

Re-Engineering of Examination Timetable Generation and Invigilation Scheduling System

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Abstract:- Timetabling is an essential component of scheduling in all sectors of education. University timetabling entails the scheduling of times and venues for lectures and examinations. This study was carried to study the existing system of examination scheduling at Faculty of Physical Science Nnamdi Azikiwe University Awka, Nigeria and to design an automated examination scheduling system. Agile methodology was adopted and Recursive, Search and Sort algorithm were applied to achieve the aim of the study. The system analysis was carried out in order to collect factual information and understand the process involved in the existing system, identify problem and recommend a feasible solution that will help the users. In studying the existing system, direct and indirect method were used to obtain data for the analysis of the existing system. The problems of the existing system were identified and an automated examination scheduling system was considered as a possible solution to the problem of the existing system. The new system will; capture the actual sizes of the students in a class and allocate examination venues accordingly, prevent double booking of examination hall during the same time slot, prevent allocation of two faculty courses on the same day for a student of a level to write and eliminate the tedious process of manual scheduling. The software tools used to develop and design the new system include; XAMPP server, JavaScript, PHP, Cascade Style Sheet, VSCode, HTML, and MySQL. The new system was dived suitable for use and therefore was recommended for users to embrace the new development.

I. INTRODUCTION

Timetabling is an essential component of scheduling in all sectors of education. University timetabling entails the scheduling of times and venues for lectures and examinations. These activities are logically structured in a time-wise manner and presented on papers and placed on notice boards in order to avoid conflicts of events (Muhammad et al, 2017). There are several categories of timetabling in educational institution and these include master timetabling, lecture timetabling, faculty timetabling, examination timetabling, etc (Oluwaniyi et. al, 2016). Of all the various types, examination and lecture timetabling has more difficulties than others during the timetabling process because of the number of constraint and resources involved (kembuan et al, 2018). Examinations play a central role in the educational system due to the fact that information generated from examinations is used for a variety of purposes. Critical decisions such as selection, placement and determining the instructional effectiveness of a programme of study all depend on data generated from examinations (Mogapi, 2016). Examination

scheduling is largely studied class of timetabling problem concerning the scheduling for testing student's performance after several weeks of receiving lectures within a specified period of time (Mohamad, 2018). According to Fiarni et al (2015), poor scheduling practices would cause double-assignments of lecturers, prolonged postponement and cancellations of presentations as well as an inefficient use of time and resources. Scheduling examinations is a problem in virtually every high school, college, and university. The basic challenge is to schedule examinations over a limited time period so as to avoid conflicts and to satisfy a number of side constraints (Carter et al, 1994). The world is changing into a global village and the quest for knowledge and information is increasing. Computing is fast dominating all the aspects of life and many academic institution activities. There is a need for an easy way for planning and scheduling the school examination time-table. Academic institutions are moving toward automated management of the educational process. One aspect of this process is the exam scheduling. The large number of students, classes, lecturers, and venues renders the manual scheduling process tedious and useless.

The Faculty of Natural Science originally consisted of two Faculties, namely: The Faculty of Biological Sciences and the Faculty of Physical Sciences. These two Faculties and the Faculty of Engineering were the pioneer Faculties of Anambra State University of Technology, ASUTECH, in 1981. Recently, the unwieldy and oversized Faculty, for administrative-cum-research convenience, was split into two, namely, the Faculty of Physical Sciences and the Faculty of Bioscience of seven and six Departments, each/respectively; the NUC visited on Resource Verification for the split and it was approved. The main objective of the Faculty is to produce self-reliant graduates capable of establishing their own out-fit upon graduation and to produce middle and high level manpower for the various sectors of the Nigerian economy, such as: Industry, Agriculture, Mineral Resources, Oil/Water Industries, Health, Education, ICT, etc. The Faculty offers programmes in both Pure and Applied Science. Taking cognizance of the fact on the advancements made in Sciences, Engineering and Technology and national needs, a constant review the programmes has been in vogue to include hybrid programmes and industrial options.. The Faculty services the Faculty of Engineering, Environmental Sciences, Health Sciences, Medicine, ICT and General Studies Unit; quite a Herculean task for a University of a population of over 30,000 students! At the end of 2008/2009, the proposal to split the Faculty of Natural Sciences into Faculties: Physical Sciences comprises the following Departments: Computer Science, Geological Sciences, Mathematics, Physics and Industrial Physics, Pure and Applied Chemistry and Statistics were accepted. Recently, the department of Geophysics was

created as a new department in the faculty of physical sciences at Nnamdi Azikiwe University Awka (www.unizik.edu.ng/faculties/physical-sciences). The aim of this study was to develop an examination timetable scheduling system for the faculty of Physical Sciences, Nnamdi Azikiwe University (NAU), Awka, Nigeria. It will replace the manual process of examination scheduling and facilitate effective scheduling of examination in the faculty. The specific objectives are to determine the specific areas of deficiency in the existing system, develop a system that avoids scheduling of two faculty courses on the same day for students in the same level and department, develop a system that will capture the hall capacity & allocate students accordingly on the hall during exams and prevent double booking of examination hall during the same time slot.

II. LITERATURE REVIEW

Many researchers have shown great interest in the area of scheduling and timetabling. A wide variety of studies, from the field of operations research and artificial intelligence have addressed the spectrum of university timetabling problems. Evolutionary techniques have been applied to solve the timetable scheduling problem, methodologies like Genetic Algorithms (GAs), Evolutionary Algorithms (EAs) etc have been used with mixed success. Researchers have employed many different approaches over the years in an attempt to generate „optimal“ timetabling solutions subject to a list of constraints.

