday, 0800 h to 1700 h thus, limiting access to services to many students especially those who are out of campus and or during a major disruption of services i.e. pandemic or natural disasters where physical access to services would be highly disrupted. Therefore, this project proposed to link the existing IMS with a mobile application, to increase access to services from the local area connection to the internet.

1.3 Rationale of the Project

The project designed and developed a Pwani University Mobile Application (PU App) to enable staff, students, community, and other stakeholders, have easy access to resources, services, and communication online. The PU App will be conveniently accessible through the internet compared to the existing local area network access on desktops and laptops. The acquisition cost, portability, and navigation, besides it, saves time and cost. Mobile devices are proving a useful supplement to a desktop computer (Hinze *et al*., 2017). The main advantages of the developed system are as follows:

(i) Students and staff can easily access the Information Management System through their connected smartphones anytime, anywhere.

(ii) Large queues and congestion in offices have been reduced since most of the students prefer the mobile application to a physical office visit.

(iii) Continuity of services during natural calamities or unforeseen disruption of services e.g. during a pandemic

(iv) The use of the online support ticketing system in the mobile app for students seeking assistance on services.

1.4 Project Objectives

1.4.1 General Objective

The main objective of this project is to develop a mobile application for Pwani University for improving access to the student's information management systems.

1.4.2 Specific Objectives

The specific objectives of this project are:

(i) To gather and analyze requirements for the proposed Mobile Application.

(ii) To integrate the current Information Management System's (IMS) Application Programming Interface (API) with the mobile system database for real-time access.

(iii) To deploy the developed mobile application.

(iv) To evaluate the usefulness of the mobile application

1.5 Project Questions

The following research questions will guide the proposed project:

(i) What would be the requirements for the Pwani University mobile application?

(ii) How will the current student management system be integrated with the mobile system's database for real-time access?

(iii) What would be the best approach to deploy the developed mobile application for easy access by students, staff, and the community?

(iv) Will the mobile application be a good alternative for users to access the university's information?

1.6 Significance of the Project

By bridging the gap and combining information systems and mobile apps, the research has made a significant contribution by interfacing between mobile applications and IMS systems for real-time data sharing. Since they can perform most of the functions at the convenience and comfort of their smartphone, anytime, wherever the mobile application can help to reduce long lines of students seeking services from physical offices.

1.7 Delineation of the Project

The study was conducted at PU. The main subjects were the staff and students, who required more access to the IMS. The study will not include the parents, university service providers and members of the public. The limitations of the study are as follows:

(i) Some faculty members are used to hardcopy paper surveys, hence could not fill in through an online platform while some students struggling with poor internet connections, since at the time of the survey students were away from campus.

(ii) Database design integration between the SQLite, MySQL, and Application Programming Interface (API)

(iii) Testing on the IPhone based operating System (iOS) platform was done on an emulator due to resource constraints it could not be done on a real device.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter contains reviews of relevant works on mobile apps for accessing information and resources from universities and other higher education institutions. The research gap has also been discussed. Over the last two decades, the rapid advancement of mobile technology has resulted in new design contexts and practices. People, architecture, and organizations all play a role in the successful incorporation of mobile technology into educational practices (Al-Said, 2020). On the other hand, because of the increasingly growing smartphone ownership by young generations and the benefits of teaching and learning, mobile devices have a very high potential for use in educational settings. High-bandwidth Internet connectivity allows for instant access to vast volumes of data and real-time communication regardless of location. As a result of these capabilities, there are a plethora of new ways to use such devices for educational purposes (Yunus, 2017).

2.2 Related Work

The work in Ahmed *et al*. (2017) discusses the creation of a mobile application using the Android programming language. The Android and Web-based College Management System made it easier for users to add and retrieve information quickly. Users could open the application; all of the schedules and events are shown clearly and concisely on the front end. There are five distinct categories of consumers: the college's student, parent, teacher, higher authorities, and administrator. The administrator is the master user, and he has the most preferences of all users. In the case of an administrator, the various roles include updating college information, permits, events, and so on. The administrator has access to all of the documents and may accept or disapprove them.

The creation of a mobile application for the Anadolu University campus app enables students and faculty staff to use their smartphones to access campus resources is discussed in Yilmazel and Ekin (2015). The new service allows any iOS or Android client to link to the University core services. A mega university's smartphone apps to assist on-campus and off-campus students. Students now hope to be able to communicate freely with their educational institutions. The app was quickly embraced by students, and the app's user community demanded new features.

The mobile application for alumni of Soegijapranata Catholic University was developed and after graduation, the application was used to stay in touch with the university (Mulianawati *et al*., 2020). The mobile application used a smartphone to connect alumni and universities by sharing job openings and offering some university services.

The mobile application for students' information systems, proposes a mobile app architecture that reuses resources from current student information systems in educational institutions (Taneja, 2015). To retrieve data from the data store, web services were developed. Data from web services is shown on appropriate displays.

In another work whereby the app was developed to create guidance and counseling for educational institutions in response to the need for disturbed students in an institution and counselors to provide an online forum where they can effectively collaborate on issues facing the students at any given moment, even though they are far apart (Ukaoha *et al*., 2020). Since the counselor can be reached at any time and the student's progress can be tracked, the advice and therapy system are designed using genetic algorithm techniques. This increases the consistency of counseling services provided.

2.3 Overview of the Existing System

Enterprise Resource Planning systems establish an interactive environment that aids in the management and analysis of internal business operations related to the creation of commodities, such as inventory control, order processing, and accounting (Scurtu & Lupu, 2016). To be competitive, businesses must link the data provided by each department into a single entity. To boost efficiency, there is a great requirement for a continuous flow of data inside and across functional units (Menon, 2019). Many software modules make up Enterprise Resource Planning (ERP) software. Each ERP software module represents a major organizational function. A greater understanding of the components and functions of ERP modules will aid in the selection of appropriate ERP functions that match the needs and requirements of the organization (Khaleel *et al*., 2016). Microsoft Dynamics Navision (NAV) is an ERP system that was created primarily for businesses and has been widely used around the world (Kini & Basaviah, 2013).

2.3.2 Conceptual Framework

The current system in PU is the ISM which runs on the NAV 2018. It is deployed on the client-server architecture model, where the core system runs on the main server which is located in the server room, the users access the system through a local area network on their laptops and desktops

computers. The current NAV system has many modules which have been expanded over time based on the business processes and requirements of PU. The ISM serves both the students and staff. The students access services such as online application, student profile management, semester registration, course registration, examination card, and examination results. In addition, they can check the balance of their fees and get fees statements. As for the staff, the services, include payslip and annual leave application. It should be noted that the services from the ISM are obtained from different departments located in various locations of the PU main campus. Therefore, the students and or staff must visit the physical office to get the required service. The app's layout is depicted in the conceptual design. From the study findings, the main challenge was the accessibility of the existing system by students and staff. The PU App will integrate with the existing student management systems for ease and convenience of access to PU services as shown in Fig. 1.

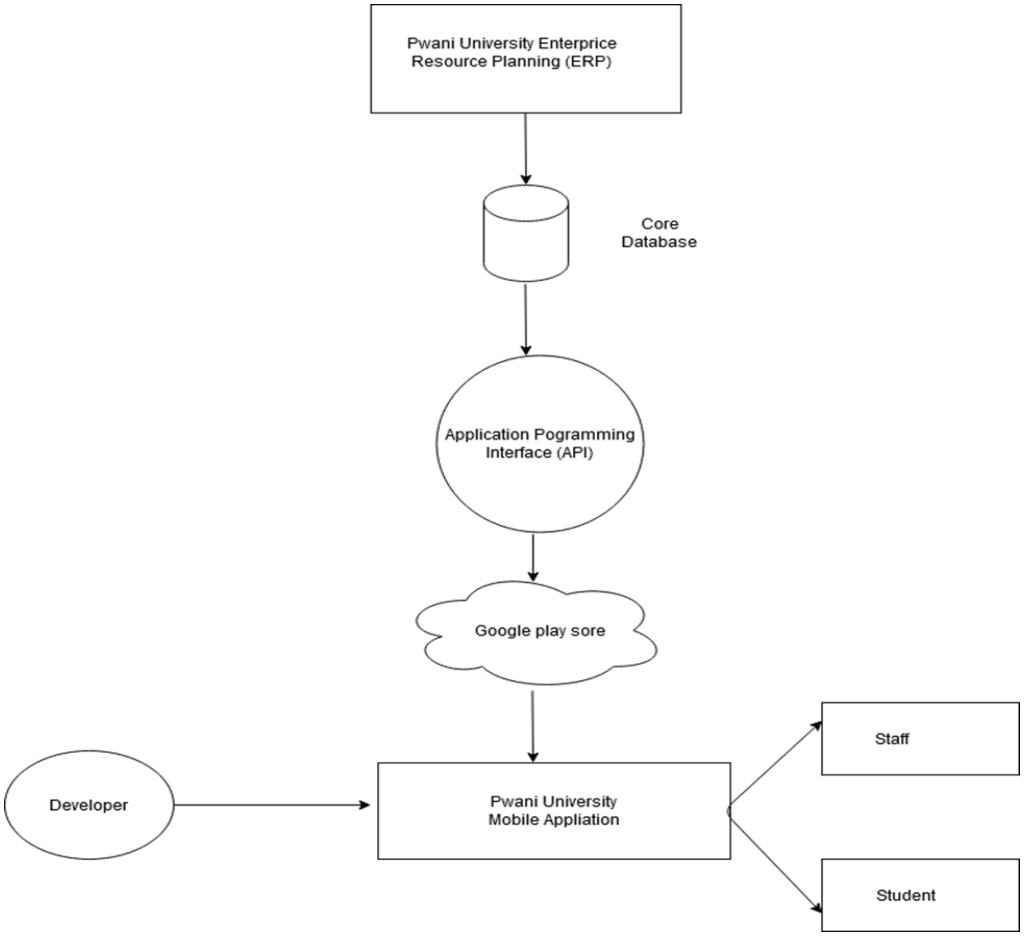

Figure 1: Conceptual framework for the mobile application

2.3.3 Security of the Existing System

The security of the ISM consists of the following:

(i) Corporate Antivirus software

(ii) Firewall security

(iii) User levels from the Super administrator, administrator to a user. Each of the levels has its rights and security privileges

(iv) Network security through Secure Sockets Layer (SSL)

2.3.4 Challenges of the Existing System

The challenges of the existing system are highlighted below:

(i) The system is accessible from physical offices since it is connected through the local area network connection, this means one has to be physically on campus to access the services, which is inconvenient, especially for students out of the main campus.

(ii) The normal working hours in the office are Monday to Friday from 0800 h to 1700 h, thus, the limitation on time for accessibility of services.

2.4 Research Gap

The developed mobile applications in the previous works were largely based on a native app model stand-alone mobile application, which hosted their resources as one full system compared to the proposed solution, which integrates the IMS and mobile application too. The proposed PU App will link directly with the IMS system, API for real-time access of essential services to both staff and students, and link other student portals to the mobile application for services such as checking fees balance, semester registration, accessing the student's profiles among others.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Introduction

The materials and methods used in this study, as well as the proposed solution's implementation methodology, are discussed in this chapter. This Chapter covers the research case study, sampling methods, data collection and analysis procedures, requirements analysis, and architectural design. This chapter also delves into the implementation details of the mobile application. This study's general approach involved a survey based on literature review, data collection (interviews, observation, and a questionnaire), for requirements gathering, system design, implementation, and validation. Agile software development approach was used to build the PU App. The survey aimed to learn more about the mobile app development process, specifically the issues and challenges that arise when linking the mobile app's inbuilt database to the student's information management system.

3.2 Research Case Study Area

One of the most critical sections of the first objective of the analysis was to understand and address research questions such as "What would be the criteria for the PU Mobile Application?" "How will the new student management system be combined with the mobile system's database for real-time access?" and "How will the current student management system be integrated with the mobile system's database for real-time access?" The case study's findings helped to shape the criteria for the PU App's growth. The research was carried out at Kenya's PU. It was selected as a study area because of its strategic location in town, it is having a strong on-campus wife internet connection from two fiber optic cable connections, with high availability of service. While the university has students from all around the world, Kenyan students make up the majority of the student body. As a result, it reflects the dynamics found at any ordinary Kenyan university.

Pwani University arose from the former Kilifi Institute of Agriculture, which was upgraded to a Constituent College of Kenyatta University on August 23, 2007. On the 31st January, 2013, PU became a chartered university. It is located in Kilifi County, about 60 kilometers north of Mombasa and adjacent to the Indian Ocean, in the scenic resort town of Kilifi. Pwani University's position helps to empower the city, inspiring many to seek higher education (International Association of Universities, 2019).

3.3 Sampling Technique

During the quantitative method, Simple Random Sampling (SRS) was applied, since it is the simplest and most frequent technique of picking a sample, in which the sample is drawn unit by unit with an equal chance of being selected at each draw (Singh, 2003). To ensure that each population has an equal probability of being chosen, a simple random sampling technique was used (Kendall *et al*., 1992). If each unit in the population is treated as equally important by simple random sampling, it seems to sense that each unit would be sampled with equal probability (Berger & Zhang, 2005). The SRS will be used to obtain the samples for the questionnaire for both staff and students. As for the qualitative methods of interview and observation, purposive sampling was applied. In a qualitative study, a purposefully selected sample of a limited number of people may be used (Miles & Huberman, 1994). Participants are individuals with the most in-depth knowledge and expertise of the phenomenon under investigation (Campbell *et al*., 2020).

3.4 Sample Size

The sample sizes for the quantitative survey were calculated using a simplified formula (Joskow, 1965). This formula was chosen because it is commonly used in statistics to calculate sample sizes. The formula is as listed in Appendix 4.

