

A Novel Framework for Student Result Computation as a Cloud Computing Service

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Abstract The enormous effect of wrongly computed student results in student academic career and the university as a whole demands that the task be performed meticulously using automated system. Student result computation literatures show that most universities in Nigeria still engage manual processing despite the proliferation of vendor results computation systems. Slow adoption of technology and innovation can be traceable to some factors such as, high cost of acquisition/licenses, maintenance, support, new infrastructures involved and security treats. This paper therefore, adopt cloud computing model in its proposed student result computation system design, thereby eliminating the above factors mentioned. The proposed system enable universities use student result computation service just like using an email service without taken cognizance of its IT infrastructure cost and complexity.

Keywords: student result computation, cloud computing, result service, Nigeria university

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1. Introduction

1.1. Background of Study

Generally, information about students as well as examination results for each semester are expected to be properly calculated and preserved by educational institutions [1]. The processing of results is tedious, time consuming, and error prone especially when computed manually and with large number of students. Unless an accurate and effective method is used, results computed are apt to convey misleading information to decision makers [2].

[1] and [3] posit that institutions still compute examination results manually. The uses of different forms of spreadsheet applications to collate and process academic results are still evident in Nigeria universities. [2] argues that the errors associated with manual method of processing of students results in most universities, make it not only desirable but imperative that computerized approach be used in measuring students' progress. Manual methods being employed suffer a number of setbacks such as late publication of results and wrong computation of Cumulative Grade Point Average (CGPA). These sometimes result to wrong class of degree award. [1] stated that the process of result computation, however, becomes a lot easier and much more accurate when carried out with a computer running a suitable software application.

Many student results computation software have been developed for use in schools and colleges [1]. Literatures

on result computation systems show that most of these systems are either standalone or client/server and they are deployed on-premises (on campus computers) or using a remote web host.

The emergence of Cloud Computing (CC) phenomenon represents a fundamental change in the way IT services are designed, developed, deployed, scaled, updated, maintained and paid for [4]. CC has led to the capability of extending existing Information Technology (IT) infrastructures thereby facilitating cheaper, available and more powerful computing resources in recent time. [5] noted that the promise of CC is to deliver all the functionalities of existing IT services even as it dramatically reduces the upfront costs of computing that deter many organizations from deploying many cutting-edge IT services.

CC being a way to increase the capacity or add capabilities dynamically without investing in new infrastructure, training new personnel, or licensing new software [14], the proposed system leverages on this paradigm to deliver a student result computation system as cloud service that enables universities use services free or on a pay-for-use mode at an affordable cost. The proposed system enables universities to eliminate the worries of planning ahead for additional IT infrastructure when provisioning new application. It also allows universities to start with basic result computing service then gradually increase to more and complex services as the need arises.

1.2. Statement of Problem

Despite the existence of several student result computation systems, many universities still compute

student's results manually and this can be traceable to high cost of acquisition. Most of the systems are designed to be deployed using traditional model (called Software as a Product (SaaS)) on a standalone computer or Campus Area Network (CAN). Some of the results system can be further extended by using a remote web host which makes them accessible over the internet. The traditional model adopted by these systems tends to incur additional cost thereby increasing the institutions IT budget. Adopting such student result computation systems compels educational institutions to sometimes purchase additional IT infrastructure and licenses, pay for maintenance and support even in time like this that they are inadequately funded by their proprietors.

1.3. Objective of the Study

Generally, the objective is to adopt CC model as a new approach to replace software traditionally installed on campus computers which will enables educational institutions do away with computing resources complexity and cost. Therefore, the paper specifically develops a student result computation system as a CC service. The SaaS model adopted is aimed at reducing the cost and complexity of owning and accessing student result computation system by Nigeria universities. It therefore, eliminates universities high expenditures and budgets in purchasing software licenses and maintaining result computation systems.

1.4. Significance of the Study

Result computation literatures show that despite the widespread of the result computation systems, none have been implemented using CC model. Therefore, the significant of this paper includes:

1. It would provide universities the opportunity to affordably own or access student result computation system as a cloud service.
2. Help academics focus on their core responsibilities and less time in result preparation.
3. Eliminate the worries of universities having to spend money on IT infrastructure that is buying hardware and software licenses, or paying for maintenance and support.
4. Provide universities the opportunity to keep up with new IT technologies and innovation without or insignificant cost.
5. Help universities reduce IT budget and cut cost by leveraging cloud services.

