Design and Implementation of an Electronic Exeat System

Ernest E. Onuiri, Ayodeji Odukoya, Christiana Yadeka and Mark Nzei
Department of Computer Science, Babcock University, Ilishan-Remo, Ogun State; Nigeria

Abstract - The term exeat is not popular. However, it is akin to systems implemented in boarding schools, colleges and some institutions of higher learning. It is probably known widely as a "pass", "exit permission" or "leave of absence". Software and systems have been designed and developed particularly for corporate institutions to keep accurate log of employees' leave. For academic institutions especially at the tertiary level, the manual method of exeat scheduling, authorization and authentication is the norm. This paper presents the design and development of an electronic exeat system which automates the manual system which is known to be cumbersome, challenging, difficult, unsecure and expensive. The case study is Babcock University, a privately owned institution of higher learning. The software developed proved to be very efficient and a robust management tool for the school administrators.

Index Terms: Exeat, Electronic Exeat (E-exeat), Authentication, Scheduling, Pass, Hall administartors, students

1 INTRODUCTION

Exeat as a term means permission from a college, boarding school, or other institution for temporary absence [1]. In this context it refers to a method of granting exit permission and entrance into an institution or organization. Depending on the organization, the purpose of implementing an exeat differs, given that certain organizations implement it as a security measure against intrusion and negligent attitude towards work while others implement for baseline control reasons. Such organizations often implement it to keep accurate records of employee movement as well as detect questionable entrance of visitors. In an academic environment, it is implemented to prevent un-authorized exits and to keep track of student movement in relation to time and destination of travel. In our case study institution, the current manual method of exeat scheduling and authentication has proven to be challenging, difficult, unsecured and expensive due to the following reasons:

i. The paper-based manual system promotes a recurrent waste of scarce resources which could be directed to other productive activities.
ii. Difficulty in analysing exeats and authorization on the part of the Hall Administrators.
iii. Data could be somewhat unreliable regarding date and time of proposed exeat.
iv. The issue of impersonation.

Consequently, the proposed system would ensure that unauthorized exits are prevented by the use of biometric verification. It will also generate an approximation of the total number of students on and off campus, at every given point in time by:

i. providing a more effective and efficient method of exeat scheduling.
ii. ensuring a secured method of validating exit of individuals.
iii. ensuring that students residence and exeat details would be registered, to exit campus.

2. CLOSELY RELATED WORKS

In this section we examine some e-exeat systems and software that are similar to the developed system. During the course of our research a majority of such systems were found to be implemented in organizations. This section discusses the most closely related, then compares and contrasts them with our system.

i. **Leave Master Software**: this software is used for applying for employee leave across organizations. It speeds up and streamlines the entire leave management process, eliminates the costly errors and monitors all types of employee leave and absence including holidays, training and sick days and produces reports highlighting absenteeism patterns and trends. [2]

ii. **Leave and Absence Management System (LAMS) –** Durham University: is an online system for recording leave and absence of staffs in Durham University throughout all departments. This system was created to replace the previous paper-based system. This system records leave of absence for staffs in their categories and also provides management information for decision making. It aids the process of leave scheduling, making it easier and cheaper for both staff and management [3]

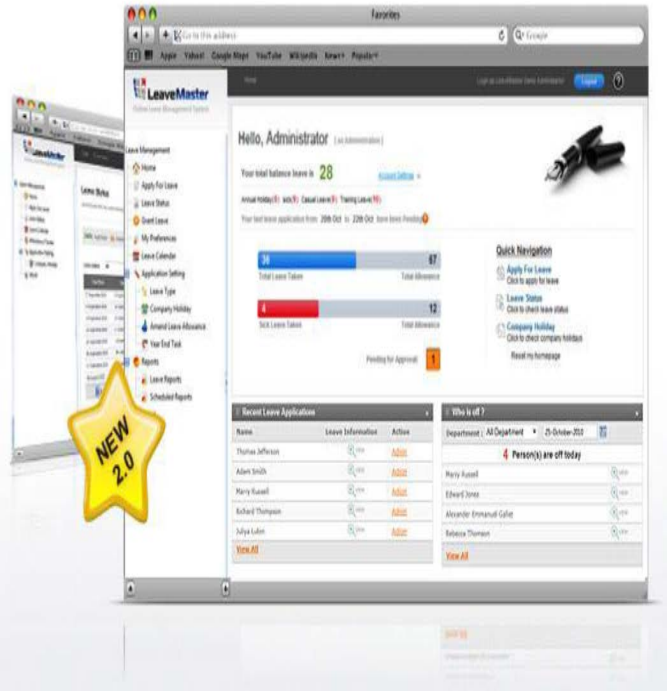

Figure 1: Leavemaster homepage. Source: [2]