Where;

n = sample size to be calculated,

N = population size = 8,500

e = acceptance sample error (margin of error) = 5%

The sample size was found to be 368.

3.5 Data Collection Methods and Tools

Questionnaires were used to obtain data in the quantitative method while interviews and observation were used to obtain qualitative data for the analysis. Data were collected for two months in 2021, from January to February 2021.

3.5.1 Questionnaire

Structured questionnaires were issued to both the staff and students according to the research objectives. The research adopted the google form as an online survey tool. These solutions, which require the use of technology, may be able to help students cross the educational gap during this unprecedented situation (Sabry *et al*., 2020). The steps in creating the survey form were as

described by Sari *et al*. (2020) and due to the adherence to the students' characteristics in this period, who were all technologically literate, google forms were also deemed appropriate for students. According to Cho (2018) with google forms, someone can create online surveys, respond to them, collect feedback, and then view and evaluate the results. Bar graphs or pie charts can be used to visualize the responses obtained through google forms. The google form questionnaire was used due to compliance with government directives on control of Corona Virus Disease of 2019 (COVID-19) pandemic, which required limitation on physical interactions, and as at the time of the survey, many students were out of campus. Emails and social media sites were used to distribute the online questionnaire to PU's various colleges, departments, and sections. For the questionnaire, kindly refer to Appendix 2. The results of the survey have been reported in Chapter 4.

3.5.2 Interview

Interviews are a type of fact-gathering technique in which a system analyst collects information from people in person (Whitten *et al*., 2001). Interviews are usually performed one-on-one. Multiple people may be interviewed at the same time due to time constraints (Dennis *et al*., 2015). Interviews were conducted with staff, students, and members of the Information Communication Technology (ICT) department to gather their views, opinions, and suggestions. In this study, the interviews were mainly targeted at collecting technical requirements from the technical personnel. For the interview guide, see Appendix 3.

3.5.3 Observation

To learn about a system, a systems analyst either participates in or observes an individual performing activities, a technique often used to validate data or when the users cannot provide clear explanations about the system due to complexity (Whitten *et al*., 2001).In the study area, observation was conducted especially during current systems performance. The key activities that were observed include; users while interacting with the systems, queues of students and staff were observed when they were seeking various services in different offices, especially from the ICT department. In addition, the Wi-Fi hot spot areas provided the opportunity to observe the type of devices the students were using to browse the internet, the duration they were taking while browsing the internet.

3.6 Data Analysis Method

The survey data from the questionnaire were analyzed using google forms' built-in functions for translating collected data into useful information through charts, graphs, and tables. As for the qualitative data that was collected from interviews and observations, the interview transcripts and observation field notes were analyzed by textual analysis.

3.7 System Development Methodology

A system development strategy is a collection of activities, procedures, best practices, deliverables, and automated resources that system developers and project managers can use to create and maintain the majority of information systems and applications (Whitten *et al*., 2001). The proposed methodology for the project has been adopted from the "Mobile Application Development Best Practices" model presented by Flora *et al*. (2014b) as shown in Table 1. Every iteration of the Agile Development technique is a full software project, including planning, requirements analysis, design, coding, testing, and documentation (Dennis *et al*., 2009). Agile development is a form of iterative development. The program is built-in incremental, rapid cycles and it is released in tiny, gradual increments that build on previous features. Each release is double-checked to ensure that the highest level of software quality is preserved (Semertzidis, 2013). The key benefits are that working software is provided daily, and even last-minute adjustments in specifications are accepted.

Table 1: Summary of Agile software methodology

Phase	Sub-phase	Activities
1. Envision	Analysis	Problem identification, goal, purpose
	Planning	Objectives, mobile technology
2. Solution	Design	Specifications, user interface, architecture
	Development	Coding, database, API's, libraries, plugins
3. Quality Assurance	Testing	Test classes, automated, real devices
	Change	Bug fixes, user acceptance
4. Product Release	Deployment	Google app store
	Support and maintenance	Bug fixes, improvements, upgrades, new features, and functionalities

Flora *et al*. (2014a)

3.8 Requirements Specifications

The process of writing down user and device specifications in a requirements document is known as a requirements specification. The user and device specifications should preferably be straightforward, unambiguous, simple to comprehend, detailed, and consistent (Sommerville, 2011). The identified system functional and non-functional requirements are shown in Table 2 and 3 respectively.

3.9 Mobile Application Implementation

This stage entailed the system's creation through the generation of actual system code. During this point, the mobile app was developed, which included the main specifications as well as user interfaces. Android Studio, JAVA, and Extensible Markup Language (XML) were used to build the mobile application. The user interface of the application was designed using Extensible Markup Language, and the application's functionalities were implemented using the JAVA programming language.

The PU mobile application was created for this project to allow users to access resources from the university's core student management system. The framework included a smartphone application as well as a restful API for interacting with the current student management system.

3.10 Tools and Techniques

The mobile application was created using the tools and techniques mentioned below:

(i) Flutter

Flutter is a Google App that lets programmers write a single code base that runs on both Android and iOS and has native performance and functionality. Android and iOS mobile apps must be developed separately without flutter, with Android development using Java and iOS development using Objective-C or Swift programming languages (Zammetti, 2019). Flutter is built on the Dart Programming Language, which was also developed by Google. Without the need for two different applications, the Flutter framework was used to build a mobile application that could run on both Android and iOS platforms. This was achieved to support a broader variety of mobile device platforms and thereby increase the number of potential end-users (Mrema, 2020).

(ii) Dart Programming Language

Dart is a Google-Developed Object-oriented Programming Language that was released in 2011. It's also a general-purpose programming language, similar to Python, that's used to create web, mobile, and IoT applications, to name a few. The Flutter system uses this programming language to build cross-platform mobile applications (Zammetti, 2019).

(iii) Extensible Markup Language and JAVA

The android layout operations, which are the key source of interaction between the mobile application interface and user inputs, were created using XML while the Java programming language was used to code the mobile application's functionalities, which included linking activities via intents, executing commands, and maintaining key configurations in the android manifest file.

(iv) Android Studio

The android layout operations, which are the key source of interaction between the mobile application interface and user inputs, were created using XML. The Java programming language

was used to code the mobile application's functionalities, which included linking activities via intents, scroll view container, recycler view to enable views of User Interface (UI) in different devices of different sizes, executing commands, and maintaining key configurations in the android manifest file.

(v) Android SQLite Database

The SQLite database is inbuilt by default in an android mobile operating system. It is an open-source C library that implements a lightweight, serverless, zero-configuration transactional Structured Query Language-Relational Database management System (SQL-RDBMS) for devices with limited hardware capabilities. It's also known as a "lighter" version of SQL, and it's supported by the majority of popular programming languages (Obradovic *et al*., 2019). The SQLite Database is the SQLite database's key class. This class contains methods for opening and closing database connections, as well as performing Create, Read, Update, Delete (CRUD) operations. It also includes the execSQL () process, which is needed to directly execute a SQL sentence (Musleh *et al*., 2018). In the PU mobile application, a local database using SQLite was created to interface with the MySQL main database of the server in the student's management system.
Other additional libraries and plugins used:

(i) Room persistence Library – an abstraction layer over SQLite

(ii) Retrofit Library – Network request, type-safe Hypertext Transfer Protocol (HTTP) client for android and java

(iii) Laravel (Hypertext Preprocessor (PHP) API Framework) – the interface between data and client (webserver and mobile client)

(iv) Plugins – flow-flow – WordPress social stream plugin

(v) WebView – it is an extension of Android's View class that display web pages as part of the activity layout

(vi) JavaScript and download listener.

(vii) Android SQLite SQLiteOpenHelper

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Results

4.1.1 Results for Requirements Gathering and Analysis

This chapter presents the results of the requirements gathering and analysis, where functional and non-functional requirements are extracted. The system design results are also discussed. In addition, the developed mobile application is presented with the results of the testing and acceptance. This section presents the results for both qualitative and quantitative methods. The questionnaire was made from google forms, which under the COVID-19 pandemic circumstances was ideal to reach as many respondents as possible. Furthermore, it has inbuilt data analysis functions that process the data into meaningful information by use of charts and graphs. The population size was 8500 including both staff and students with a sample size of 368. The survey was completed by 385 respondents. Purposive sampling was used for the interview and observation. The findings are presented below.

(i) Occupation of the Respondents

The occupation of respondents in the university is represented in Fig. 2. It was observed that more students visited offices to seek services than the members of staff.

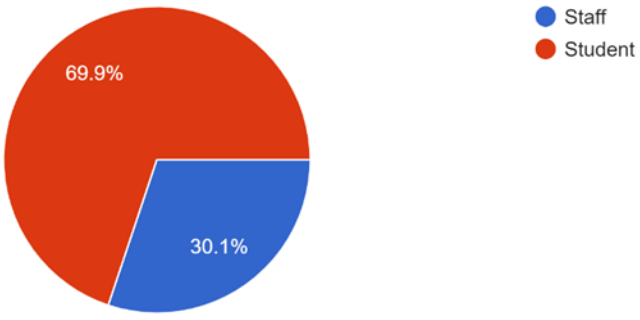

Figure 2: Pie chart represents occupation of respondents

Gender

The distribution of the gender of the respondents is shown in Fig. 3. In the Wi-Fi hotspots areas, it was observed that there were more male students than females.

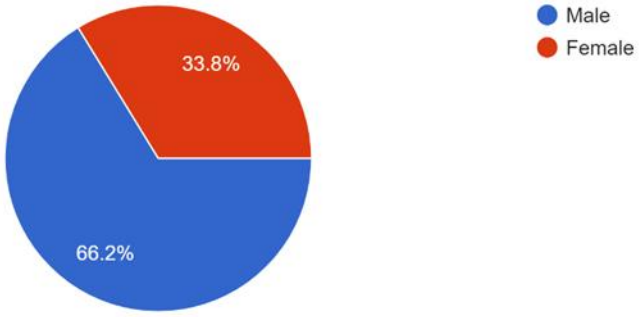

Figure 3: Pie chart represents gender

Device Ownership

The survey shows that 97% of the respondents owned smartphones, and 39% own laptops as can be seen in Fig. 4. The aim was to check the prospective users of the proposed mobile app. During the interview, many students owned smartphones and very few were on laptops due to cost factors. In addition, in the Wi-Fi hotspot areas on campus, it was observed that students were browsing through their smartphones.

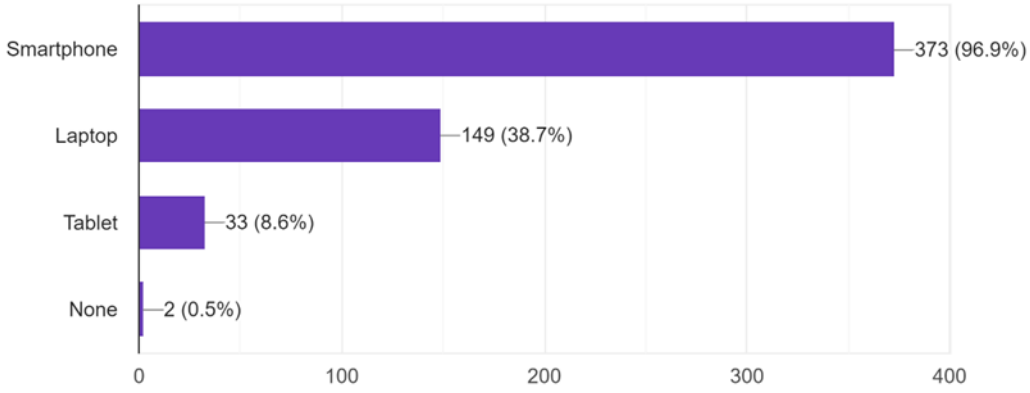

Figure 4: Graph of device ownership

Most Frequently Used Device

For the respondents who owned more than one device, they were further asked on their most frequent device, of which almost 66% were frequently using their smartphones, with almost 29% on laptops as can be seen in Fig. 5. This indicated the frequent usage of smartphones more than the other devices.

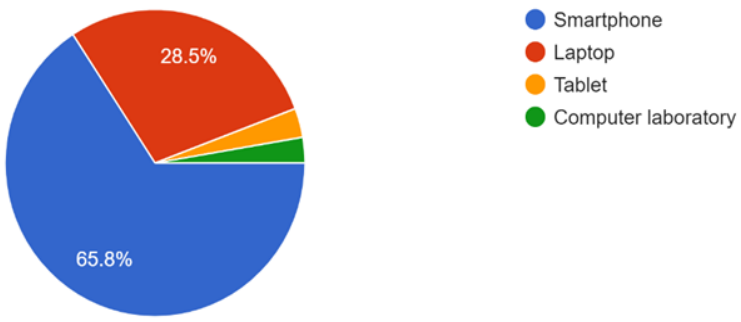

Figure 5: Pie chart for frequently used device

Operating System

Of the respondents who owned smartphones in Fig. 4, 96% were on the android platform, while 2% were on the iOS platform as results show in Fig. 6. Thus, Android is the ideal platform for mobile applications. From the interview analysis, all the smartphones were on the android operating system.

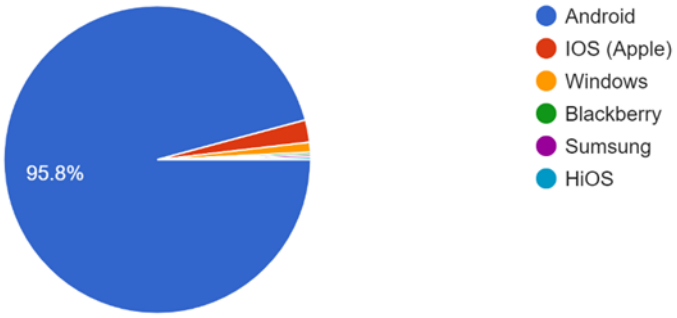

Figure 6: Pie chart represents the mobile platforms

Frequency of Smartphone Usage

Figure 7 depicts the use of smartphones with 52% using their smartphones continuously while 47% use several times a day. This indicates the potential of the proposed mobile application with the user expected to interact more with the application.