Ezeora N.J et al (2020) designed an automated time tabling system to overcome the shortcoming of manual time tabling system. This automated system simplified the manual process, ensured optimum allocation of resources and reduced the risk of omission of courses and clashes of halls and lecturers. The work was effectively evolved utilizing python structure, SQLite Database. Client experience was utilized, an easy to use programming language, and the bundle was tried and enhanced to yield a mechanized Time table plan booking control framework.

Haruna C.R, et al (2022) developed an Exam Timetable using Random Scheduling Technique with Crowd-Sourcing. A hybrid technique tailored to suit the University of Cape Coast examination timetable scheduling was proposed, where machines are first used then experts complete the scheduling. Real data set from the University is used in this research and the effectiveness of the proposed technique was presented by performing multiple experiments and the results of an examination timetable using real data sets from past academic years (semesters) from the University of Cape Coast were used. The technique first uses the machine to accept the data sets and randomly schedules the unique courses, then human experts are used on the courses that the algorithm did not schedule. The algorithm on the average, randomly scheduled 97.35% of the unique courses. While 2.65% of the unique courses are scheduled manually.

Arikpo & Okokon (2018) developed an automated system that can simplify the lecture and examination timetabling in the University. The system was designed with

an object-oriented analysis and design approach using the unified modelling language. The resulting web application was implemented using the Java Enterprise Edition version 6, with MySQL Server as the backend database system. The resultant software schedules lectures and examinations interactively and in batches for the eleven departments of the Faculty of Science at the University of Calabar, Nigeria. Lectures are scheduled randomly in timeslots, satisfying the constraints provided in the system.

Similarly, Oluwaniyi N.O et al (2016) developed an Automated University Examination Timetabling System. The system was developed using Macromedia Dreamweaver for creating the websites while MySQL serves as the database. The programming languages used consists of HTML (Hypertext Markup Language), PHP (Hypertext Preprocessor), Javascript, CSS (Cascading Style Sheets) and SQL (Structured Query Language). The system was able to successfully schedule the university examination timetable within a few seconds without clashes of invigilators and examination venues. Azilawati et al (2017) designed and implemented a Framework for University's Final Exam Timetable Allocation Using Genetic Algorithm. Actual data obtained from Faculty of Informatics and Computing, Universiti Sultan Zainal Abidin, Malaysia was studied and Genetic Algorithm method was implemented to generate automated timetable. The data from Semester 2 in 2016/2017 session which comprised of two (2) Diploma and three (3) Degree Programme conducted at the faculty was used. From the final examination timetable generated from the developed system, there was no redundant slots allocated. The results were generated in a timely manner with very least resources and there was very little human intervention throughout the timetable generation.

Chaya Andradi & Saminda Premaratne (2016) developed an automated timetable management system to the faculty of IT at university of Moratuwa to overcome time table scheduling issues. Preliminary study was conducted and hypothesized using Genetic Algorithm. In the solution, each individual called chromosome was evaluated using a fitness function in the implementation process. Five great Chromosomes with higher fitness value were considered as optimal solution or timetable schedules. The timetable administrator further refined the most suitable timetable. Tools such as PHP, Yii with MVC architecture and MYSQL were used in this system. The system was tested and evaluated in the university background and was suggested for medium scale universities.

Muhammad, S.H et al (2017) Designed an Android and Web-Based University Timetable Customization System for the Faculty of Computer Science and Information Technology, Bayero University, Kano-Nigeria. The web-based system provides an administrative module that facilitates scheduling and rescheduling of lectures, examinations and invigilation, hence addressing the high cost of scheduling and depreciation of notice boards. Similarly, the Android application combines two categories of users (lecturers and students) into one application, thereby providing facilities for viewing, customizing and setting

reminders for schedules. Experimental testing of the Android application has shown that, the customization of schedules and setting reminders for customized schedules are efficiently achievable using the Android application due to its portability and on-the-go reminder facility.

This study began by reviewing literature of various papers on automatic timetable scheduling system. Figure 1 provides a conceptual framework of the existing exam scheduling in faculty of physical sciences, Nnamdi Azikiwe University (NAU), Awka. The examination officer from each department in the faculty; Computer science, industrial physics, industrial chemistry, Geology, statistics, mathematics, Geophysics, creates a timetable for the respective departments, fixing the date, time and hall to be used. After creating the timetable, the departmental examination officers submit it to the faculty examination officer who will compile the entire timetable from each

department and approve before pasting it on the notice board for students to view their timetable as shown in figure 1. Currently, some of the challenges encountered by the faculty of Physical Science, Nnamdi Azikiwe University (NAU), Awka includes; the current manually prepared exam time table is always error prone and takes a lot of time to reschedule; students in a particular level and department do write two faculty courses the same day which is against the school rule; manual system of accessing time table is stressful and double booking of examination halls at the same period of time. The new system will help to solving the problems of the present system. This can be achieved with the help of Recursive, Search and Sort Algorithm. A direct recursive algorithm was applied in the new system where a function calls itself in its function body repeatedly. The search algorithm helped to check for an element where it is stored. While the sort algorithm helped to put elements of a list into an order.

