HYBRID RESULT PROCESSING AND MANAGEMENT SYSTEM FOR NIGERIAN UNIVERSITIES

ETUS, CHUKWUEMEKA (B.Eng., M.Eng.)
(20104845478)

A DISSERTATION SUBMITTED TO THE POSTGRADUATE SCHOOL, FEDERAL UNIVERSITY OF TECHNOLOGY, OWERRI

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DOCTOR OF PHILOSOPHY (Ph.D.) DEGREE IN INFORMATION MANAGEMENT TECHNOLOGY OF THE FEDERAL UNIVERSITY OF TECHNOLOGY OWERRI

AUGUST, 2021

CERTIFICATION

This is to certify that this work "**Hybrid Result Processing and Management System for Nigerian Universities**" was carried out by **Etus, Chukwuemeka (20104845478)** in partial fulfillment of the requirements for the award of doctor of philosophy (Ph.D.) degree in Information Management Technology, in the Department of Information Technology of Federal University of Technology, Owerri.

Prof. (Mrs.) U. F. Eze Principal Supervisor	15-09-21 Date
Engr. Dr. O. C. Nwokonkwo Co-Supervisor 1	21/9/21 Date
Dr. C. O. Ikerionwu Co-Supervisor 2	15-09-21 Date
Engr. Dr. O. C. Nwokonkwo Ag.Head of Department	21/9/21 Date
Engr. Prof. (Mrs.) G. A. Chukwudebe Dean of SICT	21/9/21 Date
Prof. C. C. Eze Dean, Postgraduate School	Date
Prof. Awodele Oludele External Examiner	26/07/2021 Date

DEDICATION

This Ph.D. Dissertation is first dedicated to God Almighty for His awesomeness and grace throughout the course of this work. It is also dedicated to my best and twin, Onyim, and our children, Cherish, Flourish, and Livingstone; who, as members of my family, have been supportive and caring always.

ACKNOWLEDGEMENTS

Deserving my heartfelt gratitude is Almighty GOD who in his infinite mercy has helped me throughout this research, I adore His holy name.

I am highly grateful to my Principal Supervisor, Professor (Mrs.) U. F. Eze and the Co-Supervisor 1, Engr. Dr. O. C. Nwokonkwo and Co-Supervisor 2, Dr. C. O. Ikerionwu; for their perseverance, tolerance, motivation, and detailed supervision during the course of this Dissertation, despite their numerous academic commitments. I salute the acting Head of Department of Information Technology, Engr. Dr. O. C. Nwokonkwo, my former principal, Professor G, C. Eheduru, and all the Postgraduate lecturers of the Information Technology Department for adding value to this research. I am expressing my profound gratitude to the Dean of SICT, Engr. Professor (Mrs.) G. A. Chukwudebe, the Associate Dean of SICT, Dr. H. C. Iwu, and the Dean of Post Graduate School, Professor C. C. Eze, for their immense contributions toward widening my knowledge in this field of study. I am really grateful to you all!

I also wish to say a million thanks to my professional colleagues Dr. H. O. Amuji of Statistics Department FUTO, Mr. K. I. Anyiam, Mr. I. A. Oluigbo, Engr. I. C. Nwakanma, Dr. A. M. John-Otumu, Mr. L. C. Nnadi, Mr. C. M. Onuoha, and Miss N. F. Esomonu of IFT Department FUTO, Dr. S. A. Okolie, Dr. (Mrs.) E. C. Nwokorie and Dr. (Mrs.) J. N. Odii of the Department of Computer Science FUTO, Mr. D. Aku of FUTO ICT, Mr. C. Ugo and Mr. C. Henry who are postgraduate students of IMT, Mr. Oni Babatunde Olubunmi and his team, the staff of FUTO and the other universities visited; who contributed immensely to this work by proof-reading it, giving technical assistance, assisting in materials gathering or data gathering or documentations that helped me in the pilot survey, system analyses, system development and statistical

analysis in this work. GOD bless you all immensely for your brilliant contributions to the success of this research.

To my Best, the woman behind my success, Mrs. Juliet Onyinyechi Etus, and to our children – Cherish Chinalurum Etus, Flourish Onyinyeomachi Etus, and Livingstone Chukwuebuka Etus - for their all-round support during the course of this study. I Love you all so much! Finally, to my physical and spiritual parents, siblings, in-laws, and friends: Mrs. Benadeth Nwanyiwunwa Etus, Pastor and Mrs. Caleb Etus, Deacon and Mrs. Roland Akandu Orieh, Mr. and Mrs. Uchechukwu Confidence Etus, Mr. and Mrs. Okey Uzowuihe, Mr. and Mrs. Onyekachi Timothy Etus, Miss Chinwendu Etus, Miss Udoka Success Etus, Miss Chiemela Etus, Mr. Chizaram Etus, Mr. Chibuzor Etus, Aunty Anthonia Orieh, Pastor Onyekachi Ekomaru-Orieh, Miss Ezinne Ekomaru-Orieh, Miss Chidinma Ekomaru-Orieh, Mr. and Mrs. Moses Caleb-Ajaegbu, Rev. Dr. and Mrs. P.N DomNwachukwu, Rev. Dr. and Mrs. J. C. Nnoje, Rev. J. Ogidi, Rev. and Mrs. V. Okeyi, Dn. Engr. Professor and Mrs. B. C. Okoro, Engr. Professor and Barr. (Mrs.) F. K. Opara, Deacon Engr. and Mrs. E. A. Okolo, Deacon O. Oshodi, and the entire family of First Baptist Church Owerri; for their prayers, encouragement, and support of different kinds. May GOD bless you all. I love you all!

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES/CHARTS

ABSTRACT

Hybrid Result Processing and Management System (HRPMS) is an optimized model that automates result computation, vetting, approval, checking, and transcript processing workflow across standalone and client-server cross-platform. It is designed to address the challenges of using only a single-platform system (legacy or modern) in results processing and management, currently existing in Nigerian universities. The objective of the research, therefore, is to develop an offline, online, scalable, decentralized, inter-networked, normalized, and secured 3-tier system able to further improve computerized automation of result processing and management in Nigerian universities, in line with the universality of management and institution-specific policy standards. The survey analysis method was used to expose the deficiency of the single-platform system which necessitates developing the HRPMS. The Agile methodology adopted followed the Scrum method for rapid Test-Driven Development (TDD), and leveraged the jMeme Metaheuristic Optimization Framework (MOF) to hybridize and optimize the standalone (offline) and the client-server (online) platforms to build the HRPMS socket middleware cross-platform application. Again, the Agile 4-quadrant approach was followed to test and validate the HRPMS development. The tools and materials deployed for the design and programming of the HRPMS subsystem modules include the Unified Modelling Language (UML), the Excel VBA Binary, Java IDE and libraries, MS POI, and API plugins, PHP IDE, and SQL DBMS. While the web application, the MySQL database, and the FTP servers were deployed to test the system across a wireless extranet. The HRPMS performance was validated through hypotheses test and Multivariate Linear System (MLS) statistical analysis on MatLab, with a set of non-functional variables (x_1-x_6) and dual-sample data collected using the Delphi technique. The results showed that the existing single-platform model is about 53.8% deficient, but the HRPMS is an improvement of the existing system with a mean Performance Difference (P_D) of $1.043458X10^{-8}$. Therefore, it presents a more efficient, more secured, hard-to-crash, and optimum cross-platform system with a hybrid database emulator to map, parse and upload flat-file data into a relational database for transcript processing. Finally, this work recommends the convergence of technologies, services, and processes as information system integration and process automation swiftly erode boundaries that separate functional platform groupings.

Keywords: *hybrid result processing, cross-platform, secured 3-tier system, socket middleware, database emulator, hard-to-crash.*

CHAPTER ONE
INTRODUCTION

1.1 Background Information

In universities, processing and management of students' results involve many complex stages (Okebukola, 2010), which include registration of students and courses, result computation (with carryover and omitted result correction), result in summary generation (both semester and graduation summaries), reference tracking, graduands status tracking, result vetting, result approval and archiving, result checking, transcript generation, and transcript processing. As more information is made available in a variety of formats and sources, processing, and management of result data becomes more and more complex. To handle the complexities, the Information System strategy is necessary to improve its process automation (Oliveira, Thomas & Espadanal, 2014). According to Gupta, Suhail, and Kumar (2018), standalone information systems preceded the client-server information systems. However, this work focused on hybridizing the standalone and client-server systems by optimizing their legacy and modern system characteristics in a socket middleware, to becoming a cross-platform system called Hybrid Result Processing and Management System (HRPMS).

In this work, the "socket middleware" is a cross-platform application environment capable of receiving spreadsheet flat-file result inputs from a standalone subsystem, process them across users for the purpose of vetting and approval, and deliver the approved results into a relational database for further processing and management. The further processing and management are in terms of individual student result checking and transcript processing. However, the flat-file to relational database conversion is done by a hybrid emulator in the socket middleware that maps, parses, and uploads approved spreadsheet result data (either in excel format or in PDF) from a standalone system to a client-

server MySQL database system, while storing the approved spreadsheet result file on a file server. The individual student results can be checked only from the modern result in the database server through a client web page, while their transcripts can be generated either from the database or from the spreadsheet legacy results in the file server. Therefore, in this work, “legacy system or result” refers to older technology that is still relevant for use today; for example, the standalone excel-based result system. On the other hand, “modern system or result” refers to newer technology that comes to complement or replace the former; for example, the client-server database and web system. Again, the “standalone system” refers to a system that works offline without a network, while the “client-server system” refers to a system that works online on a network. Consequently, the “hybrid system” refers to an offline-online cross-platform socket middleware created by combining and optimizing the standalone and the client-server architectures, where each complements the strengths and weaknesses of the other. This is the HRPMS.

According to Obiniyi and Ezugwu, (2010) and Eludire (2011), various public and private universities in developing countries have been making attempts to develop reliable solutions that will adequately process and manage student results, and convey same to the students in a seamless manner. Despite the developmental attempts leading to the proliferation of vendor result systems in Nigerian universities today, only the single-platform result processing and management system model exists (Ukem & Ofoegbu, 2012; Obasi, Nwachukwu & Ugwu, 2013; Akinmosin, 2014; Anyiam, Anyiam & Okeugwu, 2020). Interestingly, the existing single-platform model for result processing and management is either a standalone system or a client-server system, based on their architectures; which are either offline application-based, online application-based, or web-based (Padakuu, 2017).

Also, there have been several complaints from students on issues bordering on missing or omitted scores and grades both for normal and carryover courses, result corrections, wrong computations, delayed processing, and access to scores and results (Bolu, Adewumi & Egbo, 2014). Regrettably, the above challenges presently faced by the Nigerian universities and also the need for legacy-to-modern result processing to be able to have a database of past and present students' results and transcripts, have contributed to slowing down the pursuit of the goal of the Nigerian Universities Commission (NUC) towards achieving world-class universities in Nigeria (Ise, 2015). Thus, the prevalent single-platform system model has not contributed much towards meeting the above NUC goal, by not handling result processing and management challenges satisfactorily (Dada, Raji, Oyedepo, Yusuf, & Saka, 2017). Therefore, this work opted to hybridize the existing single-platform result systems to explore and combat all the challenges presently faced by the universities in Nigeria.

As a follow-up, advancements in ICT also increases the vulnerability of single-platform Management Information Systems (MIS), and require continuous improvement on their automation and computerization efforts (Chettri, Prasad, Sharma, & Manger, 2016; Beka & Beka, 2015). This concern was buttressed in the Standish Group Chaos Report 2015 as discussed in Hastie and Wojewoda (2017), on the need to improve the low success rate (29%) and alarming failure rate (71%) of single-platform MIS, which has contributed to the poor institutional acceptance and usage of some MIS (Graham, Woodfield & Harrison, 2013). Also, as good as the traditional development processes may be, they have not always produced reliable software with the single-platform model (Ferro, Loukis, Charalabidis & Osella, 2013). Amongst them are the spiral, evolutionary prototyping, crowdsourcing, and waterfall development processes. However, this study used the Agile-Scrum method to develop the HRPMS.

The HRPMS runs mainly on computers and partly on mobile phones. The use of mobile communication technology is becoming more disruptive and ubiquitous with enhanced capabilities for rich social interactions, context awareness, and internet connectivity; thus changing the face of Information Technology (IT) (Wright & Parchoma, 2011). Mobile phones are highly advantageous for easier and faster information access and dissemination among all ages, but especially among students (Persson & Nouri, 2018). Hence, this work also employs the web client-server application accessible on mobile phones, to deliver individual student results. Thus, the HRPMS development supports decentralized result processing and management across interoperable cross-platforms and inter-networks, to achieve optimality and scalability required to eradicate or reduce to the lowest minimum the deficiencies of the existing single-platform systems.

