

MyStrath Unstructured Supplementary Service Data for Strathmore University

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An Information Systems Project Proposal Submitted to the Faculty of Information Technology in
partial fulfilment of the requirements for the award of a Degree in Business Information Technology

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Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the research proposal contains no material previously published or written by another person except where due reference is made in the research proposal itself.

Student Signature:

Sign: _____ Date: _____

Supervisor's Name:

Abstract

Most educational institutions have existing software systems that enforce a significant level of student information exchange. A straightforward integration of the technique of such an application into the E-learning management system in areas that have infrastructure challenges may not achieve the maximum results. Having existence of e-learning management system solutions are primarily web-based. Resulting from this, such current technologies also need, at the very least, secure access to internet connectivity. On the other hand, several regions around the world (especially in developing countries) are characterized with bad internet accessibility, an imbalanced spread of computer technology, and acute information breach. Therefore, this work aims to develop a system that allows students' records to be exchanged between Strathmore university facilities given the challenge of lack of ubiquitous internet connectivity, unreliable internet access and also bridging the digital divide gap. This research will have positive impacts on different stakeholders in Strathmore University. Students can access their information evading the issue of poor or no internet connectivity. As a result of this, Strathmore University will be able to give a better and prompt service to its stakeholders. This research will be adapted using the USSD technology as a means of storage and retrieval of information. Through the help of client-server model, or client-server architecture, which is a distributed application framework dividing tasks between servers and clients, which either reside in the same system or communicate through a computer network or the Internet. The client requests while the server supplies the administration. This client relies on sending a request to another program in order to access a service made available by a server. The server runs one or more programs that share resources with and distribute work among clients. In order to process the AJAX requests sent from the client to the server, the server needs information where the requests will arrive and how the requests should be handled. Each request needs to be routed to a specific URL. The client server relationship communicates in a request–response messaging pattern and must adhere to a common communications protocol, which formally defines the rules, language, and dialog patterns to be used. Client-server communication typically adheres to the TCP/IP protocol suite. According to TCP/IP protocol suite, the data are divided into small fragments, also known as packets. These packets contain the data and addresses of the source and destination for communication among endpoints. With the object oriented analysis and design, the proposed system will be able to deliver different functional modules of the system.

Chapter 1: introduction

1.1. Background

USSD (Unstructured Supplementary Services Data) is a real-time session oriented technology, used to provide mobile based network (Lakshmi & al., 2017). Currently Strathmore University is using a web-based system as well as a mobile application mystrath that allow students to have access to their data. This application enables a current student to view his/her student profile, the financial details for the degree (s) he has enrolled for. The student can also view the courses enrolled in, attendance to classes, timetable for his/her courses and any library overdue charges. The application also provides links to the university website and social media accounts. Users must log in to access the features of the application. These results suggest that relying on the Internet to access information makes one more likely to rely on the Internet to access other information.(Storm & al., 2017) There are 13 % of Strathmore university students who go away sometimes from the university on holidays or due to some personal duties and some of them encounter some connectivity issues. This makes it difficult for them to retrieve or even access their information when it is needed. This causes students to not be able to register their units on time that they are undertaking during the semester which can result to penalty later on based on the school policy. Research in higher education has demonstrated that late registration in the courses has a negative impact on students' academic performance.(Pathak, 2019a)

1.2. Problem statement

Internet connectivity in Africa has been characterized by several technical challenges, coupled with the high cost of accessing and using the service.(Storm & al., 2017) Existing e-learning management system solutions for Strathmore University are primarily web-based. This causes current technologies to also need, at the very least, secure access to internet connectivity. On the other hand, several regions in Kenya are characterized with bad internet accessibility, imbalanced spread of computer technology and literacy, and acute information breach. Therefore students who are found in the areas that have infrastructure challenges and lack of internet are not able to access nor retrieve their data from the Strathmore University.

1.3. Aim

The aim is to develop an information system that will allow students to have a complete access to their data from the Strathmore University without having to worry about the lack of internet in the area he or she is found using Unstructured Supplementary Service Data. As long as students have telephones either smart phones or feature phones, they shall be able to access their data as well as registering units they are undertaking during the semester at ease. Therefore with the help of unstructured supplementary service data, it shall be very convenient to students to access data from the school system wherever they are as long as they possess a feature phone and also they are within the country. USSD (Unstructured Supplementary Services Data) is a real-time session oriented technology, used to provide mobile based network. (Lakshmi & al., 2017)

1.4. Specific objectives

- i. To critique the current techniques used by Strathmore University students to access their data.
- ii. To review the existing MyStrath app system
- iii. To develop MyStrath USSD that will make it easier for Strathmore University students to access their information.
- iv. To test the developed information system.

1.5. Justification

USSD provides a cost-effective and flexible mechanism for offering various interactive and non-interactive mobile services to a wide subscriber base; USSD supports menu-based applications

facilitating more user interactions; USSD is neither a phone-based nor a SIM-based feature.(Lakshmi &al., 2017) The proposed system will allow Strathmore university students to access their data without the need of internet wherever they are found within the area of infrastructure challenges and it allows free of charge roaming. Strathmore University students can quickly see response on their phone screens and can make more requests hence allowing faster two-way communication and interaction that is seven times faster than SMS.

1.6. Scope/limitations

MyStrath USSD will focus on Strathmore university students as to provide efficient and cost-effective way of accessing their data faster despite infrastructure challenges and lack of internet in the area that is facing some internet connectivity issues within Kenya. Regarding our Kenya operators which are national, it will be difficult for someone who is outside Kenya to access the system through our USSD.

Chapter 2: Literature Review

2.1. Introduction

A literature review can broadly be described as a more or less systematic way of collecting and synthesizing previous research (Snyder, 2019). Currently Strathmore University is using an application that facilitates Strathmore University students to access their data through the use of internet. Internet has placed itself as one of the centres of information that can be accessed from various places without being limited by space and time (Storm & al., 2017).

2.2. Description of current MyStrath app

This application enables a current student to view his/her student profile, the financial details for the degree (s) he has enrolled for. The student can also view the courses enrolled in, attendance to classes, timetable for his/her courses and any library overdue charges. The application also provides links to the university website and social media accounts. Users must log in to access the features of the application. This is the application that has been helping current students from Strathmore University to access their details very fast through the help of the internet. It provides student details as it appears in AMS student's module in the Strathmore University website. Users of the application download it from the play store. The beauty of the application is that it keeps on improving all the time. Students who are even outside the country can easily access the Strathmore University system without having any trouble. This has helped students to be aware of their academic activities and motivates them to work harder towards the exams since they know in which area they need to improve their school performance. As long as you have internet; accessing MyStrath application is very fast and simple.

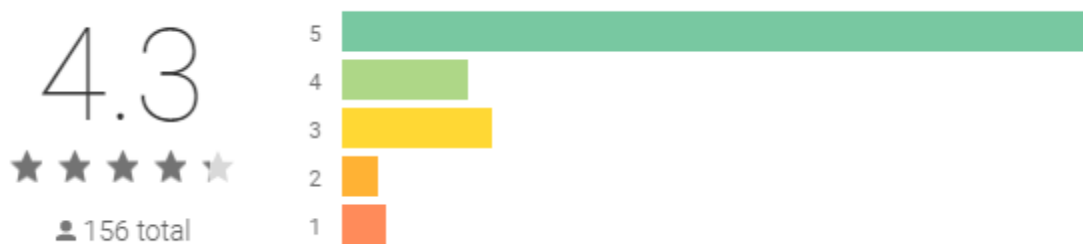


Figure 1: review of MyStrath app

5* means excellent

4* means good

3* means neutral

2* means bad

1* means worst

2.3. Challenges experienced with MyStrath app

Smart phones have become a primary device to access the Internet. (Iqbal & Bhatti, 2020) For you to be able to use MyStrath app you are recommended to have a smart phone so that you can be able to access the application as you retrieve any information about Strathmore University student. There for without a smart phone, since it requires internet to access Strathmore University system; you won't be able to see Strathmore University students' details with MyStrath app, you are unable to enrol units you should be undertaking at the beginning of the semester since MyStrath app doesn't give you the

option of self-registering the units. students registering late may underperform in achieving their eLearning outcomes because of the lack of commitment, engagement, or motivation and also due to the lack of self-selection options.(Pathak, 2019) Areas that might have internet connectivity issue would really not help you to access your details as MyStrath app user.

2.4. Solution proposed to the current system

MyStrath USSD is the proposed solution to the current system because a USSD based reporting systems offer a scalable and affordable approach to provision of accurate, timely and complete reports. USSD is a protocol defined inside the Global System for Mobile Communications (GSM) standard.(Perrier & al., 2015) when you dial a shortcut like *120*1234#, that request is actually sent to telecom; it can be either Safaricom or orange or Airtel or any other operator handset; let's use an example with Safaricom; so when Safaricom receives that request, they are going to match the application that is mapped to this shortcut or service code, so when they get the application they will just forward that request using http server. Therefore the session id will be needed as to prevent the collision; for example if they are multiple users who are in the same session, each of the sessions will be given different id and also you will need a phone number, the network code is not mandatory, and you need the service code as well as text what you will actually input to welcome you to the application. Each telecom network provides their own unique USSD code for their customers to use, so each telecom USSD code are different from each other if different customers input the same USSD code.(Mallik & al., 2020) USSD works in similar ways like client; it's a client-server paradigm where the client (phone) makes request via USSD code to GSM network that in turn contacts the appropriate remote application server. The server responds with data back to the phone and this interaction can go on for up to 180 seconds.

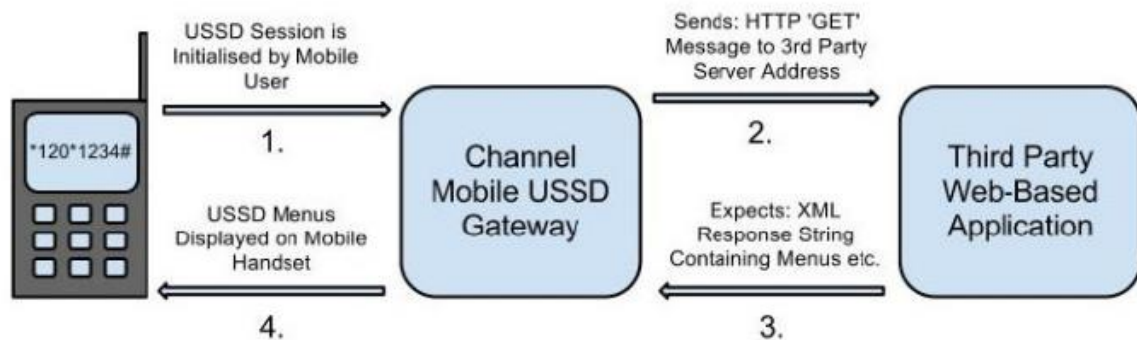


Figure 2: request is sent from mobile phone to a telecom network

USSD notifications and menus can dramatically improve the user's experience, giving you the ability to quickly and cost effectively send essential and useful alerts to engage in interaction and send important information.(Owusu & al., 2018) The quickness and responsiveness ability of Unstructured Supplementary Service Data allows the operator to provide fast and responsive services. You can use USSD cashless option if you don't have a smart phone or internet connection.(N. & al., 2017) the beauty about using USSD app is that, it is a two way communication which is up to 7 times faster than short message service and it has an intuitive menu with real time interactivity.