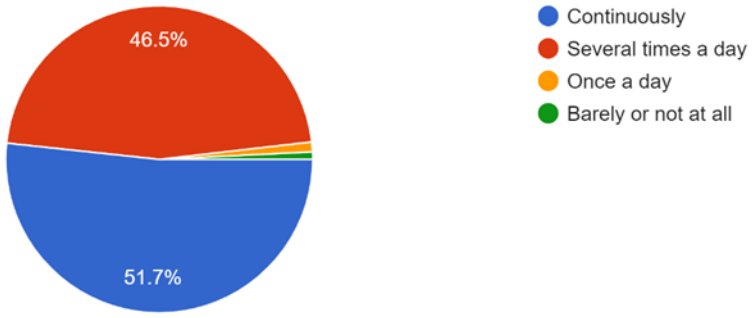

Figure 7: Pie chart shows the frequency of smartphone usage

Mobile Applications Usage

Even though 87% of the respondents were on social media, 59% were using educational apps, and 37% on YouTube, the mobile applications could be used concurrently as shown in Fig. 8. From the observations, many students were streaming on YouTube and other social media apps.

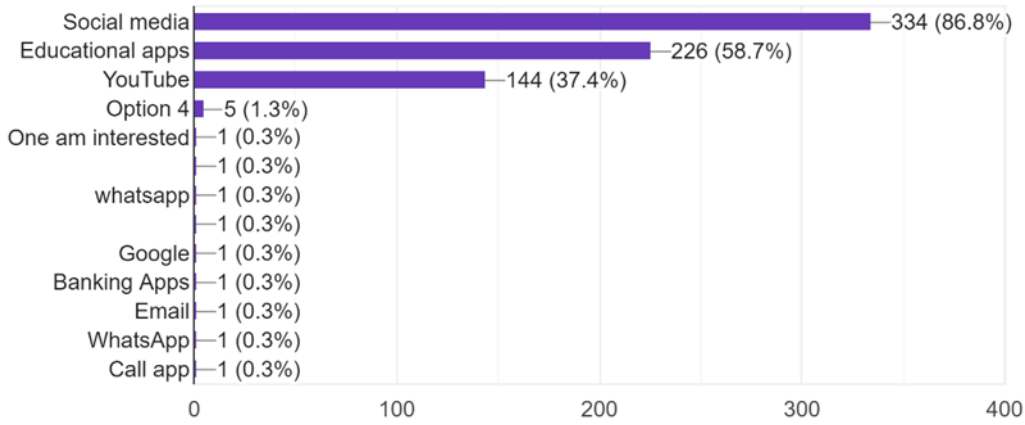

Figure 8: Graph shows mobile application usage

Justification for the Mobile Application

When respondents were asked whether they needed a mobile application to access PU services, an overwhelming majority, 97.1% responded positively as shown in Fig. 9. This is one of the justifications for the development of the PU Application.

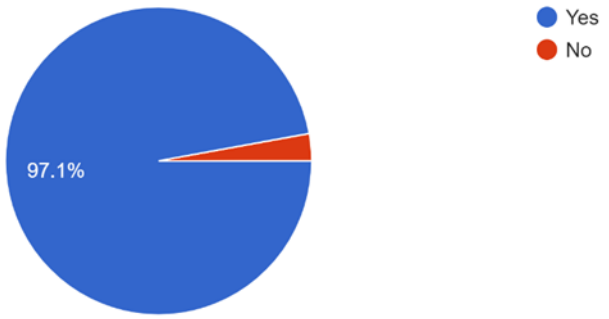

Figure 9: Pie chart shows justification for the app.

Pwani University Mobile Application Expected Content

The respondents were asked to select the mobile content of the PU App and the results were as shown in Fig. 10; these results were corroborated by the interview results, many students would like to access their profile information, course information, and exam results among others.

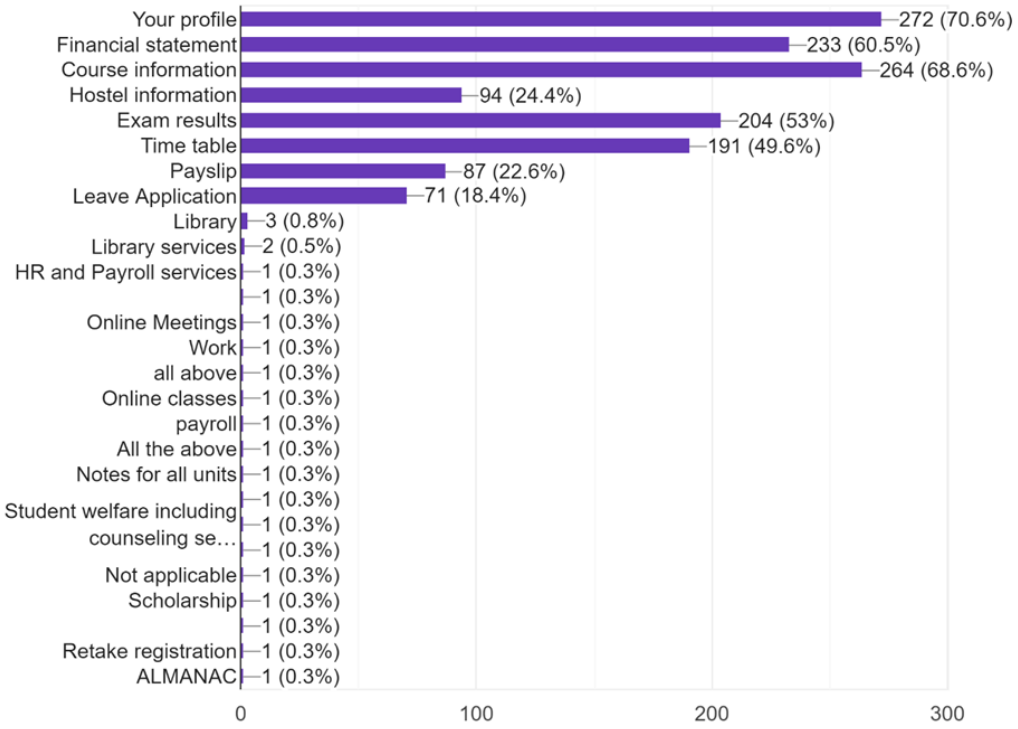

Figure 10: Graph shows expected services

Smartphone Internet Connectivity

The respondents connected through the internet mostly through the campus Wi-Fi and mobile data as shown in Fig. 11. The students and staff were connected to the internet through the on-campus

Wi-Fi and data while out of campus, this was found in the interview analysis. Also, students prefer the on-campus more to mobile data due to budgetary constraints.

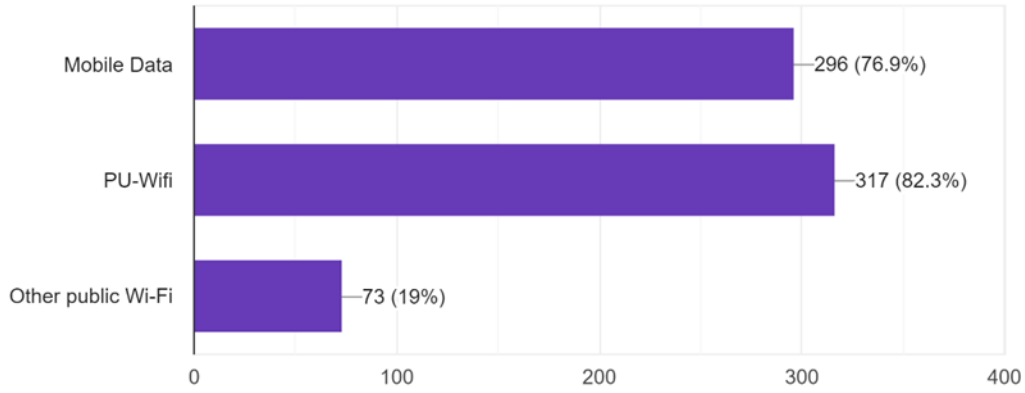

Figure 11: Graph shows smartphone internet connectivity

4.1.2 Results for system design and Information Management System mobile Application Integration

The design process determines the system's hardware, software, and network connectivity, as well as the user interface, types, and reports that will be used, as well as the particular programs, databases, and files that will be required (Dennis *et al*., 2009). The design phase aims to transform the business requirements statement from the requirements review phase into construction design specifications (Whitten *et al*., 2001). The developed mobile application has two main modules the existing student's management system and the inbuilt mobile application database and the user interface.

(i) Use Case Modeling

The Computer-Aided Software Engineering technologies (CASE tools), which are software programs that automate or assist in the development, review, and conversion of system models into application programs (Whitten *et al*., 2001). Figure 12 shows the use case diagram for the mobile application.

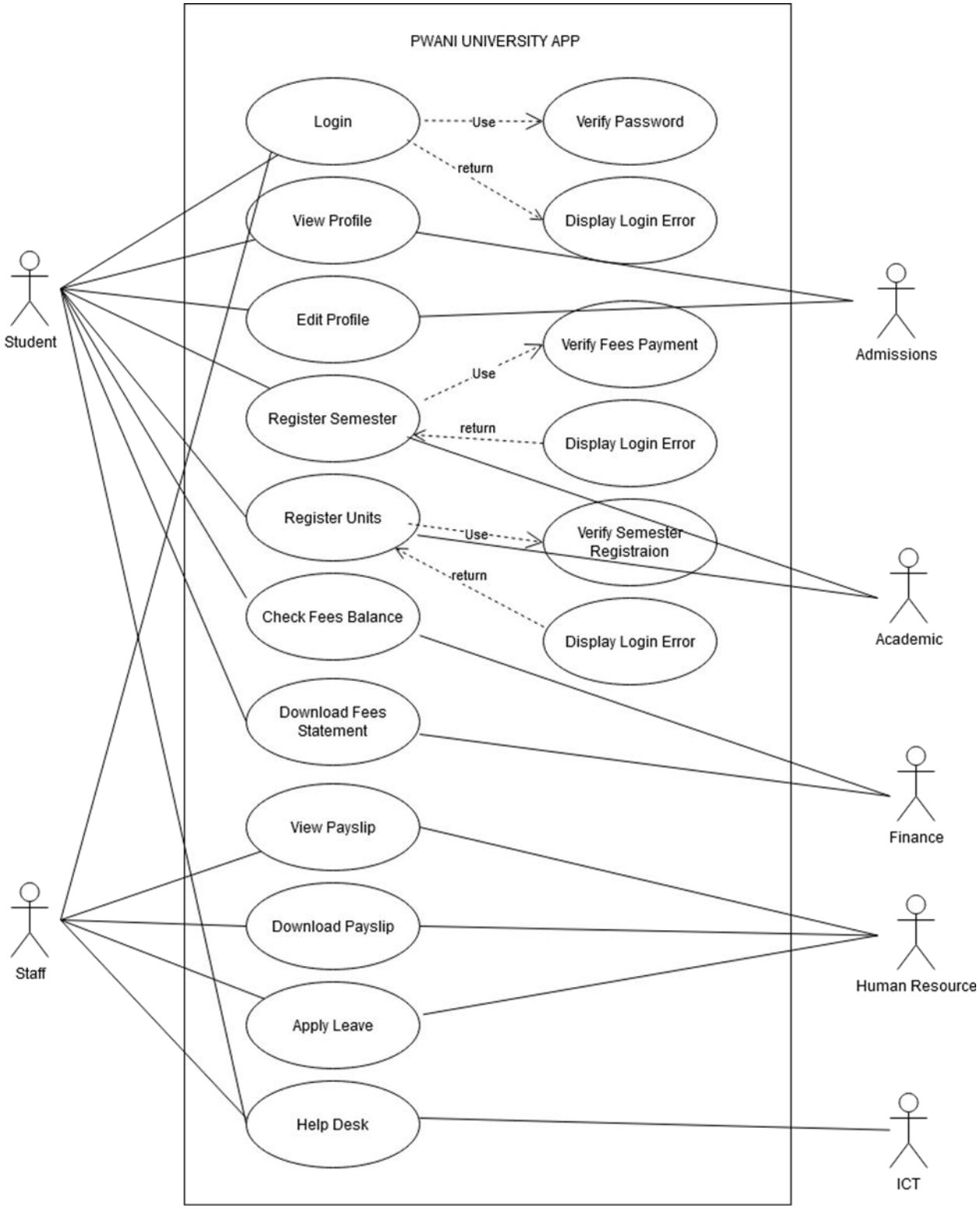

Figure 12: Use case diagram

(ii) Activity Diagram

User (or system) activities, the individual or part who completes each task, and the sequential flow of these activities are all depicted in an activity diagram (Satzinger *et al.*, 2016). Figure 13 shows the activity diagram for viewing student profile use cases.

