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Development of Student Information System using Unified Modelling Language

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Abstract

The manual approach to student data management has a number of drawbacks, including lost student information, inaccurate results calculations, delayed report release, and insecure records. Therefore, an automated platform that is adaptable for managing student data is presented in this study. A Unified Modelling Language (UML) and Java NetBeans IDE were used to design and create the system's front end, while MySQL was utilized to implement the model's back end. The Department of Computer Sciences at Tai Solarin University of Education in Ijagun, Ogun State, provided the datasets used to test the system. The main features of the system were explained by the logical progression of the system and its functional modules. Additionally, the use-case diagram displays the much functionality offered by the system as well as the various kinds of system actors. The system's adequacy, appropriateness, scalability, security, usability, interoperability, and flexibility were demonstrated in integration tests on its practicability, indicating that it is extendable and adaptable to various information management domains. Adopting this new information system will assist tertiary institutions in managing the institutions in making decisions quickly and accurately while completing high-speed activities, both of which will improve student performance.

Keywords: UML, MIS, SIS, Database, Use-case diagram.

1. INTRODUCTION

Information systems (IS) have become the backbone of most academic institutions. In almost every sector: education, finance, government, health care, manufacturing and businesses, large and small ISs play a prominent role. Everyday work, communication, information gathering, and decision-making all rely on information technology (Sagarmay, 2014). An IS, according to Kroenke (2015), is a structured system for gathering, organizing, storing, and sharing information. To be more precise, involves studying complementary networks that are used by individuals and organizations to gather, filter, analyse, produce, and disseminate data. Accordingly, an IS is a collection of elements that work together to generate information (Khumaini et al., 2024).

The effectiveness of organizational decision-making and daily tasks is critical for every organization Begam (2015). Similarly, students' IS efficiency and ability to make decisions are critical to their future growth as well as their current status. Universities ought to think about using technology to make decisions because of this. Because it is used to store data that generates reports for decision-making regarding students, instructors, departments, faculties, and curriculum, the

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student information system (SIS) is a crucial system at universities (Bayangan-Cosidon, 2016). The quality of IS, how information is presented, and other factors can all have an impact on how these systems are used and distributed throughout businesses. The task of managing information technology systems in a school environment poses unique challenges. Many of these challenges arise from inconsistently registered data, manual duplication of data entry, extra time needed to manage multiple user accounts for one user, and nonproductive time spent on technical support (Thelma et al., 2024). Apart from these issues, maintaining every single system takes a lot of work. Thus, it is anticipated that the implementation of students' IS in schools will address some of the issues raised, particularly in the realm of system integration. It is significant to remember that university enrollment is rising annually. Maintaining all of the unique student data is threatened by this growth, which also takes time, thus it is now essential to handle student data using contemporary methods. By using data models, these contemporary techniques and approaches switch from the manual or old manner of work to a computer-based system that is more convenient and efficient (Gulam and Ashok, 2011). A lack of a reliable database system has also resulted in having to manually compute and reconciliation of students' academic records (such as results), time constraints, and inefficient processing of student data due to the process of combining multiple systems into a single data source. Abubakar et al. (2017) assert that information exchange and integration foster innovation and learning inside a company, both of which have a major effect on the performance of the institution.

In order to address the challenge of combining several systems into a single data source that would guarantee accuracy, save time, and carry out other expedited tasks, we created an adaptive data model in this study. SIS handles student data, involving but not restricted to course registration, grade management, transcript management, and test data management. The concept of computerized files, which are files saved and stored in a computer system, encouraged the creation of theories and techniques for reusing electronic files (Almehmes, 2014).

Notably, almost all universities, particularly those in Nigeria, have implemented computer-based information processing systems, making them the primary hubs for learning, scientific research, and the cultivation and advancement of talent (Sara et al., 2010). ICTs are being utilized to assist in achieving educational goals and mandates. As many researches have proved that ICT use in SIS could facilitates collection, processing and spreading endeavor of student records in a more efficient, quick and inexpensive way than using the traditional paper-based methods to handle data processing and dissemination by computers easily and accurately (Steenkamp and Basal, 2010).

