

USSD System for Monitoring and Management of Employee Leave in Higher Educational Institution

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Abstract: Unstructured supplementary service data also referred to as feature code or quick code has become a monumental part of services and products offered by Telecommunication Operators, and its application to various areas of telecommunication and real-world scenarios. It is a protocol of communication utilized by global system for mobile communications cell phones to communicate with mobile telecommunication network operators and applicable to various areas of trend in modern information technology sectors such as Wireless Application Protocol browsing, mobile-money services, prepaid call back services, menu-based information services, location-based content services, paid content portal, voting surveys, and product promotion. This system was designed by integrating the designed unstructured supplementary service data channel for employee leave management system into the standard global system for mobile communications architecture. The architecture consists of three parts; the front end, the middle end, and the back end. The system is implemented using PHP for the overall programming, MySQL for the database, and Windows 7 operating system as a development environment with Adobe dream weaver CS3 IDE. Apache TOMCAT webserver was used to host the system locally. Two interfaces were developed; one side with the mobile operators, which requires setting up of SS7 stack and the unstructured supplementary service data application over the stack. On the other side, HTTP-based APIs were used for the unstructured supplementary service data application. Several types of leaves exist and their usage depends on educational institution policies. An employee may apply for study leave like maternity leave, sick leave, and annual leave. Paper-based work is time consuming, USSD based activities are very simple and effective. This research work was conducted to solve the leave management in an academic institution using the USSD. Using the developed system, 1326 USSD sessions were recorded, 1238 sessions were successful, 59 were incomplete, and 29 failed. Cumulative findings from the 41 respondents reveal that the system is faster, more convenient, and user-friendly than the manual method of applying and managing employee leave, which indicates 94% of the success of the system. Thus, it can be concluded that the system was able to manage the leave management very well and very effectively.

Index Terms: USSD, Employee-Leave, Telecommunication, Operators, GSM, Higher-Educational Institution.

1. Introduction

Unstructured Supplementary Service Data (USSD) also referred to as feature code or quick code has become a monumental part of services and products offered by Telecommunication Operators today, and its application to various areas of telecommunication and real-world scenarios. It is a protocol of communication utilized by Global System for Mobile communications (GSM) cell phones to communicate with mobile telecommunication network operators and applicable to various areas of trend in modern information technology sectors such as Wireless Application Protocol (WAP) browsing, mobile-money services, prepaid call-back services, menu-based information services, location-based content services, paid content portal, voting surveys, and product promotion. Telecommunications operators mostly used USSD for their internal applications such as promotions, data, airtime top-ups, and balance checks. USSD is one of the fastest services offered by the telecom industry and because of its speed in executing, operations couple with high cost-effective, simple steps involve, hands set independent and do not require internet; it has recently gained usage in other sectors such as utility companies and banks in configuring and integrating utility management applications,

mobile banking to ease and manage utility, and banking transactions in a timely manner across Nigeria and the African continent in general.

The use of USSD in higher education has recently gained advanced applications in developing countries especially in semester result checking and examination timetable as discussed by [1]. Another area in which USSD can be applied in higher educational institutions includes staff welfare, attendance, and leave management system. Employee leave management system is a platform that enables staff and administrators of an institution or organization to easily request, track, accurately allocate and manage employee leave [2]. Several types of leaves exist and their usage depends on educational institution policies. An employee may apply for study leave, maternity leave, sick leave, and annual leave. Superior staff and administrative departments of an educational institution are mostly considered as key assets in managing staff welfare and various activities, it is part of their functions to monitor, manage and record academics and non-academic activities of an employee such as leave requests. Most departments in a higher educational institution are information-driven, and the administrative staff drives and carries out day-to-day activities. Some of these activities are manually carried out while others are automated, it is the responsibility of the administrative department to keep a record of this activity such as employee leave requests and management which are manually carried out. Unlike Short Messaging Service (SMS), USSD does not require internet; it creates real-time connection during the session, allows up to 182 alphanumeric characters in length, allows two-way exchange of data in sequence, and can be accessed by most kinds of a mobile cell phone. Communication is established by dialling the USSD code beginning with the asterisk (*) symbol followed by the digits that comprise data/commands or password and terminated by the (#) symbol. A group of digits may be separated by an asterisk symbol. Communication between the user, mobile cell phones, and other devices are typically in real-time through a network or server. After successfully establishing a connection between the user and backend system, users directly interact from their cell phone by following the prompt and making various selections from the menus.