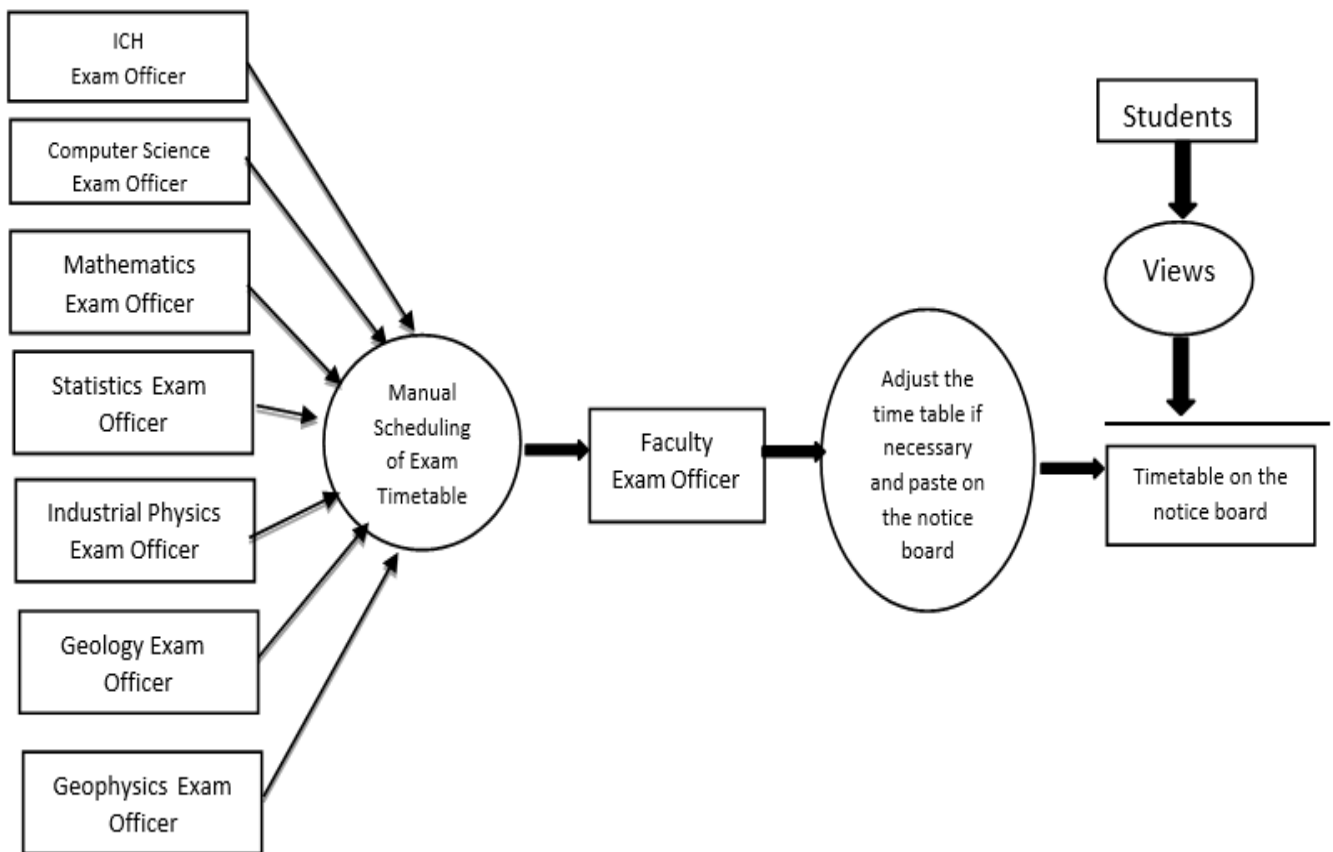


Fig 1: Conceptual framework of the existing system.

III. METHODOLOGY

The architecture of the system were designed to give the representation that describes the structure and views of the system as show in figure 2.