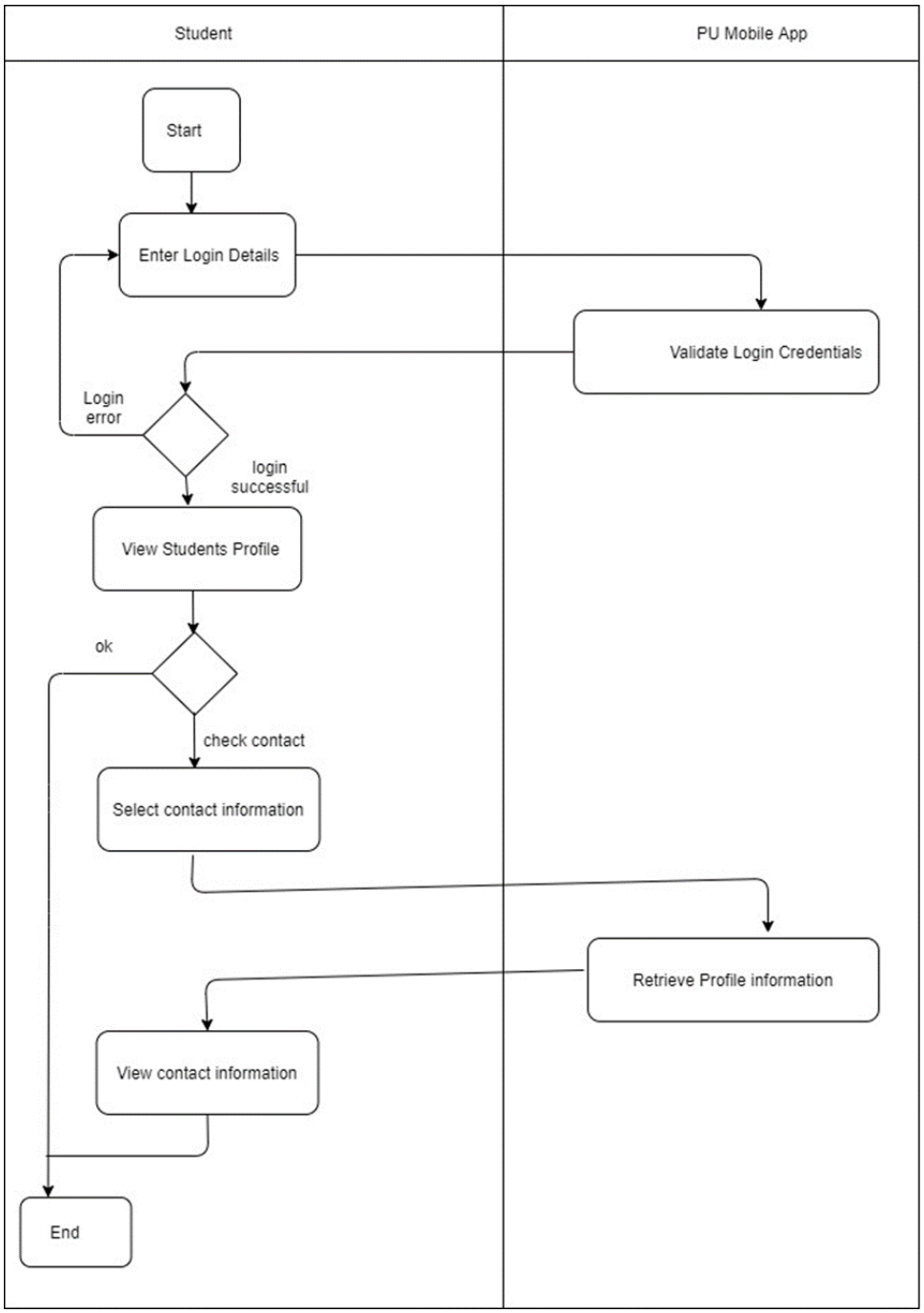

Figure 13: Activity diagram for view student profile use case

(iii) User Interface Design

User interface design is an integral aspect of the software development process (Sommerville, 2011). Bad user engagement, as a result of poor cultural factors of user interface design, leads to lower user acceptance and satisfaction (Alsswey *et al*., 2018). For the PU App, the interface was simple, yet easy to navigate to provide a great user experience as shown in Fig. 14, 15, and 16.

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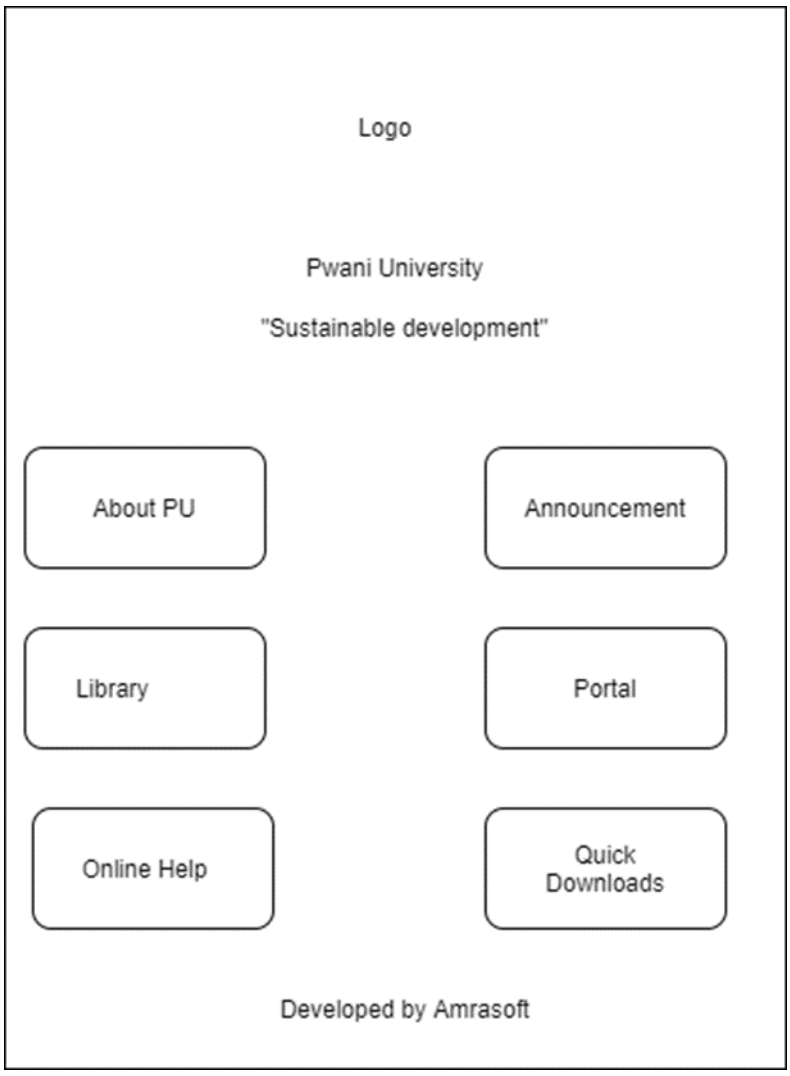

Figure 14: User interface for the main dashboard

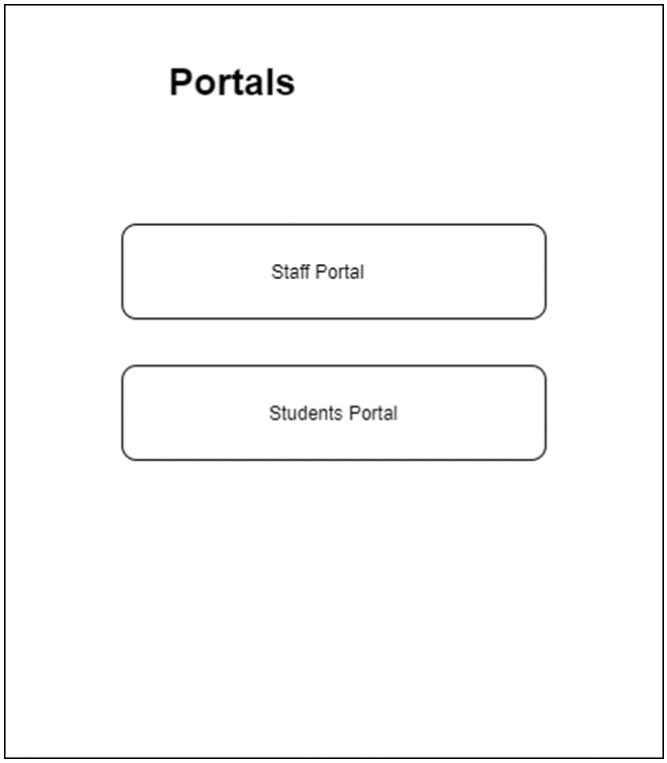

Figure 15: User interface for the portals

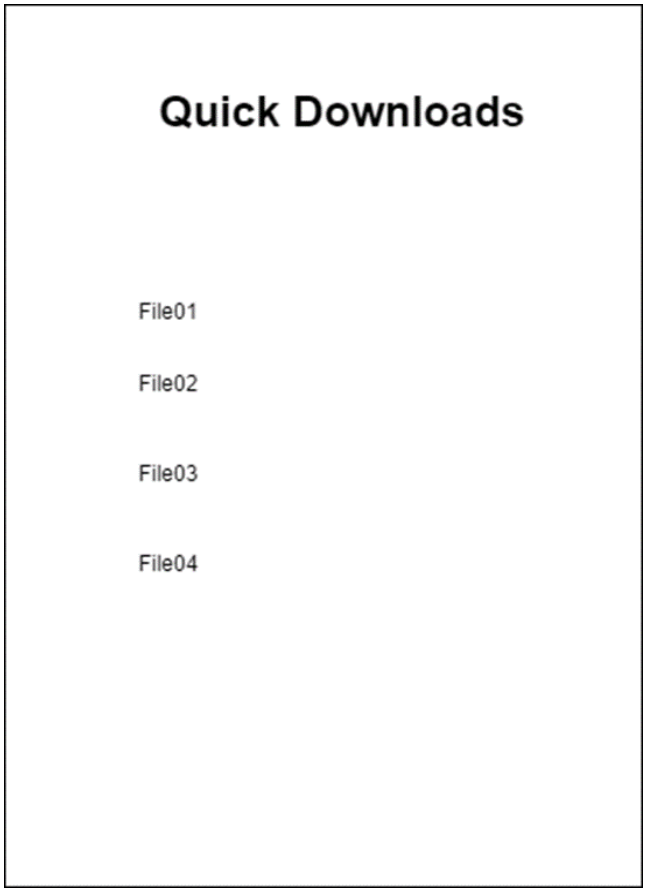

Figure 16: User interface for file downloads

(iv) Database Design

Database design uses the information provided by the domain class diagram and use case. The database for the PU Application was designed based on the requirements as depicted in the Use Case, activity, and sequence diagrams. The mobile app database design was on SQLite database which will link with API to interface with the MySQL server in the core student's management system. Figure 17 shows the relational database tables in the entity-relationship diagram.

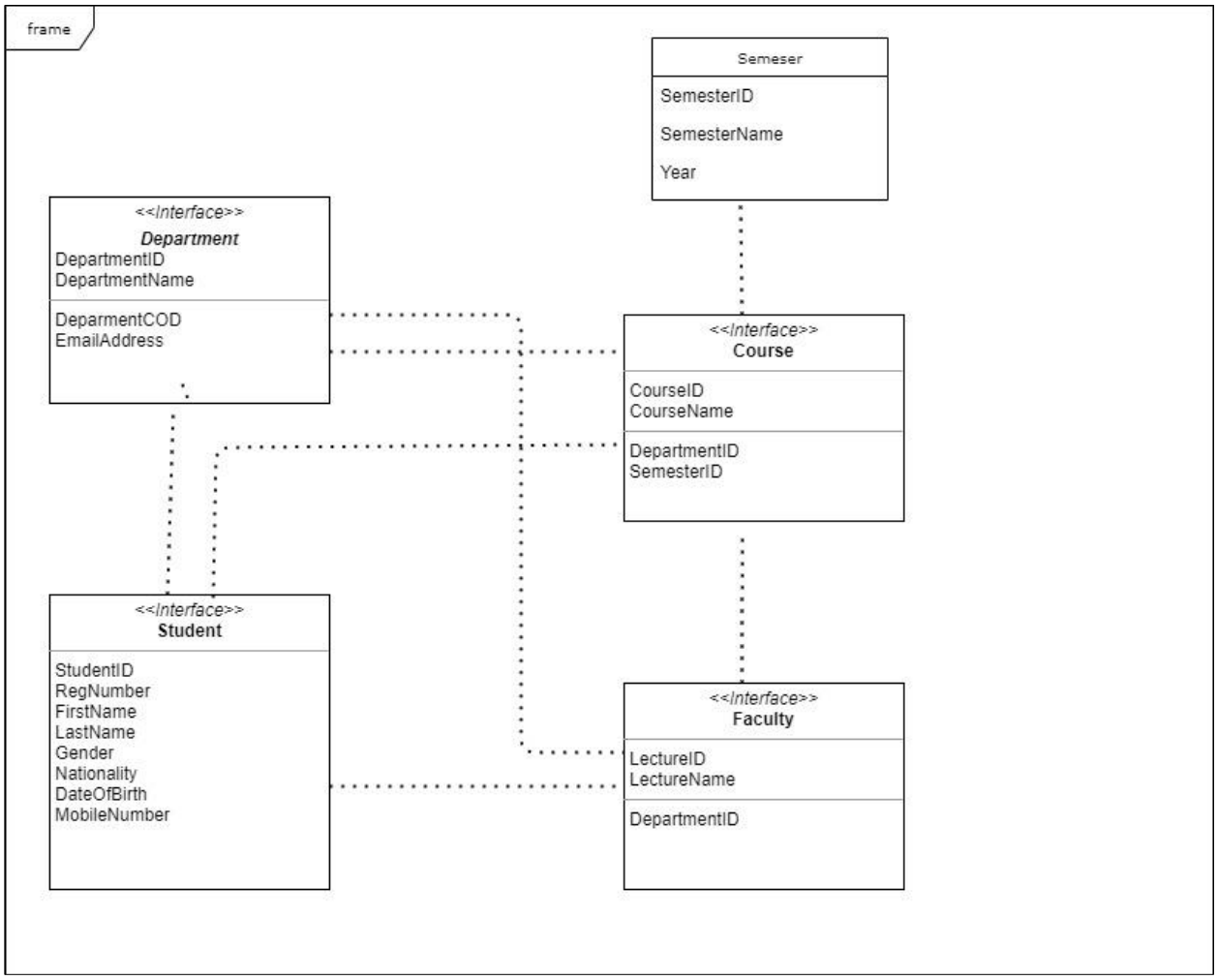

Figure 17: Entity-relationship diagram for the database

(v) Information Management System and mobile Application database Integration

The integration between the IMS and the mobile application was achieved by connecting through the Microsoft dynamics nav adapter acting as a bridge to translate service requests between the two systems as shown in Fig 18. The web services Representational state transfer (REST) API and the Web services Simple Object Access Protocol (SOAP) API are protocols for exchanging data through the adapter.