In most higher institutions of developing countries, employee leave requests and management are carried out using conventional methods. The conventional method of requesting and managing leave request entails staff or an employee to manually write and submit leave application to administrative department through Head of Department (HOD). The HOD minutes the request and forward to respective superior staff in charge whom reject/approve, file copy of the application and reply the requestor through same channel. This method is prone to error, require more paper work and time consuming. Furthermore, it was observed that the academic institution is still managing its paper-based manual process for managing application, approval, denial, or tracking of the leave of its employee. Hence the need for automated technique that is free from error, faster and easy to manage with no or less paper work. This paper presents USSD system for monitoring and management of employee leave in its educational institution to solve paper-based manual process for managing application, approval, denial, or tracking of the leave of an employee. Using this software, employee of an institution can apply and track the status of their leave application. The presented USSD system can be used as substitute to the existing method for its reliability, integrity, usability, and services that can help the employees as well as the organization. Hence, the system can be used for effective and efficient management of leave. Some of the existing or nearby solutions are provided in the literature review. Of course, like every other system this system has its limitations to which are session based timeouts and can only be access using mobile phone; which implies that employee without a mobile device cannot interact with the system.

The remaining sections of the paper are divided into four. Section two discusses literature review and section three describes the methodology used in development of the system. Section four discusses the result obtained and section five concludes and gives recommendations for future works.

2. Review of Related Works

Various techniques have been proposed and adopted by many researchers for USSD application but only few works has been carried out for employee leave management system in higher institution. USSD has been applicable to different areas of telecommunication such as mobile commerce, mobile chatting, call back services, prepaid balance inquiries, mobile banking and software upgrade [3]. These services are available as pull based resources and services such as currency updates, stock market report, sport updates, polling/voting emergency service, advertising and promotion of new product and services. [4] proposed model for location based mobile advertising system using USSD and SMS symbolic to display menu for user registration and information access. [5] developed sensors Empowerment and Accountability (SEMA) platform in Tanzanian for monitoring the functionality status of rural water service maintenance using USSD technique. [6] developed an offline USSD system for accessing agricultural E-Commerce products and services by farmers. This was achieved by using the offline module to manage crop inventory and other basic details by farmers with the aid of a mobile cell phones] suggests a method of security that is more secure while using SMS and USSD technologies in mobile banking. [8] documents an internship report on the leave management system but due to time factor, the confidentiality of organizational data and resources limitation only few details of the system were described. [9] developed an intranet-based leave management system that can be accessed within an organization. The system can be used to request, approve and generates reports of leave but only on works on the intranet. [10] developed leave and payroll management system for requesting, viewing of history and granting/rejecting

of leave requests. [11] developed Android-based leave management system for effective and efficient management of staff leave request and approval/rejection. Although the system can manage staff leave efficiently, it can only work on the Android Operating System platform as such cannot be used on non-Android phones. [12] developed prototyped of cloud-based employee management information system for African small and medium enterprises consisting of four modules; leave management, payroll management, staff appraisal and record management. Though the system is designed to cover all aspect of human resources in African small and medium enterprises, [12] prototype of the proposed system was developed at the time of carrying out this research. [13] developed an intranet based student leave management system that automates the work flow of leave approval and rejection. [14] developed algorithm for scheduling leave in Nigeria university system for academic staff. The system processes service delivery by determining staff mix by rank and lecturer-to- student ratio.

3. Methodlogy

This section gives an in-depth description of the architectural design and development of USSD model for employee leave management system for managing employee leave request, allocation, tracking and general management in Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria. The architecture of USSD model for employee leave management system is shown in Figure 1; the system was design by integrating the USSD model for employee leave management system into standard GSM architecture. The architecture consists of three parts; the front end, the middle end and the back end.