The current state of student's information management in the universities and other institutions of higher learning need absolute improvement in terms of result computation, generating profile and record management. The barrier here is that the current system cannot adequately store, retrieve and generate reports of students as at when due, and would have to go through human intervention which is susceptible to errors and delays. Hence, this paper would seek to close these gaps by achieving the following objectives: identifying the system's requirements and further identify the types of data models required for SIS, design, test and validate the model.

Therefore, a more robust data modelling for SIS needs to be implemented and evaluated in order to reduce the bureaucratic bottleneck associated with the traditional system, as it would require less time/delay to getting academic reports ready, ensure accuracy, high level of security, and help to centralize and synergize other systems to becoming a single for integrity and robustness. A data model, according to Scott (2015), is the process of investigating data-oriented structures. It entails the process of converting a complicated software system design into an understandable diagram by representing the necessary data flow using text and symbols. The graphic can serve as a guide for re-engineering an existing program or for building new software.

For viewing the same data, data modellers can employ numerous data models. All processes, entities, relationships, and data flows have been identified by Margaret (2012). As a result, there are three main methods for modelling data. These are While Logical Data Modelling (LDM) depicts the particular entities, characteristics, and

relationships that make up a business function that forms the framework for the development of the physical data model, Conceptual Data Modelling (CDM) recognizes the highest-level relationships between various entities. Physical Data Modelling (PDM) is the implementation of a logical data model that is specific to a database and an application.

This paper's motivation centres on the application of a Unified Modelling Language (UML) to develop and evaluate student information systems (IS) in order to move away from the paper-based process of managing student information management. This will also cut down on the time required to fulfil orders and requests, allowing staff members to make timely decisions regarding student information.

RELATED WORKS

Using a modified waterfall approach, Razif et al. (2020) create a web-based information system that allows postgraduate students that substitutes Microsoft Excel-based systems. The system was developed using Apache Tomcat, MySQL, Adobe Photoshop, and the NetBeans IDE. Functional and usability tests were done to evaluate the system, and the results showed that it was dependable.

Sastry-Musti (2020) study the challenges and opportunity of management IS for higher education institutions, develop and maintain academic IS. Specific strategies were suggested to deal with reluctant of users in order to mitigate cost. A powerful case towards in-house design of academic IS was made.

Lubanga et al. (2018) study the benefits of Online Student IS in Mzuzu University, Malawi by applying qualitative and quantitative methods. The study showed that the system was beneficial to the students as it reduced the time spent during new semester registration.

A study by Liu et al. (2010) on the accomplishment of SIS included the creation and upkeep of a database as well as the creation of a front-end application. The study showed how beneficial an automated SIS is for businesses. The study also displayed SIS's architectural and functional layout. It also emphasizes the database architecture, functional modules, and user-friendly functionality of a strong SIS in a system of operations.

MATERIALS AND METHODS

In designing any computer-based system, it is imperative to establish the objectives that the system would satisfy. It is on this background that an extensive study of the existing system on SIS was carried out, after which the system's requirements and type of data models required to develop SIS were identified. This helped in designing an adaptive data model for SIS using Unified Modeling Language (UML), Java NetBeans IDE was used to develop the Graphical User Interface (front-end) of the system while MySQL was used to implement the database (back-end) of the model accordingly.

Proposed System Description

The proposed system in this study was thoughtfully planned and constructed, and it is adaptable enough to support reports, queries, and data prompting when needed. This indicates that the system is easy to manage and has a straightforward structure, operations, and procedures. The database may be expanded and updated, and it is adaptable enough to handle future demands from the students. Furthermore, it is simple to incorporate the fresh requirements from the student information without a need to completely revamp the system. Additionally, it is menu-driven and user-friendly, making it simple for any data entry operator to enter data and for management to obtain results. The system can reduce data redundancy and time consumption, which are common in non-computerized systems.

Tools Used in Designing the Proposed System

i. **Front-End:** The front-end was designed using a UML and Java IDE JFrame Form. The Java IDE JFrame form made it possible to have access to the palette and JFrame properties. The palette enabled complete access to all the Java Swings which include the Swing Containers, Swing Controls, Swing Menus, Swing Windows and Swing Fillers.

ii. **Back-End:** DBMS helps every organization to organize and structure their data in a logical way. Therefore, the database for the proposed system was designed using MySQL. The database is structured into five major tasks: the first

task is to create or add new students, the second task is to insert new student's results, the third task is to view all the registered students, the fourth task is to view all student's results and the fifth task is to query for a student's results for a semester.