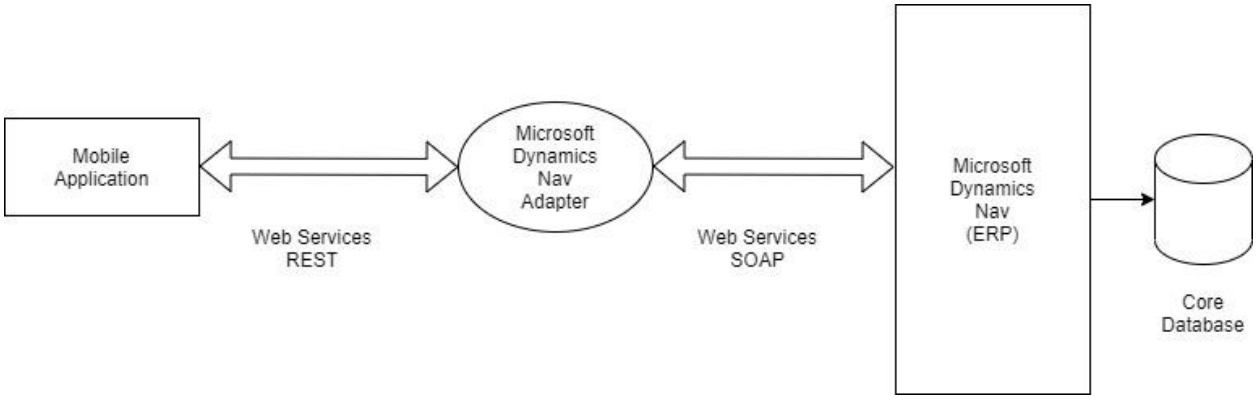

Figure 18: Architecture, adapted from (Lozano *et al*., 2014)

4.1.3 Requirements for the Developed Mobile Application

The requirements specification was an important step in the mobile application design process because it helped to define what the system would do as well as include the system's necessary and desirable properties (Pascoe, 2016). The user requirement concept is the description of how users can communicate with the system (Mrema, 2020). The functional requirements for developing the PU Application cover the registration of new users for both staff and students, semester and course registration for students. With regards to the output, the application is expected to generate reports as a result of the user requests which can act as evidence that a transaction was performed. The reports will include; registered units for the semester, fees statements, and payslips for the staff.

(i) Functional Requirements for the Mobile Application

The functional requirements for the mobile application that were extracted from the requirements specification phase are shown in Table 2, for example, it must register a new user. The user will interact with the mobile application to execute those functions and the application must accept the user request and return the desired output.

Table 2: Functional requirements

Requirements	Description	Actor
1. Register New User	All users should be registered in the system. The users will be assigned security privileges (levels) The users will be assigned secured login credentials i.e. user name and password	Systems Administrator /student/staff
2. Edit Profile	The administrator will allow some of the profile details to be edited. The user should be able to edit some of their profile details	Systems Administrator/ Student/Staff
3. Register Semester	The system will allow a user to register for a new semester	Student
4. Register Units	The system will allow a user to register for new semester units	Student
5. Check Fees Balance	The system will allow a user to query the balance of their fees	Student
6. Download Fees Statement	The system will allow a user to download fees statement in read-only mode	Student
7. View Payslip	The system will allow a user to view monthly payslip	Staff
8. Download Payslip	The system will allow a user to download a monthly payslip in read-only mode	Staff

(ii) Non-Functional Requirements for the Mobile Application

Table 3 indicates the non-functional requirements for the mobile application. These are the desirable features of the application.

Table 3: Non-functional requirements

Requirements	Description
1. Security	The system will authenticate the users
2. Reliability	The system will be stable, avoid frequent crashes, increasing uptime less downtime.
3. Maintainability	The system will be updated and upgraded to accommodate new and improved functionalities.
4. Performance	Return the expected output
5. Usability	Easy to use and navigate
6. Responsive	Respond to user inputs and commands
7. Scalability	The system should be expandable without a major overhaul

4.1.4 Results for the Developed Mobile Application

The "Pwani University mobile application" or "PU app" was created to make services from the main university student management system more accessible. The app's key features are that students can view their profile, course management, finance management, and download read-only reports such as fees statements, unit registration forms, and examination cards from anywhere as long as they are linked to the internet. The mobile application, which was available for both iOS and Android, had the following key features, which are detailed in the sub-sections. Figure 19 shows the main dashboard for the mobile application.

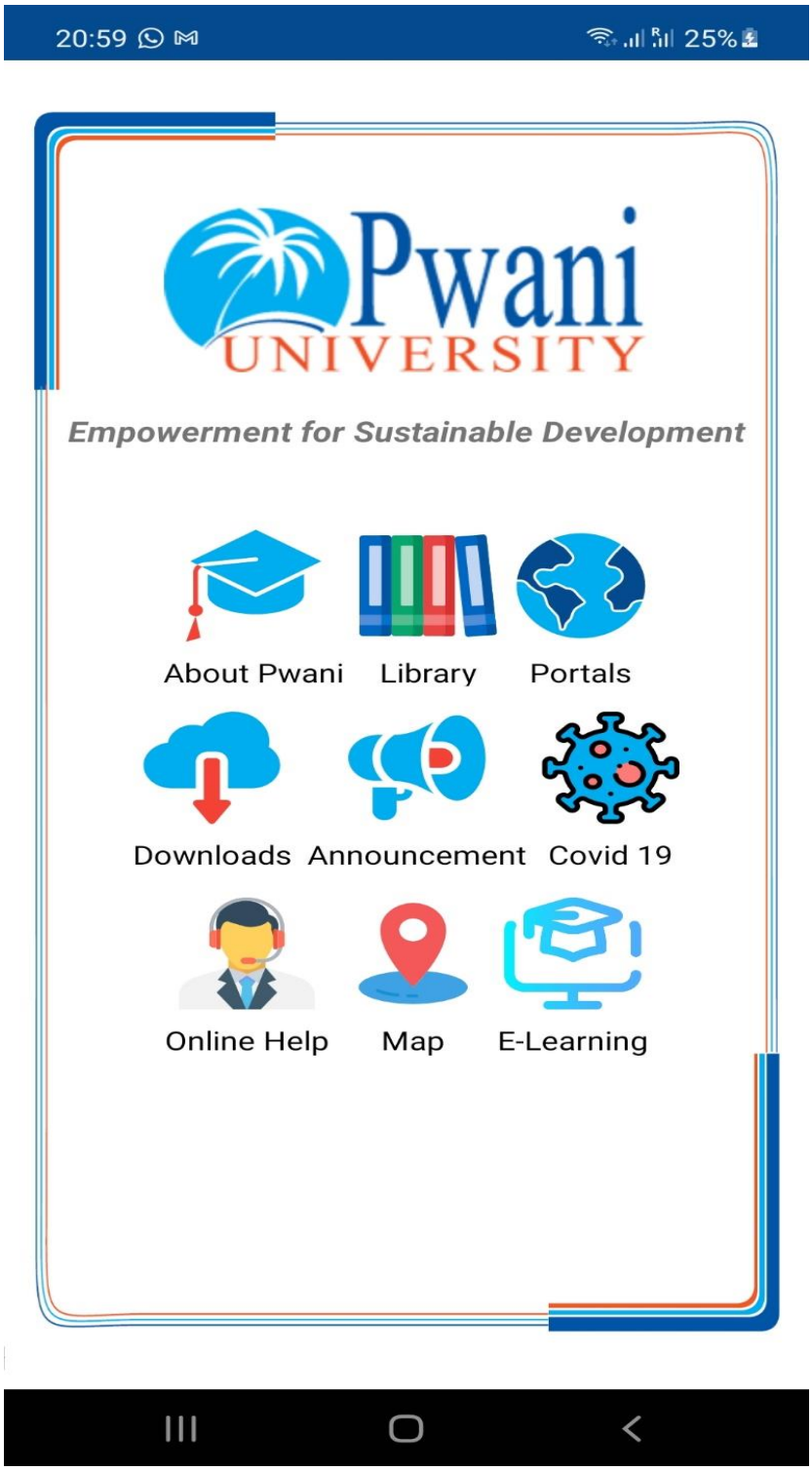

Figure 19: Main dashboard screen

(i) Login and Verification

The main PU app dashboard has no login services that can be accessed by the students, staff, and general public, while the core services are restricted to staff and students only. The login credentials of the users are generated after a successful admission process into the university. The

default user name is the student's registration number for example, "E40/PU/1234/20" and a One-Time Password (OTP) which must be changed after initial login. As for the members of staff, they receive their credentials from the human resource, user name being their staff number, for example, "PU0145" and OTP. Figure 20 shows the login screen of the student's portal and Fig. 21 shows the student's dashboard.

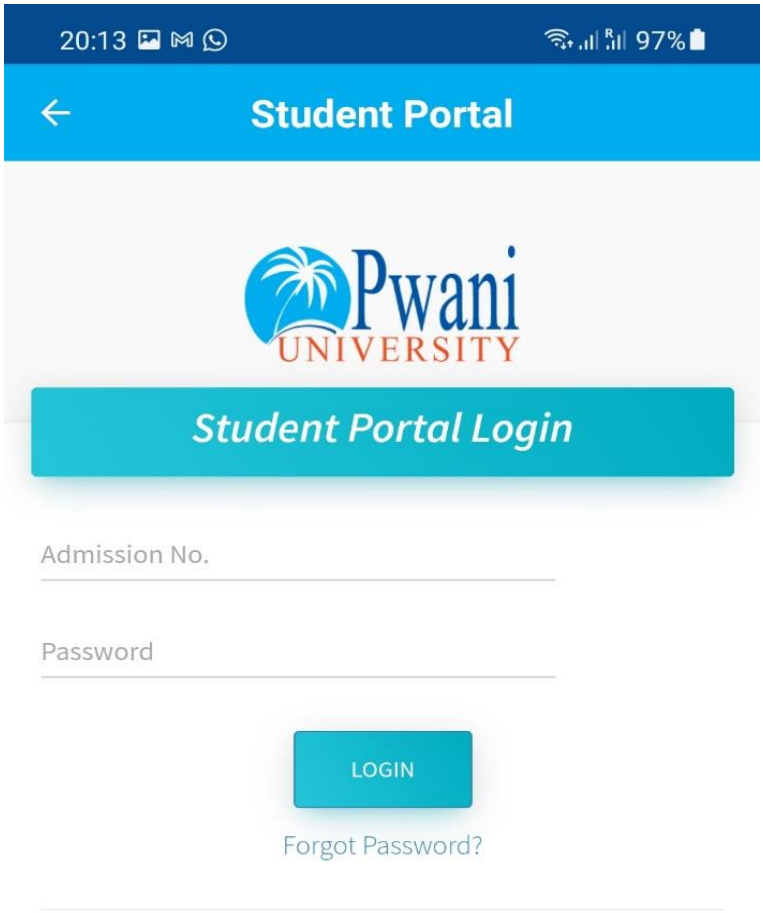

Figure 20: Student portal login

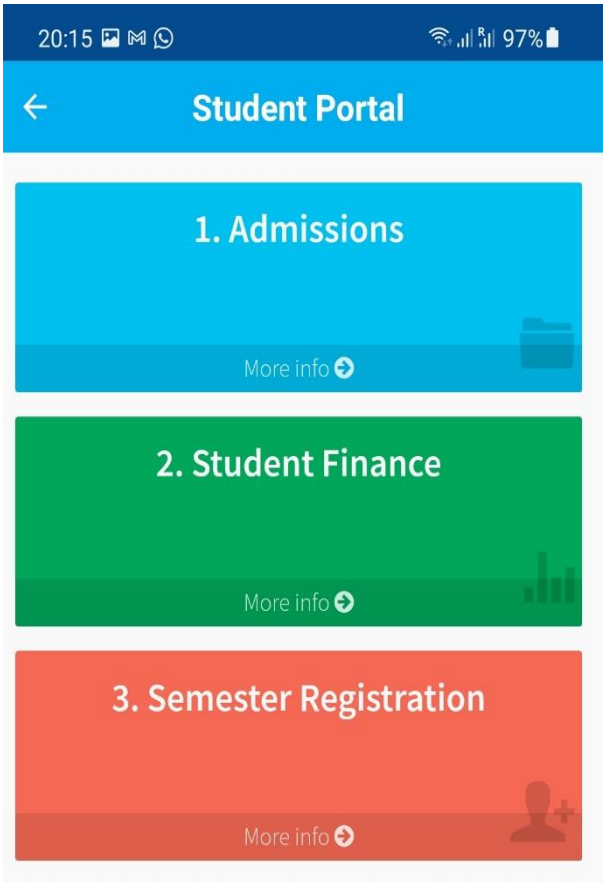

Figure 21: Student portal dashboard

(ii) Edit Student Profile

After a successful login, the student is allowed to make some of the changes to their details while others are locked, for example, they can update their contact, marital status, religion, and others, while they cannot update their names, student registration number, course details among others.