1.2 Problem Statement

Based on the review of literature and the pilot survey analysis carried out in this work, the existing standalone single-platform system, on the average, is 80% sufficient and 20% deficient, while the client-server single-platform system, on the average, is 40% sufficient and 60% deficient. Cumulatively, the existing single-platform system was found to have an average of 46.2% strength and an average of 53.8% weakness; showing a research gap of greater than 7.6% to be bridged in this work by hybridizing and optimizing the strengths and weaknesses of the standalone and client-server existing single-platform system to develop a hybrid (cross-platform and platform-independent) system.

Therefore, based on literature reviewed and the pilot survey analysis outcome, it can be stated that: “The existing single-platform system model is inadequate and incapable of independently achieving optimum automated result processing and management in Nigerian universities in line with the universality of

management procedure and institution-specific policy standards; necessitating a hybrid system model". The reason is that the existing system failed to achieve target smart process automation that adequately delivers computation accuracy, processing speed, easy but secured local and global access, paperless result vetting and approval, and transcripts generation and processing.

Hence, the HRPMS development has been proposed to address most of the challenges, deficiencies, and limitations of the existing system, and redress all avoidable human errors during results computation, unnecessary delays in processing the results and transcripts, abandonment of the legacy results due to the difficulty in recomputing them to fit into the existing system's database, incomplete and incomprehensive database archive of academic records over the years. Others include minimizing the incessant system failures (partially or fully), the high rate of abandonment of the failing systems, and loss of human and financial resources used in developing and deploying the failed systems.

1.3 Objectives

The primary objective is to develop a Hybrid Result Processing and Management System (HRPMS) for Nigerian universities. The specific objectives are to:

i. Use the survey analysis method based on some performance variables and expose the deficiency of the existing single-platform system model.
ii. Design the HRPMS input-output modules and components using the Unified Modelling Language (UML).
iii. Develop the HRPMS using Excel VBA Binary, Java 8.0 IDE, PHP 5.6.40, MySQL 5.7.31 DBMS & Core FTP 2.0 tools and technologies.
iv. Test and validate the HRPMS development over a wireless network on FTP, database, and web application servers.

1.4 Research Questions

This study will seek to answer the following research questions:

i. Does the existing system deficiency necessitate the HRPMS development?

ii. Could the HRPMS input-output design be modeled using the UML?

iii. Were the HRPMS modules constructible using the specified tools?

iv. What do the test results show?

v. Is the HRPMS development valid?

1.5 Hypotheses

The following null hypotheses were tested in this work:

H_{01}: The non-functional variables have no significant effect on system performance.

H_{02}: There is no significant difference between the existing and proposed system performance.

1.6 Justification of Study

This work is a quest to provide a generalized hybrid computerized framework to improve automation of students' result processing and management across Nigerian universities through optimizing the offline and online cross-platform interfaces of standalone and client-server applications, in line with universality management and institution-specific policy standards. Based on the opinion of Bolu, Adewumi, and Egbo (2014) towards making world-class universities, it is hoped that deploying the HRPMS would improve the visibility and ranking of Nigerian universities and boost their social, technical, and corporate self-image. Furthermore, using the system would boost internally generated revenue due to the sale of pin-codes for results checking, and the efficiency of transcripts processing generally. Finally, findings from this study will contribute to the existing literature on the subject area, and to the body of knowledge.

1.7 Scope of Study

This work focused on the HRPMS development and validation based on data collection from nine (9) selected universities in south-east Nigeria, which are part of the one hundred and seventy (170) approved universities in Nigeria (NUC Monday Bulletin, 2021). These were selected using the one-stage cluster and stratified sampling approach based on the following criteria: (a) Ownership (Federal, State and Private), (b) Generation (First: 1948-1971, Second: 1972-1994, and Third: 1995 till date), and (c) Specialty (Conventional, Science and Technology, Agriculture, Education, and Defence and Security).

Hence, the nine (9) selected universities are: University of Nigeria Nsukka (federal first generation conventional university), Nnamdi Azikiwe University Awka (federal second-generation conventional university), Federal University of Technology Owerri (federal second generation science and technology-based university), Michael Okpara University of Agriculture Umudike (federal second-generation Agriculture-based university), Federal University Ndufu-Alike (federal third-generation conventional university). Others are: Imo State University (state second-generation conventional university), Enugu State University of Science and Technology (state second generation science and technology-based university), Anambra State University Uli (state third-generation conventional university), and Madonna University Okija (private third-generation conventional university). **See Appendix XI for the definition of acronyms used in this work**.

CHAPTER TWO
LITERATURE REVIEW

2.1 Conceptual Framework

This section presented the concepts used to drive the development of the proposed system. These include hybridization of legacy and modern systems, platform optimization using metaheuristics, and decentralized processing.

2.1.1 Hybridization of Legacy and Modern Systems

Amongst others, one of the ways to reengineer legacy systems is through hybridization with modern systems (Givehchi, Landsdorf, Simoens & Colombo, 2017). This is because the concept of hybridizing the legacy and modern systems uphold that the maintenance process continues as long as the system functions correctly, while needing some newer features and functions (Desouza, 2003). Legacy systems are described as systems that have outlived their original user requirements but have remained in operation long enough to be substantially modified until the system no longer resembles that which was first developed, while modern systems are recent or current innovations also referred to as cutting edge systems (Costa & Solis, 2018). According to Avison, Lau, Myers, and Nielsen (1999), hybridization is the best way to retain the functionalities of a legacy system and also add some cutting-edge functionalities of trending systems. In fact, they opined that organizations are struggling to respond to demands for new features on existing systems whilst simultaneously being expected to incorporate new technologies. With hybridization, some system functionalities are further modified to accommodate the change in business model, and structural or technical changes such as new facilities, policies, trends, and so on; which its absence can often lead to loss and/or wastage of resources, opportunities, time and efforts.

Hybridization involves the integration of more than one information system or subsystem. Integration of systems is achieved when two or more systems (subsystems) are linked to become interdependent of each other, and are coordinated to operate as if they were one system (Douglas & Glen, 2000). The linkages between systems facilitate the flow of information and make for proper coordination in the system with many subsystems integration. Griffiths and Tabery (2013), think of integration as functional and physical, and they opine that functional integration is more likely to facilitate coordination if it addresses a society's needs and requirements in the design of an information system. Douglas and Glen (2000) refer to this as full integration, which involves linking information shared by various information systems into a coordinated information system. Hence, functional and physical integration ensures that data is delivered to achieve desired goals.

In this study, the researcher reengineered a legacy system and hybridized it with a modern system to realize a state-of-the-art mainstream system with desirable old and new abilities and functional features. The legacy system concerned is the standalone excel spreadsheet result application relevant to the data processing and presentation strategies adopted in this work, while the modern system is the combined middleware client-server application. The Microsoft Excel is a spreadsheet platform used to input and output tabular data (Spreadsheet Analytics, 2010; Asproth, 2012). A major drawback of the excel sheet file is that it is a domain-specific tool, which must be standardized to interface well with modern systems (Grossman, Mehrotra & Ozluk, 2007; Grossman & Ozluk, 2011).

Standardization is the only means of providing a more stable and reliable spreadsheet software product (Powell & Baker, 2009). To standardize a draft of the excel interface, the platform design should provide a strategy for integration

(Grossman, 2006). This facility creates an opportunity for effective exchange and flow of information between interfaces – offline and online. The key to an offline-online (that is, standalone-client-server) hybrid system lay not in using the simple functions open to simple spreadsheets, but in a critical analysis of the sheet (Raffensperger, 2001; Spee, Jarzabkowski & Smets, 2016).

Top-down programming by contract is one standardization concept used by hybrid-platform developers to prepare offline data for uploads to online applications, and vice versa (Sun Microsystems, 2004). Its protocols are: (i) The Excel interface must be a single excel (for example, a single excel file sheet must contain the result for a class of students for a particular semester and year); (ii) The fields available must be consistent throughout an excel sheet; (iii) There are to be no free columns (a free column is a redundant column that lacks semantic presence, serves no purpose, useless, and must be eliminated); (iv) The fields must also be contiguous from row to row (once a data field begins, it must run to the end with no unused row in-between the ends). Again, it is essential to consider some facts about a typical spreadsheet result namely: (i) There can be a variable number of results per semester per level; (ii) Given that we know the number of courses, we can determine the number of cells to process per student; (iii) Cells with numbers (for example, students registration numbers and course units) and the cells with name strings (for example, students names and course grades) can coexist; (iv) It is possible to maintain a parallel array of global data for the results and units; (v) It is possible to do one-time processing based on the business logic design adopted. Based on these, the offline-online hybridization was done in an attempt to meet changing user needs, meeting changing policies and mandates by the Nigerian Universities Commission (NUC), and meeting the challenge of improving online visibility, impact factor, and global ranking of Nigerian universities.

2.1.2 Platform Optimization Using Metaheuristics

Metaheuristics are computational intelligence algorithm paradigms especially used for solving sophisticated optimization problems (Urli, 2014). Since every metaheuristic has a distinct search strategy, operators or components from different algorithms might be modified and combined (crossed-over) to become new hybrid algorithms with better performances to solving Combinatorial Optimization Problem (COP). The process is called metaheuristics hybridization. When a metaheuristic changes its original paradigm by adding new components from other algorithms, it is described as implementing low-level hybridization, but only sequencing them without any modification, makes it high-level hybridization. The metaheuristics that receive new components from other algorithms are referred to as master-metaheuristics while the one that is received is the sub-metaheuristics. A master-metaheuristics receive new components from one or many sub-metaheuristics. The hybridization technique in this work focused on the family of population-based metaheuristics (p-metaheuristics), and the modification process is restricted to proprietary (in-built) components.

The major metaheuristic techniques available to solve standardized benchmark problems include the Genetic Algorithms (GA), Evolutionary Algorithm (EA), Evolution Strategies (ES), Particle Swarm Optimization (PSO), and Simulated Annealing (SA). Others are Water Waves Optimization (WWO), Clonal Selection Algorithm (CSA), Chemical Reaction Optimization (CRO), Harmony Search (HS), Sine Cosine Algorithm (SCA), Teaching-Learning Based Optimization (TLBO), League Championship Optimization (LCO), Tabu Search (TS), Variable Neighbourhood Search (VNS), and others (Parejo, Ruiz-Cortés, Lozano, & Fernandez, 2012). According to Sörensen & Glover (2013), the standardized problems on which the above algorithms are used include routing problems (Traveling Salesman Problem and Capacitated Vehicle

Routing Problem), scheduling problems (Job Shop Scheduling Problem and Multiprocessor Scheduling Problem), and function optimization problems (n-dimensional real-valued test functions). These could be automation and robotics, bioinformatics, hydraulic engineering, information processing and classification, data mining, manufacturing and industrial applications, telecommunications, software engineering, development, and testing (to which the HRPMS development belongs); for exploring large search spaces, such as in the optimization of dynamic data types and memory managers in computer or embedded systems (Alba, Luque, & Nesmachnow, 2013).

A metaheuristic optimization Framework (MOF) provides ready-to-use extensible functions or software modules both for adaptation of metaheuristics already implemented and for development of hybrid metaheuristics (Parejo *et. al.*, 2012; Roberge, Tarbouchi, & Okou, 2015). Some available MOFs include Metaheuristic Development Framework (MDF), HotFrame, HeuristicLab, and OptLets (Acampora, & Vitiello, 2016; Muthuraman, & Venkatesan, 2017; Silva, de Souza, Souza, & de Franca Filho, 2018; Cicirello, 2020). MDF is an environment for hybridization of different metaheuristic parallel optimization techniques such as Evolutionary Algorithms (EAs) and Particle Swarm Optimization (PSO), to solve COPs. HotFrame allows the user to develop algorithms based on existing optimization techniques by combining parts of the algorithms, not parallelizing them. Heuristic-Lab is where different optimization techniques can be applied to different problem classes. OptLets offers a novel way to develop algorithms that are not based on existing optimization techniques. However, these frameworks suffer from a very long runtime. To overcome the runtime difficulties, parallel computer systems and consequently also parallel optimization algorithms are often used not only for testing but especially for practical implementations (Alba, Luque, & Nesmachnow, 2013).

Other existing libraries for parallel heuristic optimization are like JDEAL, Distributed BEAGLE, DREAM project, Easylocal++ or Localizer++ mainly focus on a specific kind of optimization paradigms like Evolutionary Computation or Local Search strategies which often support parallelism and distributed computation in a rather insufficient way (Roberge, Tarbouchi, & Okou, 2015). Only a few parallel optimization frameworks, of which ParadiseEO and jMeme are probably the most developed of them all, can deal with different kinds of optimization paradigms and also with various parallel computation architectures. However, ParadiseEO is rather complex to install, use and maintain (Abdel-Basset, Abdel-Fatah, & Sangaiah, 2018), leaving us with jMeme. Based on the literature reviewed, it can be seen that software metaheuristic hybridization frameworks are intentionally developed to support rapid software development with a flexible programming environment.