3. METHODOLOGY

The methodology of choice is Rapid Application Development (RAD); this is because the objectives of RAD include high speed, high quality and lowered cost. RAD emphasizes the use of special techniques and computer tools to speed up analysis, design and implementation phases. Tools include Computer Assisted Software Engineering (CASE) tools, Joint Application Design (JAD) and fourth generation programming languages. All of which are inline and essential to the proposed system. [4]

The RAD methodology goes through the following phases:

Phase 1: Requirements Planning: refers to a review of the areas immediately associated with the proposed system. Areas associated with the proposed system include:

i. Mode of user exeat scheduling
ii. Mode of user verification
iii. Mode of data collection and organization
iv. Mode of data communication between point of and points of exits

i. User Exeat Scheduling: The proposed system would schedule exeat by going through the following:
   a. Student request exeat through his or her page stating clearly details of destination, name of host, date of leave and date of entry.
   b. On completion, the request is forwarded to the hall administrator's desktop application. The hall administrator only decides whether to approve or deny request.
   c. On denial, student can't re-apply until the subsequent week. If on the other hand, approval is given, all names of approved students would be forwarded to the security unit manning the gate where validation would take place.

ii. User Verification: this achieves our objective of ensuring a secured method of validating exit of individuals. Users would be verified by a unique identity possessed by them. A common and easily implemented mode of verification is by fingerprint. Therefore, user verification would be carried out using a bio-metric fingerprint scanner, which identifies its user based on pre-recorded data in its database.

iii. Data collection and verification: before users can be verified, there's a need for pre-recorded data in the memory i.e. database of the system. Consequently, the data of every prospective user (student) needs to be collected to allow verification. Data of already admitted students can simply be recovered from the registry after all permissions required are granted. This includes bio-metric details. Students that reside off-campus would be required to give bio-metric details in respect to their fingerprint as well. At the point of exit (university gate), students will be required to scan their fingerprint on the scanner to verify that they have been permitted to leave school. The system, automatically takes into account the time of leave, and records exeats.

iv. Data communication between points of scheduling and points of exits: The proposed system would operate on an intranet. This is a network only accessible by members of a particular organization. In this case, the university information would be sent over this network, from the hall. This information is not necessarily complex, but simply a list of students permitted to exit the campus from the hall. Essential additional information about the student may be sent. Other information concerning destination name of host, need not be sent. This information is simply required in the hall as this is the current requirements, to take a leave. At points of exits, precisely the school gate, information required is whether or not you have been cleared at your residential hall to exit school.

Phase 2: User Design: This stage uses workshops to model the system's data and processes and to build a working prototype of critical system components [5]. In the course of the software development, a prototype was developed to model the system and take into consideration user perception of the system. This working model aided in recognizing and implementation of designs that enhance interaction and system operation from the standpoint of the users. User-design is therefore implemented. A key objective of this system makes it very much user friendly, as it is a more convenient form of exeat scheduling and verification.

Phase 3: Construction: Here, developers worked directly with users, finalized the design and built the system. The software construction process consists of a series of "design-and-build" steps in which the users have the opportunity to fine-tune the requirements and review the resulting software implementation [4]. Furthermore, user specification of the system was acquired by a test run. A random sample of users had worked on the prototype, and their specifications collected by interviews. Finalizing the system after user design was then considered. User design was implemented and presented to ensure a significant amount of satisfaction. Because RAD has an iterative frame work [6], where user approval was poor, previous stages were repeated, until user approval was improved. Construction stage deliverables included documentation and instructions necessary to operate the new application and routines and procedures needed to operationalize the system. Software development and designed was then completed leading to the consequent software documentation.

Phase 4: Implementation: The implementation stage involved implementing the new system and managing the change from the old system environment to the new one. This included implementing bridges between existing and new systems, converting data, and training users.

4. DATA ANALYSIS

Data to be used in this system would come from three major end users. The student, the hall administrator and the institution's student records. Data would be generated, manipulated and stored in a database. The tables and the data generated in them are analyzed as follows:

4.1 *Students Table:* This table contains the students' registration details and also the authentication details of each student. The authentication details include the student's matriculation number and password. Other registration details include; lastname, firstname, hall of residence, course of study and the student's biometric detail, in this case the thumb and index prints of both hands.
The values stored in this table are generated from the school's record and may be entered by the Hall Administrator of the hall of residence to which the student is to be registered.