Program Modules

The proposed approach, which was thoughtfully created to be accessible to both academic staff and students, as shown in Figure 1. The academic staff has three distinct functions within the system: course lecturer, examination officer, and system administrator. Each of these functions makes up a system module, which is further divided into smaller components. The first interface has two modules: *Student* and *Admin* (Staff). The interface upon clicking would direct the student or staff to the second module for login. The staff will login as an admin with the login credentials: *username* and *password*. While the students would login with their Matriculation Numbers, it is worthy to note here that the system gives higher access privileges to the admin (staff) compared to the students.

Upon successful log in as an admin, the system should give you access to add new students, insert or create new student's results, view registered students, view all students' results and publish students results according to the semester. On the other hand, the students after successful logging in would search for their registered courses and check their results.

Architecture for the Proposed System

The architecture in Figure 2 depicts a high-level overview of the suggested system, highlighting its key elements, services they offer, and communication channels. A two-tier architecture including a front-end (GUI) as well as back-end (database) was used to implement the system. In view of the benefits of simple maintenance, modification, and quick connection between the client application (client tier) along with database (data tier), as shown in Figure 2, the two-tier design was chosen.

System Implementation

UML diagrams represent the finished result of this research. A full UML diagram is created using all of the components and relationships, and it depicts a system. The most crucial aspect of the entire procedure is the UML diagram's visual impact. It is completed by using all the other components. Use-case, Class, Object, Sequence, Collaboration, Activity, State-chart, Deployment, and Component diagrams are among the nine diagram types that are part of UML. The suggested system was designed using a use-case diagram for the purposes of this paper.

Use-Case Diagram

Identifying, elucidating, and organizing system requirements is done through the use-case technique, which consists of a collection of possible sequences of interactions between a system and users within a certain setting in relation to a specific objective. The ellipse is used to depict it. An outside party that uses the system under model is known as the *actor*.

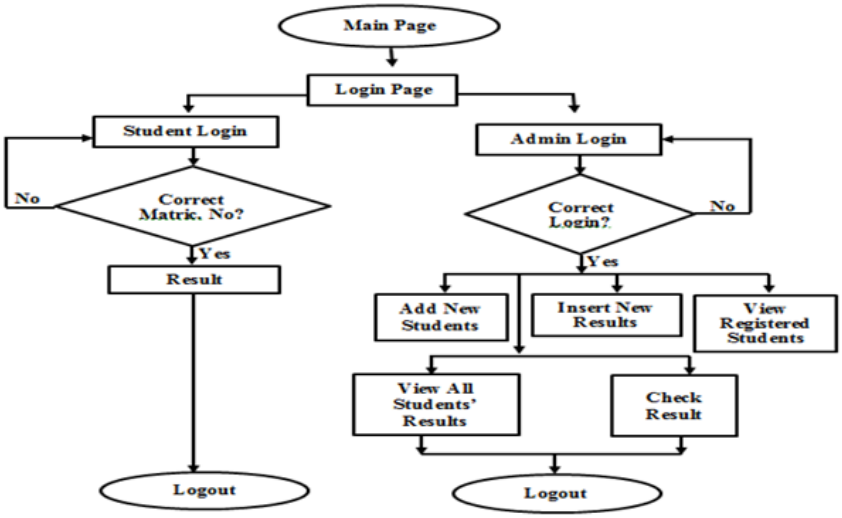

Figure 1. Logical Flow of the Proposed System.

Figures 3 and 4 show the use-case diagram of both students and administrator in the proposed system.

RESULTS AND DISCUSSIONS

The new system can be hosted both online and offline, and can run on the following software and hardware requirements. The minimum software requirements includes: Operating System: Microsoft Windows XP or higher version of Mac. While, the minimum hardware requirements include: Processor: 2.4 GHz processor speed, minimum of 1GB RAM 80GB of disk space, with an 800 x 600 colour display (1024 × 768 high colour; 64-bit recommended). Consequently, the different screenshots below display the sample output and results.