A family of MOF with metaheuristics that combine global search approaches with local search techniques is called Memetic Algorithm (MA) (Acampora, & Vitiello, 2016; Hassan, & Pillay, 2019). Suitable hybridization design of global and local search techniques which emerged as a powerful tool for tackling hard optimization problems more efficiently is referred to as Competent Memetic Algorithm (CMA) (Gherbi, Lakdja, Bouzeboudja, & Gherbi, 2019). jMeme is one intelligent generic Java framework used to automatically develop a CMA free of rapid design errors (Acampora & Vitiello, 2016). When developing parallel metaheuristics in Java, the most commonly used method to implement its communication and synchronization is the built-in Remote Method Invocation (RMI). Using RMI, a Java program exports an object that will be accessible across the network using a TCP port, where other processes connect and call the methods that the distributed object provides, whether implementing from the scratch or using generic frameworks (Masrom *et. al.*, 2017).

Figure 2.1 shows a Java framework of Graphical User Interface (GUI) and software libraries (with in-built template program) that provide access to all main components, easily configured by employing the Java refection Application Programming Interface (API) libraries. Thus, displaying instance fields and compound class objects in an integrated manner directly from class definitions. The accessibility and direct coupling of Java instances make handling flexible and rapid in development (Gruler, Armas Adrián, Juan, & Goldsman, 2019).

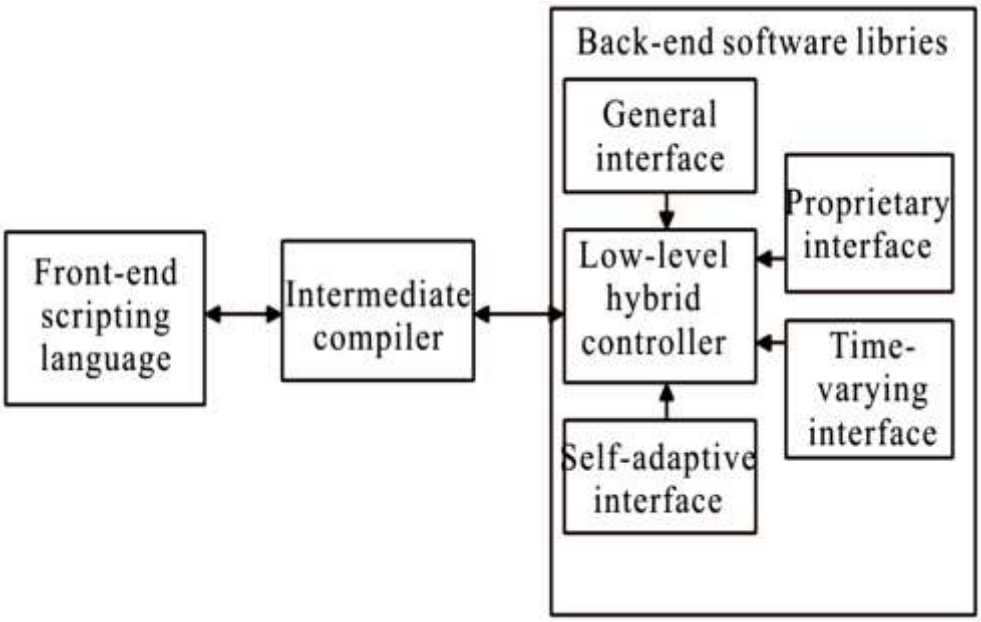


Figure 2.1: HRPMS Hybridization Framework (Masrom, *et. al.*, 2017)

The programming approach implemented for metaheuristics hybridization in the HRPMS is the software libraries approach with in-built metaheuristic template program components in the libraries at the back-end of the jMeme framework. The approach is highly flexible and supports single, high-level and low-level hybridization. In comparison to the GUI approach (which is simpler but has limited capability for implementing extensive program modification), it is tedious and complicated. To perform extensive metaheuristics modification, the programmer modifies the Java libraries and automatically generates the program

codes based on a user-defined model bounded by in-built components in the software library. Resolving the deficiencies of this programming approach requires providing a scripting language programming environment like eXtensible Markup Language (XML) as an alternative solution. While scripting language is less complicated to use, it is also applicable for the development of complex functional programs. The low-level hybrid controller exists as an important element that consists of a low-level hybrid engine for implementing low-level hybridization. It generates Java codes from the script codes at the front-end by compiling the scripts at the intermediate interface of the software framework, which supports rapid and flexible user-defined low-level metaheuristics hybridization. Hence, the scripting language and the application programming language are complementary to each other. While scripting language promises better productivity for integrating different software codes and libraries, Java language supports high-efficiency performance for algorithm implementation.

Figure 2.2 shows that solution representation, neighborhood structure, search strategy, fitness function, and penalty function are first encoded and decoded. The solutions will be randomly selected to go through the fitness evaluation process according to a particular search strategy and objective function. The fitness function is an important element of a metaheuristic that formulates the search objective, describing the quality or fitness of solutions to guide the search toward better solutions. Depending on the problem, a fitness function is subjected to some kind of constraint that is formulated in a penalty function. The neighborhood structure is relatively important for metaheuristics classified as single-based metaheuristics such as Simulated Annealing, Tabu Search, and Variable Neighborhood Search. Different from population-based, single-based metaheuristics implement generation and replacement of solutions from a single solution. The set of replacement solutions is determined from the solution

neighborhood. Thus, in single-based metaheuristics, the performance role of the neighborhood structure is crucial.

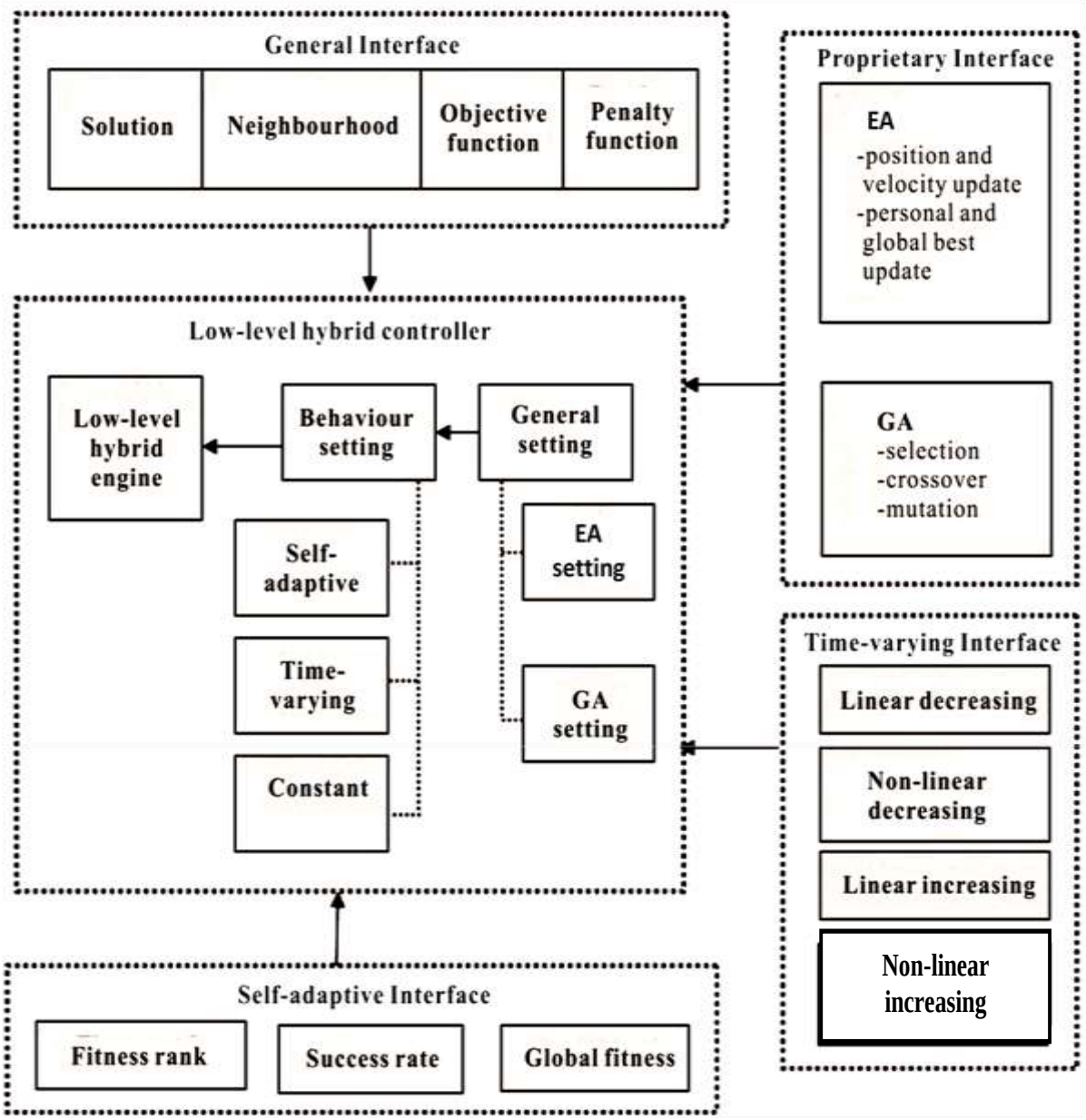


Figure 2.2: Back-End Hybridization Architecture (Masrom, *et. al.*, 2017)

The Java interface facilitates metaheuristic dynamic behavior, such as mutation rate for Genetic Algorithm and constriction parameters for Evolutionary Algorithm, through its self-adaptive and time-varying behaviors. Self-adaptive behavior determines parameter values with regards to metaheuristics

searchability of exploration and exploitation. In metaheuristics, exploration ability promotes high accuracy of solutions while exploitation facilitates fast convergence speed. Hence, the balance of both abilities is important to the performances of metaheuristic algorithms. Based on studies, one of the successful ways to balance searchability is by providing a self-adaptive environment. Also, the time-varying behavior contributes to the improvement of metaheuristics performance. Through the time-varying behavior, the exploration and exploitation search abilities can be dynamically adjusted based on some iterations (Masrom, Abidin, & Omar, 2012).

2.1.3 Decentralized Processing

To maximize the strengths and minimize the weaknesses of single-platform systems, there is need to also decentralize data processing on them (Popovic, Hackney, Coelho & Jaklic, 2012; Hemmatian, Fereidoon, Sadollah, & Bahreininejad, 2013; Zhang, Wang, Dong, Phillip, Ji, & Yang, 2015). Since decentralized processing is relevant to optimizing the inherent sufficiency and deficiency of separate single platforms, the researcher intends to deploy the HRPMS over three (3) single-platforms namely - the standalone platform for offline processing, the private-cloud (Intranet) platform over private servers, and public-cloud (Internet) platform over public servers, for online processing. Processing on a private cloud ensures fairly good security and confidentiality but provides limited presence and access due to limited coverage. However, global presence and access is the major strength of processing on the public cloud, while vulnerability to security and confidentiality threats of varying degrees, is its biggest challenge or weakness. These inherent strengths and weaknesses are therefore critical to the success and failure of the single platform information systems (Shin, 2016; Labra et al., 2016; Ward & Peppered, 2016).

2.2 Theoretical Framework

The theories relating to computerized result (data) processing and management include the Information System (IS) theory, the continuum theory, and the software development theory and processes, amongst others. The relevant theories and their principles as reviewed, generally provide more understanding and showed the foundations of the proposed system development in this work.

2.2.1 Information System Structure

This review was relevant to understanding the elemental structure of Information Systems (IS). Cover and Thomas (2012) described the three main elements of an IS structure as being: (a) strategy, (b) information systems, and (c) current and predicted information flows. He noted that an information system structure depends heavily on the scope and continuous review of the service requirements of the operations. The protocol and management requirements and transition issues are important stages in the successful operation of an information system structure. Cover and Thomas provided the ten golden rules for the successful design of an information system structure, which were followed to design the HRPMS. These are: (i) identify strategic systems applications with the greatest impact on the bottom line; (ii) finish process by setting quantifiable and prioritized objectives for systems installation; (iii) let the quality of software application drive technology selection, not vice versa; (iv) integrate the requirements into the budget and time allocations; (v) involve the perspectives of users; (vi) design systems that adhere to key industry standards; (vii) build scalability into a system to avoid premature redesign; (viii) design for maximum usability; (ix) design networks around departmental and central repositories for business information; (x) design for maximum systems uptime, reliability, effective backups, and recovery procedures to guard against loss of data.