Table 1: Students Table

FIELD	TYPE	NULL	KEY
MATRIC_NO	VARCHAR(10)	NO	PRIMARY
FIRST_NAME	VARCHAR(50)	NO	
LAST_NAME	VARCHAR(50)	NO	
HALL_O_RESDNCE	VARCHAR(50)	NO	
ROOM_NO	VARCHAR(50)	NO	
PASSWORD	VARCHAR(100)	NO	
COURSE	VARCHAR(100)	NO	

4.2 *Hall_admin Table*: This table contains the authentication details and information of each Hall Administrator in charge of all the halls of residence. Authentication details include the Hall ID and password. Other details are lastname, firstname, hall of residence, and phone number. Just like the data gathered for the students table, the data would be generated from the school's record, or directly entered by the database administrator if required.

Table 2: Hall Admin Table

FIELD	TYPE	NULL	KEY
STAFF_ID	VARCHAR(10)	NO	PRIMARY
FIRST_NAME	VARCHAR(50)	NO	
LAST_NAME	VARCHAR(50)	NO	
HALL_O_RESDNCE	VARCHAR(50)	NO	
PHONE_NO	VARCHAR(20)	NO	
PASSWORD	VARCHAR(100)	NO	

4.3 *Status_desc table:* this is a collation exeat status indicator a student's exeat can have once the exeat has been applied for. Its fields include status, which hold status letter representations and description, which describes the letters. Hence if a status is 'Y' its description means permitted. If it holds 'N' its description means denied. In addition, data here is determined by the database administrator who is at liberty to add, modify or remove status and their descriptions as required.

Table 3: Status_desc table

FIELD	TYPE	NULL	KEY
STATUS	VARCHAR(10)	NO	PRIMARY
DESCRIPTION	VARCHAR(20)	NO	

4.4 *Exeat:* this table contains the details of each student's exeat application. Data here is generated from the webpage exeat forms filled by the students. Data here consists of the Exeat ID automatically generated by the use of an SQL procedure, on data insertion. Matriculation number, type of trip, destination i.e.state, destination address, support/host name, support phone number, date of departure, date of arrival and reason

for exeat. All of these are generated from the exeat form filled on the web page. However, date of exit and date of return are determined by the system upon exit from and entrance into the premises while signing in with their fingerprints. The permission field holds the status of the exeat and is determined by the system and the hall administrator. When an exeat is requested it holds the status 'P' (pending); if the hall administrator denies the exeat it holds the status 'N' (denied) but when permitted holds the status 'Y' (permitted). Upon leave from school it holds the status 'L' (Left School), however upon return it holds the status 'R' (Used and returned) and if exeat remains unused, i.e. student does not leave it holds the status 'U' (unused).

4.5 Records Table: This table simply contains old exeats as the exeat in the exeat's table is emptied at the beginning of every semester into the records table. It serves as a backup table for old exeat.

Table 4: Exeats Table

FIELD	TYPE	NULL	KEY
EXEAT_ID	VARCHAR(30)	NO	PRIMARY
MATRIC_NO	VARCHAR(10)	NO	FOREIGN
STAFF_ID	VARCHAR(10)	NO	FOREIGN
TYPE_O_TRIP	VARCHAR(10)	NO	
DEST	VARCHAR(50)	NO	
DEST_ADDY	VARCHAR(50)	NO	
SUPPORT_NAME	VARCHAR(50)	NO	
SUPPORT_NO	VARCHAR(50)	NO	
DATE_O_DEP	DATE	NO	
DATE_O_ARRIV	DATE	NO	
REASON	VARCHAR(50)	NO	
PERM	VARCHAR(1)	NO	
DATE_O_RETURN	DATE	NO	

5. COMPONENTS AND SYSTEM TESTING

This section discusses the testing of the system in units/components in terms of the database and interface testing. The database and interface(s) is/are units of the composite system. It goes on to discuss the testing of the composite system as a whole which includes how the different components communicate and interact within the system. The functional and non-functional requirements of this system were deduced following the requirements for a student to acquire an exeat card as is required in the current manual mode of exeat and the requirements for a hall administrator to authorize and exeat.