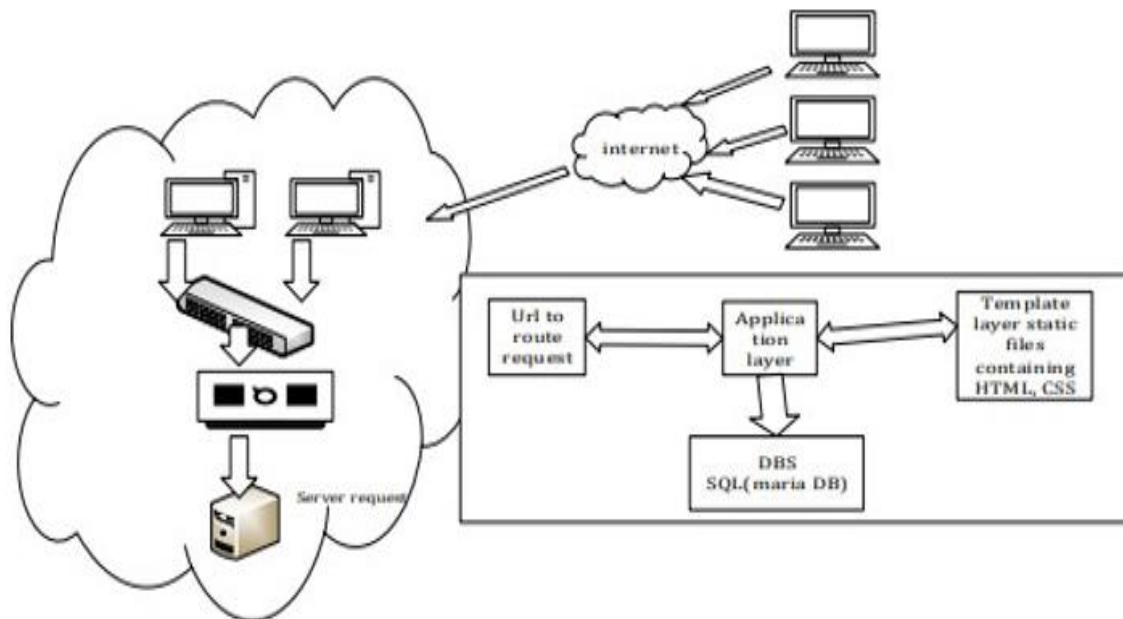


Fig 2: Overall system Architecture of Examination Scheduling system

The system was designed using a PHP programming language. It consists of the client interface, computer software that offers service to software application (middleware) and database. The graphical user interfaces (front side) was designed and developed using HTML version 5, CSS and JavaScript, while the middleware was designed based on the WSGI web server and the back-end was the MySQL database system. The database, which is where all the records are stored, was designed with MySQL (MariaDB) and can be managed through PHP MyAdmin GUI database management system setup on XAMPP Server. The requirements for the system were specified using Use Case as depicted in Table1.

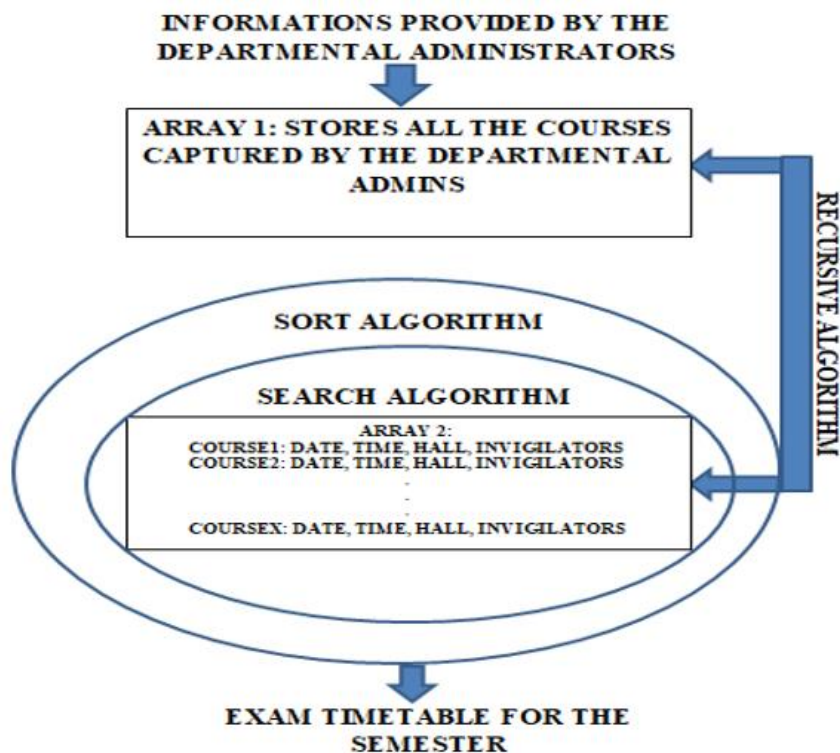


Fig 2: Diagram depicting the Recursive, Search and Sort algorithm used in Faculty of Physical Sciences NAU.

After considering the basis for recursive, search and sort algorithm. Figure 2 above highlights the application of the algorithms in generating the timetable. The departmental administrators supply the halls, invigilators, course offered etc. into the new system. The system picks the whole courses provided and places it in an Array1. An empty Array2 is created. The system picks a course from array1 and assign date, time, Hall and Invigilators to the course and then places it on the Array2. The system repeats the same

procedure again by picking another course and assigning date, time, Hall, and invigilators. This process of picking a course and assigning the necessary examination information to them is made possible with the help of a recursive algorithm. When the system is picking a course and assigning the necessary examination information, it searches the Array2 to know if the time and date is existing on a course been offered by people in the same level (this will help to avoiding a student writing two exams on the same day), The search process is made possible by the help of a search algorithm. When all the courses have been represented in the Array2, the sort algorithm helps to arrange the examination date in an orderly form. The system assigns time duration for each course based on the credit unit of the course provided by the departmental administrator.

Table1: Shows Use Case specification Table for the proposed examination scheduling system

S/N	USE CASE NAME	USE CASE DESCRIPTION	PARTICIPATING ROLE
1	LOGIN	The faculty and departmental administrators logs into the system with a username and password to gain legal entry	Departmental and Faculty administrators
2	ADD ADMIN	The faculty administrator is allowed to add a new departmental admin.	Faculty administrator
3	SCHEDULE	The faculty administrator is allowed to schedule the duration of the examination and as well generate a timetable	Faculty administrator
4	ADD COURSES, ADD HALL, ADD INVIGILATORS	The departmental administrator is allowed to add courses, hall and invigilators	Departmental administrator
5	VIEW TIMETABLE	The faculty admin, departmental admin and students are allowed to view the timetable	Faculty administrator, Departmental administrator and students