The structure of an information system (IS) should comprise not only the network that coordinates the system but also the storage of information in the repositories for data warehousing (Jarke, Lenzerini, Vassiliou & Vassiliadis, 2013; Power, Sharda & Burstein, 2015; Demirkan & Delen, 2013; Sagiroglu & Sinanc, 2013). Data warehousing is the storage of consistent historical data, which can be accessed easily and manipulated for decision making. This requires a familiarity with the data and the information needs of various organizations, and coordination of networks (Musil, Musil & Biffi, 2013). However, coordination of organizations requires proper identification of entities (e.g. student information), while the network system should possess standards (e.g. protocols) to manage their operations and ensure proper collaboration among partners. IS design should integrate people, organizations, technology, and the socio-economic, technical, and political environments, and also standardize procedures in terms of policy, strategy, uniformity, access, and coordination strategies. These were factored into this work.

Information systems can be offline or online. Offline is synonymous with "Standalone computing" and it is coined from what happens when resources, applications, and services are used only on individual computer systems and not on a network. Also, online is synonymous with "client-server cloud computing" referring to the many different types of services and applications being delivered in the internet cloud, and the fact that, in many cases, the devices used to access these services and applications do not require any special applications (Kumar, Zadgaonkar, & Shukla, 2013). Some notable examples of cloud delivering companies include Google, Microsoft, and Salesforce.com. In the cloud, services and resources can extend their capabilities, or extend standalone services or applications, or provide new interactivity capabilities to current services (Nelson, 2009; Battiston, Farmer, FlacheGarlaschelli, Haldane, Heesterbee & Scheffer, 2016; Griffiths & Tabery, 2013). For "on the move"

business people, these can be accessed through a smartphone, which increases productivity even while away from the office. They can be accessed from any location and be linked to current services to extend their capabilities.

The common deployment models of cloud services include private, public, community, and hybrid clouds. Some of the possible benefits of cloud computing-based services and applications include cost savings, scalability, and flexibility, reliability, fewer maintenance requirements, mobile accessibility. Some notable challenges causing cloud computing to slow down include but are not limited to security and confidentiality, Lack of Standards, Continuous Evolution, and Policy standards Compliance Concerns (Eke & Nweke, 2016). According to Shin (2016) and Labra et al. (2016), Cloud computing has a variety of characteristics, which main ones include Shared Infrastructure (services, storage, networks), Dynamic Provisioning (Demand-based services), Network Access (Broad range internet access using the computer and mobile devices), Managed Metering (optimized metering and billing services).

According to Xu (2012), deploying cloud computing can differ depending on requirements; hence four cloud deployment models have been identified. Each of them has specific characteristics that support the needs of the services and users of the clouds in particular ways. Private Clouds are cloud infrastructures deployed, maintained, and operated for specific organizations. The operation may be in-house or with a third party. Community Clouds are cloud infrastructures shared among some organizations with similar interests and requirements. This helps limit the capital expenditure costs for its establishment as the costs are shared among the organizations. Also, the operation may be in-house or through a third party. Public Clouds are cloud infrastructures available to the public on a commercial basis by a cloud service provider. This enables consumers to develop and deploy services on the cloud with very little cost

compared to the cost of other deployment options. Hybrid Clouds are cloud infrastructures consisting of two or more clouds of different types, having the ability through their interfaces to allow data and applications to be moved between them, to support data and services in an organization.

Once a cloud is established, how its cloud services are deployed in terms of business models can differ depending on user requirements (Nelson, 2009; Boons & Ludeke-Freund, 2013). The primary service models being deployed are commonly known as Software as a Service (SaaS) (purchasing access to use software and applications hosted in the cloud), Platform as a Service (PaaS) (purchasing platform access to enable one to deploy his software and applications in the cloud), and Infrastructure as a Service (IaaS) (controlling and managing other system resources but not the cloud infrastructure). The HRPMS standalone sub-system is deployable on private machines for reasons of security, confidentiality, and scalability, while the internet sub-system is deployable on a public cloud platform for global accessibility.

2.2.2 Continuum Theory

This review was relevant to understanding the HRPMS file operations and records management as boundariless, that is, being both current and archival. The rapid introduction and usage of Information and Communication Technology (ICT) in records management in the 1980s introduced a new dimension in records management. This generated a debate on the relevance of the life-cycle model (Shepherd and Yeo, 2011). The result was the invention of a new model, called the continuum theory (Ngoepe, 2008). The continuum approach sets no strict boundaries between archives and records management responsibilities (see Table 2.1). It argued that current records can also become archived right from creation, rather than waiting for their final disposal.

Table 2.1: The Continuum Approach

Process	**Records Management Process**	**Archives Management Actions**
1. Identification & Acquisition	Creation or Receipt	Selection and Acquisition
2. Intellectual Control	Classification within a logical System	Arrangement and Description
3. Access	Maintenance and Use	Reference and Use
4. Physical Control	Disposal by destruction or transfer as archives	Preservation

(International Records Management Trust, 1999; as cited in Nwaomah, 2015)

The record continuum model developed by LanMachean in the 1990s provides a framework for the operation of electronic records management programs. Among scholars it has been stated that "the electronic environment makes it impossible to use theories and methodologies that were used in the paper-based world" (Upward, 1997), asserting a change from object to process, and from static to dynamic process. In contrast to the well-established life cycle view of managing records and archives which states that records can only live once at each stage in their life which clearly defines responsibilities for the management of records at each stage. The record continuum model asserts that records and archives are always in the state of being created, that is, records management is described as an interactive process that continues throughout the life of the records beyond time and space to satisfy business, legal, social, and cultural needs (McKemmish, 2001; Upward, 2000; Ngoepe, 2008).

2.2.3 Software Development Theory and Processes

The software development theory can better be understood by looking at its processes. Software development is concerned with producing software products. A software development process is concerned primarily with the production aspects of software development before the technical aspect, such as

software tools. Specific software development tools are useful and often necessary, but the true art in software development is applying the correct process and then using tools to support the method. Without a method, tools are worthless (Karagiannis, 2015).

The Software Development Life Cycle (SDLC) phases serve as an important guide to software development processes and activities and provide a flexible but consistent way to develop software to match its scope (Sommerville, 2016). Accordingly, each SDLC phase has key tasks and expectations related to the phases for effective development. In SDLC, baselines or startup points are important parts. These baselines are established after each phase of the SDLC and are critical to the iterative nature of the model (Sommerville, 2016). Each baseline is considered a milestone in the SDLC. As shown in Figure 2.3, the basic activities involved in a software project are analogous to activities in software-producing organizations. They include developing a software development plan, defining the activities, making a design, coding or building, testing and deployment.

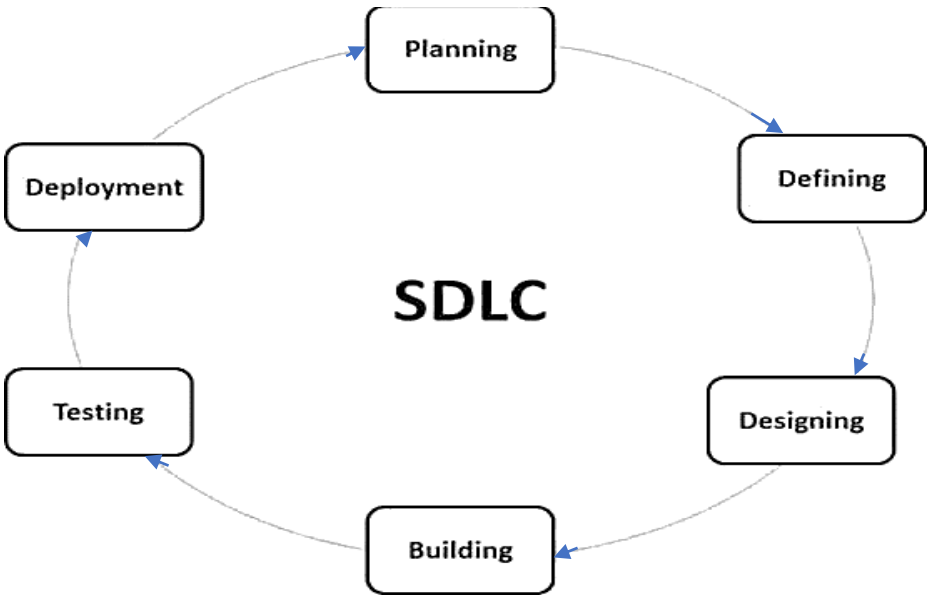


Figure 2.3: SDLC Phases (Sommerville, 2016)

According to Sommerville (2016), it is better to plan more in a software project, because it makes for good development, experienced team leadership, and capable software testing, thereby helping to complete the project as scheduled. In addition to a good plan, the definition of the processes is equally important and helpful. The design activities include designing the interfaces and databases, selecting the system architecture, and selecting suitable tools and languages for use in developing the software. Coding converts the design to a product or construction and is done in a structured and scientific manner. Product testing usually goes along with the development stages. Final testing is done after the complete development of the software. The deployment phase includes hardware selection, software set-up, network formation, and installation. Training of the end-users is also done in this phase.

The SDLC, as a framework of various software development methodologies, supports various software development processes due to its peculiarity in solving various software development needs. The software development models and processes include Code-and-Fix Model, Waterfall Model Process, Spiral Model, Staged Delivery Model, Evolutionary Prototyping Model, Design-to-Schedule Model, Crowdsourcing Process **(**Boehm & Turner, 2005; Khan & Beg, 2013). Software development methods and processes are so many that developers battle with choosing from them for different projects. Practically, most of them are the same in their processes, except for different variations to correct or improve the deficiencies in them. To assist in the choice of software development methods and processes, Khan and Beg (2013) rated the models alongside project management techniques, such as risk management, quality and cost control, success predictability, progress visibility, and customer involvement. The degree of influence of the management techniques was rated from 1 (least influencing factor) to 5 (most signifying factor), as in Table 2.2.

In Table 2.2, code-and-fix showed as a weak project management application technique with poor risk management, quality/cost control, success predictability, but with improved progress visibility, and customer involvement. Evolution prototyping also revealed different levels of project management influence on them. In all, the choice of software development model was guided by the task at hand, risk management, quality/cost control, predictability of the project, progress visibility, and customer involvement/feedback. Hence, the software development model adopted in this work is the Staged Delivery which has medium to high range ratings of the signifying factors as in Table 2.2.

Table 2.2: Software Development Model Matrix (Rated 1-5 for Each Category)

Software Development Model	Risk Mgt	Quality/ Cost Control	Predict-ability	Progress Visibility	Customer Involvement
Code-and-fix	1	1	1	3	2
Waterfall	2	4	3	1	2
Spiral	5	5	3	3	3
Evolutionary Prototyping	3	3	2	5	5
Staged delivery	3	5	3	3	4
Design-to-schedule	4	3	5	3	2

(Khan & Beg, 2013)

A new version of the Staged Delivery Software development model used is the Agile Model, with quality/cost control and customer involvement as the most important matrixes of focus. The Standish Group report of 2015 (Hastie & Wojewoda, 2017), had it that using the agile approach resulted in more successful projects and fewer outright failures, hence its adoption in this work.

2.2.4 Agile Software Development Process

This review gave an overview of the Agile development method. Rapidly changing environments characterized by evolving requirements and tight schedules require software developers to take an agile approach, instead of the

traditional software development approaches (Theunissen, Boake, & Kourie, 2005). The Agile methods include practices such as short iterations, frequent releases, simple and emerging design, peer review, and on-site customer participation (see Figure 2.4). Also, clear from Figure 2.4 are that Agile processes are characterized by iterative development, continuous code integration, and the ability to handle changing business requirements (Boehm & Turner, 2005; Aveling, 2004). Implementations of the agile method include the following approaches: Rational Unified Process, Extreme Programming (XP), Scrum, Crystal Clear, Adaptive Software Development, Feature-Driven Development, Test-driven Development, Lean, Kanban, and Dynamic Systems Development Method (DSDM) (Avison, Lau, Myers, and Nielsen, 1999).