Table 5: Records Table

FIELD	TYPE	NULL	KEY
EXEAT_ID	VARCHAR(30)	NO	PRIMARY
MATRIC_NO	VARCHAR(10)	NO	FOREIGN
STAFF_ID	VARCHAR(10)	NO	FOREIGN
TYPE_O_TRIP	VARCHAR(10)	NO	
DEST	VARCHAR(50)	NO	
DEST_ADDY	VARCHAR(50)	NO	
SUPPORT_NAME	VARCHAR(50)	NO	
SUPPORT_NO	VARCHAR(50)	NO	
DATE_O_DEP	DATE	NO	
DATE_O_ARRIV	DATE	NO	
REASON	VARCHAR(50)	NO	
PERM	VARCHAR(1)	NO	
DATE_O_RETURN	DATE	NO	

5.1 Database Testing: These tests were carried out by running Data Manipulation Language (DML), Data Control Language (DCL) and Transaction Control Language (TCL) statements:
DMLs include SELECT, INSERT, UPDATE, DELETE and MERGE statements
DCLs include GRANT and REVOKE
TCLs include COMMIT, ROLLBACK and SAVEPOINT
Tests carried verified the existence of functioning relationships and domain constraints between database tables as planned and designed in Chapter three of this document. Hence, entity types and constraints, data integrity and security are preserved.

5.2 Interface and Components Testing: The components of this system fall in four categories. The software components, the hardware components, networking components and warm ware components. Each component has its interface, which was tested individually.

5.2.1 **Software Components:** These refer to parts of the system, with written programs or procedures that make up their functioning. The software components of this system include a

i. Database
ii. Web application
iii. Desktop application

The interfaces are described and analyzed below:

Web Interface: The web application is available to students over the intranet, to improve accessibility for the users (students) and ease the connection to the database hosted on the server. The web application interface was tested at different modular levels. They include; the login module, the change

password module, the exeat scheduling module, the student history module and the logout module. The users of this interface as regards our case study are the students:

Login Module: This may also be referred to as the authentication module. The user which is assumed to be the student in this case, provides his/her matriculation number similar to a username used in other forms of authentication systems because it is unique to every student. Alongside the matriculation number, the student provides a password which is basically the key to the student's exeat page.

Change Password Module: This is available to the student only when logging in for the first time with the default password assigned by the system, or when his/her password has been reset to the default password by the hall administrator upon the student's request.

Exeat Scheduling Module: This module allows the student to either schedule for a long distance exeat or short distance exeat. The parameters for scheduling differ based on the type of exeat. This would be further analysed in the user guide.

The Student History Module: Students may also view personal exeat history on the web application.

The Logout Module: The student after exeat scheduling is expected to log out here.

Desktop Interface: This application is installed on the personal computers of staff in charge of exeat authorization and authentication. The users of this interface as regards our case study are the Hall Administrators. Its modules include: the login module, the reset password module, the register student module, the view and process exeat module, the search module and the logout module:

The Login Module: Here, the staff is required to provide their hall name/id and their password. The hall id just like the matriculation number is unique to the staff. It is provided alongside the password which finalizes the authentication process.

The Reset Password Module: Here, the staff may reset his/her password or the password of a student as requested, to the default.

The Register Student Module: This module helps register students as required. Although the student table would be populated from the school's record of students registered that semester on campus. This module exists for contingencies in the occurrence of hall change or in case of an error in terms of student's hall as registered in the school's database.

The View and Process Exeats Module: This module is the heart of this interface. The hall administrator may view and sort exeats at his/her convenience to make it easier to analyse exeats and authenticate. All exeats irrespective of type may be viewed based on date or type. Also, all short exeats may be differentiated from the long exeats; all pending exeats may also be differentiated from permitted exeats or denied exeats and so on. Exeats may be viewed as a table or singularly with more details as would be seen in the user guide below. As each exeat is viewed an exeat history of that student under view for that semester appears. Changes are also automatically saved.

The Search Module: this allows the hall administrator to search for exeat records, based on name or matriculation number.

The Logout Module: After carrying out exeat authorization, the staff/employee is expected to logout here.

5.2.2 **Networking Components:** This handles the communication between the different interfaces. The system would be supported by the school's intranet, hence the web application, and desktop application at the hall and points of exit verification would communicate with the database via the intranet.

5.2.3 **Warm-ware Components**: These refer to the school employees i.e. hall administrators and security staff. It also includes the students. The student schedules exeat, the hall administrator authorizes exeat and the security staff authenticates exeat (leave).