(iii) Semester Registration

According to the university academic policy, students must register at the beginning of each semester. The student can only register after clearing the fee balance. The app has facilitated the students to perform the semester registration seamlessly. Figure 22 shows the semester registration user interface.

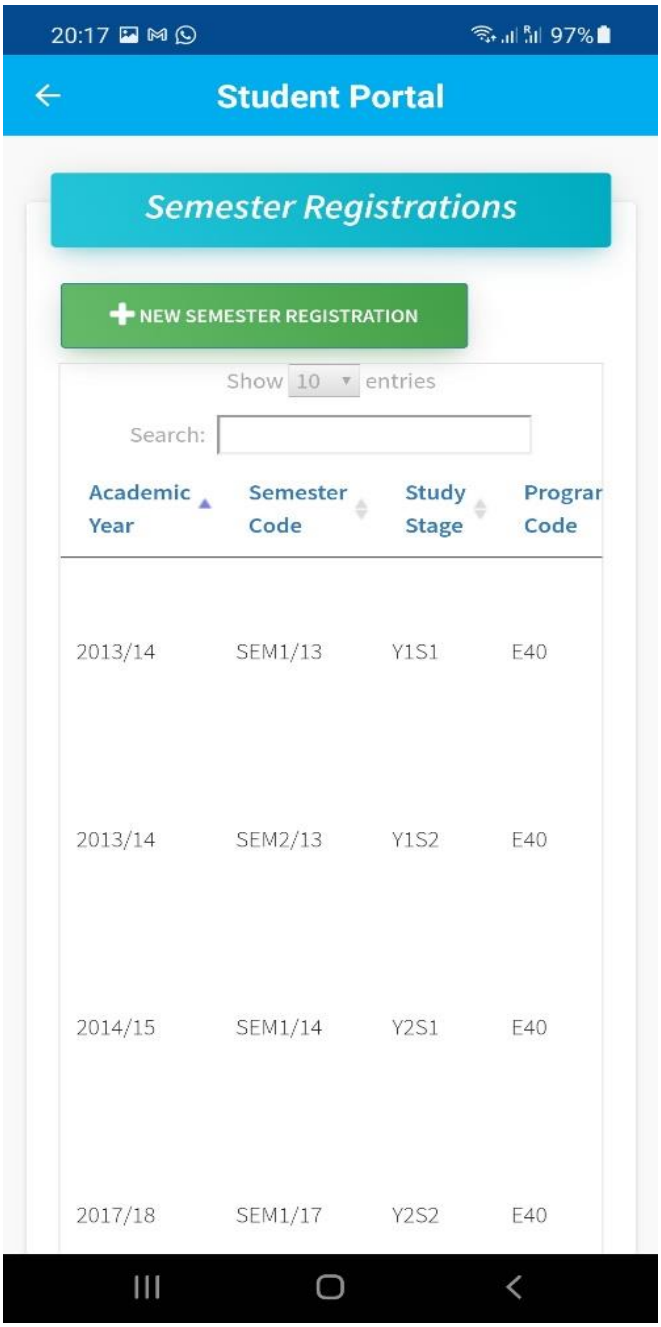

Figure 22: User interface for semester registration

(iv) Course Registration

Likewise, as in (iii), above, students must register for the courses they will be learning in the semester. Figure 23 indicates the course's user interface for registration.

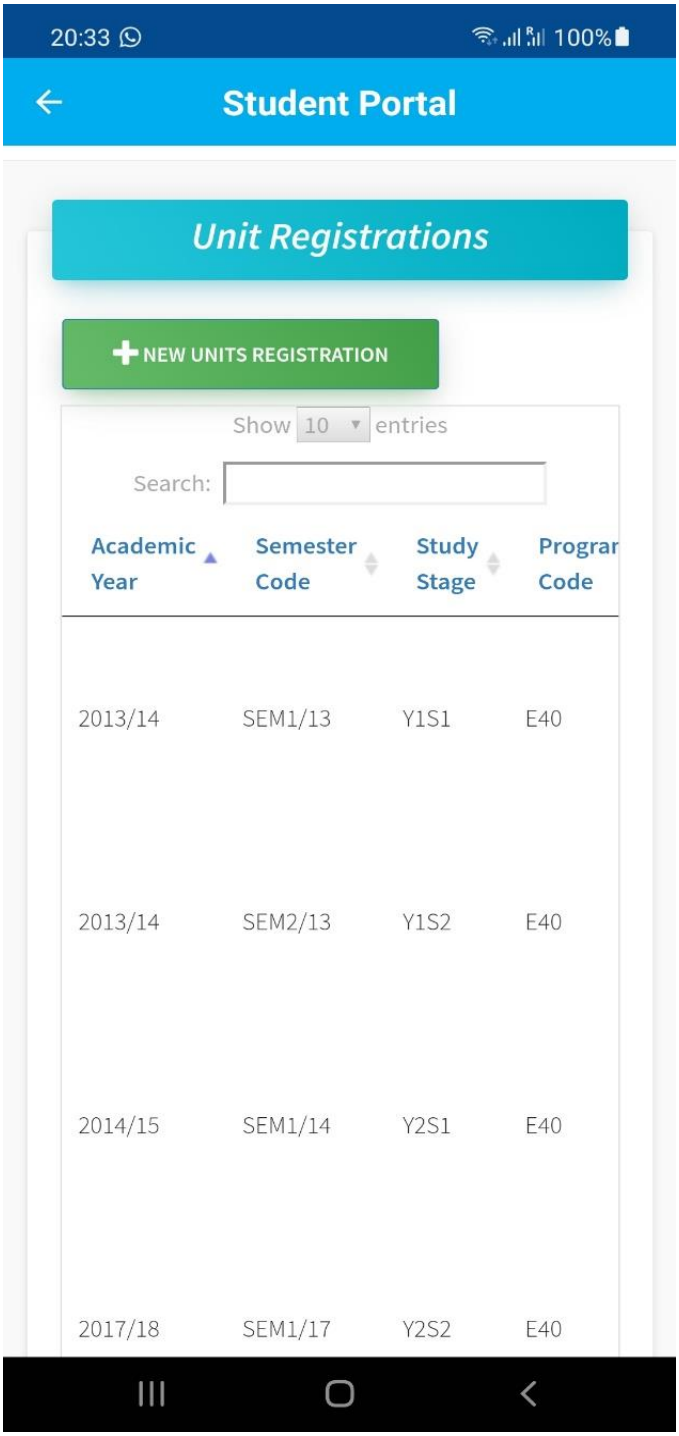

Figure 23: User interface for course registration

(v) Check fees balance

The students can quickly check the balance of their fees in their student portal account. This helps to get quick updates whenever their guardians or sponsor pay the university fees as shown in Fig. 24.

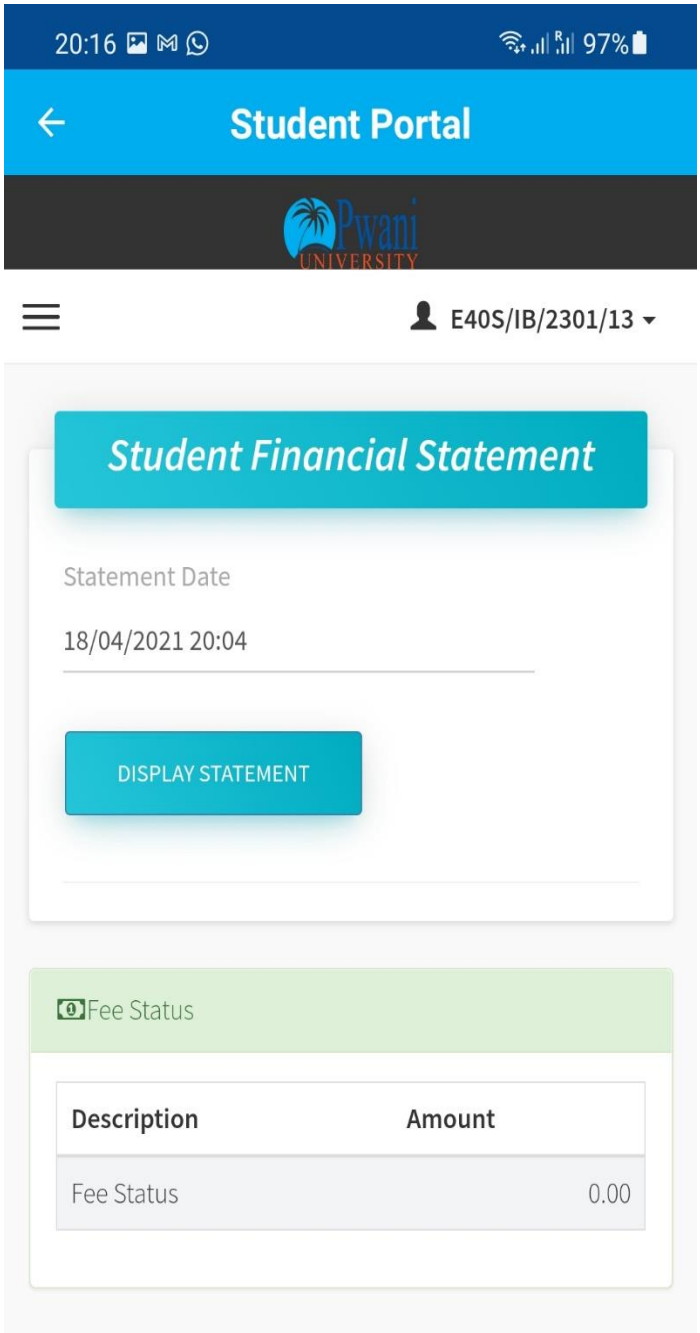

Figure 24: User interface for checking fees balance and statement download

Download Fees Statement

The student can either view the statement on screen or can choose to download too for their future reference and submit it to their guardians or sponsors. The download is in Portable Document Format (PDF), read-only mode. The fees statement indicates the semester invoicing and the fees payments. The balance is shown at the end of the statement. As shown in Fig. 24.

View and Download Payslip

The members of staff can view their payslips and download them for future reference through the staff portal. Figure 25 and 26 show the staff portal login page and the payslip download interface.