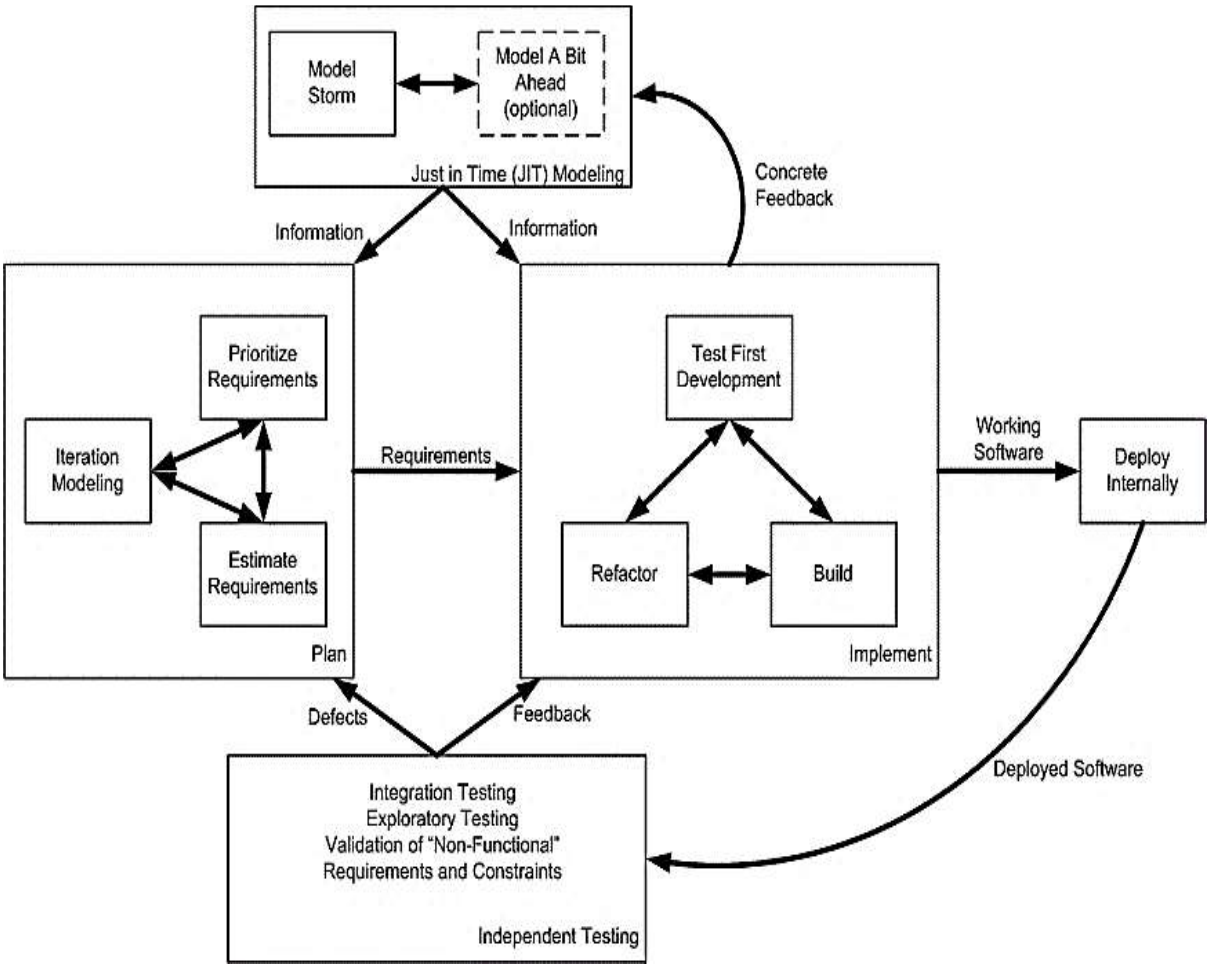


Figure 2.4: Agile Development Process (Theunissen, Boake, & Kourie, 2005)

The Agile process has many techniques. The Agile Manifesto collectively refers to these techniques as the agile methodologies (Fowler & Highsmith, 2014). The Manifesto holds that, while we value the items on the right, the items on the left are valued more. The values highlighted (Agile Alliance, 2001) are: (i) Individual interactions over processes and tools; (ii) Working software over comprehensive documentation; (iii) Customer collaboration over contract negotiation; (iv) Responding to change over following a plan. The Agile Scrum method was adopted rather than Extreme Programing (XP) because it manages the entire software project rather than just the development practices.

2.2.5 The Scrum Approach

According to Leau, Loo, Tham, and Tan (2012), in today's software development environment, requirements often change during the product development lifecycle to meet shifting business demands, creating endless headaches for development teams. The Scrum development process model came to address this concern of changing requirements. Scrum is a process for incrementally building software in complex environments (Kroeneke & Hattach, 2000). It provides empirical controls that allow software development to occur as close to the edge of chaos as the developing organization can tolerate. Scrum is a software development process for small teams. According to Reeder (2015), small teams that work independently are more effective. Scrum is incremental, sprinted (time-boxed) process with an added twist: the frequent meetings to review and address the risk elements.

Scrum is appropriate for software developments where the requirements cannot be defined upfront, and chaotic conditions are anticipated throughout the software development life cycle. Consequently, the Scrum process results to: products that become series of manageable chunks, progress made even when requirements are not stable, everything is visible to everyone, team

communication improvement, team sharing successes along the way to the end, customers seeing on-time delivery of software increments, customers obtaining frequent feedback on how the product works, customer (user) relationship that builds trust and grows knowledge, and culture created where everyone expects the project to succeed. Hence, the Scrum approach has been defined as a flexible, holistic product development strategy, proposed to result in fast, flexible, and holistic product development (Reeder, 2014).

In Scrum, cross-functional teams develop products or projects in an iterative, incremental manner. Development is structured in time-boxed cycles of one (1) to four (4) weeks of work (called Sprints), which takes place one after the other without pause for a few months. The Sprints (time-boxes), end on specific dates whether the work was completed or not, and are never extended. Usually, Scrum Teams choose one Sprint length and use it until they improve and can use a shorter cycle. At the beginning of each Sprint, a cross-functional Team selects items (requirements) from a prioritized list. The Team agrees on a collective target of what they believe they can deliver by the end of the Sprint, something tangible is “done” (Deemer, Benefield, Larman, & Vodde, 2012).

During the Sprint, no new items may be added; Scrum embraces change in the next Sprint, but the current Sprint is meant to focus on a small, clear, relatively stable goal. Every day the Team gathers briefly to inspect its progress and adjust the next steps needed to complete the work remaining. At the end of the Sprint, the team demonstrates what it has built and obtains feedback that can be incorporated in the next Sprint. Scrum emphasizes working product at the end of the Sprint that is really “done”. In the case of software, this means a system that is integrated, fully tested, end-user documented, and potentially shippable (Deemer, Benefield, Larman, & Vodde, 2012). The key roles, artifacts, and events are summarized in Figure 2.5.

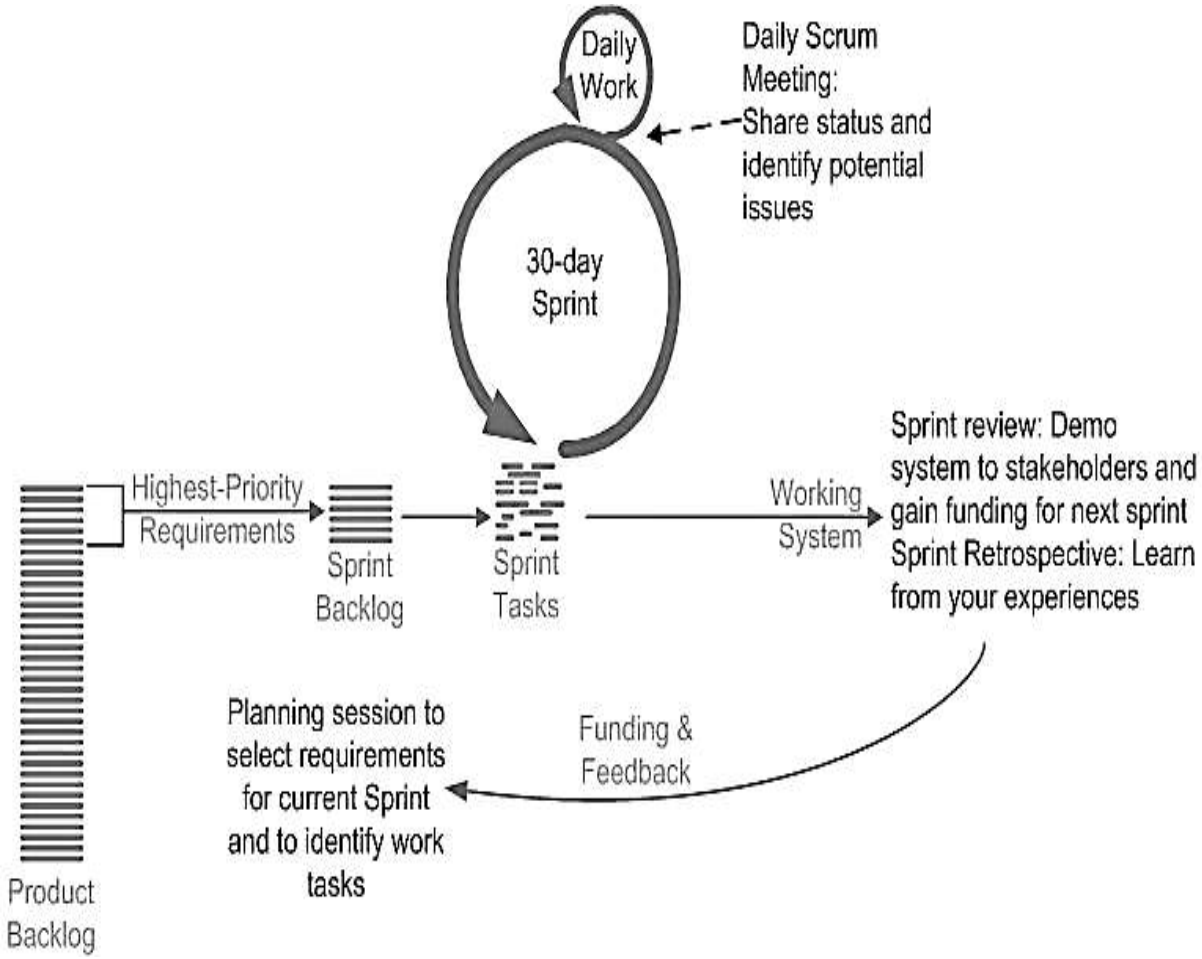


Figure 2.5: Overview of the Scrum Approach (Deemer *et. al.*, 2012)

Every Scrum team has three roles: Product Owner, Scrum Master, and Team Development. Individuals in these roles work together to bring a product from an idea to life (Deemer *et. al.*, 2012; Reeder, 2014). Scrum teams are self-organized and cross-functional. Self-organized because rather than directed, they choose how best to accomplish their work. Cross-functional because they have all competencies needed to accomplish the work without depending on others not part of the team. The Scrum team is designed to optimize flexibility, creativity, and productivity. Finally, Scrum includes five activities that make for transparency and adaptation: Product Backlog refinement, Sprint planning, Daily Scrum, Sprint Review, and Sprint retrospect (Schwaber & Sutherland, 2015; Schwaber & Sutherland, 2014). Before the sprint comes the Product Backlog containing the Vision Statement, the product roadmap, and the

deliverable features. These provide a concise description of the goals of the project for focus, an initial visual timeline of major product features to be delivered, and the requirements that make them up. All these stories make up the Product Backlog. Scrum does not wait until the Product Backlog is 100% prepared with all the details to start the Sprints, but starts the Sprints as soon as the Product Backlog is mature enough and has enough stories defined. Product Backlog would be kept updated during the project (Rad & Turley, 2013).

According to Philips (2014), Scrum has the benefits of divide and conquer, inspect and adapt, and transparency. By divide and conquer, Scrum divides complex work into simple pieces, large organizations into small teams, and far-reaching projects into a series of short time horizons called sprints. Simple pieces make it easier to map out what needs to be done. With a clear roadmap, the team starts work immediately, knowing what items need to be worked on together and when the job has been completed. Sprinted projects and small teams make it easier to maintain focus because less time is spent coordinating and communicating details. It is easier to plan for short periods involving less. By Inspect and Adapt, the team gathers feedback more quickly from completed and functioning products in the hands of users than it otherwise would have. Feedbacks help the team improve the product based not only on what they have learned during development but also on people interacting with the product. By Transparency**,** Scrum uses shared tools called Artifacts, and regular meetings called Ceremonies to track and visualize activities over the length of the sprint and also facilitate team communication. This way, it is easy for everyone to know how things are moving along - what needs to be done, who is doing it, and how it is being accomplished. Stakeholders and management can make more informed strategic decisions when they have an honest and clear idea of how a project is progressing.

2.3 Empirical Framework

This section specifically reviewed related students result processing and management systems in some Nigerian Universities, with available and properly documented students' result systems. They include Ahmadu Bello University (ABU) Zaria, Gombe State University (GSU), Joseph Ayo Babalola University (JABU), University of Calabar (UNICAL), University of Portharcourt (UNIPORT), Nasarawa State University (NSU), and Federal University of Technology Owerri (FUTO). The reviews showed the existing systems, their development drivers, their design, their implementations, and their assessments that gave rise to the research gap identified in this work.