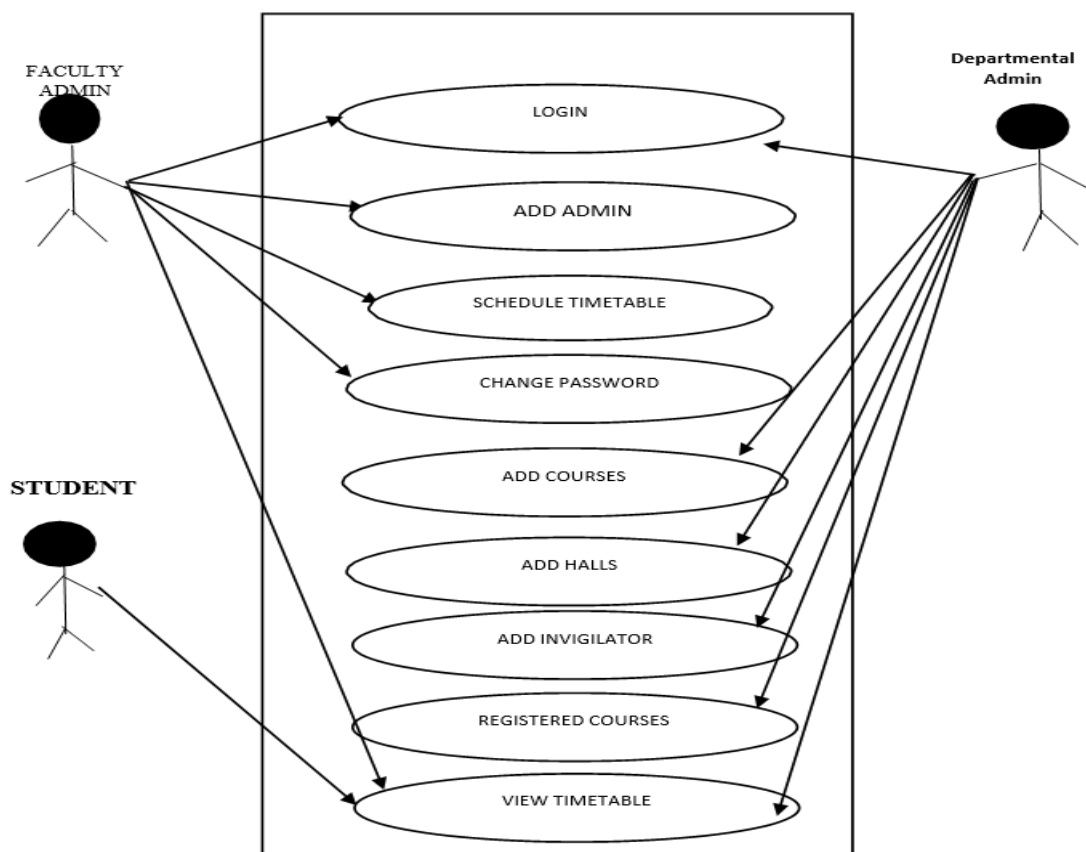


Fig 3: Use Case diagram of the proposed examination scheduling system. IMPLEMENTATION

The proposed automated exam scheduling system is a platform independent scheduling system for Faculty of Physical sciences, Nnamdi Azikiwe university Awka, Nigeria. The new system isa web-based application that does not require installation on a physical hardware but rather canbe accessed through a local host web server or hosted remotely in the cloud as shown in figure 2. With the goal to overcome the timetabling challenges affecting universities every year and reduce high cost and slow turnaround involved in the generation of near-optimal timetables, the proposed examination scheduling system will be built. The three actors that interact with the system are; the Faculty admin, Departmental admin and Students. The Faculty is the super admin of the system who is in charge of adding departmental admin and scheduling examinations. The Departmental admin carries out activities that are important in the departmental level such as; uploading courses (specifying the departments that offer it and the total of number of students), adding invigilators and providing available halls and their capacity for examination. Though the student does not perform any activity that helps in the scheduling ofexamination, it is important for every student to know the days on which their examination falls. Therefore, a student can access the system to view the generated timetable.

A. HOME PAGE

The home page of the new system is accessible to all the users of the system; Faculty administrator, departmental administrator and the student as shown in figure 4. The faculty administrator clicks on the faculty administrator button before supplying the username and password to login, such is also applicable to the departmental administrator to clicking on the departmental administrator button before supplying the username and password to login. The students only have access to the view timetable.



Fig.4: Screenshot showing the Home page of the examination scheduling system

B. FACULTY ADMINSTRATORS LOGIN PAGE

The faculty administrator's dashboard depicted in figure 5 shows the dashboard of the faculty Administrator in the new system. This dashboard is visible when the Faculty admin log in successfully into the system. The faculty administrator has the access to add a departmental administrator, view the list of administrators, schedule a timetable and as well view the schedule time table.