2.5. Related work

USSD can be used for WAP browsing, prepaid call back service, mobile money services, location-based content services, menu-based information services, or even as part of configuring the phone on the network. Use of various combinations of authentication technologies has been proposed to increase the security of systems. The use of graphical passwords for authentication has also been widely explored.(Kinai &al., 2020) Another important feature of a secure system is its ability to detect fraudulent transactions. Fraud detection in credit card and e-commerce transactions has been explored in using machine learning techniques. They used labelled past transactions (fraudulent and non-fraudulent) to train machine learning models that are able to flag new fraudulent transactions when they are carried out.(Kinai & al., 2020)

Chapter 3: System Development Methodology

3.1. Introduction

System development methodology provides a framework for planning, executing, and managing the process of developing software systems.(Okonkwo & Huisman, 2018) It is defined as the formalized approach to implementing system development life cycle. To overcome the above-mentioned problem, we introduce the efficient USSD Based Data Collection System; the system is a USSD and a WEB Application. The proposed system uses a client-server-based network model for communication between the web application server and the mobile application and web application backend.

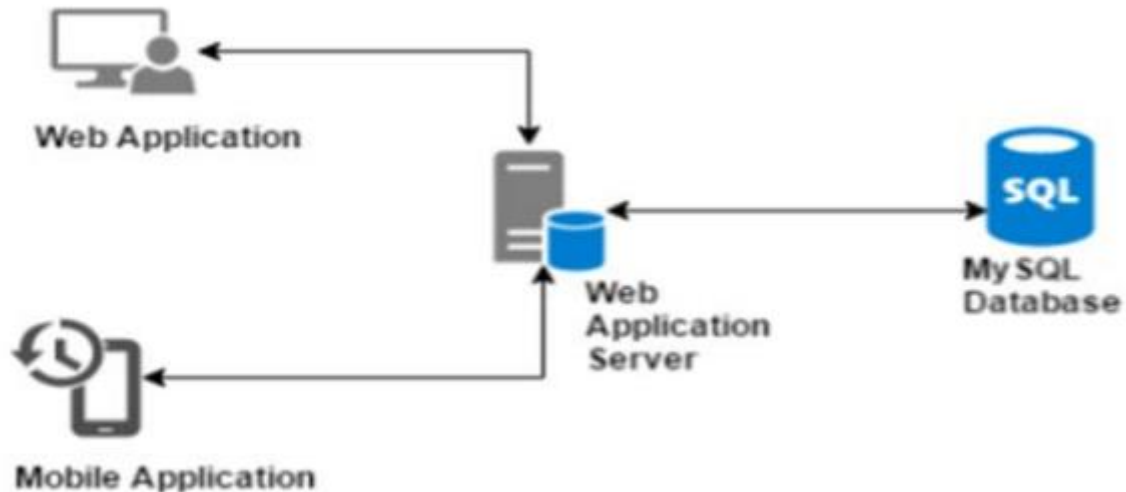


Figure 3: Client Server Model

3.2. Description of client –server model

The client-server model, or client-server architecture, is a distributed application framework dividing tasks between servers and clients, which either reside in the same system or communicate through a computer network or the Internet. The client requests while the server supplies the administration.(Garg & al., 2019) The client relies on sending a request to another program in order to access a service made available by a server. The server runs one or more programs that share resources with and distribute work among clients. In order to process the AJAX requests sent from the client to the server, the server needs information where the requests will arrive and how the requests should be handled. Each request needs to be routed to a specific URL.(Weber & al., 2019) The client server relationship communicates in a request–response messaging pattern and must adhere to a common communications protocol, which formally defines the rules, language, and dialog patterns to be used. Client-server communication typically adheres to the TCP/IP protocol suite. According to TCP/IP protocol suite, the data are divided into small fragments, also known as packets. These packets contain the data and addresses of the source and destination for communication among endpoints.(Badshah & al., 2017)

TCP/IP model is divided into four layers and each layer works using a variety of protocols with specific functions.(Alotaibi & al., 2017) TCP protocol maintains a connection until the client and server have completed the message exchange. TCP protocol determines the best way to distribute application data into packets that networks can deliver, transfers packets to and receives packets from the network, and manages flow control and retransmission of dropped or garbled packets. IP is a connectionless protocol in which each packet travelling through the Internet is an independent unit of

data unrelated to any other data units. Every object connected to internet, it mean every object must use TCP/IP protocol suite which plays an important role to drive Internet.(Godhankar & al., 2015) Client requests are organized and prioritized in a scheduling system, which helps servers cope in the instance of receiving requests from many distinct clients in a short space of time. The client-server approach enables any general-purpose computer to expand its capabilities by utilizing the shared resources of other hosts. Popular client-server applications include email, the World Wide Web, and network printing. Targeting Web-applications, technologies from the domain of Linked Data and Semantic Web have been found suitable to decouple clients from servers (Spieldenner & Schubotz, 2020)

3.3. Categories of Client-Server Computing

There are four main categories of client-server computing:

- i. One-Tier architecture: consists of a simple program running on a single computer without requiring access to the network. A typical one-tier architecture in manufacturing is composed of individual workstations, such as manufacturing equipment or computers, that both provide and consume data and information (Helu & al., 2017) User requests don't manage any network protocols, therefore the code is simple and the network is relieved of the extra traffic.
- ii. Two-Tier architecture: consists of the client, the server, and the protocol that links the two tiers. the two-tier architecture is shown to be superior to the one-tier architecture in terms of the energy transfer efficiency and the system's realization complexity.(Zhou & al., 2020) The Graphical User Interface code resides on the client host and the domain logic resides on the server host. The client-server GUI is written in high-level languages such as C++ and Java.
- iii. Three-Tier architecture: consists of a presentation tier, which is the User Interface layer, the application tier, which is the service layer that performs detailed processing, and the data tier, which consists of a database server that stores information. It is supposed that a single server has the ability to serve multiple clients.(Barabanova &al., 2019)
- iv. N-Tier architecture: divides an application into logical layers, which separate responsibilities and manage dependencies, and physical tiers, which run on separate machines, improve scalability, and add latency from the additional network communication. N-Tier architecture can be closed-layer, in which a layer can only communicate with the next layer down, or open-layer, in which a layer can communicate with any layers below it. n-tier architecture helps in more efficient software reengineering.(Stojkov & al., 2020)

Microsoft MySQL Server is a popular example of three-tier architecture, consisting of three major components: a protocol layer, a relational engine, and a storage engine. Any client machines that connect directly to SQL Server must have a SQL Server client installed. MySQL database helps you to add, access, and process the data stored in the database.(Christudas, 2019) Microsoft's Client-Server Runtime Process helps manage the majority of the graphical instruction sets on Windows operating system.

3.4. Difference between Client and Server

Clients, also known as service requesters, are pieces of computer hardware or server software that request resources and services made available by a server. Client computing is classified as Thick, Thin, or Hybrid.

- i. **Thick Client:** a client that provides rich functionality, performs the majority of data processing itself, and relies very lightly upon the server. s. By providing functionality for both, thin-client and thick-client applications, the system scales for client devices that are vastly different in computing capabilities (Discher & al., 2018).
- ii. **Thin Client:** a thin-client server is a lightweight computer that relies heavily on the resources of the host computer -- an application server performs the majority of any required data processing. Nowadays ,cloud based services are mostly accessed from thin client therefore future cloud based security solutions should be thin client friendly (Khan & al., 2018).
- iii. **Hybrid Client:** possessing a combination of thin client and thick client characteristics, a hybrid client relies on the server to store persistent data, but is capable of local processing. The hybrid client/server architecture provides a system in which natural language expressions may be evaluated both locally and by a remote service (Le & al., 2020).

A server is a device or computer program that provides functionality for other devices or programs. Any computerized process that can be used or called upon by a client to share resources and distribute work is a server. Some common examples of servers include:

- i. **Application Server:** hosts web applications that users in the network can use without needing their own copy. Software application servers, examples of which include Oracle WebLogic Server (WLS) and Glassfish, generally provide a managed environment for running enterprise software applications.(Hopkins & al., 2018)
- ii. **Computing Server:** shares an enormous amount of computer resources with networked computers that require more CPU power and RAM than is typically available for a personal computer. computing servers located in the network edge might provide services at reduced latency and energy cost, compared to the remote cloud (Ranadheera & al., 2017).
- iii. **Database Server:** maintains and shares databases for any computer program that ingests well-organized data, such as accounting software and spreadsheets. In network environments where database servers can receive a large number of queries, the database servers can spend a lot of resources to service each query (Sah & Joshi, 2020).
- iv. **Web Server:** hosts web pages and facilitates the existence of the World Wide Web.

3.5. Difference between Server Side Programming and Client Side Programming

Creating mobile applications often requires both client and server-side code development (Baldini & al., 2016). Server-side programming refers to a program that runs on the server and focuses on the generation of dynamic content. Server-side programming is used for querying and interacting with the database, accessing files on a server, interacting with other servers, processing user input, and structuring web applications. Popular programming languages for server-side programming include C++, Java and JSP, PHP, Python, and Ruby on Rails. server-side programs are much longer-lived than client-side programs, with normal lifetimes spanning thousands or millions of events.(Davis & al., 2017) Client-side programming refers to a program that runs on the client machine and focuses on the user interface and other processes such as reading and/or writing cookies. client-side web applications, so-called “web apps”, are becoming increasingly common for querying, browsing, visualizing and analyzing scientific data.(Abriata & al., 2018) Client-side programming is used for sending requests to the server, interacting with local storage, interacting with temporary storage, creating interactive web pages, and functions as an interface between client and server. Popular programming languages for client-server programming include AJAX, CSS, HTML, Javascript, and VBScript.