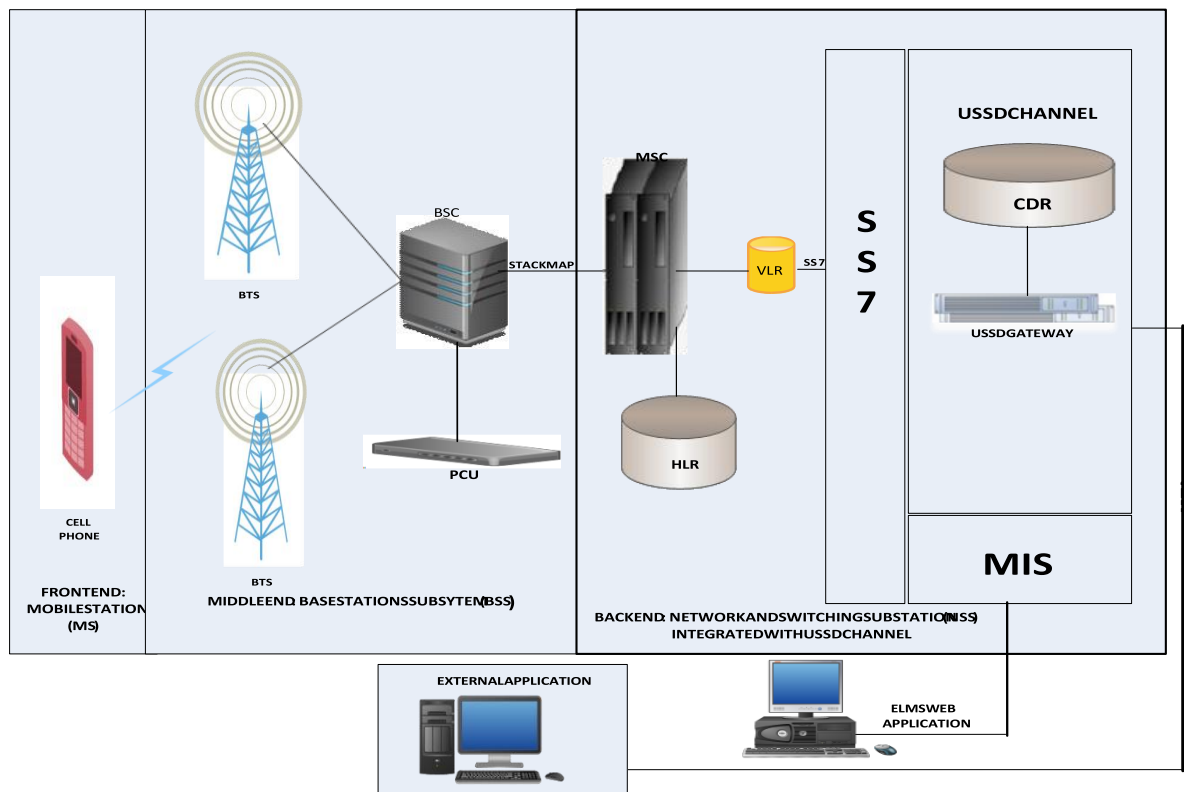


Fig. 1. Architecture of USSD Model for Employee Leave Management System

The front end is also known as Mobile Station (MS) unit, the MS unit is the unit which the employee sees and operates with the aid of mobile cell phone configured to enable USSD interface connection between the front end and middle end, connection between these end is establish when the user (employee) dialled the required string. The middle end also known as Base Service Substation (BSS) consists of the Base Transceiver Station (BTS) and Base Station Controller (BSC) elements. The fundamental functions of these elements are associated with establishing communication between the employee mobile device and the network. The BTS network consists of antennas with associated radio transmitter and receiver for directly transmitting and receiving signals with the employee mobile cell phone and also equipment for encrypting/decrypting communication. The function of the BTS is controlled by parent BSC through Base Station Control Function (BCF). The BSC controls group of base transceiver stations by managing radio resources, allocating channels and controlling hand over within the group of BTS. This enable several users of the USSD system of employee leave management to concurrently access the network. Further connection between the