5.3 System Testing: This involves integrating one or more components of the system and testing the composite system. This phase handles the integration of the entire system. In this case the components include the database, the web application and desktop application. This system testing was carried out by hosting the database on a personal computer, where the desktop application and web application were not resident. The web application was accessed over the intranet from a personal computer where neither the desktop application nor database is installed. The desktop application was also installed on a personal computer where other components (web application and database) were not resident. Exeat was scheduled on the web application, sent to the database over the intranet, the desktop application authenticated login with records in the database over the intranet and was able to display pending exeats of that hall id logged in, according of date of leave in ascending order and commit changes to database over the

intranet. The hall administrator was also able to sort exeats as required. During the system testing, the requirements i.e. the functional and non- functional were tested, to ensure the abilty to deploy these requirements unto the system.

6. DISCUSSION OF RESULTS

Results obtained from performed tasks showed favorable outcome in most areas although marginal lapses were also observed. The system's efficiency was measured and rated in its scheduling, authorization and authentication phases. For the scheduling and authorization phase, the criteria include:

Ease of Exeat Scheduling by Students: the new system proves to be cost effective, reliable and time saving as regards the scheduling of exeat. The system design which included hosting the webpage on the school's intranet reduced the dependence on the internet. The school's intranet has little or no downtime hence exeat can be scheduled with convenience within the campus.

Security in Scheduling: the new system was designed as an improvement (upgrade) of the current manual exeat system. It has a fool-proof method of scheduling exeat because a student exeat cannot be passed over to another. All breach attempts regarding this, during the tests were rendered void.

Figure 2: Short distance schedule form

Ease of exeat analysis and authorization by hall administrator: Like the manual exeat system, exeat authorization will not take place until the hall administrator visits his or her page. The same convenience the student enjoys, the hall administrator does too. A sample with a few hall administrators proved the system to be effective. The new system designed makes available the following:

i. Exeat history of a student for the current semester, which includes the exit date and time, and also the entry date and time. It ranked exeat based on the scheduled day of leave. Much attention can now be focused on those who would have to leave in less than 3 days, while others can still be left pending.

ii. Unlike the current manual system where the hall administrator's office would be crowded when large number of students would request for exeat permission for vacation or holiday, this new system eliminates that approach. The hall administrator can now work in solitude, and at his or her discretion, the student can be sent for.

iii. Security in exeat analysis and authorization

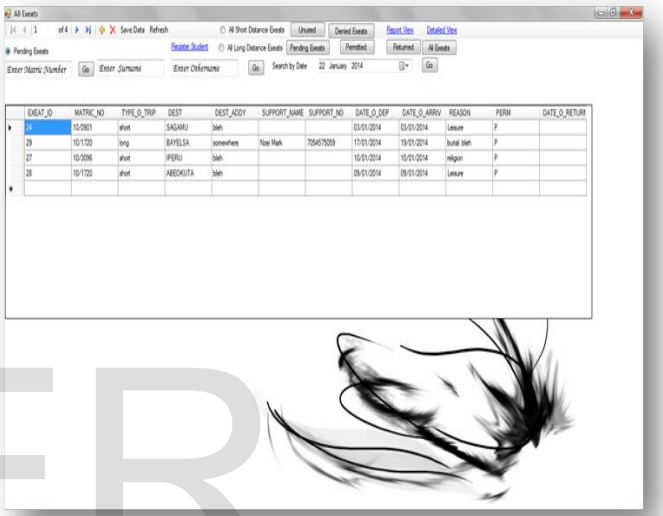

Figure 3: Exeat analysis view

For the authentication phase, the criteria include:

i. Ease of Authentication at points of exit.

Student: this system eliminated the exeat validation students' face even when they go about it the right way. The crowd and the struggle at the gate and at the hall administrator's office create an unhealthy environment and an ugly sight. This new system ensures that students come in and leave with ease. Also, student was allocated at most three attempts to pass the fingerprint validation before he or she is side-stepped for manual verification. The inflow and outflow of a student in and out of school is at an increased pace as the average student spent not more than 15 seconds.

Security in authentication: When granted exeat, a student would only be allowed to leave school based on the fingerprint validation ability which would be made available upon validation. This solution to a gross extent would remain secured because of the level of flexibility disallowed. The system

is rigid, and all activities go through a phase before the next. Failure to successfully move through a stage, the exeat will be nullified immediately. This enables a monitored entry and exit mode for the students. The security unit has less to do in this regard. They majorly have to ensure all students verify their approved exeat with their fingerprints. In addition, the efficacy of the network time was laudable. Exit and entry time of a student during an exeat leave was acquired to an exact precision. It also gives notifications to the hall administrator to enable him or her make informed decisions in future for a particular student.