2. Previous Works

Students result computation seems to be an old area of research. But due to its significant in every educational institution, there is need to keep improving in its processes. Some recent works in this area are: the work of [7]. The paper examines the inadequacies involved in the manual method and proposes a solution by developing a software system using Microsoft Visual Basic (VB) 6.0. The system was developed and tested with respect to the peculiar situations and problems associated with educational system. [8] presented a design that is based on Client Server Distributed Database for Student Results Processing. In the work, emphasizes on advantages of

distributed system over centralized database system was made and based on that a distributed database approach was adopted. [3] in their work adopted a web based approach in their design. The system expedites efficient service delivery in academic records management. It eliminates the delays associated with computing results and processing academic documents. It also provides an interface between students and the institution.

Focusing on speed of collection of students' academic data to expedite processing of results and transcripts at various levels Ayodele and Absalom (2010) work was based on Neural Networks using open source approach. [1] introduce a Fortran algorithm for Data Analysis and Result Computation (DARC). The paper stated that statistics over a period of time about students such as gender and age representation in a department or faculty are usually not readily available. Existing programs are therefore inadequate in addressing some of these problems. This challenge informed the desire to develop an algorithm that will accurately compute student's results while giving important statistics about student population and their academic performances. [10] employs Microsoft Excel spreadsheet program to build an Intelligent Knowledge-Based System (IKBS), making use of various programming facilities provided by that application (Excel). The central issue here is that the programming is hard coded into the cells, and cell referencing is used to monitor and track student's performance. The system has been reported to be working fine. However, it appears to be rather restrictive, and calls for substantial expertise in programming. In IKBS, cell referencing tracks students' performances in hard coded Excel cell and the program appears to be restrictive and requires substantial programming abilities [2].

3. Cloud Computing (CC)

National Institute of Standards and Technology (2011) defines CC as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. [6] posit that cloud has revolutionized the way computing infrastructure is abstracted and used. Some of the features which make CC desirable includes: elasticity (the ability to scale on-demand), pay-per-use (low or no upfront investment) and transfer of risk (from the small application developers to the large service providers). NIST further describe five essential characteristics, three service models, and four deployment models of CC as shown in Figure 1.

Educational institutions throughout the world have become highly dependent on information technology to service their business requirements. Procuring and maintaining a wide range of hardware and software require substantial, ongoing investment and the skills to support them. The economies of scale and other features of CC are likely to mean an increasing shift away from institutionally-hosted services. These services are increasingly provided using Internet technologies to staff and students and accessed from web browsers. The services are offered cheaply or freely to education, often with much higher availability than can be provided by the

educational institution [12]. In responds to increasing demands from students and faculty by educational institution while still coping with fixed or declining budgets, CC has become an increasingly attractive option for delivering education services more securely, reliably, and economically [13].

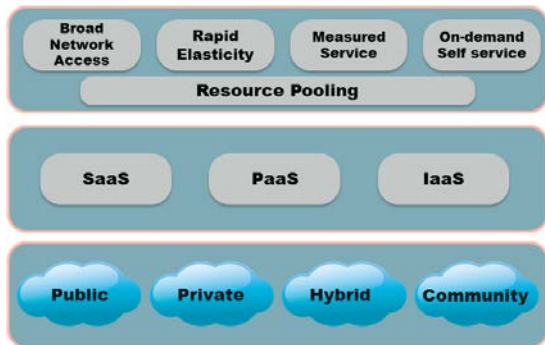


Figure 1. Cloud computing model. Source [11]

A. Characteristics of Cloud Computing

The characteristics of CC as suggested by NIST include on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service. On-demand self-service means that users (usually organizations) can request and manage their own computing resources. Broad network access allows services to be offered over the Internet or private networks. Pooled resources mean that users draw from a pool of computing resources, usually in remote datacenters. Services can be scaled and the use of a service is measured and users are billed accordingly.

B. Cloud Computing Service Models

NIST posit that CC service models are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). In Software as a Service model, an application, along with any required software, operating system, hardware, and network are provided. In PaaS, an operating system, hardware, and network are provided. The user installs or develops its own software and applications. The IaaS model provides just the hardware and network; the user installs or develops its own operating systems, software and applications.

C. Deployment of Cloud Services

Cloud services are typically made available via a private cloud, community cloud, public cloud or hybrid cloud. Generally speaking, services provided by a public cloud are offered over the Internet and are owned and operated by a cloud provider. In a private cloud, the cloud infrastructure is operated solely for a specific organization, and is managed by the organization or a third party. In a community cloud, the service is shared by several organizations and made available only to those groups. The infrastructure may be owned and operated by the organizations or by a Cloud Service Provider (CSP). A hybrid cloud is a combination of different methods of resource pooling (for example, combining public and community clouds) [11].