employee’s mobile cell phone, the middle end and back end (network and switching substation) is enable via the BTS and BSC using stack Mobile Application Part (MAP) protocol. The essential function of the MAP protocol is enrooting messages using USSD; MAP also contains layers which are present on both MS and network server handler in the network nodes. The back end generally known as Network and Switching Substation (NSS) consists of Mobile Service Switching Centre (MSC), the Home Location Register (HLR) and the Visitor Location Register (VLR) elements integrated with the employee leave management USSD channel. The employee leave management USSD channel consists of database called Call Data Record (CDR) where all staff data are stored. A USSD gateway; Classic USSD was collaborated into the system. The USSD gateway integrated into system uses *325*11#. The USSD is process using classic USSD API after setting up an account and a register code.

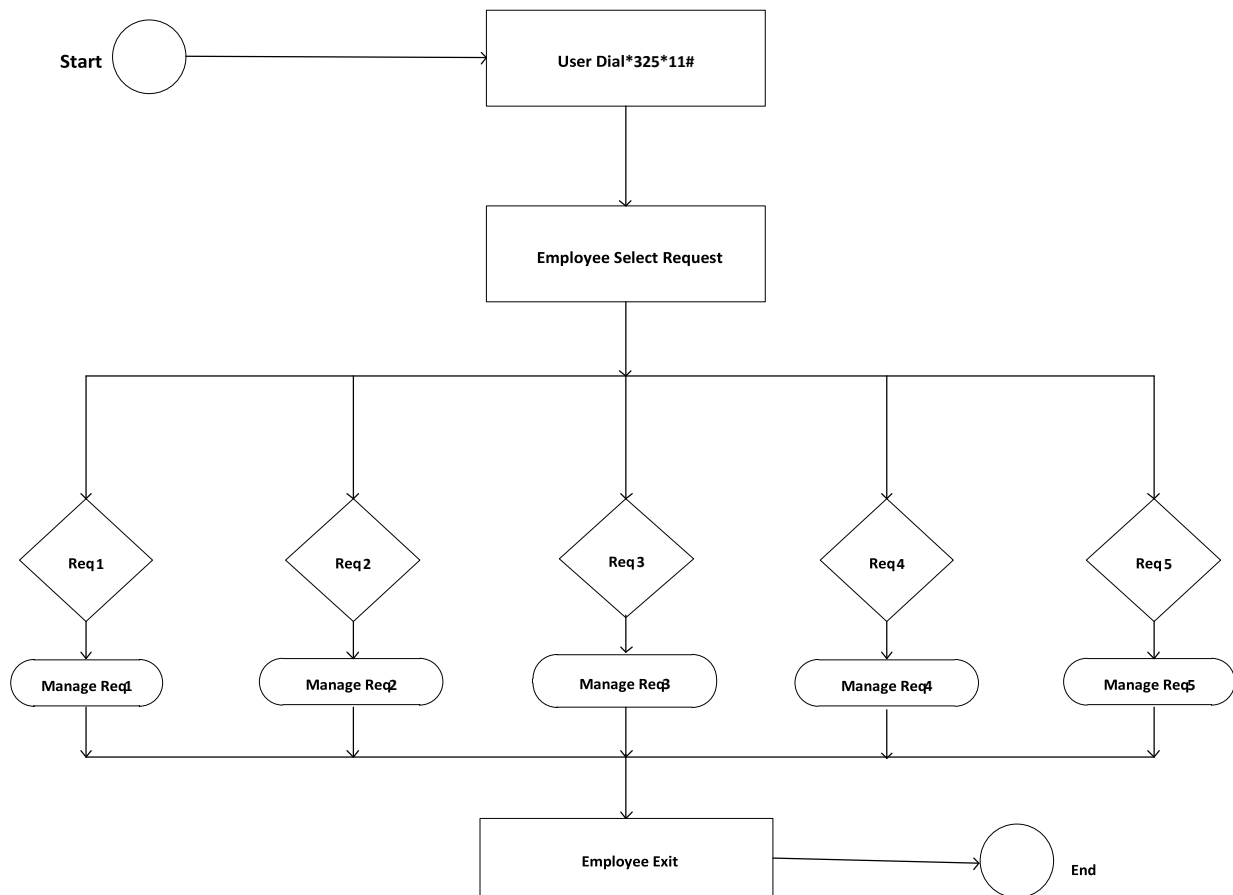


Fig.2. Activity Diagram of USSD Model for Employee Management System

The USSD channel contains Management Information System (MIS) which communicate and manage the employee leave web applications and an external system for managing external applications. The MSC is the core switching service centre which acts like normal switching node within Integrated Service Digital Network (ISDN) or Public Switch Telephone Network (PSTN) and provide fundamental functionality which enable the support of mobile user requirement. These requirements include call routing, inter MSC hand over, users registration and authentication. The Home Location Register(HLR) is a database in home network containing each GSM subscriber’s information with their last known location to assist and enable the GSM network to route signals/data to most desirable base station for the MS. The VLR is a database of the MS that roamed into the vicinity of MSC which it serves, this enable the main BTS in the network to be served only one VLR at a time. The VLR also act as an integral part of MSC entity containing selected information of visitor’s location from the HLR individual subscribers that enable specific services to be provided to these subscribers. When an employee initiates a leave request using USSD operations from MS, signals passes through the BST controlled by BSC using stack MAP protocol to forward the signal to the MSC. If the MSC, HLR/VLR (in hierarchical operation) is able to decode the requested service/operation or if one of the network nodes contains the required data, then the operations continue to the MSC. However, if the network nodes decode the requested services but can’t support the required