2.3.1 The ABU Zaria Result Processing and Management System

According to Obiniyi and Ezugwu (2010), in their work at Ahmadu Bello University (ABU) Zaria identified the causes associated with delays in processing and releasing results in universities and proposed an enhanced computer program for result computation integrated with a database for storage of the processed results. This simplified the university grading system and overcame the shortcomings of the existing packages. The system took inter-departmental collaboration and alliances into consideration, over a network that speeds up the collection of processed results from designated departments through an improved centralized database system. This expedites the processing of results and transcripts at various levels of management and makes access to the results online more readily.

The technological approach for the implementation of the system was based on open source solutions – the crowdsourcing development process. Apache was used as the Web server extended with PHP for server-side processing. In recognition of the confidentiality of data contained in the system, communication networks were protected with the open-SSL library for data

encryption and role-based authentication. This system increased the service delivery efficiency and benefited both the administration and students. However, this system suffered from online security threats from the editing and administrative rights. This hampered its performance and institutional usability.

2.3.2 The GSU Students Result Processing System

In the work done by Youh (2010), today's university environment had an increasing need for distributed database systems as the desire for easy, reliable, scalable, and accessible information is steadily increasing. The inadequacies of centralized database systems in handling students' results necessitated the use of distributed database systems in that work. According to the author, the system was a relational database designed in a way that each academic department in the university had its database including the Central Record Processing Unit (CRPU), Exams and Record Unit, Student Affair Division, Dean's Offices, and Senate. The master database was hosted at CRPU. Also in the system development, Microsoft Visual Basic 6.0 and Structured Query Language (SQL) were used to design a prototype of a client-server distributed database system for processing students' examination records. But this system had a non-global presence as a drawback since the system was not accessible over the internet. This also hampered its institutional usability.

2.3.3 The JABU Students Academic Record Management System

Some problems bedeviled the student academic record management, like improper course registration, late release of students' results, inaccuracy due to manual and tedious calculation and retrieval difficulties, and inefficiency. In most cases, the data generated by academic institutions are usually created in non-delineated files for use by different departments and units within the institution with the same data appearing on several of these files. This meant that a simple change of address would have to be processed in two and probably

three or four places, depending on the number of other files on which these data appears. Hence, according to Eludire (2011), the development of the database concept is the answer to the above-mentioned problems, where the amount of redundant data is reduced, with the possibility of inaccurate data contained on a file because they were never updated.

Therefore, Eludire discussed the design and implementation of student registration and course management database application with Microsoft Access. The work also discussed the issues of selecting appropriate database models, interface design, system deployment, and maintenance. A projection of record growth concerning student population and system requirements was carried out in the study. Finally, the work discussed the applicability of the system in academic institutions. This system was developed using the evolutionary prototyping model development process. Consequently, the system could only be deployed as standalone since the Microsoft Access database used is not network-based. Hence, the system could not be accessed globally from anywhere in the world. This hampered its institutional deployment and usage.

2.3.4 The UNICAL Result Processing and Management System

In the work done by Ukem and Ofoegbu (2012), a computer software application was developed to facilitate the automated processing of the result in the University of Calabar, Nigeria. The software was developed following the code-and-fix development process, with Java programming language and the database was designed by employing MySQL Relational Database Management System. The developed software performed well and produced the expected result on completion. With it, it was possible to compute Grade Point Average and Cumulative Grade Point Average for each student based on examination scores entered. This system was deployed on a private server only, which limited its global accessibility, especially the viewing of results outside the

institution. It also tended to be vulnerable to hacking should it be hosted online, due to the editable administrative privileges on it, amongst other security threats. This hampered its institutional usage.

2.3.5 The UNIPORT Result Processing and Management System

The UNIPORT system also presented a single platform used to manage and process data for all categories of students seamlessly and interactively. The design technology adopted for the implementation was a client/server technology, with MySQL as the server technology and Visual Basic.NET as the client technology. Internet Information Server (IIS) was used as the Web server. The software development methodology adopted was the incremental model in conjunction with the prototyping technique (evolutionary prototyping development process) (Obasi, Nwachukwu, and Ugwu, 2013). An empirical evaluation of the system showed that the system expedites the processing of students' results and generation of other related academic information and increased efficient service delivery with the added advantage of academic records management. Nevertheless, the system was web-based and run on the public cloud, thus bedeviled by the vulnerabilities of hacking and unauthorized access. These seriously limited the actual use of the system to computing 100 level students' results, beyond which the system suffered heavy cyber attacks.

2.3.6 The NSU Result Processing and Management System

This research was done at Nasarawa State University, Keffi Nigeria, was focused on creating automated students result management system using Oracle database, forms, and reports. Akinmosin (2014), in the work, showcased a computerized examination result management system for tertiary student's examination records. According to the researcher, the manual method of students' academic result processing was found to be tedious, especially when carried out for a large number of students, and this also makes the entire process

time-consuming and error-prone. The system designed was meant to register students as soon as they have paid their departmental registration and only then will they be able to view their results. The system presented a private-network-based single platform to be used to manage the processing of all examination records within the institution. The research implemented an application for student result storage, and users can access this software from anywhere as long as they are working within the network coverage of the application server.

This application was designed using Oracle database for keeping the records (data), Oracle forms for creating the user interface, and Oracle reports for presenting information to the user, having been developed through the waterfall process. The system enabled users with the right permission to insert new user details, student examination records, as well as update these records whenever necessary. The review showed that the system expedites the processing of students' examination results and its reporting. Nevertheless, users of the system need a certain level of Oracle-related skills, and they need to be present in the institution to connect to the network before using the system. Poor user-friendliness and physical presence, amongst other challenges, are the constraints to the actual usage of this system.

2.3.7 The FUTO Result Processing and Management System

This work revealed the result processing and checking challenges presently faced by the Federal University of Technology Owerri. The development used the Structured System Analysis Development Methodology (SSADM) to design and implement an enhanced students' result processing and management system with result checking ability, in the bid to remedy the freezing challenge of the existing system. This development provided an unambiguous identification of users through their username and password. It provided a platform for easy course registration by students, result collation, grading and publishing by

lecturers, result checking by students, and management decisions by school authorities and the exams and records unit. The system ran on the SQL Server 2012 DBMS to aid result collation, processing, publishing, and checking (Anyiam, Anyiam & Okengwu, 2020). However, the system development, management, and maintenance were not in-house but completely outsourced to a third party, which increases the risk of security threats to the database and also poorly addressed its data redundancy. These made the system more vulnerable to cyber-attacks capable of grounding the entire system when compromised.

2.3.8 The Research Gap

The empirical review of literature in this work showed the research needs to explore and use the under-explored hybrid system model for results processing and management. This became necessary since efforts at improving the single-platform results model can neither eliminate its inherent weaknesses nor effectively address its attendant effects. These weaknesses form the research gap, and comprises: (a) delayed processing of results offline; (b) difficulty computing legacy and borrowed results, and doing complex result corrections online; (c) poor scalability and compliance to formats, institution-specific policy standards, and regulations; (d) security and confidentiality threats that include privilege escalation, SOL injection, phishing, DoS session hijack, wireless cracking, back-door, and blended attacks; and (e) little or no database of students' results for past years. The immediate and remote effects of the research gap include: (a) poor institutional usage; (b) incessant system failure (partial or full); (c) high rate of abandonment of the failed systems; and (d) loss of human and financial resources. Thus, the single-platform system model can be said to be deficient and inadequate, necessitating another system model that will optimize the strengths of the offline and online systems, and address most of these deficiencies and inadequacies, to bridge the established research gap.

To bridge the research gap between the single and hybrid results processing and management systems, the HRPMS was developed and validated following the Agile-Scrum development and Agile four-quadrant test processes using the functional and non-functional requirements. The proposed system consists of interoperable cross-platform offline-online modules deployable over offline (standalone) and online (client-server internetworked) platforms. This helped to address the attendant inadequacy of the single-platform result system model and optimize its strengths and weaknesses. The validation tests targeted evaluating user requirements, system operations, cost-effectiveness, and system performance improvement in alpha and Beta stages, both technically and statistically. The functional and non-functional requirements were selected considering the user and the system specifications for the HRPMS.

2.4 Summary of Literature Review

This work reviewed the conceptual, theoretical, and empirical frameworks for achieving the system development and statistical analysis in this research. The concepts reviewed include the legacy system concept, spreadsheet standardization (data harvest) concept, the platform optimization concept, and the hybrid validation concept using the system's functional and non-functional requirements. The theories reviewed include the offline-online systems hybrid theory, the consistency and integration theory, the continuum theory, and the Agile-Scrum theory. The related works reviewed include result systems of ABU Zaria, GSU Gombe, JABU Osun, UNICAL Calabar, UNIPORT Port Harcourt, NSU Nasarawa, and FUTO Owerri. These reviews were relevant to understanding and establishing the principles of the HRPMS, and showed the research gap that was bridged by the hybrid system. It also revealed the system conceptual model, the established user and performance requirements, and the Agile-Scrum software development model framework adopted.

Table 2.3 presents the summary of the existing systems review and their attendant inherent weaknesses as shown by the shortfalls. Notably, most of the universities have upgraded or developed better results processing systems, which were captured in the survey data using questionnaires interview but the literature containing the upgrades was not yet available at the time of this study. However, based on the literature, the single-platform result system model is inadequate and incapable. Hence, the need for a hybrid system model to eliminate the weaknesses of the single-platform model and further improve the process automation of results processing and management.

Table 2.3: Summary of Existing Systems Reviewed

S/N	Systems Reviewed	Development Technique / Tools	General Outputs	Shortfalls
1.	ABU Result System	Crowdsourcing/ PHP and Apache Server	Increased service delivery efficiency, benefited the management and students	Suffered editing and administrative network security threats
2.	GSU Result System	Prototyping / using MS VBA 6.0 and MS Access DBMS	Deployed as a client-server distributed database system for processing students' result records	Not implementable over the Internet, hence, it is limited to non-global presence for user access
3.	JABU Result System	Evolutionary Prototyping / MS Access DBMS	Minimized amount of redundant data by implementing Database	Deployed as standalone and do not have global access and presence
4.	UNICAL Result System	Code-and-fix / Java and MySQL DBMS	Performed well and computed GPA / CGPA accurately per student using exam scores entered	Deployed as standalone and deficient in global accessibility for results checking
5.	UNIPORT Result System	Incremental Modelling / using VB.NET, MySQL, and IIS Web Server	Expedites result processing, generation of other related information, and manages academic records efficiently	Deployed as web-based, suffers heavy cyber-attacks for unauthorized access to compromise results beyond 100 level
6.	NSU Result System	Waterfall / Oracle DBMS and Interface	Expedites result reporting and processing, ability to insert new users and records, and update them	Poor user-friendliness with Oracle skills, and physical presence to connect and use system
7.	FUTO Result System	SSADM / SQL Server 2012 MySQL DBMS	Enhanced online course registration, grading, processing, publishing, checking, and archiving	Deployed as web-based, faces cyber-threats, and data redundancy. Fail to handle extra-year issues

(Field Work)

CHAPTER THREE
METHODOLOGY

3.1 Preamble

This chapter presented the methodology used in this research for the HRPMS development, testing, and validation. It showed the technical methods or techniques, procedures, and tools for the HRPMS design, coding, and deployment. It also shows the technical and statistical methods, procedures, and instruments for evaluating (through testing) and validating the HRPMS development. These were put together in the HRPMS Dissertation structure, which was followed to develop its conceptual model before its physical development.

3.1.1 Research Design

The HRPMS research design is the Dissertation structural framework that guided its development. It demanded as well as provided answers to questions about relationships and generalization of results in line with the standards (Madukosiri & Bawo, 2012; Petroshius, 2015). These showed that research design models research as a systematic study outline or a researcher's compilation method detailing how the study will arrive at its logical conclusions (Creswell, 2013; Maxwell, 2012; Yin, 2013).

Hence, to develop the HRPMS, the researcher studied the existing systems (pilot study) to verify processes and devices, monitor facilities and activities involved, and make relevant decisions. The pilot study and the literature reviews helped to refine the research design further. The final framework shows that the work comprises: topic selection, literature reviews, problem statement, identifying the research gap, identifying the functional (operational) and non-functional (performance) requirements, and creating the research model. Others

are selecting the materials and methods, analyzing the existing single-platform systems, designing the HRPMS, constructing the HRPMS, testing the modules and presenting the results, collecting the performance feedbacks, analyzing the feedback data, and presenting findings to validate the HRPMS development.

3.1.2 HRPMS Conceptual Model Framework

The model framework of the HRPMS conceptualized and organized the system development, and captured the high points of the system solution. It presents the proposed system as a three-tier model (see Figure 3.1), modeled to isolate and selectively implement the result processes, some on the standalone subsystem modules and some on the network subsystem modules, to optimize their strengths and weaknesses. Hence, it addressed the research gap.