3.6. Benefits of Client-Server Model

Organizations often seek opportunity to maintain services and quality competition to sustain its market position with the help of technologies. Deployment of client-server computing in organization will effectively increase its productivity through the usage of cost-effective user interface, enhanced data storage, vast connectivity and reliable applications services

- i. Improve data sharing: data is retained by usual business process and manipulated on a server is available for designated users (clients) over an authorized access.
- ii. Integration of services: every client is given the opportunity to access corporate information via desktop interface eliminating the necessity to log into a terminal mode or processor.
- iii. Data processing ability despite the location: client-server users can directly log into a system despite of the location or technology of the processors.
- iv. Easy maintenance: client-server architecture is distributed model representing dispersed responsibilities among independent computers integrated across a network. Therefore, it's easy to replace, repair, upgrade and relocate a server while client remains unaffected.
- v. Security: server have better control access and resources to ensure that only authority client can access or manipulate data and server updates are administered effectively.

3.7. Disadvantages of Client-Server Model

- i. Overloaded server: when there are frequent simultaneous client requests, server severely gets overloaded, forming traffic congestion.
- ii. Impact of centralized architecture: since it is centralized, if a critical server failed, client requests are not accomplished. Therefore, client-server lacks the robustness of a good network.

3.8. Deliverables

The system proposes the facility to access Strathmore system using SSD. There are various tasks that the developed system give facility to, and that depends on each users' role:

3.8.1. Student Module

The student will be able to:

- View Attendance
- View marks
- View Strathmore info
- Give a comment

3.8.2. Teachers' Module

The Teacher will be able to:

- Update marks
- Update Attendance
- View student's marks
- View student's attendance

3.8.3. Admin Module

The Admin will be able to:

- Add/delete a Teacher
- Add/delete a student
- Create/delete a subject
- Create/delete a course

3.9. System Design Tools

- i. **PHP (Hypertext Preprocessor)** is a widely-used open source general-purpose scripting language that is especially suited for web development and can be embedded into HTML (The PHP Group, 2017).
- ii. **HTML (the Hypertext Markup Language)** is the language that provides the structure of a web page (W3C Organization, 2017).
- iii. **JavaScript** is a programming language used to make web pages interactive. It runs on your visitor's computer and does not require constant downloads from your website (Chapman, 2016).
- iv. **JavaScript Object Notation (JSON)** is a lightweight format based on the data types of the JavaScript programming language.
- v. **CSS** is the language for describing the presentation of Web pages, including colours, layout, and fonts. It allows one to adapt the presentation to different types of devices, such as large screens, small screens, or printers. CSS is independent of HTML and can be used with any XML-based markup language (W3C Organization, 2017).
- vi. **MySQL** is a popular choice of database use with web applications, and is a central component of the {traditionally used XAMPP. My SQL is also used in many high-profile, large-scale websites, including Google.
- vii. **XAMPP:** is a completely free, easy-to-install Apache division containing MySQL, PHP, and Perl. The XAMPP wide open source package has recently been set up to be incredibly easy to set up also to use. XAMPP allows website designers and developers to test their work on their own computer systems without Internet connection. In practice, yet, XAMPP is often used to help web pages on the web. A special built-in tool is provided to password-protect the main parts of the package. XAMPP is a perfect solution for web-developers, programmers or admins as it provides all the tools essential for their work.

Postman is a powerful GUI (Graphical user interface) platform to make your API development faster & easier, from building API requests through testing, documentation and sharing. (Liotiris, 2018) It was designed from the group up, to support all aspects of API development. Postman's apps are built on a single underlying layer, ensuring consistent performance and user experience. Postman has features for every API developer: request building, test and pre-request scripts

Chapter 4: System Analysis and Design Description

4.1. Introduction

Modelling methods have been proven to provide beneficial instrumental support for different modelling tasks during information system analysis and design. (Sandkuhl & Seigerroth, 2019) This chapter describes how data flow diagrams are developed using good style conventions. It also discusses the idea of levelling of data flow diagrams step by step for developing high quality information. Through the help of object-oriented analysis and design, the propose project will use diagrams as follow: use case diagram, class diagram, sequence diagram, entity relationship diagram and finally database schema

4.2. Requirement Gathering

Requirement gathering is an important step in the construction of any project, it imposes tedious work on the side of the system administrator. (AlZu'bi & al., 2018) The goals of a software system requirement gathering techniques are to identify the stakeholders, their needs, documentation and successful subsequent implementation. The requirement gathering process is a human centric process. Thus, it needs to include the behaviour or skills of the people that directly or indirectly involved with the software project (Tiwari & Rathore, 2017). It involved analysing and interaction with the different users of the system to be able to know on what specific task will be accomplished by the system and how the user will be an actor to the different types of task putting in mind that the different users of the system will not perform the same function together but will require some indirect type of relationship for some actions to be fulfilled. There are different methods used by researchers to gather and understand the system requirement and some of these methods include use of questionnaires, observation, documentation review, interviews, brainstorming, and personal experience and among others. Some of these methods proved effective to our requirements identification

4.3. System Requirements

Requirement analysis is involved with the customer objectives and their needs. This is the background for the function of system in standard system attribute, which are determined requirements, environment and plan (Gunawardhana, 2019). Software requirement analysis is basically the functional and non-functional requirements of the system. The system requirements are divided into functional and non-functional. The functional requirements elaborate the requirements that are crucial to the basic functioning of the systems towards fulfilling its main purpose, while the non-functional are those that serve as supplementary to the core functions in making the use of the system better for the users it serves.

4.3.1. Functional Requirements

The functional requirements of the system include the core actions. They will elaborate the requirement itself, the actor who performs it and any conditions that must be met to fulfil the requirement.

ID	Requirement	Actor	Occurrence
F01	User Registration	administrator	The administrator will enter the user data into the system to generate their access credentials
F02	Authentication of users	All users	Once the correct credentials are provided the system will enable the users access
F03	Access control	All users	Depending on the user type the system will display content relevant to their access type

F04	Viewing records	Administrators	The system will enable the administrators to view records of all the lectures and students registered once logged in
F05	Assign students' marks	Lectures	Lectures will have the ability to view and assign marks to students
F06	View fee balance	Students	Students will be able to view their respective fee balances once they have logged in
F07	Unit registration	Students	Users will be able to self-register for new units after they have logged in
F08	View attendance	Students	Students will be able to view their attendances once they have logged in

4.3.2. Non-Functional Requirements

The non-functional requirements of the system include the supplementary actions. They will elaborate the requirement itself, the actor who performs the requirement and any conditions that must be met to fulfil the requirement.

<u>ID</u>	<u>Requirement</u>	<u>Actor</u>	<u>Occurrence</u>
NF01	Password security	All users	The system should provide secure authentication through the use password hashing algorithms
NF02	Authentication	All users	The system should provide secure authentication using users' telephone numbers as unique ID
NF03	User friendly system layout	All users	The system clearly space out the various component links allowing users to access the various sections containing similar system components for ease of access.
NF05	System availability	All users	Given the systems ussd-based platform the server hosting the database will ideally be up at all required times to ensure constant system availability
NF06	Mass data storage	All users	The system will ensure that even with large sums of data it still displays the data correctly and accurately when needed

4.4. System Architecture

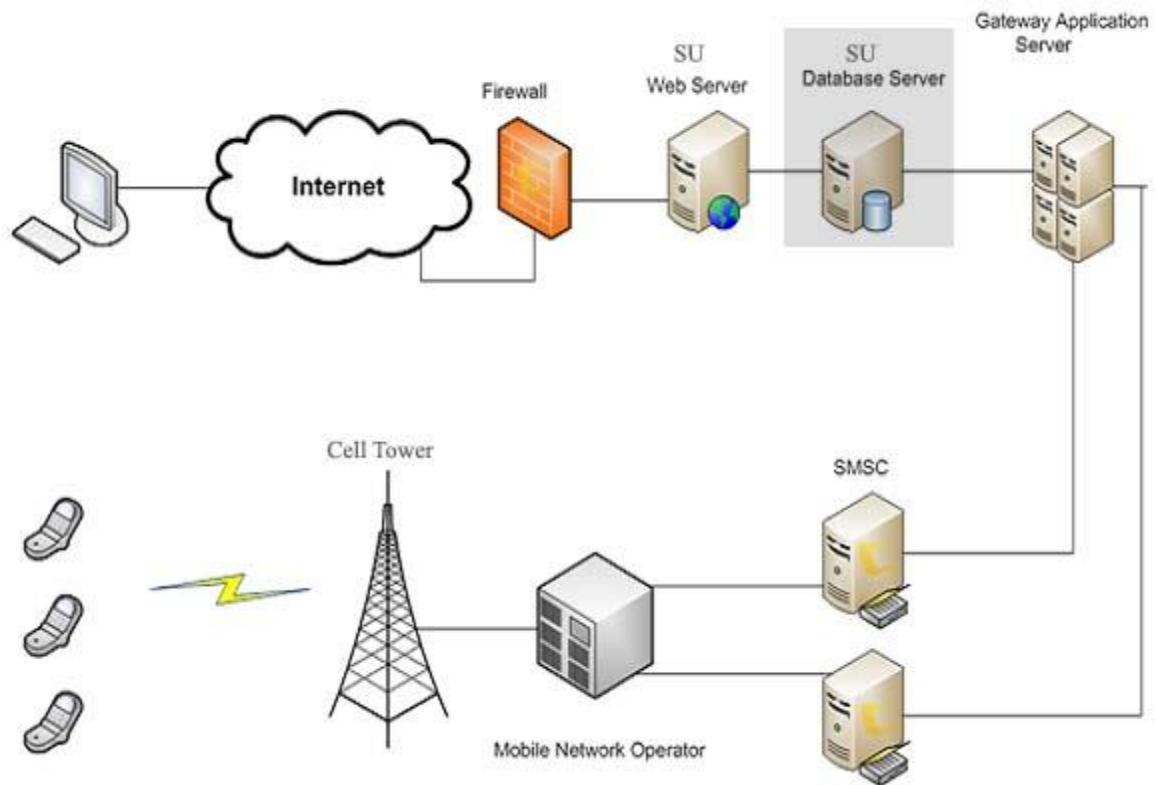


Figure 4.4 system architecture

4.5. Use Case Diagram

OMG (Object Management Group) defines a Use Case Diagram as the specification of a set of actions performed by a system, which yields an observable result that is, typically, of value for one or more actors or other stakeholders of the system. (Brazil. & al., 2017) Sometimes to describe a system it is necessary to modularize the behaviours and the software scenarios, and therefore a use case can extend and/or include other use cases.