application/request, then the decoded request is forwarded using Signal System 7 (SS7) protocol MAP stacks to the USSD gateway via the Call Data Record (CDR) to fetch the requested information. SS7 protocol also assist in receiving, transmitting, maintaining and terminating sessions from the ID pool. The USSD gateway is service provider’s platform which enables the operator to introduce USSD messaging service as bearer in fast response time to route requests to machine hosting the application. The USSD gateway routes all

employee requests/operations to the employee leave management web portal and external application for further actions/processes and vice versa. It also connects the telecommunication network on one side and provides Application Programming Interface (API) for receiving and sending strings from the user mobile cell phone on the other hand using same process with the help of API provided by the mobile service provider. Gateway uses its interface with the MSC over the SS7 protocol in receiving and sending information of employee leave request. If an employee dials a wrong USSD code and the MSC network does not recognise the string of the code, it sends this operation to the VLR, if the VLR is unable to decode the operation, it forwards it to the HLR. If the HLR also does not decode or recognise the operation, an error message is passed back to the MS (employee mobile device) and the session is terminated. Communication between the USSD gateway and to external application is enabled by the use of Short Message Peer-to Peer (SMPP) standard protocol.

The system is implemented using PHP for the overall programming, MySQL for the database and at least Windows 7 operating system as development environment with Adobe dream weaver CS3 IDE. Apache TOMCAT web server was used to host the system locally. Two interfaces were developed; one side with the mobile operators which requires setting up of SS7 stack and the USSD application over the stack. On the other side, HTTP based API's were used for the USSD application. The minimum hardware requirement for the development of the system include network of Intel P4 computers with 100 GB hard disks capacity, 4GB RAM, mobile cell phone and 2x1.6 Hz CPU processor with 3.5 GB. An 80 GB hard disk is also required for the virtual machine configuration of the web server. The use case and the activity diagram are shown in Figure 2 and 3b respectively.. Functionality of the system element were determined by extracting the number of successful sessions, the number of failed sessions and the time taken to complete a session from the API gateway, MAP Test Utility can also be used to determine the functionality of these elements.