Screenshots of the Developed System

a. **Main Page:** Figure 5 shows the main page that has two modules: Student and Admin. The Students will click on the Student Module to view the Students Login Page while the Staff will click on the Admin Module to view the Staff Login Page (Figure 6).
b. **Admin Login:** Figure 6 shows the Admin Login that enables Staff to successful login upon entering the correct login credentials.
c. **Add New Student Page:** Figure 7 shows the page that enables staff to create or capture the bio-data of new students.
d. **Insert New Results:** Figure 8 shows the result page where the staff can save new results of the students based on the number of courses offered by such student in a semester.
e. **Registered Students Page:** Figure 9 shows the database view of all the registered students in a particular department in a valid semester. Every student belongs to a College, Department with a unique Matriculation Number and in a particular level or path.
f. **Registered Students Page:** Figure 9 shows the database view of all the registered students in a particular department in a valid semester. Every student belongs to a College, Department with a unique Matriculation Number and in a particular level or path.
g. **View All Results Page:** Figure 10 shows the database view of all the students' results in a successful semester.
h. **Student Login Page:** Figure 11 allow students to login and search for their results using their Matriculation number as a unique search key. Upon the entry of a valid Matriculation Number, the student would view the results as entered by the lecturers.
i. **Student Result Checking Page:** Figure 12 shows the page where the students can check their results for a particular semester after the results are published.

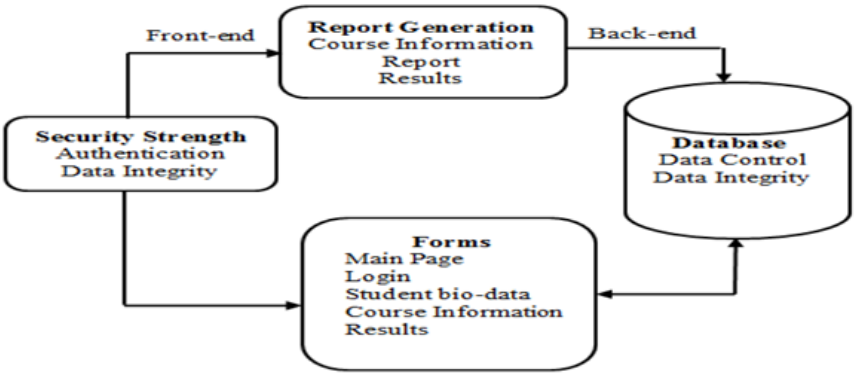

Figure 2. System Architecture for the Proposed System.

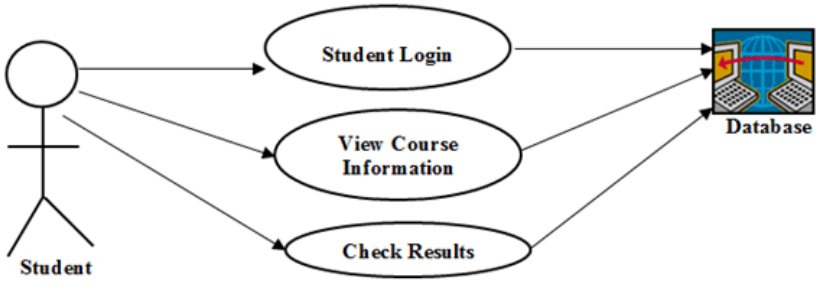

Figure 3. Use-Case Diagram for the Students.