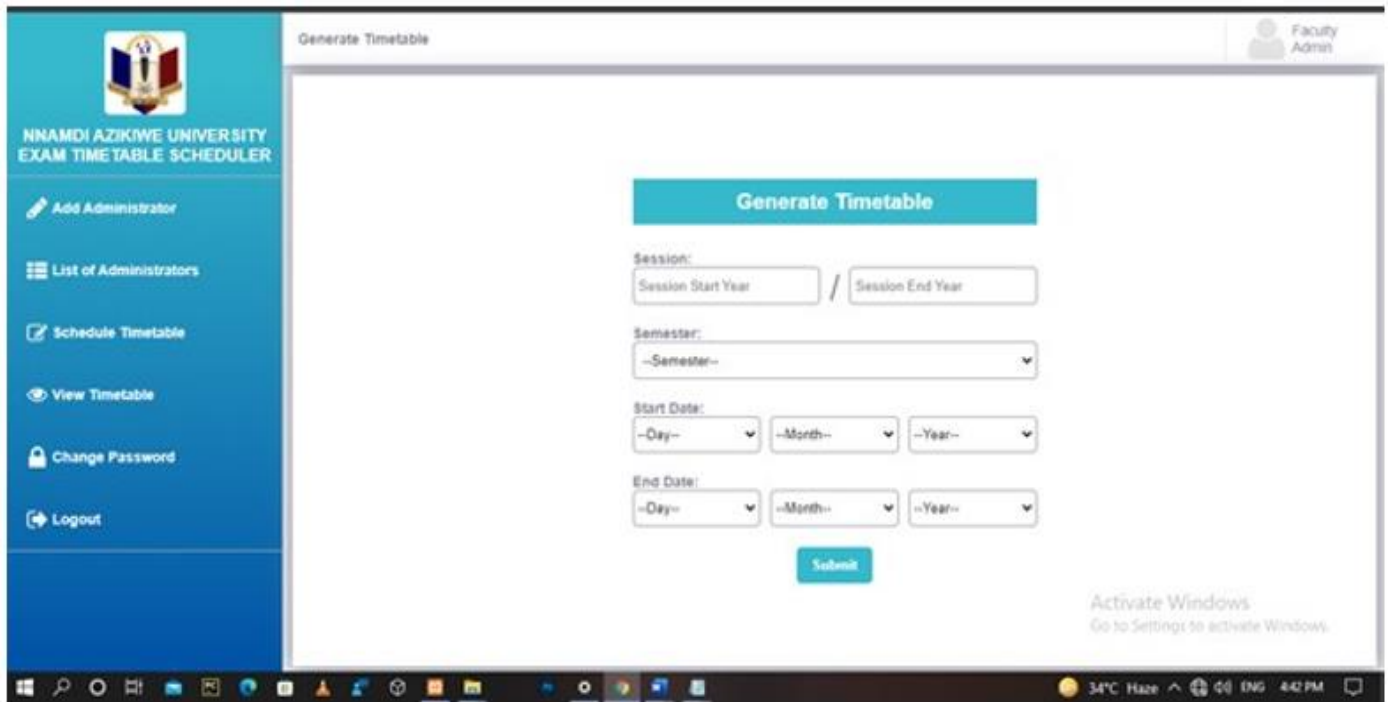


Fig. 5: Screen shot of the Faculty administrator’s dashboard

C. Departmental Administrators Login Form

The departmental administrator’s login form is another feature of the new system. The only users eligible to login successfully on this form are the departmental admins successfully created by the faculty administrators. Figure 6 shows the departmental administrator’s login form.

In addition, the departmental administrators dashboard as depicted in figure 7 shows the necessary functions a departmental administrator can perform in the new system, they include; add courses, add halls, add invigilators, view registered courses and view timetables.