3.1. Cloud Security Issues and Justifications

Despite the publicity CC has gained, enterprise users are still reluctant to deploy their business in the cloud. Security is one of the major issues which reduce the growth of CC and complications with data privacy and data protection continue to plague the market [14]. This has become a major hurdle preventing its widespread adoption especially for outsourced data services that the owner's exclusive control over its data is ultimately relinquished to the CSP [15]. It is of great importance to consider security treat especially when the proposed system stores result data which are very sensitive in the cloud.

According to Office of the Privacy Commissioner of Canada (2011), cloud computing could offer better protection of personal information compared with current security and privacy practices. Through economies of scale, large cloud providers may be able to use better security technologies than individuals or small companies and they also have better backup and disaster-recovery capabilities. Cloud providers may also be motivated to build privacy protections into new technology, and also to support better audit trails. [17] stated that concerns about security and privacy as frequently mentioned may be more an issue of perception rather than reality. They argue that there are no fundamental obstacles to making a cloud-computing environment as secure as the vast majority of in-house IT environments, and that many of the obstacles can be overcome immediately with well understood technologies.

The majority of intellectual property breaches typically results from internal attacks and therefore do not impact the decision whether or not to adopt CC [18]. To make full use of the cloud, institutions will need to put aside their fears about data security in particular and manage the risks by ensuring appropriate contractual arrangements with providers. They will also have to accept that users will increasingly be able to by-pass institutional policies over computing provision and live in an environment where applications are subject to rapid upgrades outside the control of the institution [12].

3.2. Educational Adoption of Cloud Computing

With the advancement in information and communication technology (ICT), the need to change education delivery system arises. Traditional education delivery process is currently being replaced by online educational system using new technology such as CC [19]. Universities and colleges usually do not have sufficient fund to install and continuously maintain state-of-the-art ICT technologies for learning environment that can support students, staff, researchers and developers. The rate, at which ICT technologies change, will continue to place pressure on institutions' budget [20]. But the good news is that CC had eliminated this burden by the availability of more cheaper and powerful computing resources than ever. CC use to be associated only with business organizations but today it is blaring in every sector including education. It has been widely adopted because of its potential to improve collaboration, increased efficiency, support academic programs, connect students globally, and reduce costs and complexity of owning computing resources. According to EdTech

Magazine, organizations were mostly motivated by the cloud's ability to increase productivity, as well as their desire to increase efficiency, mobility and innovation [21]

Many educational institutions have begun their movement to CC by outsourcing their student email provision [22]. Both Google and Microsoft offer email services for free to the educational sector in many countries [12]. For example some universities in Nigeria including Federal University of Petroleum Resources Effurun and University of Benin now use Gmail.

[23] stated that many managers in small business and academicians in universities are not aware of benefits and characteristic of minimizing the cost of CC. IT companies are eager to encourage educational adoption of cloud computing. For example free Google Apps for educational institution by Google and IBM Cloud Academy that provide a global forum for educators, researchers and IT professionals from education industry to pursue cloud computing initiatives, develop skills and share best practices for reducing operating costs while improving quality and access to education [24].

Despite critics and drawbacks of CC, it seems it is here to stay. Prevailing economic situation will continue to compel more organizations to consider adopting cloud services.

3.3. Benefits of Cloud Computing to Educational Institutions

[12] noted some benefits of CC to education. They are as follows:

1. The primary advantage for many institutions is economic. This is particularly clear where services such as email are offered for free by external providers.
2. It allows institutions to begin with small-scale services and builds them up gradually without significant up-front investment.
3. Availability may be higher with less downtime due to the superior resources and skills available to cloud providers.
4. It enables educational institutions to reduce their own electricity consumption.
5. It allows institutions to concentrate on their core business of education and research.

4. Proposed System Framework

The proposed system is a cloud service that enables universities use student result computation system just like using an email service.