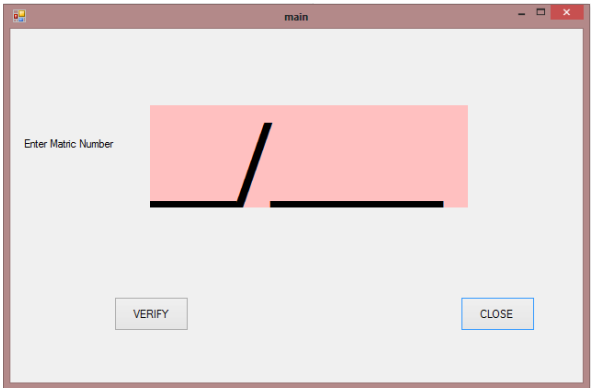

Figure 4: Fingerprint verification view

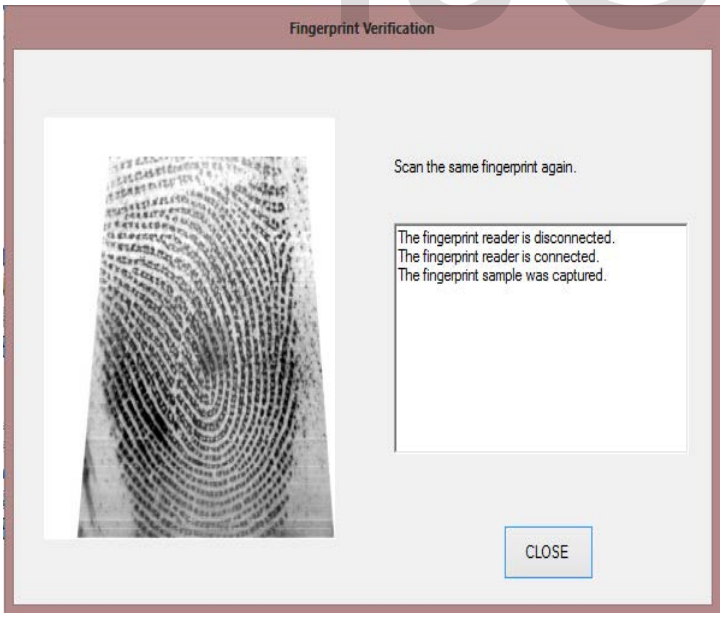

Figure 5: Fingerprint enrollment view

7. RESULTS AND FINDINGS

In exeat system, leave of absence management systems, employee tracking system and all other related systems, not much economic benefits are derived because such systems are only needed to curb and restrict human behaviors and movements.

8. END SECTIONS

8.1 Recommendations

If improvement to this system would be needed, it would be in the phases of the validation. Bots and intelligent systems could be used to substitute human intervention. The system could use some algorithm to validate the exeat, and use more than one method of verification to make sure it can never be falsified. Regular human intervention could also be needed to ensure optimum performance. However, this might not be necessary, because such a system would only prove to be too rigid and frustrating to students and staff alike, not to mention the additional cost of setting up and maintenance.

8.2 Conclusion

The benefits of this new exeat system outweigh that of the current manual system as well as its shortcomings. The system captures the objectives listed in section 1 with the exception of the amount of students in and out of the institution at a particular point in time due to its ambiguity. This system would lose value if the fingerprint validation could be bypassed. Students would no longer need to schedule and wait for validation to leave school. In addition, the system is in some aspects subject to human truthfulness. The system would also be ineffective if the authorities in charge are dishonest. Without all these defects, the system is expected to perform optimally.

REFERENCES

[1] Oxford Dictionaries, Language Matters. www.oxfrddictionaries.com Retrieved 8th of February.
[2] Leave Master: "" Retrieved from http://www.leavemaster.com/ June 4th 2013.
[3] Leave of Absence Management System (May 2013): "" Retrieved from http://www.dur.ac.uk/hr/policies/absence/lams/ June 3rd 2013.
[4] Konstantinou P. (ISAM 5635):"Rapid Application Development". Retrieved April 1, 2013.
[5] CASEMaker Totem: "What is Rapid Application Development" www.CASEMaker.com/ Retrieved 2nd April, 2013
[6] Department of Health and Human Services (Mar. 27 '08):"Selecting a Development Approach"USA. Retrieved April 1, 2013.