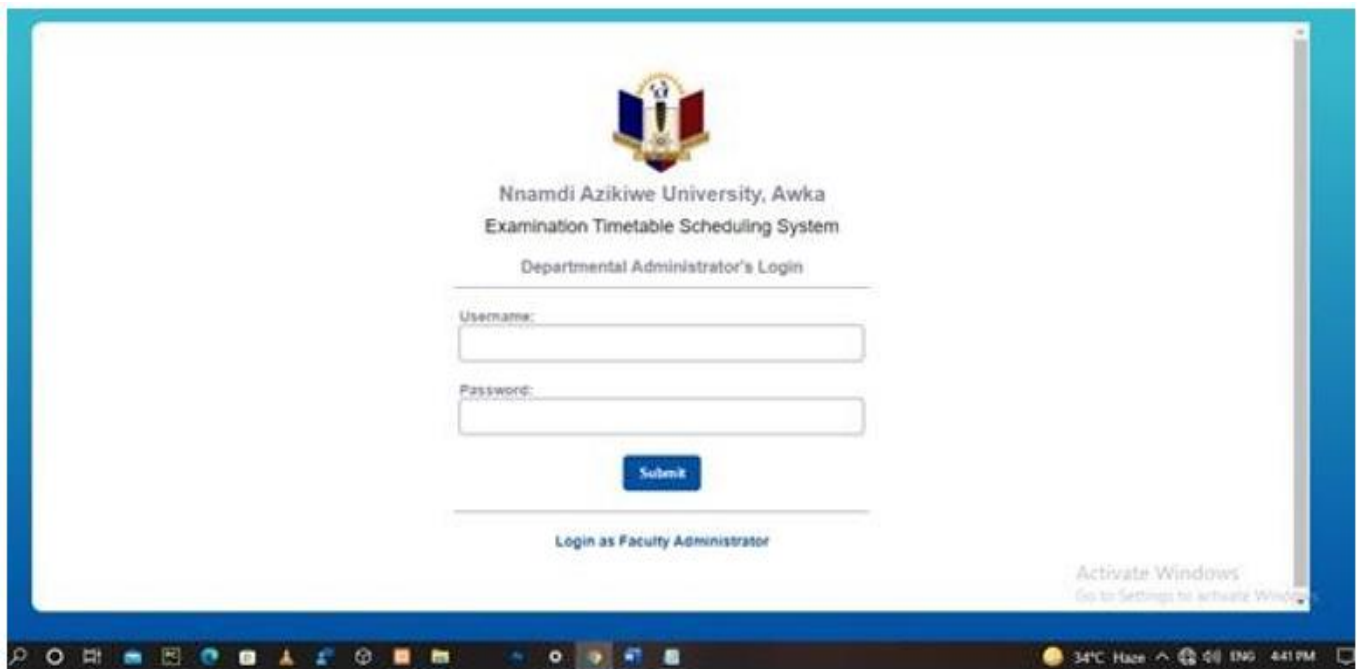


Fig. 6 : Screenshot showing the departmental administrator’s login form

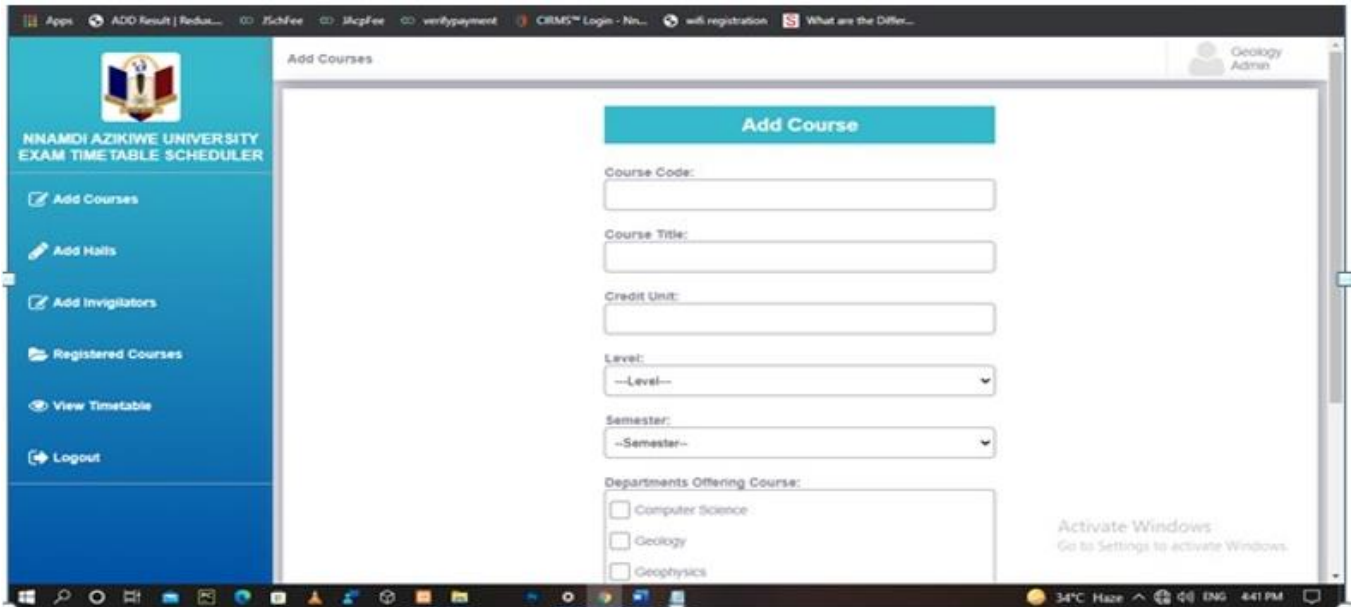


Fig. 7: Screenshot showing the departmental administrators dashboard

D. Generated Timetable

The generated timetable shown in figure 8 is the output interface in the new system showing the examination timetable for a semester. The timetable is generated by the Faculty administrator that has the higher privilege to scheduling an examination. The timetable generated by the faculty administrator is as result of the information provided by the various departmental administrators in each semester.

Date	Time	Course Code	Course Title	Credit Load	Hall	Hall Capacity	Number of Students	Invigilators
02-02-2021	10:00 AM - 01:00 PM	ich 111	Inorganic chemistry	3	Digital Library	400	200	Dr. CHUKWUKELUE ADAOB, Prof. Chukwu Maxwell, Mr. Ezech Philips
02-02-2021	12:00 PM - 03:00 PM	GEO 411	Geological Sciences	3	maths hall	200	60	Mr. Ezech Philips, Prof. OBIOHA LAWRENCE T., Prof. OBIOHA LAWRENCE T.
03-02-2021	02:00 PM - 05:00 PM	geo101	geoph	3	stat hall	150	150	Dr. Nnenna Harrison, Prof. OBIOHA LAWRENCE T., Dr. CHUKWUKELUE ADAOB
03-02-2021	08:00 AM - 11:00 AM	geo 101	introduction	3	Jupob Auditorium	200	150	Dr. Ezech Darlington, Dr. CHUKWUKELUE ADAOB, Mrs. Nwanikwa Onyiake
03-02-2021	11:00 AM - 02:00 PM	geo 121	survey	3	maths hall	200	150	Mrs. Nwanikwa Onyiake, Prof. OBIOHA LAWRENCE T., Prof. OBIOHA LAWRENCE T.
04-02-2021	01:00 PM - 04:00 PM	MAT 101	introduction to Mathematics	3	physics lab	600	120	Prof. OBIOHA LAWRENCE T., Mrs. CHUKWUKELUE ADAOB, Prof. OBIOHA LAWRENCE T.
04-02-2021	01:00 PM - 04:00 PM	MAT 321	Calculus	3	stat hall	150	70	Prof. OBIOHA LAWRENCE T., Dr. Ezech Darlington, Dr. CHUKWUKELUE ADAOB
04-02-2021	02:00 PM - 04:00 PM	CSC 300	Intro to CSC	2	Digital Library	400	12	Mrs. Nwanikwa Onyiake, Mr. AKURETO NNAMDI, Dr. Ezech Darlington
04-02-2021	09:00 AM		Physics					Dr. CHUKWUKELUE ADAOB, Dr. Nnenna