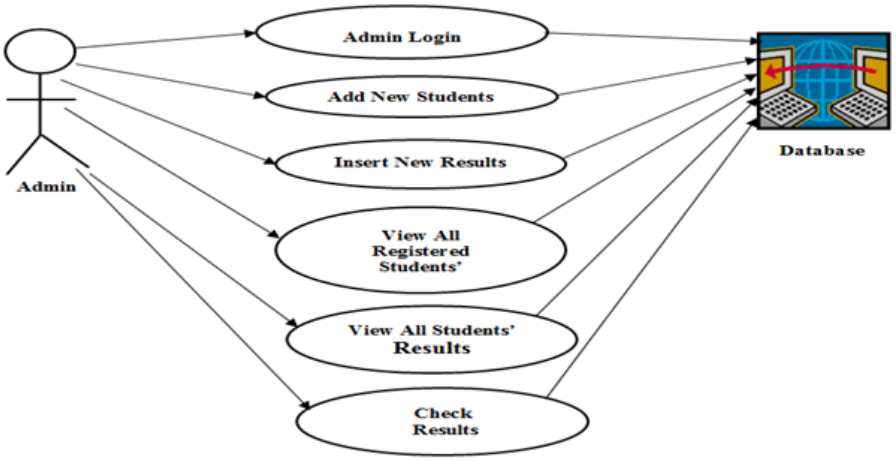

Figure 4. Use-Case Diagram for the Administrator.

Figure 5. Main Page.

Figure 6. Admin Login.

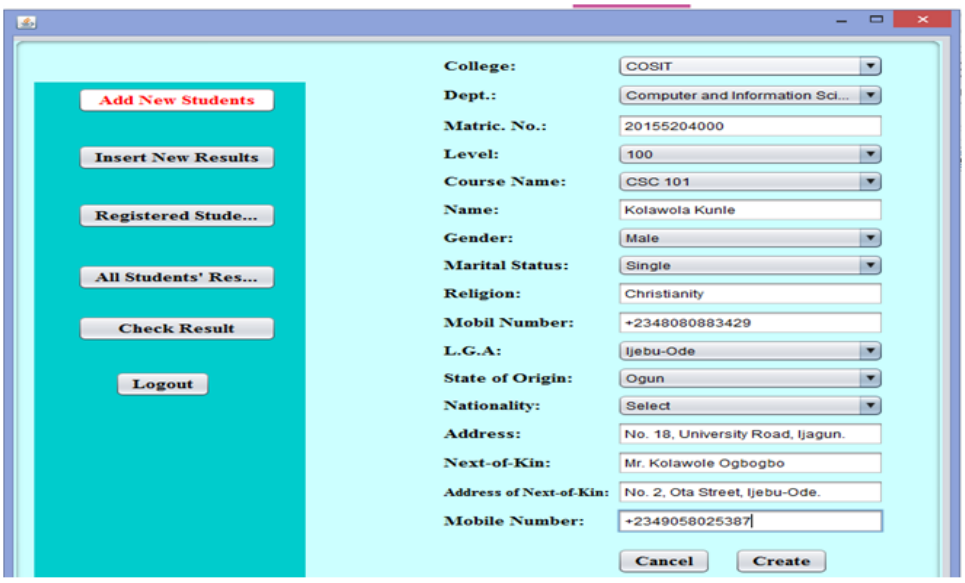

Figure 7. Add New Student/ Student Bio-Data Page.

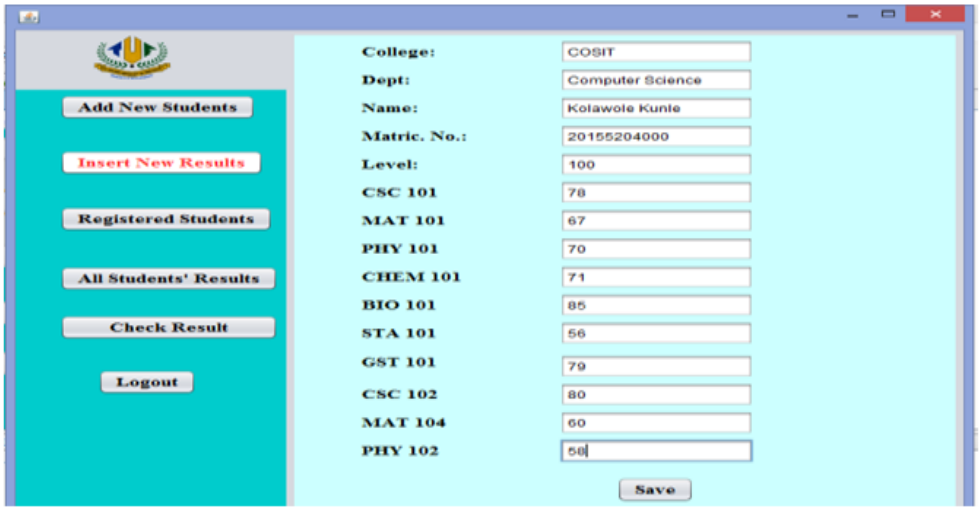

Figure 8. New Student Results.