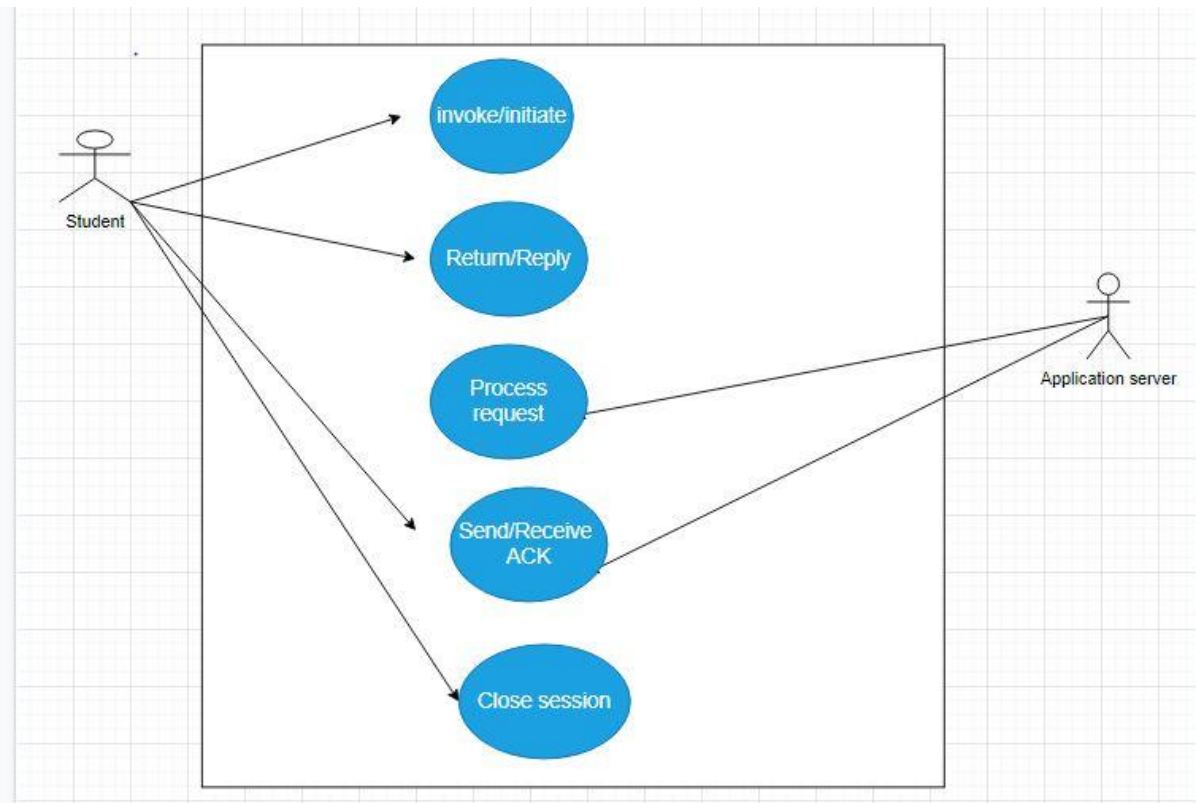


Figure 4.4 Use case diagram

4.6. Class Diagram

The class diagram is considered to be the backbone of every object-oriented design. It describes a high level static structure of the software system and is widely used for transformation.(Shaikh & Wiil, 2018).

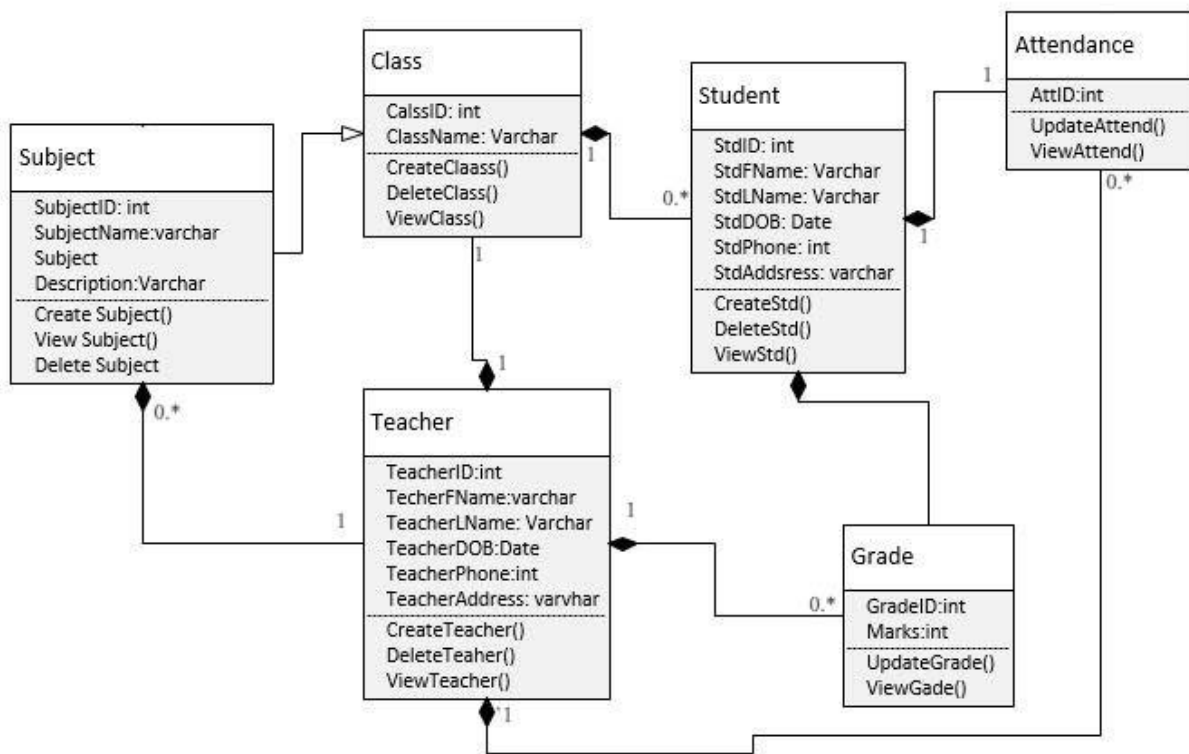


Figure 4.5 Class diagram

4.7. Activity diagram

Activity diagram (AD) describes the flows of activities and actions of the system. Activity diagram is another important diagram in UML to describe the dynamic aspects of the system. Activity diagram is basically a flowchart to represent the flow from one activity to another activity.

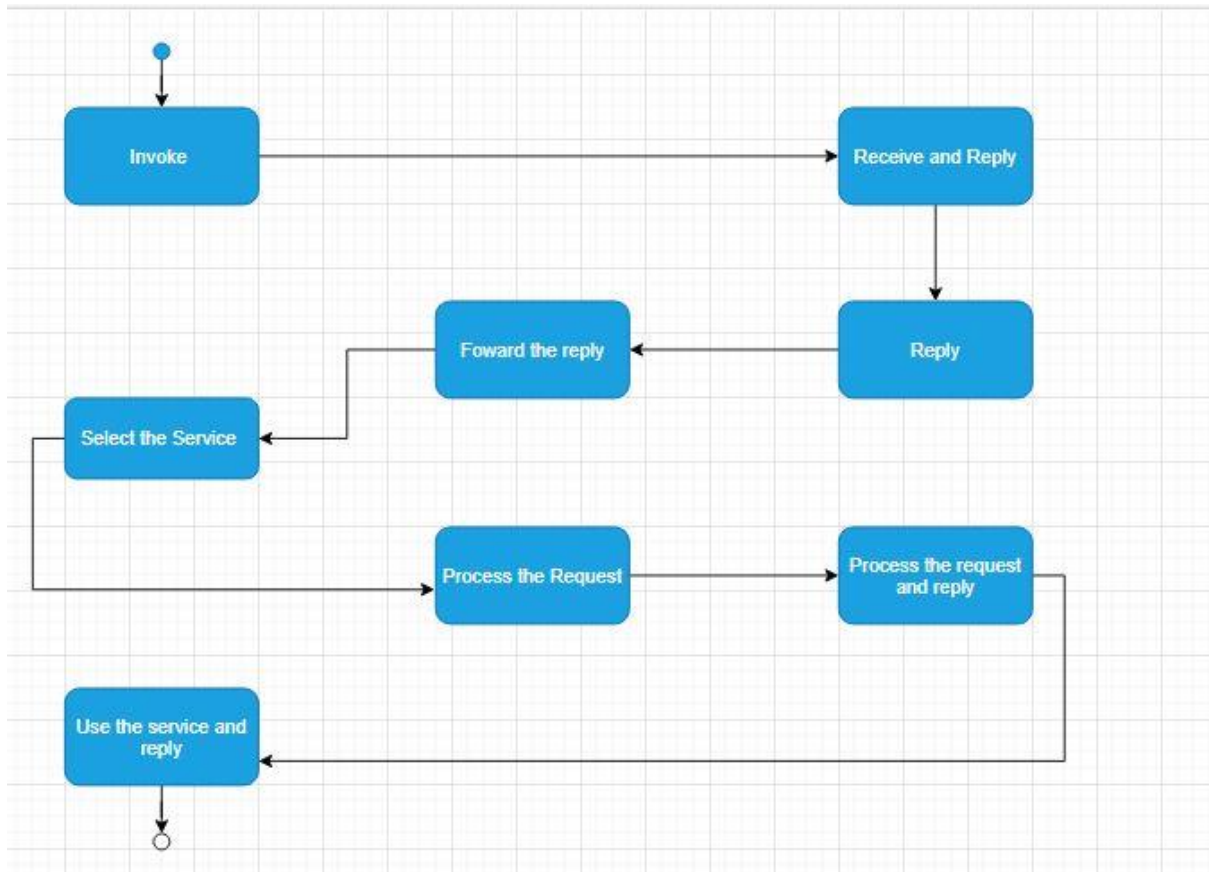


Figure 4.6 Activity diagram

4.8. Entity Relationship Model

An entity relationship diagram (ERD) is a graphical representation of an information system that depicts the relationships among people, objects, places, concepts or events within that system (Rouse, 2018).