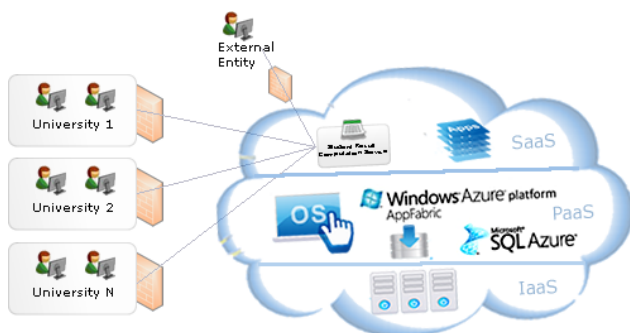


Figure 2. Student Result Computation Service Architecture

As depicted in Figure 2, the student result computation system is SaaS, which enables individual universities and other external entities to interact with the service over a secured internet using a web browser. The result service is hosted in the cloud. This eliminates the need to install and run service from any Personal Computer (PC) or CAN. It is available anytime, anywhere and can be accessed using PCs or mobile devices. Universities interacting with the result service are not burdened with software license, updates, security patches, backup and a host of other administrative and technical task associated with on-premises result systems.

The system is designed in such a way that each module exist as a service. A particular service can be activated by the user (university) as the need arises. For example, Result Computation (this is the default service), Transcript, Reports and Result Analyzer are all services.

The result computation algorithm used by the proposed system is the National University Commission (NUC) new result grading system and degree classification standard as shown in Table 1 and 2 respectively. A generalized result template was developed for result reporting at various board meetings as shown in appendix 1D and 1E.

Table 1. Result Grading System. Source [31]

Marks %	Letter Grade	Grade Point
70-100	A	5
60-69	B	4
50-59	C	3
45-49	D	2
Below 45	F	0

Table 2. Degree Classification. Source [31]

CGPA	CLASS OF DEGREE
4.50-5.00	First Class
3.50-4.49	Second Class (Upper Division)
2.40-3.49	Second Class (Lower Division)
1.50-2.39	Third Class
Less than 1.5	Fail

The computed result data are highly secured as they are encrypted during transmission and before storage in the database using Advanced Encryption Standard (AES) 256 encryption algorithm. AES is a specification for the encryption of electronic data established by the US National Institute of Standards and Technology in 2001. [25] noted that AES is one of the most used and most secure encryption algorithms available today and it is the preferred encryption standard for governments, banks and high security systems around the world.

The activity diagram in Figure 3 shows the result computation process of the proposed result service.

There are five major user roles in the system including the Administrator. The process of student results computation is performed by four of the roles which begins with the Course Adviser entering/uploading the result score of the students. The result is queued in waiting for the Exam Officer's authorization which is a first level authorization. The workflow proceeds to the HOD, waiting on a queue for a second level authorization. On denial of authorization of any level, the result is moved to the preceeding roles for reconsiderations. Otherwise, the HOD can generate result sheets in either College or Senate format for board meeting consideration. On the approval of the result by Senate, the HOD can publish the result for students to view.

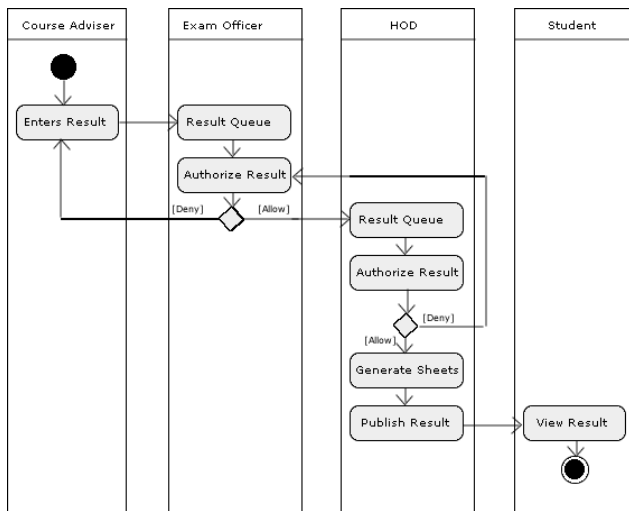


Figure 3. Activity Diagram of Student Result Computation Process

4.1. Service Analysis and Design

Object Oriented Analysis and Design (OOAD) approach was used in the analysis of the existing system as well as in the design of the proposed system. [26] refers to OOAD as the application of object-oriented modeling to the analysis of systems or system requirements and to designing object-oriented systems fulfilling these requirements. The approach views a system as a collection of self-contained objects that have both data and processes. The concept enables complex system to be broken into smaller and more manageable modules, which can be worked individually and easily integrated back together to form a whole system [27].

Objects and classes are the main building block of the entire system. The objects are usually drawn from the system requirement during the analysis stage and the classes describe the set of common objects. The entire processes of OOAD of the proposed system are documented with the Unified Modeling Language (UML) diagram. The approach follows the identification of objects associated with the system (such as student, result and report), identifying their relationships with each other and finally making a design that can be implemented using OO language.