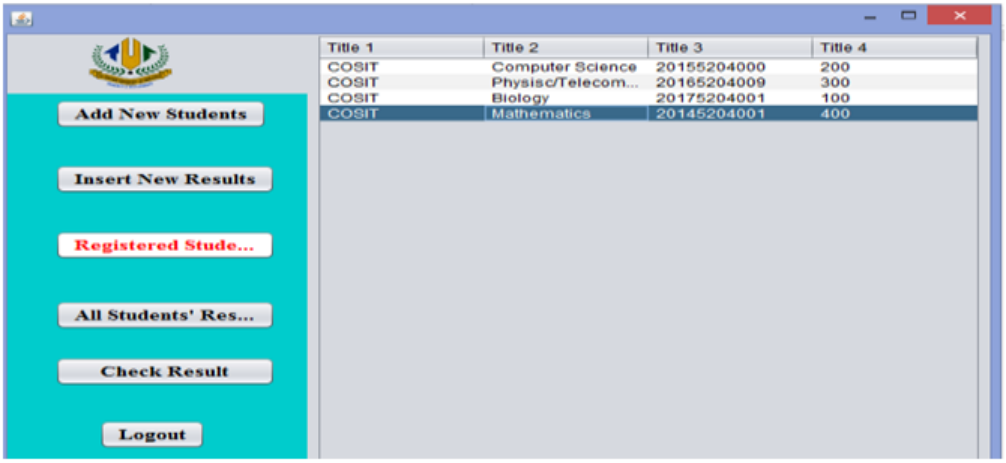

Figure 9. New Student Results.

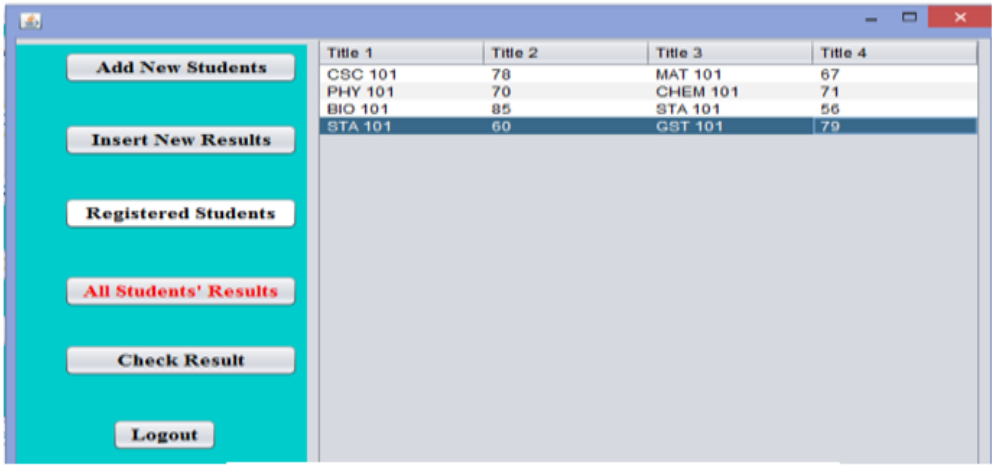

Figure 10. View All Results.

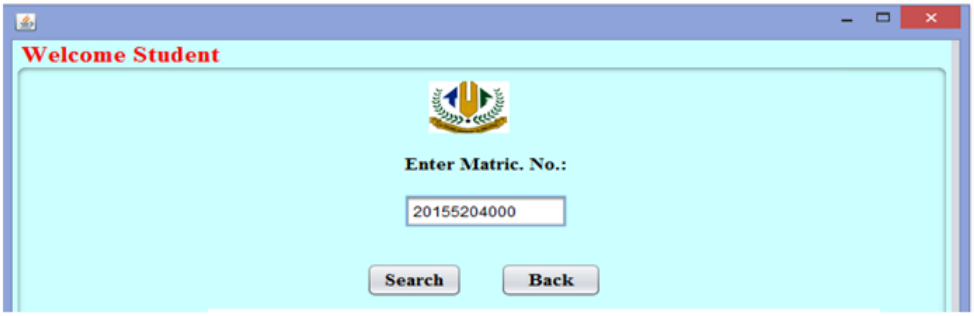

Figure 11. Student Login.