Fig. 8: Screenshot showing the generated timetable by the faculty administrator

IV. CONCLUSION

The proposed system will be of great benefit to the staff and students of faculty of physical sciences, Nnamdi Azikiwe University Awka, Nigeria. The new system is expected to optimize and improve the efficiency of the examination scheduling process in the faculty of Physical Sciences, NAU, Awka. The result showed that the proposed system was successful and can produce schedule without scheduling of two faculty course exam on the same day for students in a level to write; allocating examination in a hall that is lesser in

capacity to the size of the students and double booking of examination hall during the same time slot etc. The system validates departmental and faculty admin, granting higher privilege to the faculty admin and giving students access to only view timetable. The system provides data management mechanisms to facilitate persistent data storage as regards courses, examinations, lecture venues, department, invigilators etc.

REFERENCES

- [1]. Azilawati Rozaimée, Adibah Nabihah Shafee, Nurul Anissa Abdul Hadi and Mohamad Afendee Mohamed (2017). “A Framework for University’s Final Exam Timetable Allocation Using Genetic Algorithm” World Applied Sciences Journal 35 (7): 1210- 1215, 2017 ISSN 1818-4952 © IDOSI Publications, 2017 DOI: 10.5829/idosi.wasj.2017.1210.1215
- [2]. Carter, M. W. Laporte, G. and Lee, S. Y., 1996. Examination timetabling: algorithmic strategies and applications. Journal of Operational Research Society, Vol 47 (3), pp. 373–383.
- [3]. Charles Roland Haruna, Elliot Attipoe, Isaac Armah Mensah, Kwame Opuni-Boachie Obour Agyekum (2022) “Using Random Scheduling Technique with Crowd-Sourcing to Solve Exam Timetable”. International Journal of Computer Applications (0975 - 8887) Volume 183 - No.50, February 2022
- [4]. Chaya Andradi, Saminda Premaratne (2016). “Utilization of Timetable Management System to a Medium Scaled University”. International Journal of Modern Research in Engineering and Technology (IJMRET) www.ijmret.org Volume 1 Issue 2 | July 2016.
- [5]. Fiarni, C., Gunawan, A. S., Maharani, H., & Kurniawan, H. (2015). Automated scheduling system for thesis and project presentation using forward chaining method with dynamic allocation resources. *Procedia Computer Science*, 72, 209-216.
- [6]. Iwara Arikpo, Abigail Okokon (2018). “An Automated Scheduling System for University Lectures and Examinations” International Journal of Scientific & Engineering Research, Volume 9, Issue 8, August-2018 ISSN 2229-5518
- [7]. Kembuan, O., Rorimpandey, G. C., Rompas, P. T. D., & Runtuwene, J. P. A. (2018). Development of Web based Timetabling System. In Proceedings of the 7th Engineering International Conference on Education, Concept and Application on Green Technology(pp. 317-322). SCITEPRESS-Science and Technology Publications.
- [8]. Mogapi, M. (2016). Examinations Wash Back Effects: Challenges to the Criterion Referenced Assessment Model. Online Submission, 3(3), 78-86.
- [9]. Mohamad A.M. (2018). Final Exam Scheduling Timetable a Case Study. [Online]. Available: https://www.researchgate.net/publication/273521527_Final_Exam_Scheduling_Timetabl_e_a_Case_Study. (Accessed on 2nd January, 2022)
- [10]. Muhammad, S. H., Galadanci, B. S., Mustapha, A., & Yahaya, A. S. (2017). Design and implementation of an android and web-based university timetable customization system. Bayero Journal of Pure and Applied Sciences, 10(1), 320-325.
- [11]. Muhammad, S.H., Galadanci, B.S., Mustapha, A. and Yahaya, A.S (2016) “Design and Implementation of an Android and Web-Based University Timetable Customization System”. Bayero Journal of Pure and Applied Sciences, 10(1): 320 - 325, ISSN 2006 – 6996. <http://dx.doi.org/10.4314/bajopas.v10i1.50>
- [12]. Nathaniel Olufisayo Oluwaniyi, Babajide Olakunle Afeni, Bukola Abimbola Onyekwelu (2016). “Development of an Automated University Examination Timetabling System”. International Journal of Scientific & Engineering Research, Volume 7, Issue 1, January- 2016 ISSN 2229-5518
- [13]. Nnamdi Johnson Ezeora, Uzo Izuchukwu Uchenna, Gregory E. Anichebe, Obayi Adaora Angela, Mathew Daniel E, Ihedioha Uchechi. M, Onyedeke, Obinna C, Uka Emmanuel Uche. (2020). “An Automatic Examination Timetable System Using Selection and Crossover Technique”. International Journal of Research and Innovation in Applied Science (IJRIAS) | Volume V, Issue VIII, August 2020 ISSN 2454-6194
- [14]. Oluwaniyi, N. O., Afeni, B. O., & Onyekwelu, B. A. (2016). Development of an Automated University Examination Timetabling System. Available on <http://repository.elizadeuniversity.edu.ng/jspui/handle/20.500.12398/1160> (Accessed on 27th December, 2021)