4.2. Service Modeling

Software systems such as the proposed system usually involve different users having different view of the system. To better communicate the system to their understanding, various model of the system is usually developed using a modeling language. This paper employed the UML. This enables proper capturing and presentation of the result of the OOAD of the system to the users.

UML is an industry standard for modeling object oriented systems. In the same manner that an architect's blueprint presents design details for a building. UML allows software models to be constructed, viewed and manipulated during analysis and design. It provides clear understanding of the system under development especially complex systems and also helps ensure correct interpretation of the system [28]. UML are used to visualize, specify, construct and document the artifacts of software and non software systems.

UML has nine diagrams which are broadly categorized into two namely; structural diagram (this present the static aspect of the system) and behavioral diagram (this present the dynamic aspect of the system). Structural diagrams includes class diagram, object diagram, component diagram, and deployment diagram while the behavioral diagram includes use case diagram, sequence diagram, collaboration diagram, statechart diagram, and activity diagram.

In this paper, the use case and the class diagram were used to capture and visualize the static and dynamic aspect of the proposed result service.

4.2.1. Use Case Diagram

The use case diagram is used to document or capture the system requirements. They specify what the system is supposed to do; that is, it presents the "core" system functionalities. Use case diagram can also be used to depict the interaction between the user and the system. Figure 4 is the use case diagram for the proposed result service. It consists of different actors (users) and their various roles in the system.

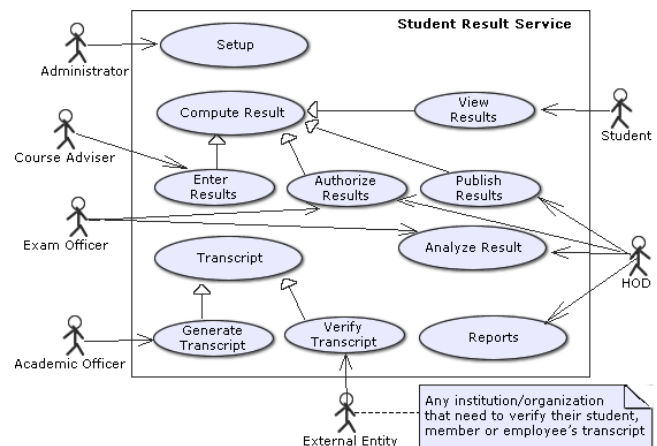


Figure 4. Use Case Diagram of the Result Service

4.2.2. Class Diagrams

UML class diagrams model static class relationships that represent the fundamental architecture of the system. Class diagrams are the most popular UML diagrams used by the object oriented community. It describes the objects in a system and their relationships.

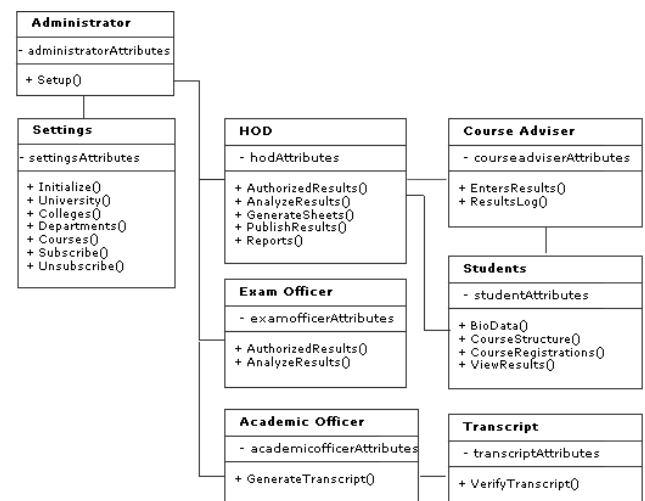


Figure 5. Class Diagram for the Result Service

4.3. Service Development Methodology

A methodology is a formalized approach to implementing the Software Development Life Cycle (SDLC). There are many different systems development methodologies and each one is unique based on the order and focus it places on each SDLC phase [28]. The OOAD approach used in this paper technically can use any methodologies (Waterfall, Agile, Prototyping, Rapid Application Development, V-Model, Iterative and Big Bang). However, the proposed system adopted iterative model. The process begins with a simple implementation of small modules and iteratively enhanced the version until a fully functional system is deployed. This methodology is vital to the proposed system because it enable additional and improved services to be added to the result system in iterative and incremental manner.