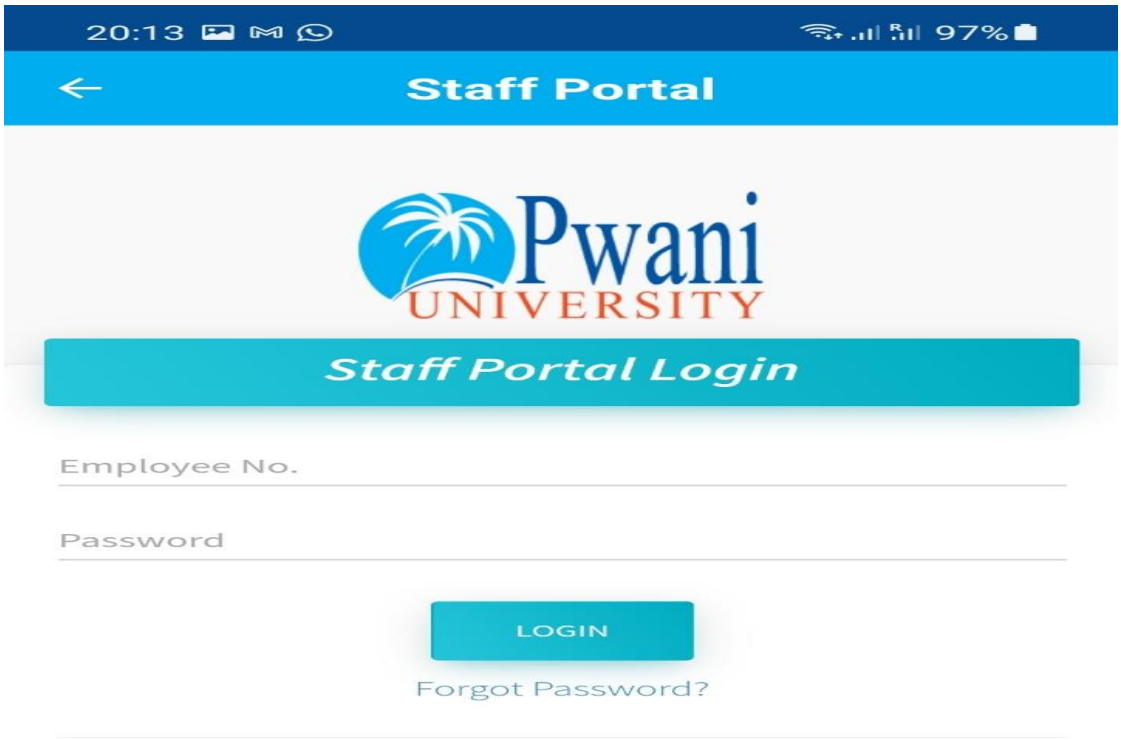

Figure 25: Staff portal login

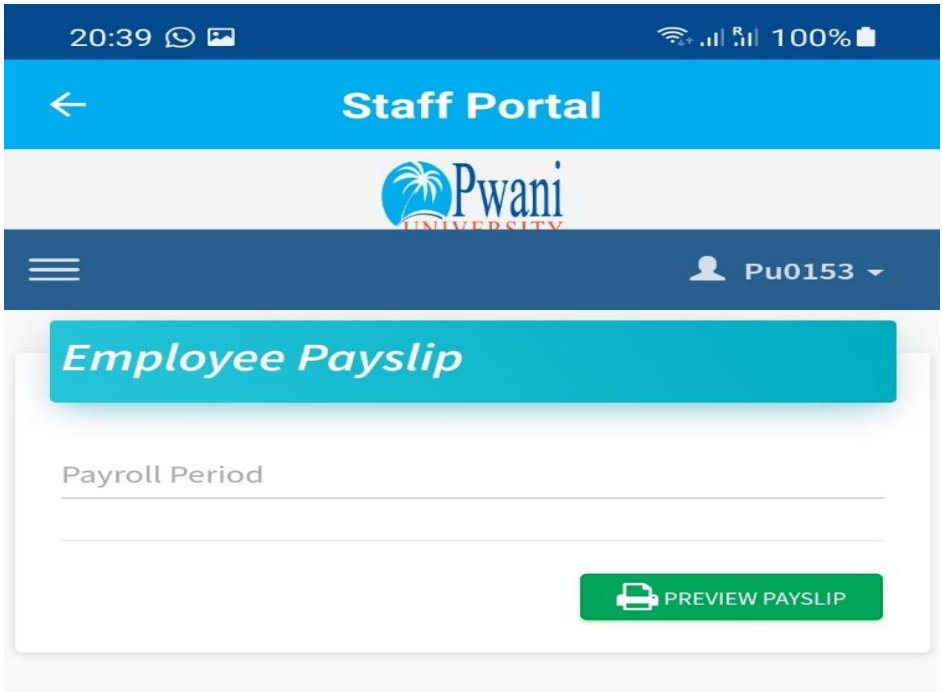

Figure 26: User interface for payslip view and download

4.1.5 Validation

Program validation is the process of confirming the system's user requirements as it determines whether the framework captured the users' requirements. During the validation process, the software was checked to confirm if the desired results were obtained, thereby enhancing the software's accuracy. Unit testing, integration testing, application testing, and user acceptance testing were all performed on the PU App to ensure its validity.System validation determines if the correct system was created. The developed framework was validated through user acceptance testing. To validate the method, a group of users was selected at random. Following that, a survey was performed to assess the system's perceived utility, ease of use, and attitude toward use. The data for the assessment was gathered via an online questionnaire.

4.1.6 Unit Testing

This was done to test the functionalities of independent modules of the mobile app to ensure they perform as designed. Unit monitoring ensures that the system's functionalities are reliable, resulting in improved accessibility and usability. The following are some of the main modules that were put to the test: Layout activities, transfer of data between the mobile app and main server, user authentication, and user interaction. After the design of the layout activities were tested independently before linking them with intents. It was easier to identify non-functionalities and fix them. Besides, the java code for each activity was also easier to debug independently.

4.1.7 Integration Testing

After unit testing was completed, the systems or modules were incorporated, which necessitated integration testing. Integration testing is aimed to ensure that the integrated modules are usable, perform well, and are reliable. The integrated part of the PU mobile app and the main server of the student’s management system was linking very well and it was possible to exchange data and transactions between the two main independent components.

4.1.8 System Testing

This is the method of checking the mobile app to determine if it complies with the specified requirements. In system analysis, the system's functionalities are assessed from start to finish. During mobile app testing, the previously separate modules were combined to form a full mobile application to ensure that it met both functional and non-functional specifications while also keeping track of any unwanted or unexpected operations and performance. The layouts, operations,

tools, databases, and java code for the PU mobile application were all merged into one framework. Table 4 shows the results of the system testing.

Table 4: System testing results

System requirements		Test results
1. Register New User	The system should allow registered users to log in	PASS
2. Edit Profile	The user should be able to edit some of their profile details	PASS
3. Register Semester	The system should allow a user to register for a new semester	PASS
4. Register Units	The system should allow a user to register for new semester units	PASS
5. Check Fees Balance	The system should allow a user to check the balance of their fees	PASS
6. Download Fees Statement	The system will be used to download fees statement in read-only mode	PASS
7. View Payslip	The system should allow a user to view monthly payslip	PASS
8. Download Payslip	The system should allow a user to download a monthly payslip in read-only mode	PASS

4.1.9 User Acceptance Testing

The application's android application package file was installed on android-enabled smartphones. Both employees and students, who are the app's main users, participated in the device testing. The PU mobile application was shown to some staff and students to learn about user perceptions and opinions about the software. The respondents were allowed to express their own opinions on the app that had been created. The information was gathered through an online questionnaire listed in Appendix 5, followed by interviews and observations, before the data was analyzed. In section 4.2, the results are discussed.

4.1.10 Findings on Usability and Acceptance Testing

The results of the usability and acceptance testing are presented in Table 5. 73% of the users were satisfied and would like to use the mobile app, 55% found the app to be easy to use while 45% did not require any assistance from a technical person to use the app.

Table 5: Usability and acceptance testing results

	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)
1. I believe I would enjoy using this mobile app.	0	0	0	27	73
2. I thought the app was overly complicated.	36	64	0	0	0
3. I found the app to be easy to use.	0	0	0	45	55
4. To use this app, I believe I will need the assistance of a technical individual.	45	55	0	0	0
5. The app's different functions were well incorporated in my opinion.	0	0	0	55	45
6. This app had a lot of inconsistency in my opinion.	27	73	0	0	0
7. Most people, I believe, will quickly pick up on how to use this app.	0	0	0	27	73
8. I considered the software to be extremely difficult to use.	36	64	0	0	0
9. Using the app gave me a lot of confidence.	0	0	0	55	45
10. Before I could get started with this app, I had to learn a lot of things.	55	45	0	0	0

4.2 Discussion

The use of mobile apps by students to access the core university student management system and the nature of the proposed university mobile application were explored in this study. This study presents the results of statistical analyses and validations conducted on data obtained through testing instruments and the design of mobile application systems. In the field study, data were obtained using quantitative and qualitative methods such as questionnaires, evaluation, and interviews. The purpose of the survey was to learn about the demographics of the respondents to extract the app's specifications. As a result of the data analysis, it was discovered that: To begin, findings show that laptops and smartphones, the majority of which run on the Android platform, are the two most common mobile devices among students. The findings are consistent with those available in Lee *et al*. (2020), smartphones and laptops were the most commonly used mobile devices 98.7% and laptops 94.0%. Concerning the frequency of mobile phone usage, most students 83.5% used their mobile phones between 1 to 10 times a day. Second, the smartphone was used often during the day, indicating that the product had a lot of promise. The majority of students agreed that the justifications for developing the app were valid. Many students want access to course information, hostel information, and exam results, according to the study's findings. This result is in line with Ojino and Mich (2018), on the perceived use of mobile applications, 56% of students desired apps for classes and 53% exam results. The university workers wanted access to payroll systems and the ability to apply for online leave.

In terms of the proposed mobile application's framework design, a use case model and operation diagram were used to represent the actors and activities of the app, which assisted in the development of the user interface and database. The PU mobile application was implemented in the android studio by integrating the layouts to create the user interface, databases to store and exchange data between the app and the student's information system. Unit, integration, and system testing were performed to ensure the intended specifications were met. The usability and acceptance testing were very successful with more than 90% of users liked the app while 45% more than 80% did not need any assistance to use the app and did not find it cumbersome.

Two conclusions can be drawn from the findings of the reported result. For starters, there is a need and potential for the creation of mobile applications to access existing university services through the student management system at any time and from any location, particularly during pandemics. Second, this study adds to the limited literature on collecting, analyzing, specifying, and designing mobile device requirements.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This research looked at the creation process of a university mobile application to improve access services. The study analyzed previous work on a mobile application for universities and institutions of higher learning and gathered the requirements and specifications of the mobile app through the agile methodology. Furthermore, the mobile application design was formulated. In the design phase, based on the functional and non-functional requirements were used to design the database and the user interface of a mobile application. The developed mobile application "Pwani University" for accessing IMS in PU, increasing accessibility of university services to the staff and student. The main advantage of the app is students will access services through their smartphones from anywhere as long as they are connected to the internet, saving them time, and cost. Finally, the mobile application was reviewed and checked by prospective users to see whether it met any of the criteria in performance. Potential users demonstrated a high degree of acceptance for the system and decided to use it to help increase access to university resources.

5.2 Recommendations

The following are recommended for future work:

(i) The PU App incorporated a three-tier security architecture, from the ISM, the network connection, and the app database. However, it requires a design of security architecture to add more features in mobile applications since the security of the university mobile application is paramount to ensure reliability and availability of services. Also, it protects to ensure data integrity and authenticates the intended users to access the premium services. Critical services like the examination results, financial records must be protected not to be modified by unauthorized users.

(ii) While the project adopted the online survey for quantitative data collection, in the future more Interactive and user-friendly online data collection instruments can be developed.

(iii) Even though flutter was applied to design a cross-platform app, challenges in the limitation of hardware for the iOS platform for the development and testing. Therefore, future projects Design a cross-platform mobile application.

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APPENDICES

Appendix 1: Internship agreement

CENIT@EA

INTERNSHIP AGREEMENT

Name of student:	Amrani Athumani Hassan
Gender:	Male
Postal address:	PO Box 195-80108, Kilifi- **KENYA**
Telephone number:	+254 723 417063
E-Mail address:	hassana@nm-aist.ac.tz
Date of birth:	01/03/1979
Nationality:	Kenyan

Name of host supervisor:	Mr. Newton Juma ICT Manager, Pwani University
Internship dates:	**01st September, 2020** to **07th May, 2021**
Working hours:	8:00a.m – 5:00pm.
Company financial contribution:	NIL

Assignment: Development Pwani University mobile application

Activity timetable and expected deliverables:

- Online and offline Pwani University mobile application in **Android**, integrated to the existing Pwani University website (https://www.pu.ac.ke/) with detailed activities as follows:

1. Include modules for student portal, Register students, check fees balance, register units, access library services, graduation portal, staff portal.
2. An integrated M&E tool in the Pwani University application to monitor most requested and viewed content and measure change over time;
3. Release of Pwani University app in Google Play Store;
4. Pwani University mobile application user manual;
5. Produce a report on the performance and recommendation for improvements and updates of Pwani University mobile application.

Appendix 2: Data collection questionnaire

PWANI UNIVERSITY MOBILE APPLICATION SURVEY

Dear respondent,

Pwani University, ICT Department is in the process of developing a Mobile Application to increase access to services to students and staff. Kindly spend some few minutes of your time to respond to this questionnaire.

Thank you for your participation and contribution to this project.

* Required

1. 1. What is your current occupation? *

Mark only one oval.

- ◯ Staff
- ◯ Student

2. 2. Gender *

Mark only one oval.

- ◯ Male
- ◯ Female

3. 3. Which device(s) do you own? *

Check all that apply.

- ☐ Smartphone
- ☐ Laptop
- ☐ Tablet
- ☐ None

8. 8. Which Pwani University services do you access currently? *

Check all that apply.

- [ ] Student portal
- [ ] E-learning portal
- [ ] Library
- [ ] Downloads
- [ ] Hostel services
- [ ] Payslip
- [ ] Leave Application

Other: [ ] _____

9. 9. Would you like to access the above Pwani University services through a mobile application? (Refer to No.8) *

Mark only one oval.

- ◯ Yes
- ◯ No

10. 10. Which services would you like to see in the proposed Pwani University mobile application? *

Check all that apply.

- [ ] Your profile
- [ ] Financial statement
- [ ] Course information
- [ ] Hostel information
- [ ] Exam results
- [ ] Time table
- [ ] Payslip
- [ ] Leave Application

Other: [ ] _____

4. 4. If you own a smartphone, Which platform (Operating system)? *

Mark only one oval.

- ◯ Android
- ◯ IOS (Apple)
- ◯ Windows
- ◯ Blackberry
- ◯ Other: _____

5. 5. How often do you use your smart phone? *

Mark only one oval.

- ◯ Continuously
- ◯ Several times a day
- ◯ Once a day
- ◯ Barely or not at all

6. 6. Which mobile apps do you often use in your smartphone? *

Check all that apply.

- ☐ Social media
- ☐ Educational apps
- ☐ YouTube

Other: ☐ _____

7. 7. Which device do you MOSTLY use to access Pwani University services? *

Mark only one oval.