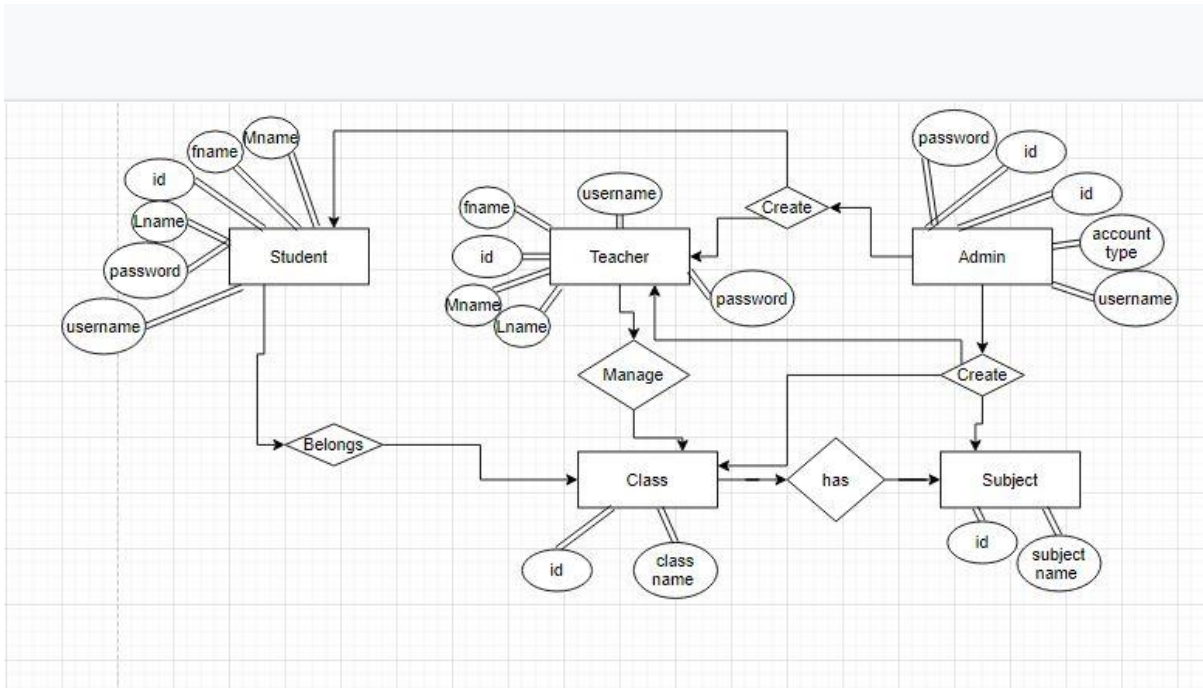


Figure 4.7 Entity Relationship Model

4.9. Database schemas

Database schema design is studied qualitatively, targeting the efficient processing of frequent queries and updates. In classical schema design, update inefficiencies are avoided by removing data redundancy caused by functional dependencies (FDs). (Link & Prade, 2016) Schema matching is considered as one of the essential phases of data integration in database systems. (A. & al., 2017) the main aim of the schema matching process is to identify the correlation between schemas which helps later in the data integration process.

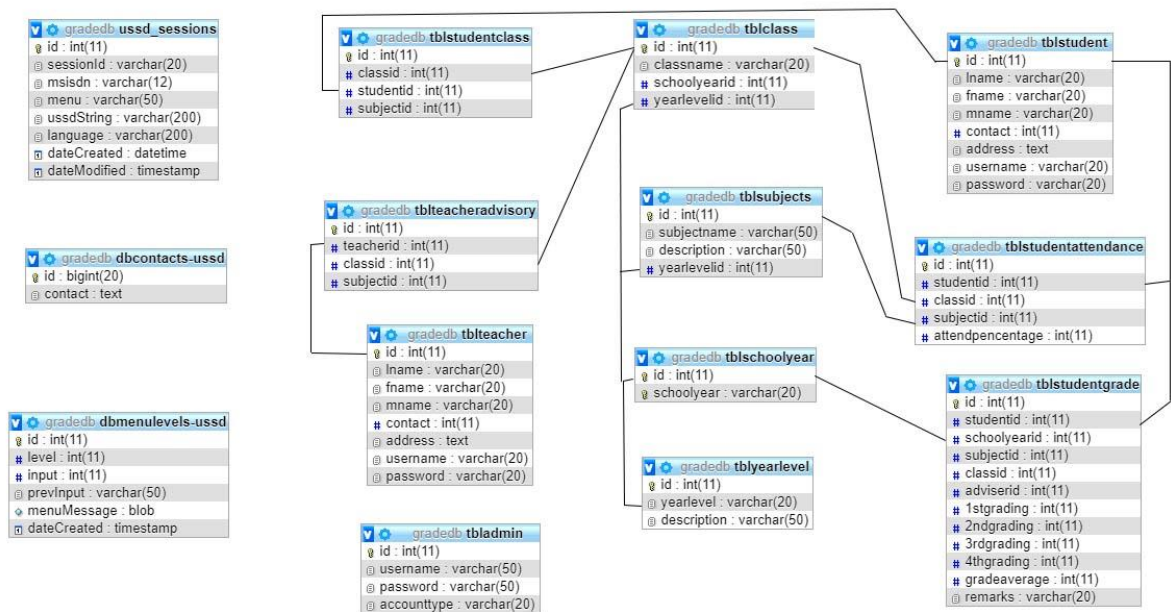


Figure 4.8 Database schemas

Chapter 5: System Implementation and Testing

5.1. Introduction

System Implementation uses the structure created during architectural design and the results of system analysis to construct system elements that meet the requirements developed in the early life cycle phase. (SEBoK, 2018) Systems implementation is the process of defining how the information system should be built (i.e., physical system design and software), ensuring that the information system is operational and meets quality standard. System testing is a level of the software testing process where a complete, integrated system/software is tested. (Honest, 2019) The purpose of this test is to evaluate the system's agreement with the specified requirements and Acceptance testing is a level of the software testing process where a system is tested for acceptability.

5.2. System Installation Procedure

Since our system is a web based system that is being incorporated with the unstructured supplementary service data, we shall therefore use postman to test how our system shall be interacting with its different component. For optimum functionality the system's minimum hardware requirements should be:

- i. Processor (CPU) with 2 gigahertz (GHz) frequency or above
- ii. A minimum of 2 GB of RAM
- iii. Monitor Resolution 1024 X 768 or higher
- iv. A minimum of 20 GB of available space on the hard disk
- v. Keyboard and a Microsoft mouse or some other compatible pointing device.
- vi. Internet connection Broadband (high-speed) internet connection with a speed of 4 Mbps or higher.

For efficient functionality, the system's minimum software requirements should be:

- i. An operating system which is either windows 7 or higher version and MaC osx 10.8 or higher version.

- ii. Microsoft office word
- iii. Xampp server which allows in transitioning from a local test server to a live server possible.
- iv. Notepad++ IDE
- v. Browsers: Google chrome, Mozilla Firefox, Internet Explorer and Safari 6+.

5.3. System Manual

This section will help us to illustrate and provide in form of screen shots of different modules of the system and how it performs different functionality. This will include the backend and the frontend of system. The frontend is typically the part of the application that the users sees and interacts with, while the backend is usually the part of the application that contains the business logic and the data storage. Different modules of the system are shown below:

- i. **Student:** This section will allow students to view their grades, attendance, unit registered, school fees, contact us, compliments about the service offered.

the image below displays the areas students have access to:

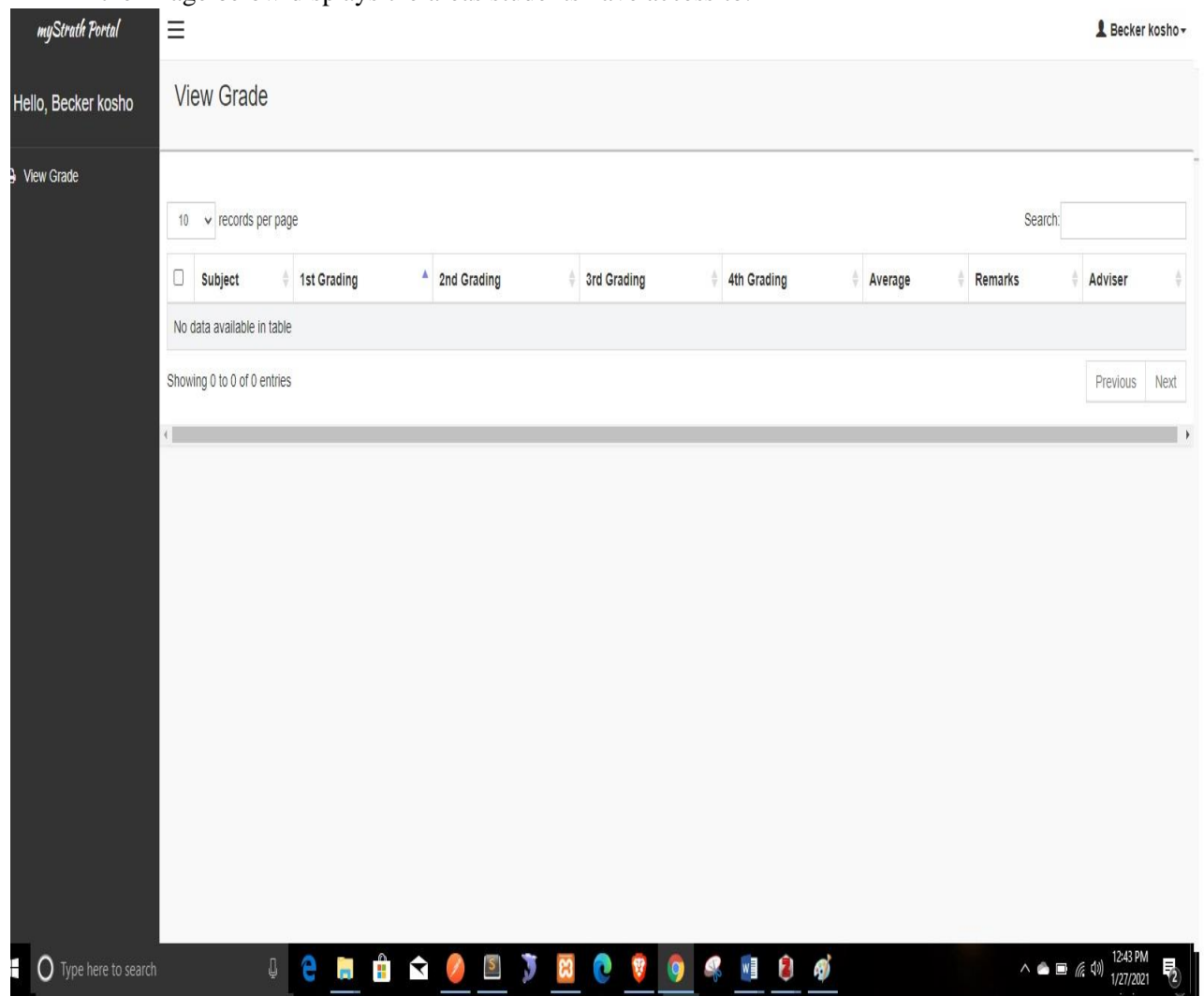


Figure 5.3.1: Student Interface

- ii. The admin will be in charge of managing all the users of the system. In addition, he/ she will be able to manage recipes posted and check reports of the system. In this module the admin will be able to perform CRUD operation to different section of the system. The image below displays the areas facility level administrators have access to.