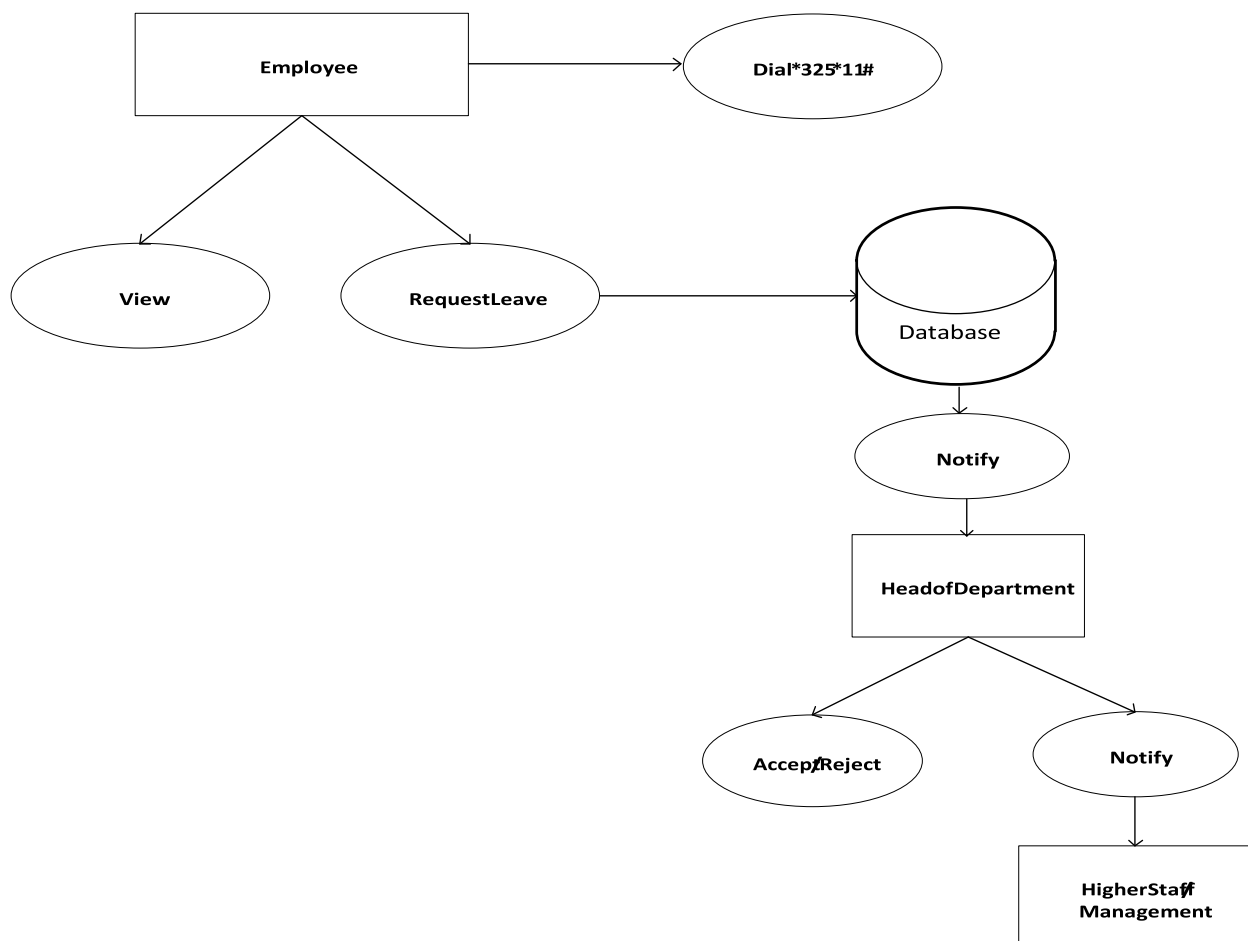


Fig. 3. System Functionality

4. Result and Discussion

Employee initiates the USSD service of the leave management system by dialling *325*11# to commence various operations as shown figure 4:

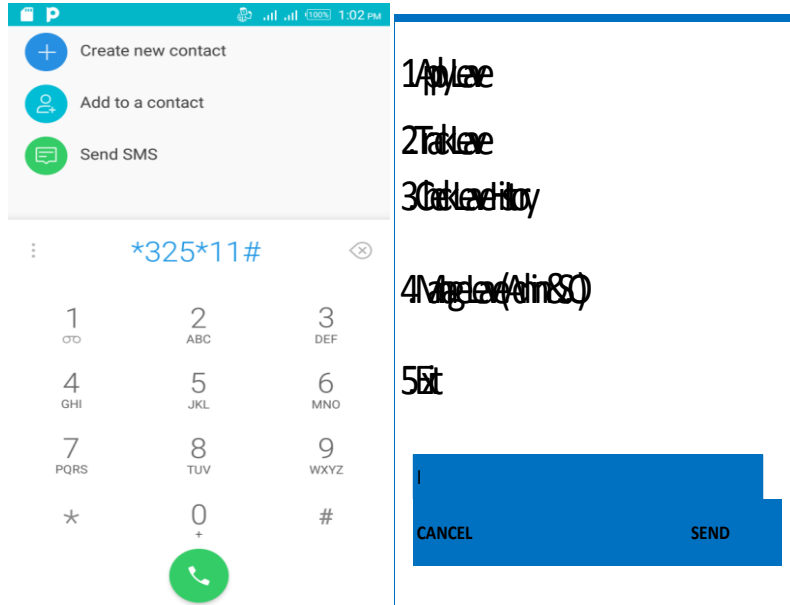


Fig. 4. Welcome Screen

A Transaction Capabilities Application Part (TCAP) is initiated with a MAP to process unstructured request operations and forward to the USSD web application portal. The USSD web application portal receives the request and initiates a USSD and return results as shown in Figure 4. Employee select create account from the list of menu if he/she is first user of the system. Existing user can directly login using staff number as user ID and required password.

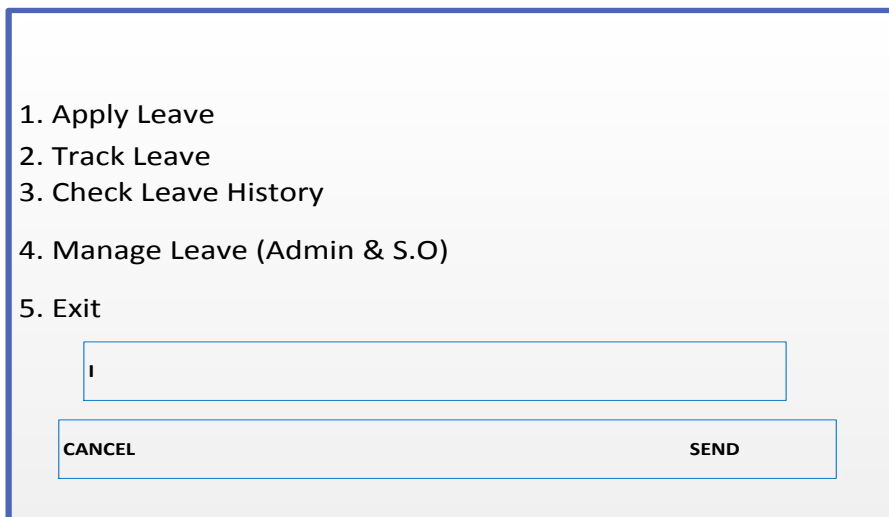


Fig. 5. Requesting Leave

To apply for the leave, the employee reply with option number 1 and wait for response, having return result, user select from list of option depending on the type of leave employee is requesting. User respond with choice of leave, complete the subsequent page by entering number of days and submit. Employee can also track leave by selecting option 2 in Figure 5 and option 3 to view history.

5. System Performance Evaluation

The system was tested and evaluated at Ibrahim Badamasi Babangida University Lapai, a total of fifty two (52) staff were selected to test the developed system and compared with the conventional method of leave request and management through administering of questionnaire. Forty-seven (47) responses were received from the completed questionnaires and the primary data of the questionnaires were collected, compiled and analysed using SPSS using descriptive data analysis. The evaluations were based on usability, speed and conveniences for efficient usage and management of staff leave through the perception of the employee assessments of these qualities as shown in Table 1 and Figure 6, at the end of the pilot test, a total of 1326 USSD sessions were recorded as shown in Table2.