- ◯ Smartphone
- ◯ Laptop
- ◯ Tablet
- ◯ Computer laboratory

Appendix 3: Interview guide

INTERVIEW GUIDE TO GATHER TECHNICAL REQUIREMENTS

1. Which devices do you own?

2. How often do you use your smartphone?

3. Which mobile apps do you use in your smartphone?

4. How do you connect to the internet with your smartphone?

5. What platform would you like your mobile application to be developed on?

6. What are the most critical attributes or features you want to see with your app?

7. What's the name of your app?

8. How do you plan to distribute your app?

9. How secure does your app need to be

10. What are your app's core features?

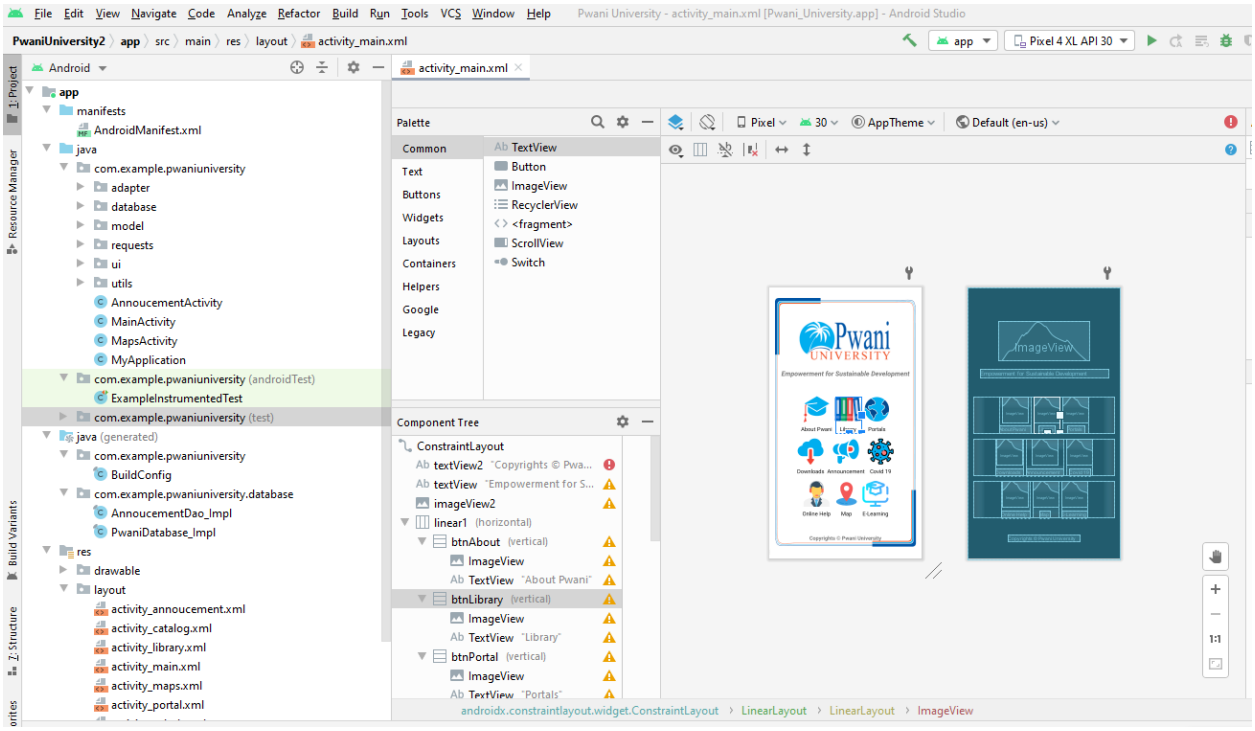
11. Does your app integrate with an existing database?

12. What admin features do you need?

Appendix 4: Yamani sample size calculation formula

$$n = \frac{N}{1 + N(e)^2}$$

Appendix 5: Mobile application Android studio implementation



Appendix 6: Usability and acceptance testing questionnaire

Dear Respondent,

Pwani University, ICT Department has developed a Mobile Application to increase access to services to students and staff. We would like to hear your views on the app. Kindly spend some few minutes of your time to respond to this questionnaire.

Thank you for your participation and contribution to this project.

For each of the following statements, select one on a scale of Strongly agree (5) to Strongly disagree (1)					
	Strongly disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
1. I believe I would enjoy using this mobile app.					
2. I thought the app was overly complicated.					
3. I found the app to be easy to use.					
4. To use this app, I believe I will need the assistance of a technical individual.					
5. The app's different functions were well incorporated in my opinion.					
6. This app had a lot of inconsistency in my opinion.					
7. Most people, I believe, will quickly pick up on how to use this app.					
8. I considered the software to be extremely difficult to use.					
9. Using the app gave me a lot of confidence.					

10. Before I could get started with this app, I had to learn a lot of things.					

Appendix 7: Sample codes for mobile application

```
<?xml version="1.0" encoding="utf-8"?>
<androidx.constraintlayout.widget.ConstraintLayout
xmlns:android="http://schemas.android.com/apk/res/android"
   xmlns:app="http://schemas.android.com/apk/res-auto"
   xmlns:tools="http://schemas.android.com/tools"
   android:layout_width="match_parent"
   android:layout_height="match_parent"
   android:background ="@drawable/main_app_background"
   tools:context=".ui.MainActivity">
   <TextView
      android:id="@+id/textView2"
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:layout_below="@+id/bodyLayout"
      android:layout_alignParentBottom="true"
      android:layout_centerHorizontal="true"
      android:layout_marginVertical="20dp"
      android:layout_marginStart="83dp"
      android:layout_marginEnd="83dp"
      android:layout_marginBottom="32dp"
      android:text="Copyrights © Pwani University"
ndroid:textStyle="bold"
      app:layout_constraintBottom_toBottomOf="parent"
      app:layout_constraintEnd_toEndOf="parent"
      app:layout_constraintStart_toStartOf="parent"
      app:layout_constraintTop_toBottomOf="@+id/linear3" />
   <TextView
      android:id="@+id/textView"
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:layout_marginStart="16dp"
      android:layout_marginTop="24dp"
      android:layout_marginEnd="16dp"
      android:layout_marginBottom="50dp"
      android:text="Empowerment for Sustainable Development"
      android:textSize="18dp"
      android:textStyle="italic|bold"
```

```
    app:layout_constraintBottom_toTopOf="@+id/linear1"
    app:layout_constraintEnd_toEndOf="parent"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toBottomOf="@+id/imageView2" />

<ImageView
    android:id="@+id/imageView2"
    android:layout_width="246dp"
    android:layout_height="wrap_content"
    android:layout_marginTop="90dp"
    android:src="@drawable/logo"
    app:layout_constraintBottom_toTopOf="@+id/textView"
    app:layout_constraintEnd_toEndOf="parent"
    app:layout_constraintHorizontal_bias="0.496"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toBottomOf="@+id/textView" />
  <LinearLayout
    android:id="@+id/linear1"
    android:layout_width="match_parent"
    android:layout_height="98dp"
    android:layout_margin="16dp"
    android:layout_marginTop="32dp"
    android:layout_marginBottom="16dp"
    android:gravity="center"
    android:orientation="horizontal"
    app:layout_constraintBottom_toTopOf="@+id/linear2"
    app:layout_constraintEnd_toEndOf="parent"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toBottomOf="@+id/imageView2">

<LinearLayout
        android:id="@+id/btnAbout"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginEnd="8dp"
        android:gravity="center"
        android:onClick="btnClick"
        android:orientation="vertical">
```

```
        <ImageView
            android:layout_width="70dp"
            android:layout_height="70dp"
            android:src="@drawable/ic_school" />
        <TextView
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:layout_marginTop="8dp"
            android:text="About Pwani"
            android:textColor="#000"
            android:textSize="15sp" />
    </LinearLayout>

<LinearLayout
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        android:layout_height="wrap_content"
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        android:gravity="center"
        android:onClick="btnClick"
        android:orientation="vertical">
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            android:layout_height="70dp"
            android:src="@drawable/ic_books" />
        <TextView
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:layout_marginTop="8dp"
            android:text="Library"
            android:textColor="#000"
            android:textSize="15sp" />
    </LinearLayout>
    <LinearLayout
        android:id="@+id/btnPortal"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:gravity="center"
```

```
        android:onClick="btnClick"
        android:orientation="vertical">
        <ImageView
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            android:layout_height="70dp"
            android:src="@drawable/ic_globe" />
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            android:layout_height="wrap_content"
            android:layout_marginTop="8dp"
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            android:textColor="#000"
            android:textSize="15sp" />
    </LinearLayout>

</LinearLayout>
  <LinearLayout
    android:id="@+id/linear2"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:orientation="horizontal"
    app:layout_constraintEnd_toEndOf="parent"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toBottomOf="@id/linear1"
    android:layout_margin="16dp"
    android:gravity="center">
    <LinearLayout
      android:id="@+id/btnDownload"
      android:onClick="btnClick"
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:orientation="vertical"
      android:gravity="center"
      android:layout_marginEnd="8dp">
      <ImageView
        android:layout_width="70dp"
        android:layout_height="70dp"
        android:src="@drawable/ic_arrow"/>
```

```
        <TextView
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:layout_marginTop="8dp"
            android:textColor="#000"
            android:textSize="15sp"
            android:text="Downloads"/>
    </LinearLayout>

<LinearLayout
        android:id="@+id/btnAnnounce"
        android:onClick="btnClick"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:orientation="vertical"
        android:gravity="center"
        android:layout_marginEnd="8dp">
        <ImageView
            android:layout_width="70dp"
            android:layout_height="70dp"
            android:src="@drawable/ic_megaphone"/>
        <TextView
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:layout_marginTop="8dp"
            android:textColor="#000"
            android:textSize="15sp"
            android:text="Announcement"/>
    </LinearLayout>
    <LinearLayout
        android:id="@+id/btnCovid"
        android:onClick="btnClick"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:orientation="vertical"
        android:gravity="center">
        <ImageView
            android:layout_width="70dp"
```

```
            android:layout_height="70dp"
            android:src="@drawable/ic_virus"/>
        <TextView
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:layout_marginTop="8dp"
            android:textColor="#000"
            android:textSize="15sp"
            android:text="Covid 19"/>
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    android:id="@+id/linear3"
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    android:layout_height="wrap_content"
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    android:layout_marginTop="48dp"
    android:gravity="center"
    android:orientation="horizontal"
    app:layout_constraintEnd_toEndOf="parent"
    app:layout_constraintHorizontal_bias="0.093"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toBottomOf="@id/linear2">
    <LinearLayout
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        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginEnd="8dp"
        android:gravity="center"
        android:onClick="btnClick"
        android:orientation="vertical">
        <ImageView
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            android:layout_height="70dp"
            android:src="@drawable/ic_support" />
        <TextView
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
```

```
            android:layout_marginTop="8dp"
            android:text="Online Help"
            android:textColor="#000"
            android:textSize="15sp" />
        </LinearLayout>
        <LinearLayout
            android:id="@+id/btnMap"
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:layout_marginEnd="8dp"
            android:gravity="center"
            android:onClick="btnClick"
            android:orientation="vertical">
            <ImageView
                android:layout_width="70dp"
                android:layout_height="70dp"
                android:src="@drawable/ic_location" />
            <TextView
                android:layout_width="wrap_content"
                android:layout_height="wrap_content"
                android:layout_marginTop="8dp"
                android:text="Map"
                android:textColor="#000"
                android:textSize="15sp" />
        </LinearLayout>

    <LinearLayout
            android:id="@+id/btnSocial"
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:gravity="center"
            android:onClick="btnClick"
            android:orientation="vertical">
            <ImageView
                android:layout_width="70dp"
                android:layout_height="70dp"
                android:src="@drawable/elearning" />
            <TextView
```

```
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:layout_marginTop="8dp"
            android:text="E-Learning"
            android:textColor="#000"
            android:textSize="15sp" />
        </LinearLayout>
    </LinearLayout>
</androidx.constraintlayout.widget.ConstraintLayout>
```

Mobile Application Development for University Students Management System: The Case of Pwani University, Kenya

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Introduction

Universities in Kenya have demonstrated a great increase of mobile gadget users to access university-related information. In Pwani University, the Information Management System is currently accessible through a local area network connection on laptops and desktop computers, which are fixed in offices. In addition, the working hours of the office between Monday to Friday limit access to services to many students especially those who are out of the main campus.

Objectives

The objective of this project is to develop a mobile application and integrate it with the existing university Information Management System for improving access and user experience for services to be accessed anytime, anywhere through connected smartphones.

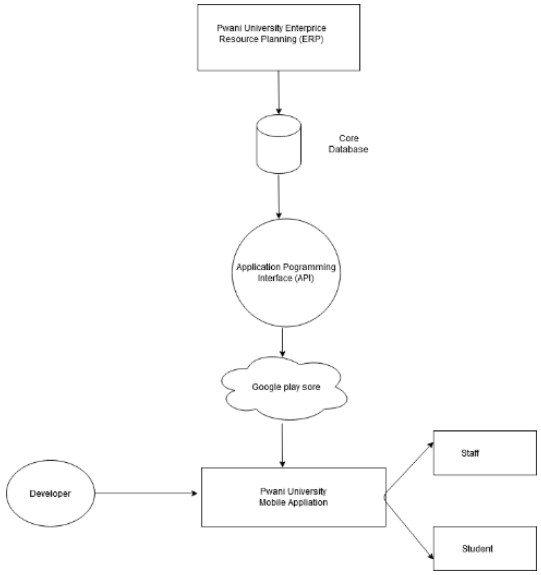

Fig. 1: Conceptual framework

Methodology

An online survey, interviews, and observations to collect the system requirements were gathered and analyzed essential requirements for the design and development of the mobile application. Agile software methodology was used because of its flexibility to accommodate changes.

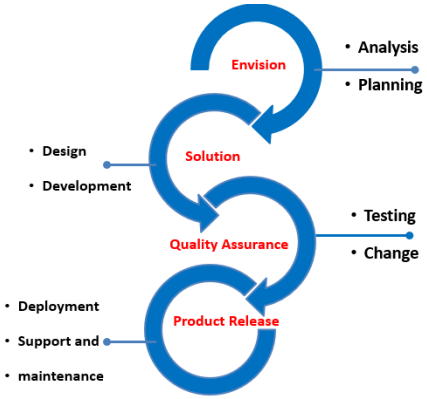

Fig. 2: Agile software methodology

Fig 3: PU App main dash board

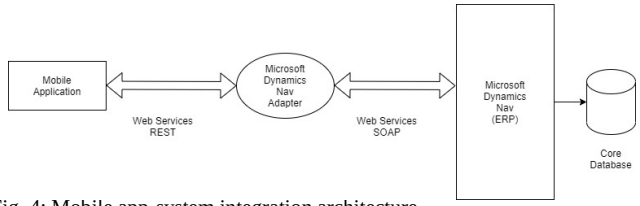

Fig. 4: Mobile app-system integration architecture

Conclusion

The developed mobile application allows staff and students to access the Student Information Management System, making university services more accessible to them. The app's key benefit is the convenience that students can use their smartphones to access resources from anywhere as long as they are connected to the internet, saving them time and money.