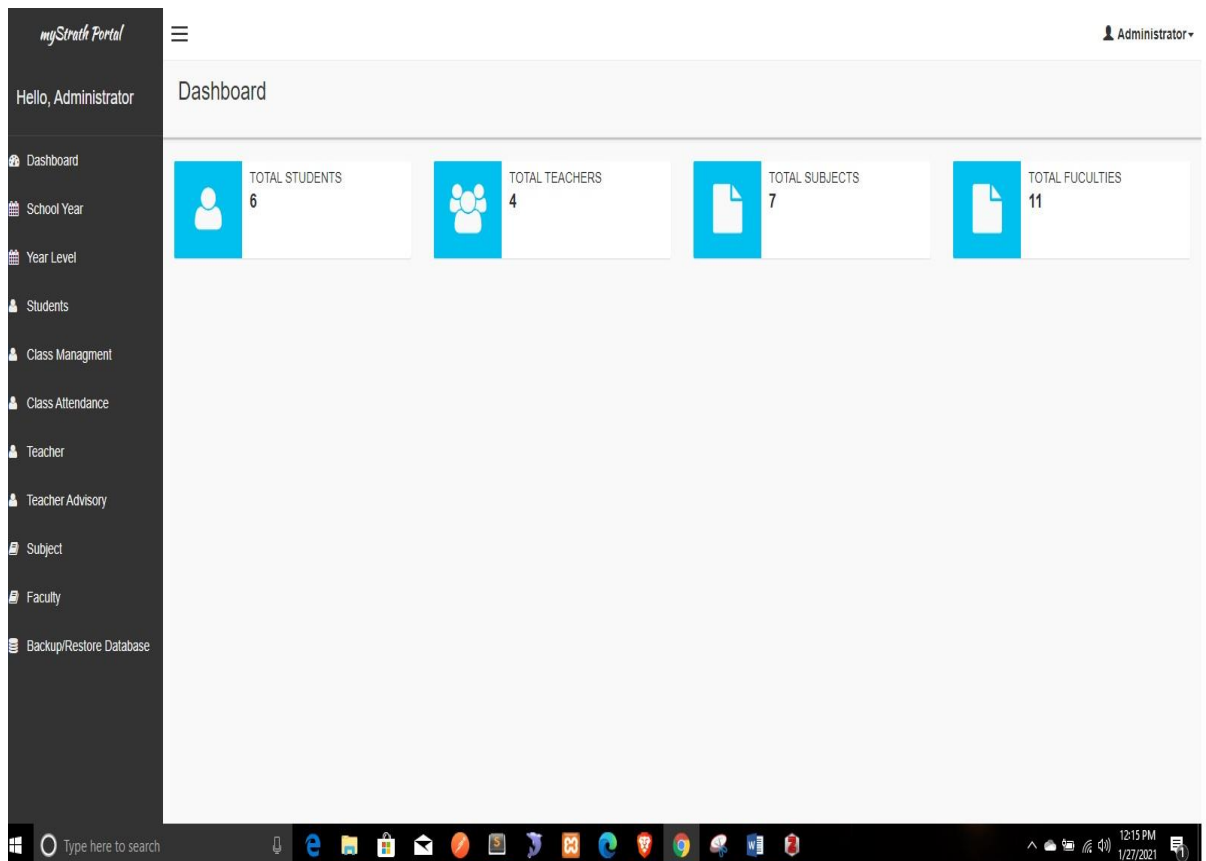


Figure 5.3.2: Admin Interface

- iii. **Lecture:** this section shall allow lecturer to updates students grades, attendance as to keep on tracking the performance of the students which will help students to be aware of how they are performing at school. The image below displays the areas county level teachers have access to:

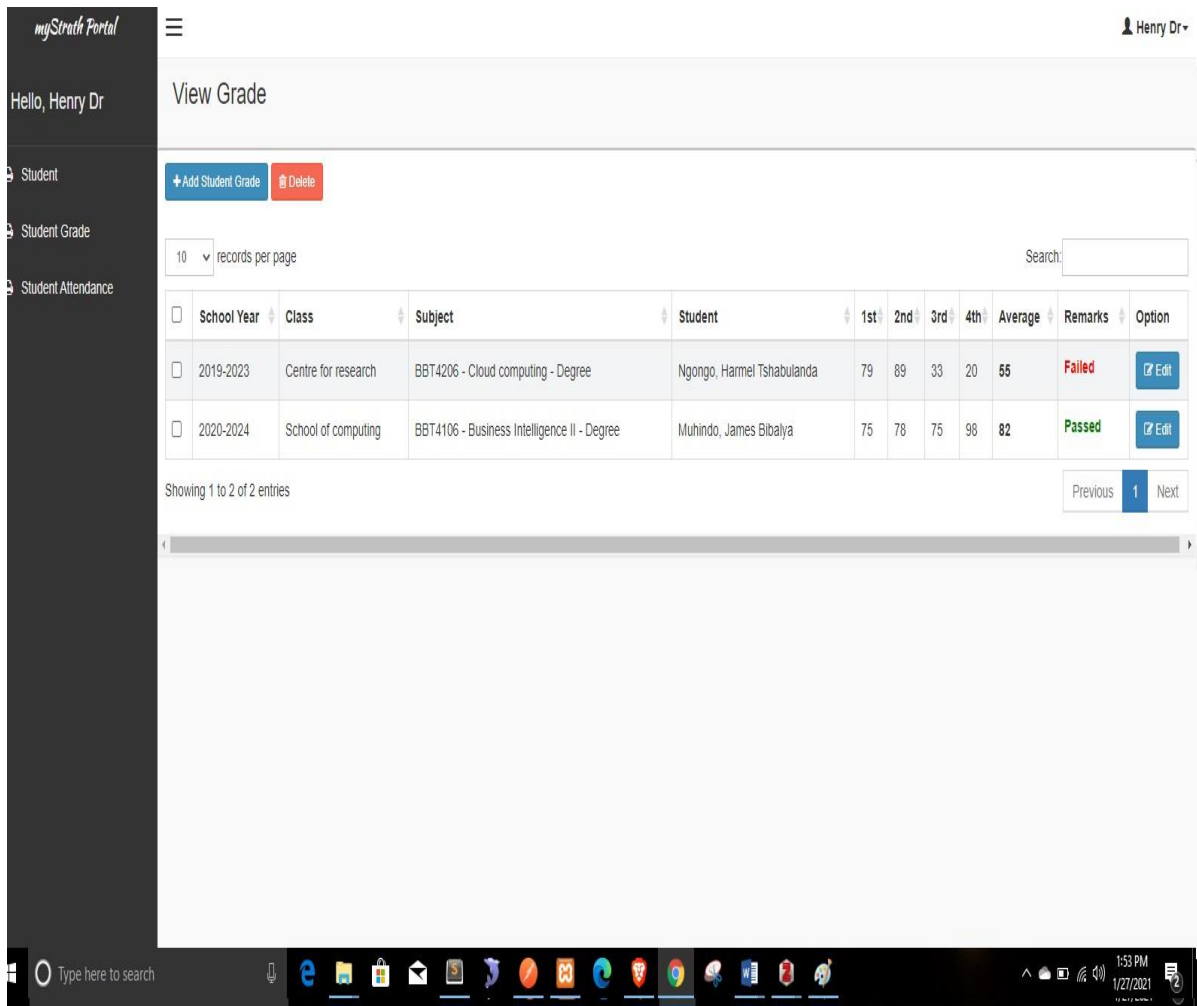


Figure 5.3.3: Lecture Interface

- iv. **MyStrath USSD:** This section will allow students to have a complete access to their data from the Strathmore University without having to worry about the lack of internet in the area he or she is found using Unstructured Supplementary Service Data. As long as students have telephones either smart phones or feature phones, they shall be able to access their data as well as registering units they are undertaking during the semester at ease.