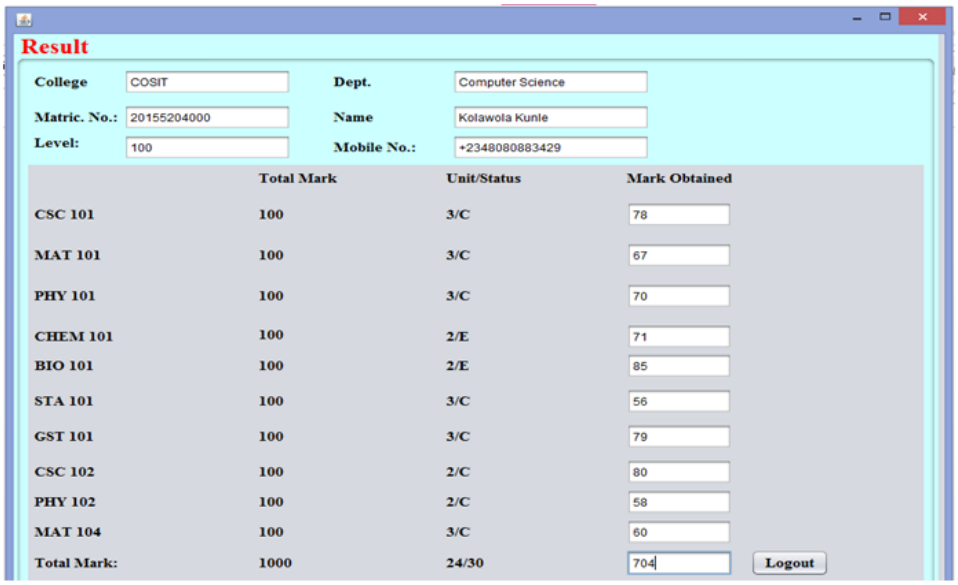

Figure 12. Check Results.

CONCLUSION

The current global era of digital economy attempts to eliminate wastage of resource and this call for paradigm shift to technological method in all sphere of human life including education. An effort to bring innovative system into the administration of tertiary institutions will definitely move education beyond the wall where students can access their information anywhere in the world. In this paper, an adaptive data model for students' IS was introduced. For flexible use, the proposed system has user-friendly features and effective data controls. The system will drastically reduce the rigorous paper-based method involved in managing students' information to a more accurate and convenient computer-based method. It is important to say that the creation of this suggested system will enable academic staff to gather and handle student data without having to deal with the burden of paperwork, which can result in loss, damage, or unauthorized changes by unauthorized individuals. Furthermore, since a robust and safe database system was successfully created, educational institutions will not have to worry about data loss thanks to this technology. This system is security oriented as members of staff are expected to login with their login credentials and students will also login with their valid matriculation number. The system approach will also enable the users to access data in a flexible manner. Therefore, the system if adopted by institutions of learning would reduce the time and effort required to manage and process students' information. This will also enable the management of the system to make quick and precise decisions about the students. For further studies, this study can be expanded to welcome other academic and administrative staff who may use SIS for various reasons.

RECOMMENDATIONS

Considering the advantages of a computerized SIS, the present study is anticipated to serve as a roadmap for a substantial amount of research needed to enhance SIS for future needs. Institutions of higher learning should use SIS because it will enable them to develop an integrated suite of tools that will enable them to efficiently oversee school management and move education beyond the physical barrier. If educational institutions used SIS, it would also save time and effort in managing and processing student data, allowing system administrators to make accurate and timely choices regarding the students. However, SIS software is not just utilized by academics and educational administrators; parents may also use its modules, which make it a useful tool for parent-child communication. Users need to be well-informed or taught in order to utilize SIS efficiently and guarantee a seamless rollout of the new system. Enhancements to SIS would facilitate staff members' ability to make prompt, informative judgments and get particular knowledge that could be useful when interacting with students.

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