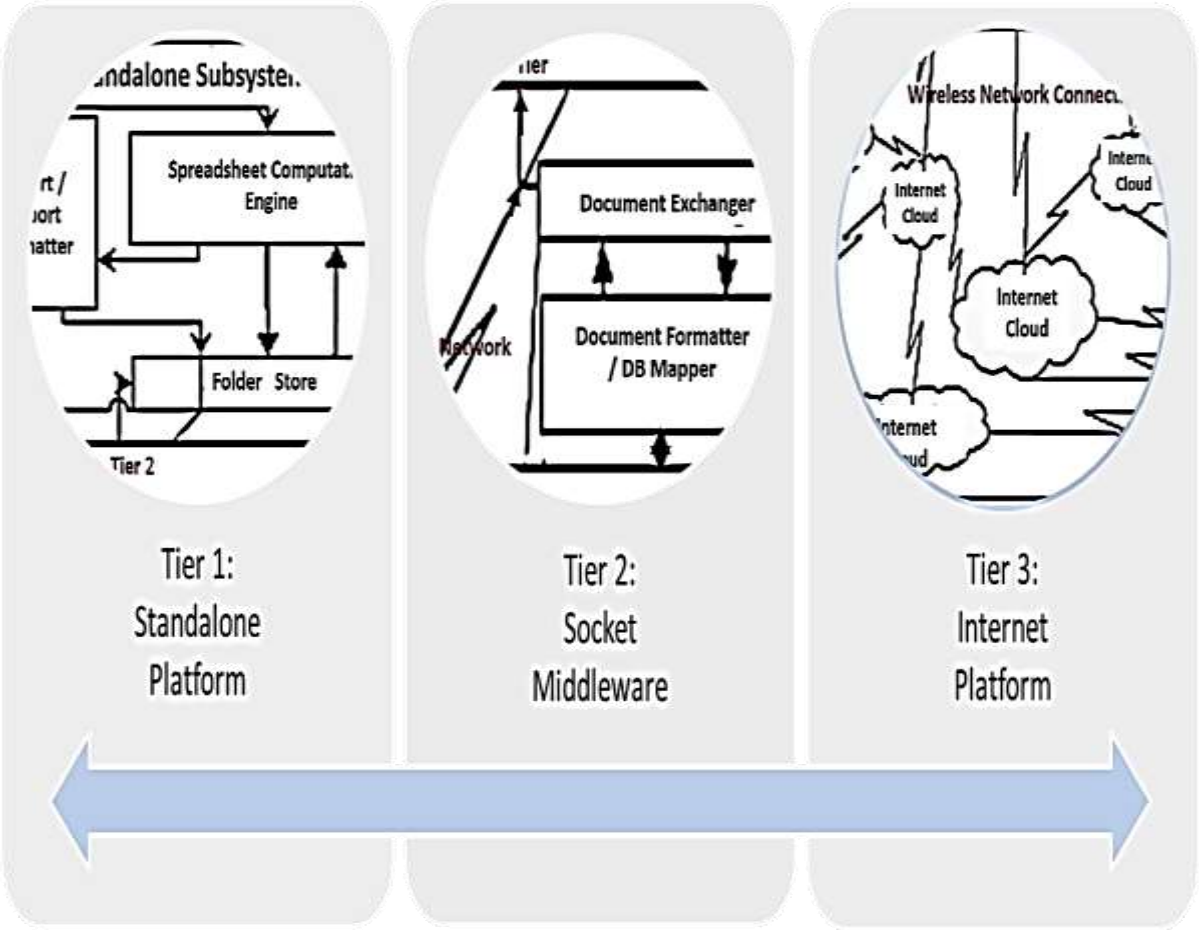


Figure 3.1: The HRPMS as a three-tier Model

The three tiers of the HRPMS solution are as shown in Figures 3.2, 3.3, and 3.4. They are the standalone, the socket middleware, and the Internet subsystems. Figure 3.2 is the standalone subsystem comprising the spreadsheet worksheets, export-import formatter, and folder store, used for complex dynamic computing. These include enlisting students and courses, tracking outstanding courses, managing result corrections and omissions, generating semester summaries and graduation status, and generating transcripts from the spreadsheet in one click.

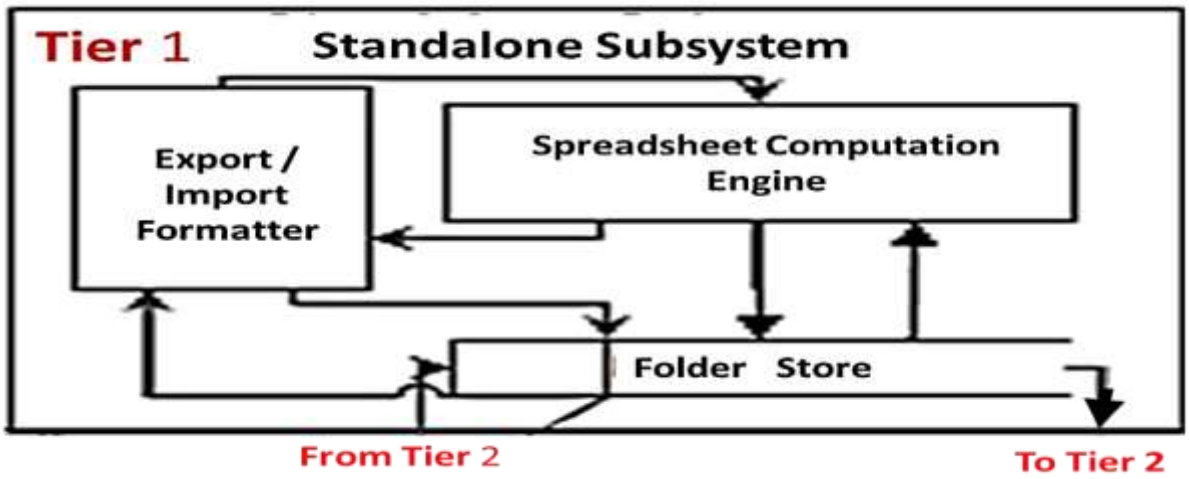


Figure 3.2: The HRPMS tier-1 (Standalone Subsystem)

Figure 3.3 is the socket middleware application comprising the user verifier, document exchanger, flat file-to-relational database emulator (mapper), and software administrator's pane for user management and Personal Identification Number (PIN) generation. It is used for closed-group communication (between result processors, HODs, Deans, DVC academic, and VC), and distributed processing of results. These include legacy-to-mainstream results processing, result files access and transmission, result data upload by harvesting flat files into a relational database, and extending the HRPMS capability using other media platforms e.g. Emails, Telegram, WhatsApp, and so on.

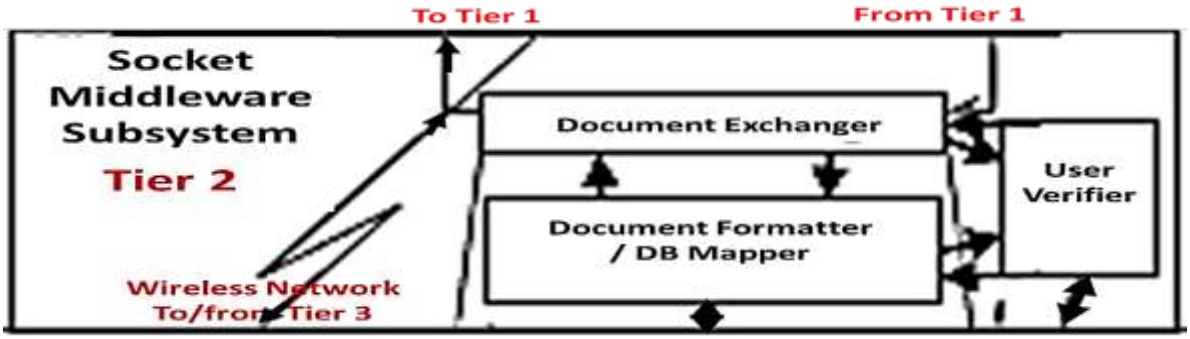


Figure 3.3: The HRPMS tier-2 (Socket Middleware Subsystem)

Figure 3.4 is the Internet subsystem comprising the web application for results checking and remote servers (file, database, and web servers), which enhances result files transmission and houses the database, secured folders for flat files storage, result data, and result files. It is used for secured access, storage, and retrieval of result files and result data. These are possible using a combination of students' registration numbers, departments, sessions, semesters, and pins over multi-server (file, database, and web servers), to access normalized dual database servers. The database normalization was done to separate and hold authentication data (namely, users, memos, path-logs, and PINs) and result-data (namely, students' names, course codes and titles, grades, GPAs, and CGPAs).

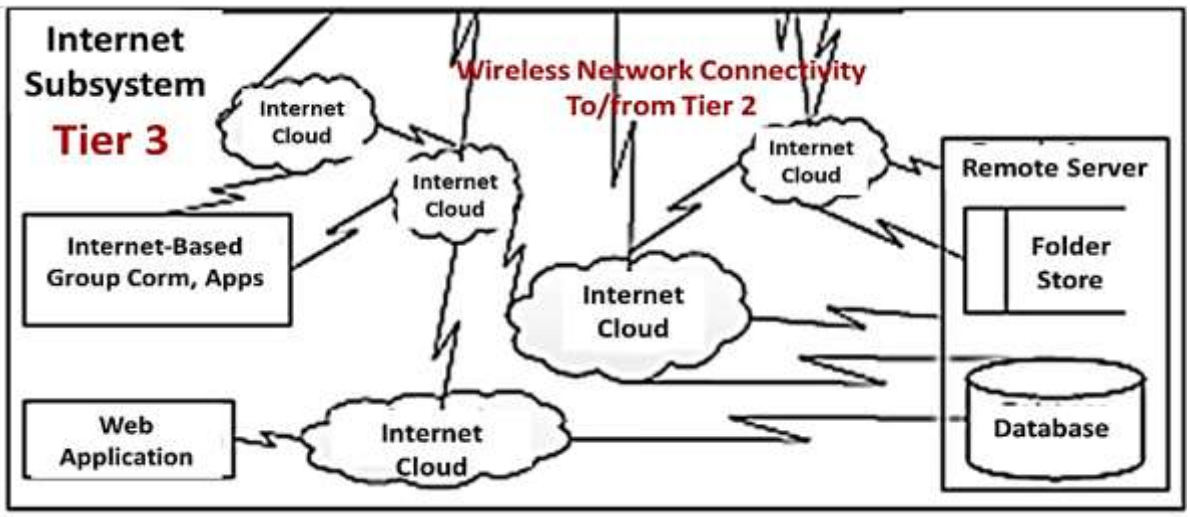


Figure 3.4: The HRPMS tier-3 (Internet Subsystem)

As shown in Figure 3.5, the HRPMS model conceptual framework consist of a hybrid of the three-tier subsystems described earlier, which ensures process automation and communication between the standalone and the internet subsystems aided by the socket middleware subsystem. As earlier described, it handles the more critical and scalable result processing functions on the standalone, handles the metaheuristics hybridization on the socket to optimize the objective functions and ensure results management on the socket middleware, and handles the less critical and less scalable results processing functions on the internet subsystem. Implementing the HRPMS model ensures decentralized results computation processing, secured-group paperless results transmission access and management, and efficient results storage and retrieval. It also ensures redundancy in keeping and archiving approved results.