Table 1. Evaluation of USSD Model on Employee Leave Management System

User Perception	Manual Method	Developed System
1. Usability: 6% of responded agreed that the use developed system is easier to use	94% of respondent agreed that the	manual method is easier to
2. Usability: 6% of responded agreed that the use developed system is easier to use	94% of respondent agreed that the	manual method is easier to
3. Conveniences :5% of responded agreed that the convenient. developed system is more convenient	95% of respondent agreed that the	manual method is more
4. Speed: 2% of responded agreed the faster developed system can deliver service timely manner	98% of respondent agreed that the	manual method is in efficient and

Findings from usability revealed that 94% of respondent agreed that the developed system is easy to use compared to the existing method as shown in Table 1 and Figure 6. Precisely 98% of respondents agreed that the system can deliver service in timely manner compared to the existing system. The findings of convenience assessments revealed that 95% agreed that the developed system offers convenience service to both academic and non academic staff of the university compared to the existing method.

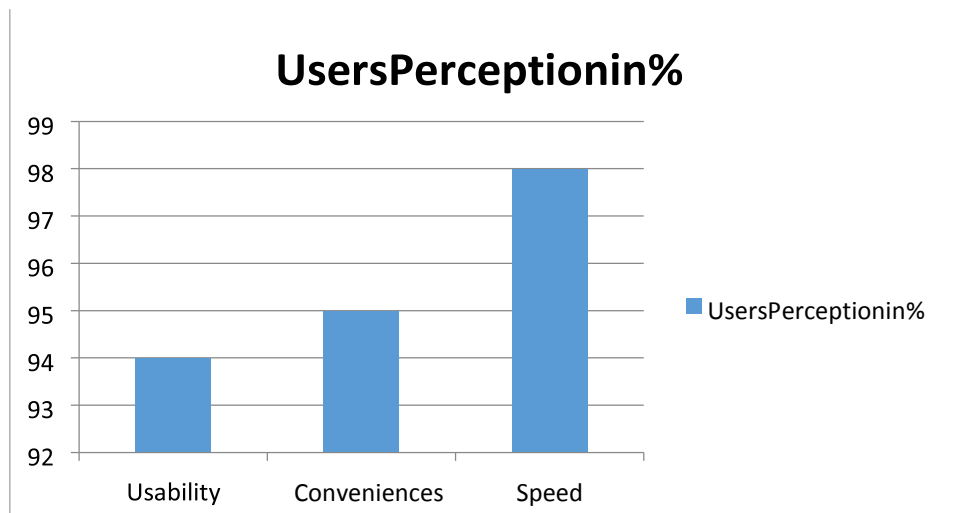


Fig. 6.Users Perception on USSD Model of Employee Management System

Table 2. USSD Sessions Recorded

S	Successful Session	Incomplete Session	Failed Session
1326	1238	59	29

A total of 1326 USSD sessions (S) were recorded, 1238 sessions were successful, 59 were incomplete and 29 sessions failed, these were determined by extracting the number of successful sessions, the number of failed sessions and the time taken to complete a session from the API gateway.

Cumulative findings from the forty-one (41) respondents reveal that the system is faster, more convenient, and user-friendly compared to the manual method of applying and managing employee leave.

6. Conclusion and Recommendations

USSD model for requesting and managing staff leave in higher institutions has successfully been developed. The system was developed by integrating the USSD model for employee leave management system into standard GSM architecture and implemented using PHP for the overall programming, MySQL for the database, and Windows 7 operating system as a development environment with Adobe dream weaver CS3 IDE. Apache TOMCAT webserver was used to host the system locally. Two interfaces were developed; one side with the mobile operators which requires setting up of SS7 stack and the USSD application over the stack. On the other side, HTTP-based APIs were used for the USSD application. The minimum hardware requirement for the development of the system includes a network of Intel P4 computers with 100 GB hard disks capacity, 4GB RAM, a mobile cell phone and 2x1.6 Hz CPU processor with 3.5 GB. An 80 GB hard disk is also required for the virtual machine configuration of the web server. The system serves as improvement in staff management, maintain accuracy, transparency and highlight the need to integrate advance technology in employee record and welfare management in higher institution. The developed system enables the employees in academic institutions to request and track their leave at their own convenient time in timely manner. Superior officers of the institution and administrative department can create leave policies, check transparency and plan activities ahead of time.

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