4.4. Cloud Tenancy Option

According to Chappell (2012) one the biggest decision that can be made when creating a SaaS application is whether the software will be single-tenant or multi-tenant.

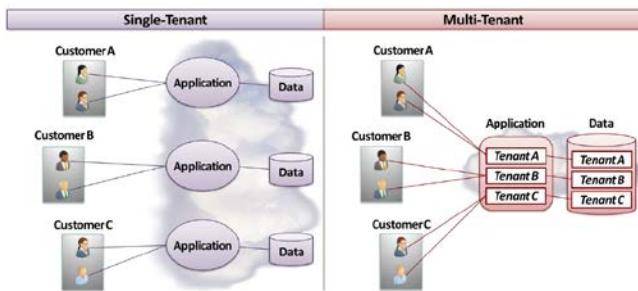


Figure 6. Single-Tenant or Multi-tenant SaaS Application

[29] stated that in a single-tenant application, each user has its own instance of the application with its own distinct data storage. In a multi-tenant application, multiple users share an instance of the application and the data storage it relies on.

The proposed result service uses multi-tenant approach which enables multiple users (universities) share an instance of the application and the data storage it relies on. [29] argues that multi-tenant applications require more complex implementation but are significantly economical to maintain over time, especially as the number of users it serve grows.

4.5. System Experimentation and Implementation

As a proof of concept, a result service was developed using Visual Studio 2012 IDE with Azure SDK installed. Built on ASP.NET 4.0 C#, Microsoft SQL Server, JavaScript, HTML, and CSS on a local computer as web application, the project was initially debugged and tested. To make it a SaaS application, the web project was simply migrated to Microsoft Azure platform. This is done effortlessly because azure provides a standard Windows computing and storage environment that could support the result service's business logic in the cloud. The service is capable of running and storing its data in Microsoft datacenters. This frees subscribing universities from investing in IT infrastructure thereby turning capital

expenses into operating expenses. Azure is Microsoft's application platform for the public cloud which provides developers with Platform as a Service (PaaS) that enables web based application hosting. According to [30] azure is an open and flexible cloud platform that enables quick building, deployment and management applications across a global network of Microsoft datacenters. See appendix 1 for snapshots of the proposed system.

5. Conclusion

This paper presented CC as a new approach for hosting and delivery of student result computation system. The approach tends to replace the traditional model of SaaS with SaaS model. It also aim at reducing IT cost and complexity for Nigeria Universities, so that irrespective of their size and financial capabilities can affordably own and use result service without the need to purchase software or maintain its own data centers.

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A. Course Adviser Add/Upload Result Page

#	Code	Session	Semester	Level	Status	HOD Remark	Date	Update
1	QSR 112	2013/2014	First Semester	100	Verified	Unpublished	August 18, 2014, 1:06 pm	
2	QSR 111	2013/2014	First Semester	100	Verified	Unpublished	August 18, 2014, 1:03 pm	
3	QSR 113	2013/2014	First Semester	100	Verified	Unpublished	August 18, 2014, 12:59 pm	
4	QSR 119	2013/2014	First Semester	100	Verified	Unpublished	August 18, 2014, 12:18 pm	
5	QSR 111	2013/2014	First Semester	100	Verified	Unpublished	August 18, 2014, 1:42 pm	
6	QSR 113	2013/2014	First Semester	100	Verified	Unpublished	August 18, 2014, 1:27 pm	

B. HOD Result Authorization Page

C. HOD Result Sheet Generation Page

MATRIC No.	NTH	MTH	CSC	PHY	PHV	CHM	BIO	BIO	GSE	GSE	CARRY OVER	CURRENT	PREVIOUS	CUMULATIVE	REMOUSTANDING
1	111	112	111	111	119	112	111	119	111	112	1	75	22	3.41	75
2	111	112	111	111	119	112	111	119	111	112	2	94	22	4.27	94
3	111	112	111	111	119	112	111	119	111	112	3	66	22	3.00	66
4	111	112	111	111	119	112	111	119	111	112	4	56	22	2.55	56
5	111	112	111	111	119	112	111	119	111	112	5	77	22	3.50	77

D. College Result Sheet Template

MATRIC No.	Full Name	GPA	CGPA
1	OSADE FOSTER	3.41	3.41
2	OSADE FOSTER	4.27	4.27
3	OSADE FOSTER	3.00	3.00
4	OSADE FOSTER	2.55	2.55
5	OSADE FOSTER	3.50	3.50

E. Senate Result Sheet Template

Appendix