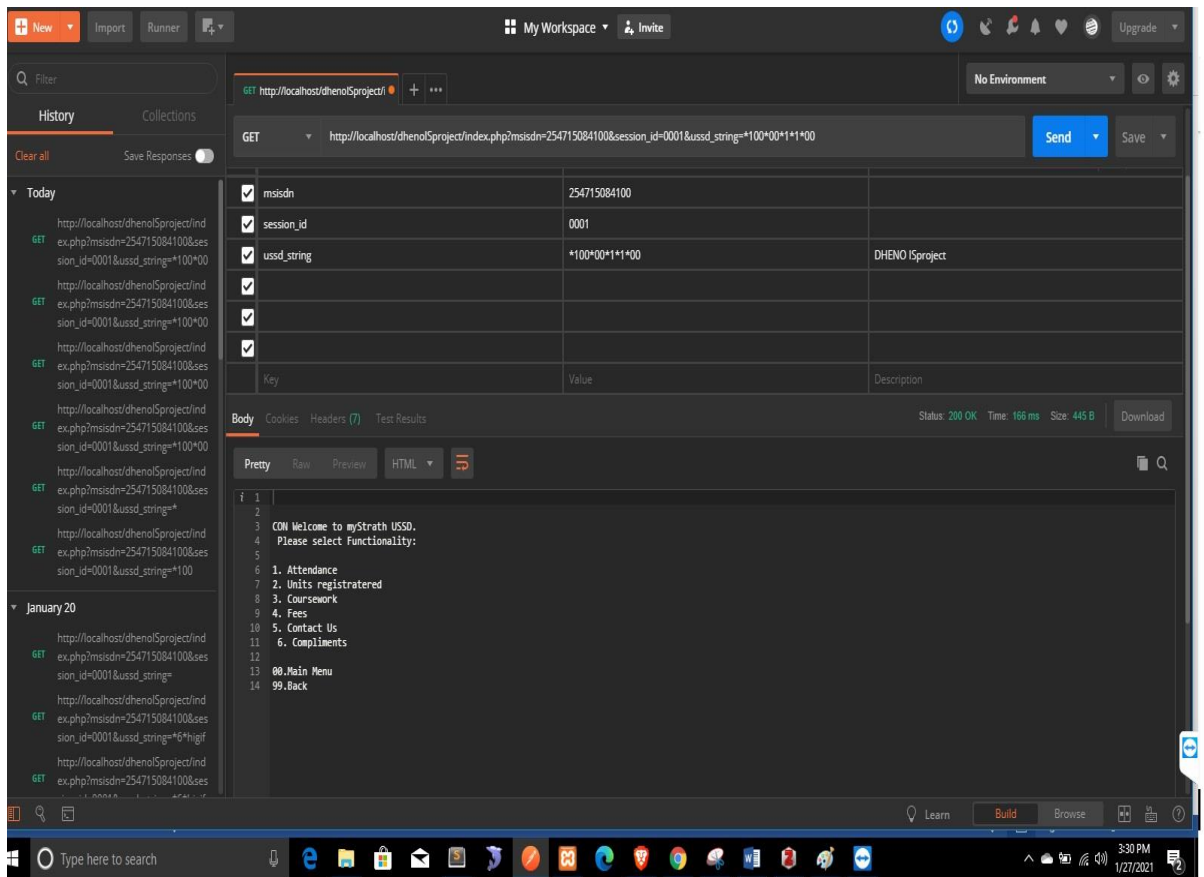


Figure 5.3.4 Mystrath USSD interface

- v. **Attendance module on MyStrath USSD:** this is the section that will allow students to view number of classes they attended as well as the complaints that they may rise concerning the attendance issues. The image is displayed below :

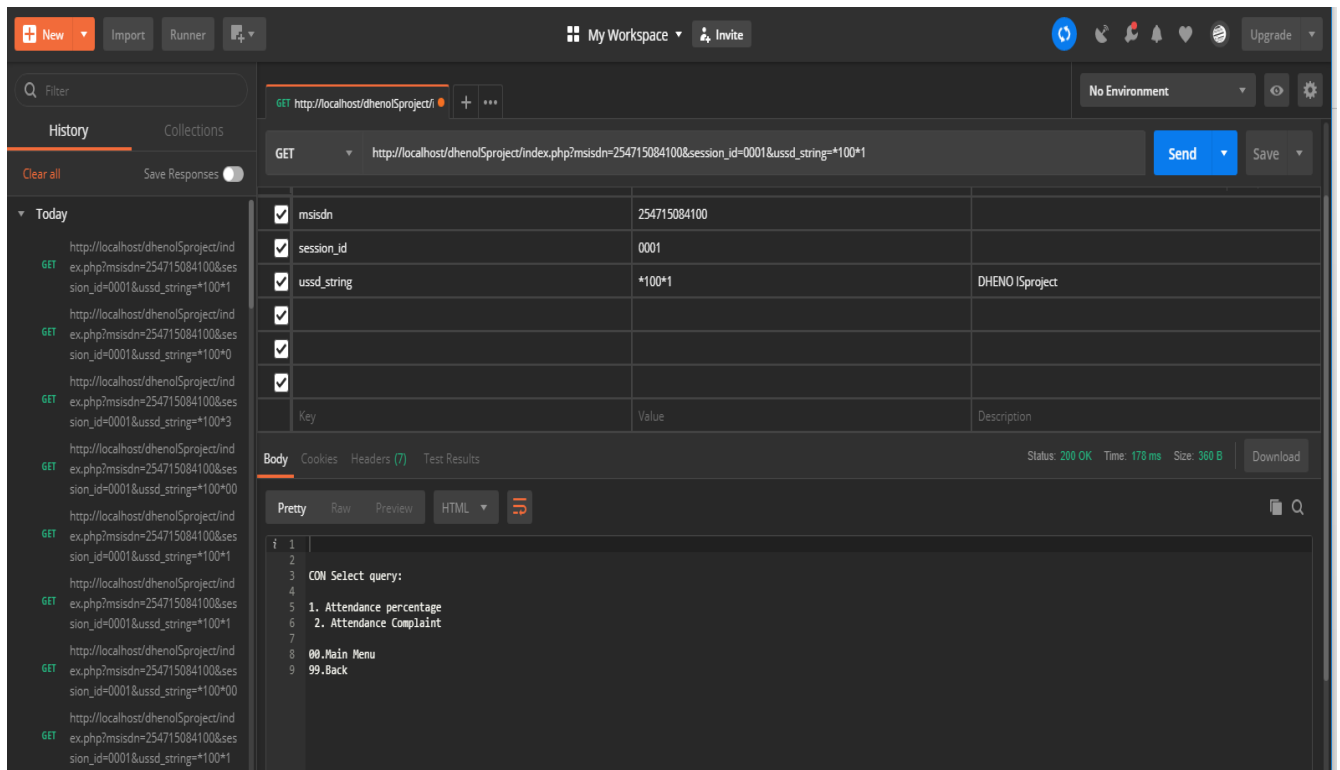


Figure 5.3.4 Attendance module on MyStrath USSD

- vi. **Units registered module on MyStrath USSD:** this is the module that represent the units registered in the system that students shall be undertaking during the semester. The image is displayed below:

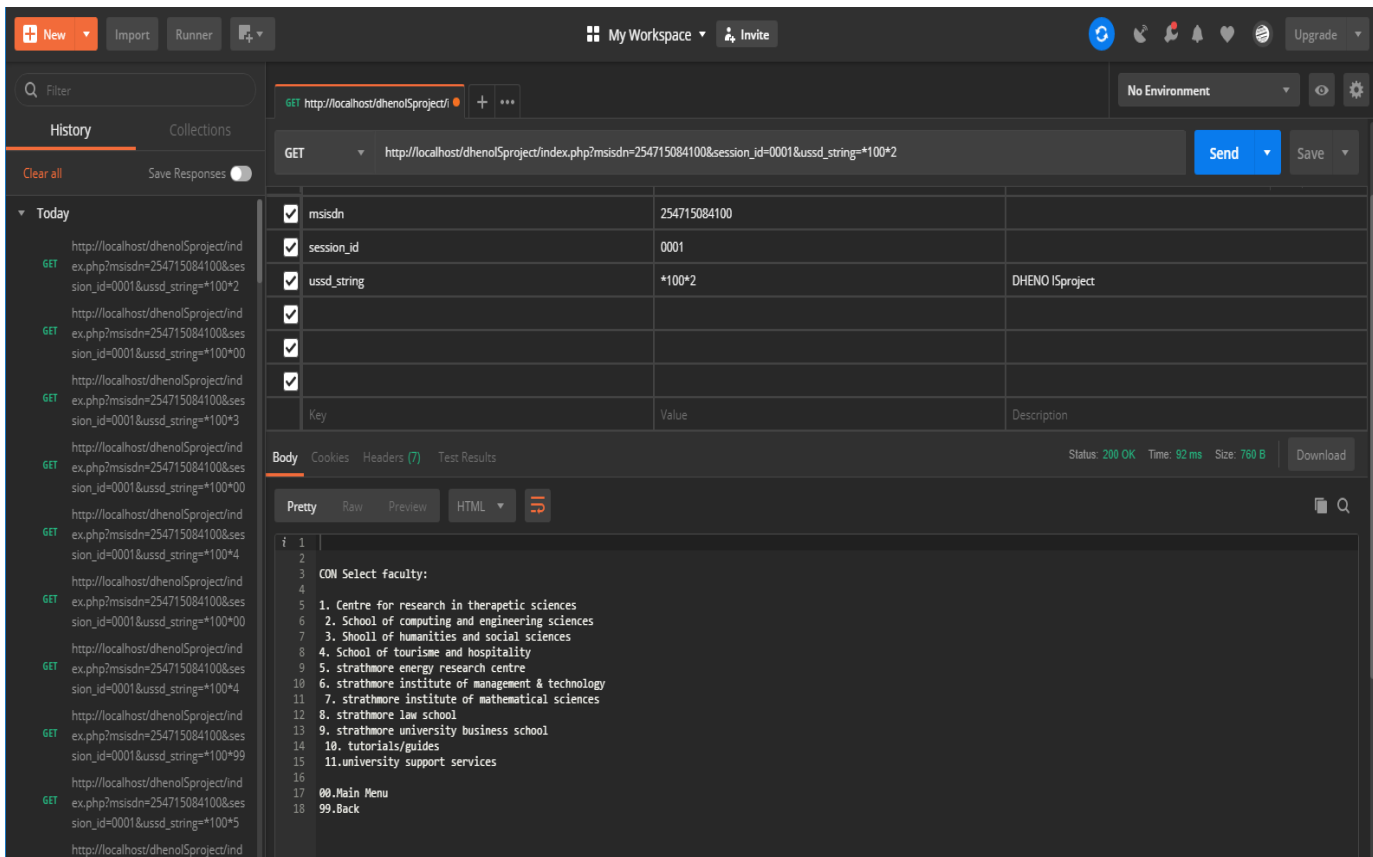


Figure 5.3.4 units registered module on MyStrath USSD

- vii. **Course work on MyStrath USSD:** this section shall be helping the students to view their grades. The image is displayed below:

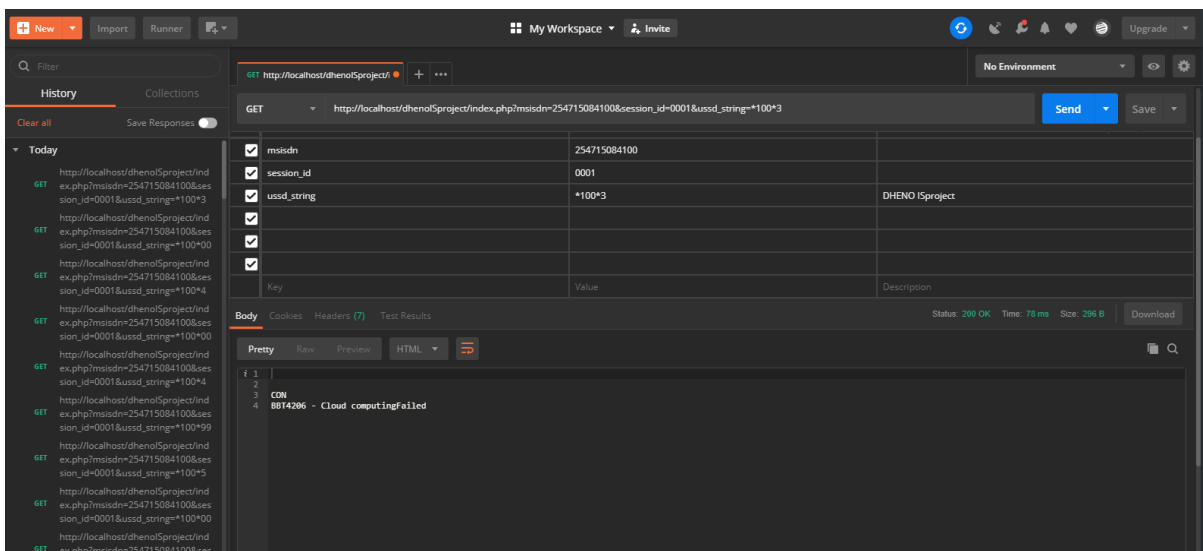


Figure 5.3.5 course work module on MyStrath USSD

- viii. **Fees module of MyStrath USSD:** this is the section that will allow students to view the balance of their school fees. The image is displayed below:

Figure 5.3.4 fees on MyStrath USSD

- ix. **Contact us:** this section will allow students to reach the school management via different school contact such as phone number, email, P.O.BOX. The image is displayed below:

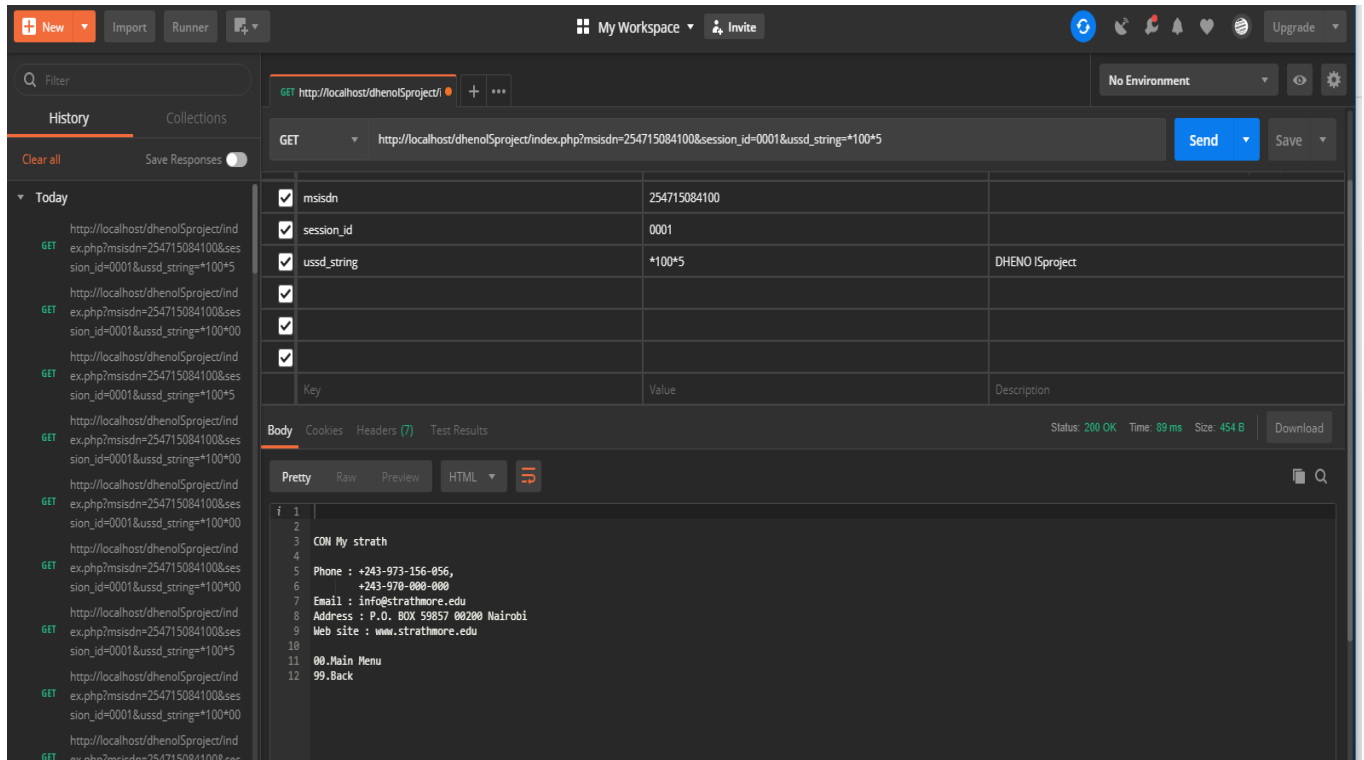


Figure 5.3.5 contact us on MyStrath USSD

- x. **Compliments:** this will allow students to send any positive or negative feedback about the service offered by School. The image is displayed below:

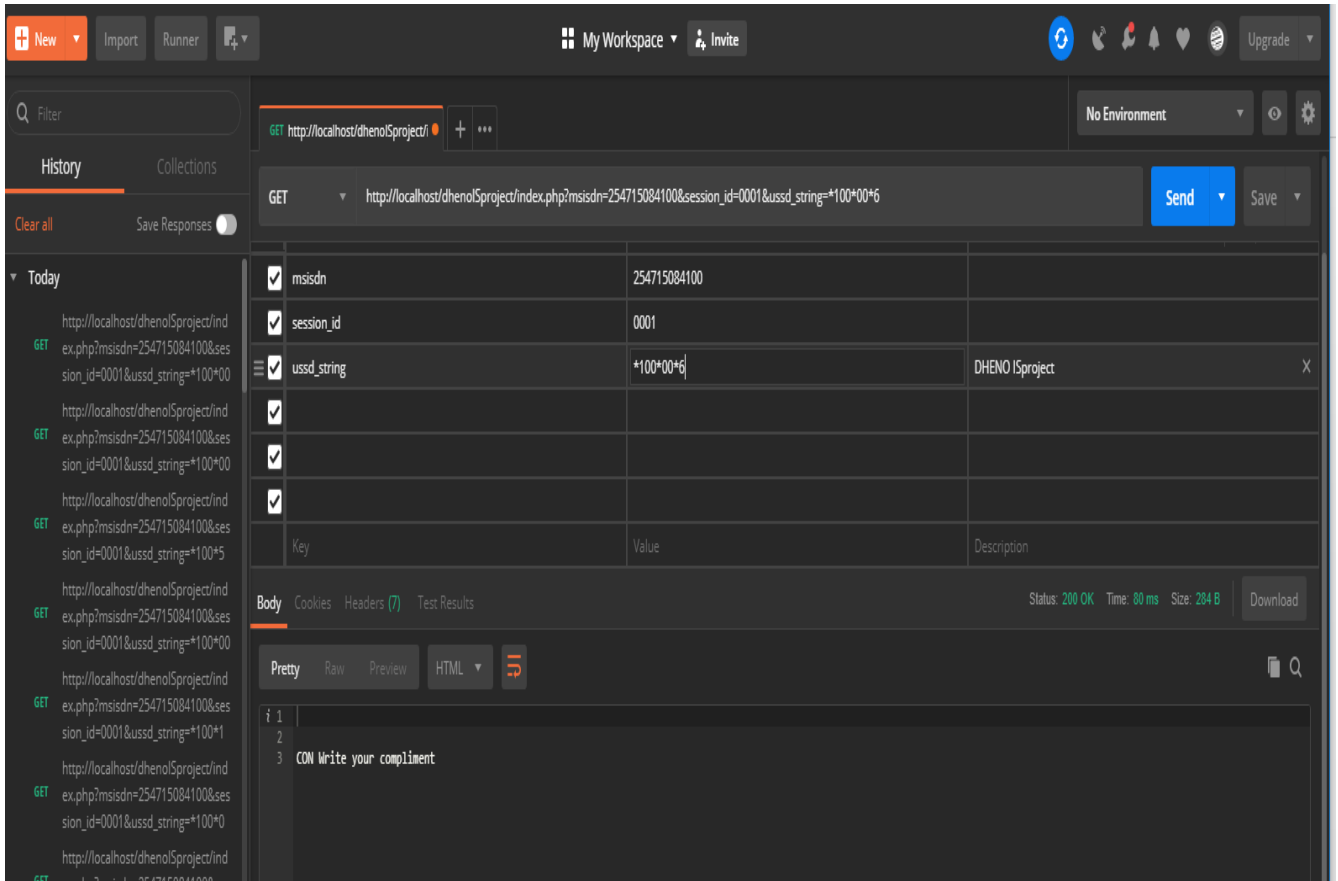


Figure 5.3.6 compliment on MyStrath USSD

5.2 System Testing

To test the system both unit testing and data flow testing were carried out. The unit testing was done to ensure each module functioned according to expectations by taking in the input and providing the expected output once the process completes.

5.2.1 Unit Testing

The table below highlights the various test cases, the expected outcome, the obtained outcome, the result, the description of the occurrence and the description of the lack of an occurrence if any.

5.2.2 Data flow testing

The images below shows the impact of testing the CRUD operations by highlighting the validation required and the expected results.

Chapter 6: Conclusion, Recommendations and Future Work

6.1 Introduction

This chapter presents the conclusions, judgments, implementations, future works and suggested improvements of the research described in the document. The aim and objectives of the research, outlined in chapter 1, are reviewed and their achievement addressed. Proposals for future work indicated by the research are suggested.

6.2 Conclusions

The system aims to allow students to access their portal using Unstructured Supplementary Service Data (USSD), even when they are in rural areas where there is no internet. This system can be implemented by Strathmore University to ensure that some tasks like updating marks, viewing fee balance, units' registrations, etc. are not being delayed due to lack of internet.

6.3 Recommendations

For the system to function to its best capability, the developers recommend:

- i. The server to be constantly connected to internet access.
- ii. The latest versions of antivirus to be installed and frequently updated in order to detect the very many virus programs emerging in the I.T technology.
- iii. Every user of the system to uniquely have his/ her unique username and password that is not shared with other users' accounts.

6.4 Future Works

The system only has the capability to view and update different records; for future works, the integration of the facility to undertake school surveys and apply for graduation is highly recommended.