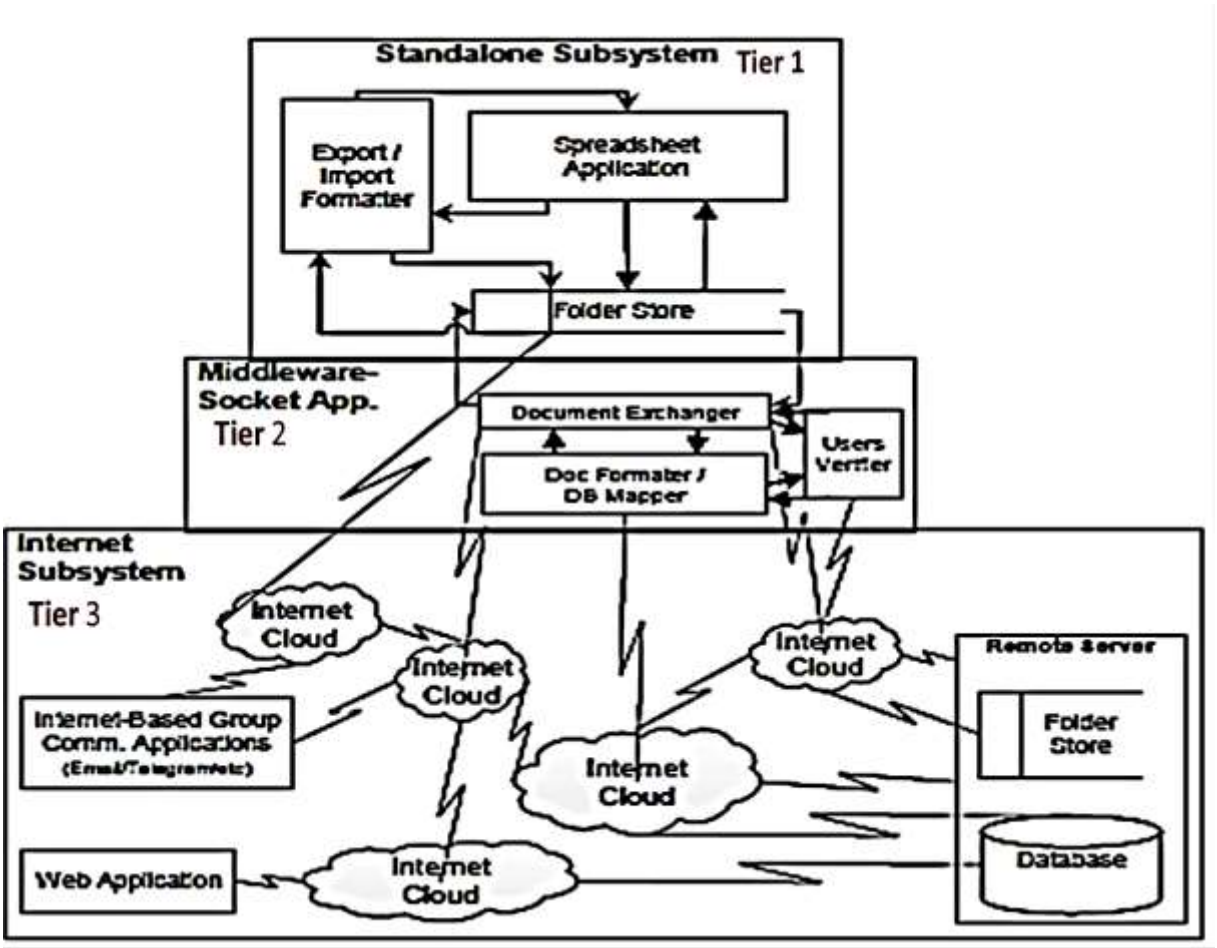


Figure 3.5: The HRPMS Hybrid Conceptual Model Framework

From Figure 3.6, HRPMS is a decentralized processing system that consists of the client-side components (that receives input from the standalone computation engine), the logic components (that process between the client and server sides), and the server-side components (that receive, store and retrieve result files to/from folders and result records to/from normalized database tables).

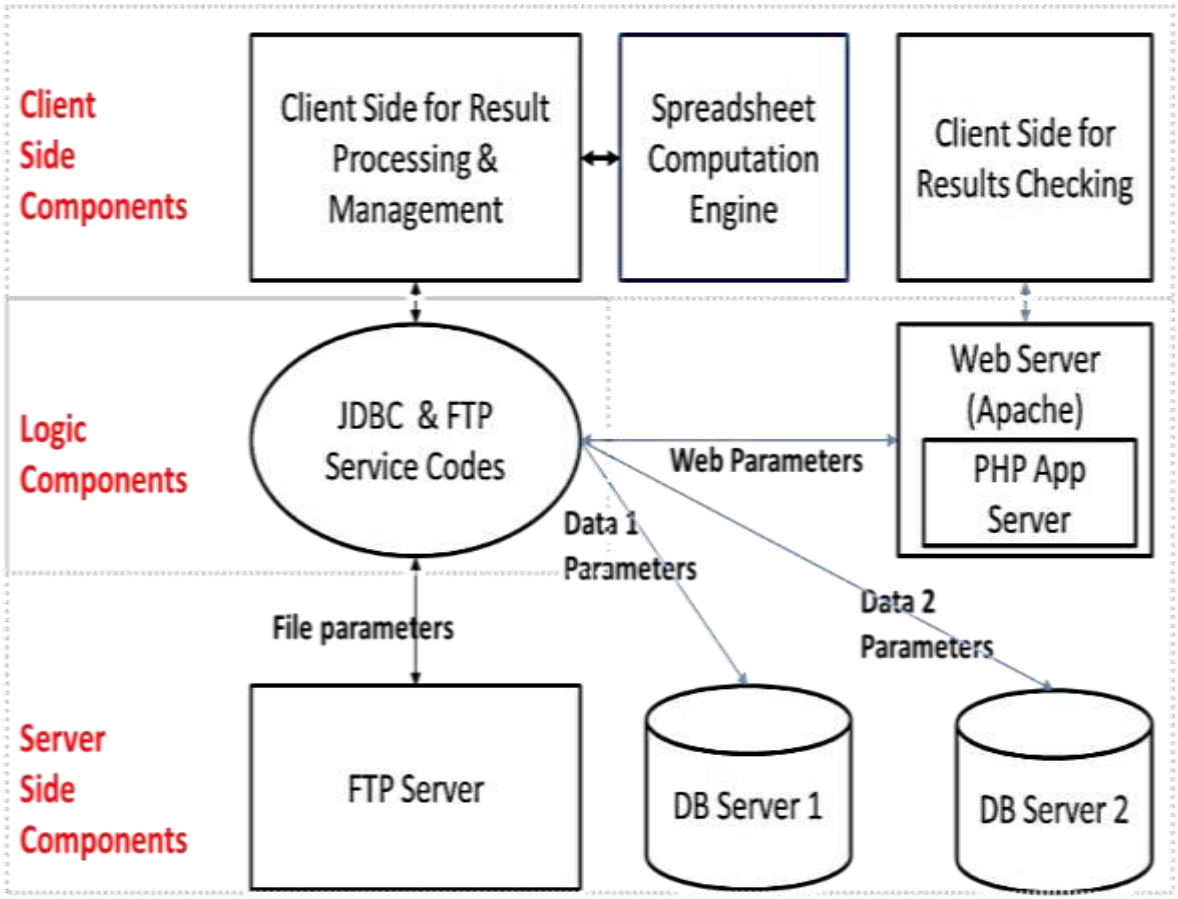


Figure 3.6: The HRPMS Implementation Model

3.2 System Analysis and Development Method

3.2.1 Existing System Analysis Technique

The pilot survey method (using the qualitative technique), was deployed in this work to systematically analyze the existing single-platform system to determine

their weaknesses. The qualitative technique is easy to use and produces precise results (Mills, Teplitsky, Arroyo, Charmantier, Becker, Birkhead & Bushuev, 2015; DaSilva, Neto, O'Leary, deAlmeida & deLemosMeira, 2015). Interview and observation tools were to gather the pilot data, which were tabulated to show the results and inferences. The High-Level Model (HLM) diagram was used to present the existing systems' structural overview.

3.2.2 HRPMS Analysis and Development Technique

The Agile Scrum Method was used to develop the HRPMS modules. This is because it follows both structured and object-oriented analysis and design methodologies. Also, it yields better software as attested to by the Standish group chaos report in 2015 and 2016, which had it that the agile software approaches resulted in more successful projects and fewer outright failures. Also, according to SquareSpace in 2013 as cited by Herzberg & Sisombat (2013), more than 70% of teams across IT industries are practicing Scrum Agile procedure. Even, companies like Microsoft, Adobe, CA, and HP, use Scrum Agile in their software development. Agile Scrum focuses on holistic management of the software development project rather than just the activities or practices (Deemer, Benefield, Larman, & Vodde, 2012; Herzberg & Sisombat, 2013; Rad & Turley, 2013; Reeder, 2014; Schwaber & Sutherland, 2015; Isaias & Issa, 2015; Esiefarienrhe, Adeiza & Ejura, 2015). Basically, the method was chosen because it requires less planning, divides and handles tasks in small iterative increments, and reduces errors (see Figure 3.7). Hence, it is a quick and efficient way of achieving modularity, increased flexibility, software interfacing, changeable requirements according to user needs with new features easily added (Masila, 2014; Michaels, 2013; Leau, Loo, Tham & Tan, 2012). The outcome of the subsequent iteration is an enhanced working product. This is repeated till all functionalities are accomplished.

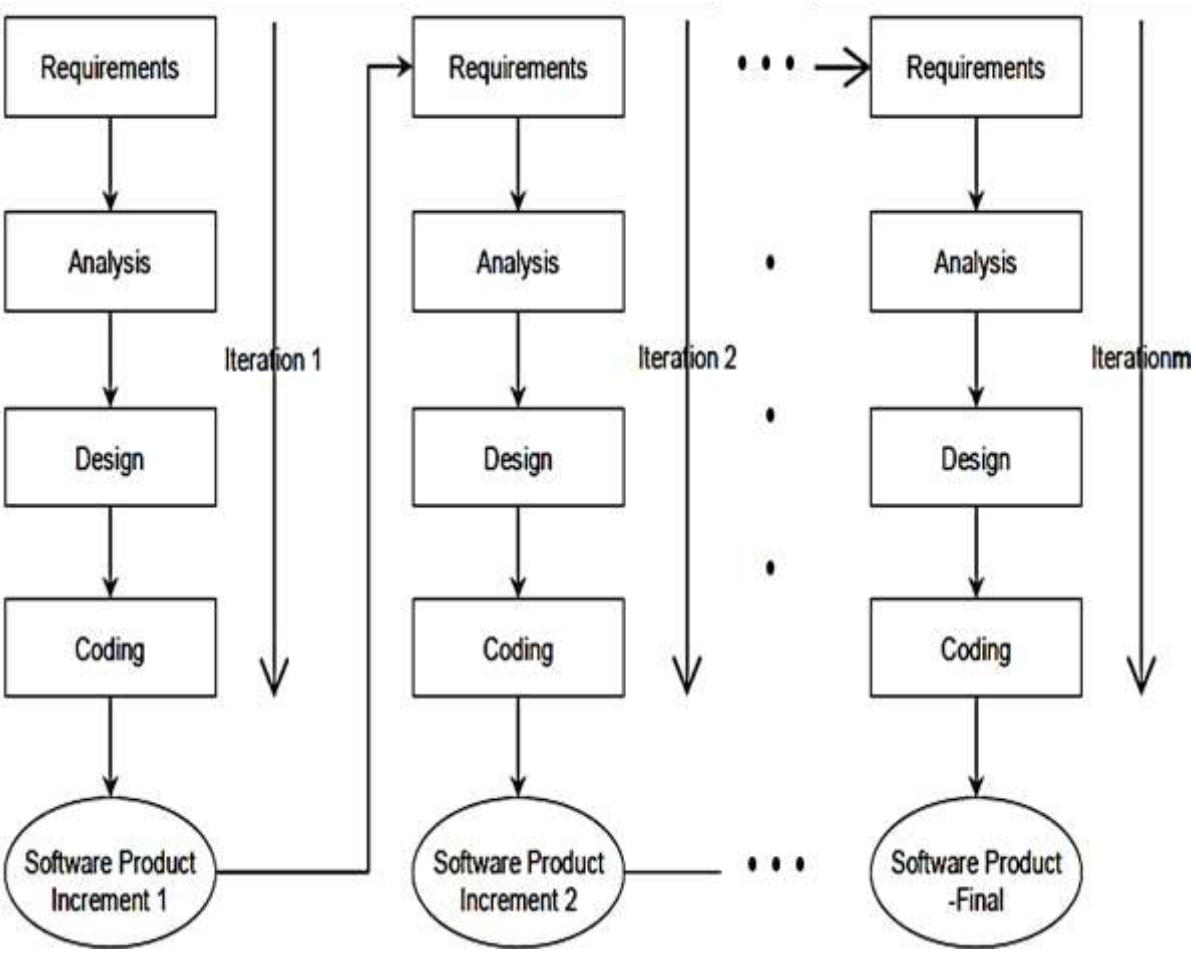


Figure 3.7: Scrum Agile Software Development Model (Michaels, 2013)

The steps and activities done to achieve each phase are as follows:

a. Requirements phase: This is the articulation of the system's functional and non-functional requirements from user and system specifications.
b. Analysis Phase: This is the articulation of the system processes based on the system's functional and non-functional requirements.
c. Design Phase: This is the logical and behavioral modeling of the system processes module by module.
d. Coding Phase: This is the physical construction, integration, and testing of the system modules to carry out specific system operations.

Following the phases, the development cycle in Figure 3.8 was established. Customer satisfaction is the highest priority of the Scrum Agile method, hence,

it promotes interaction throughout the development process cycle, and customers are directly involved in software evaluation. This makes it adaptive in planning, iterative in process, and time boxing in duration.

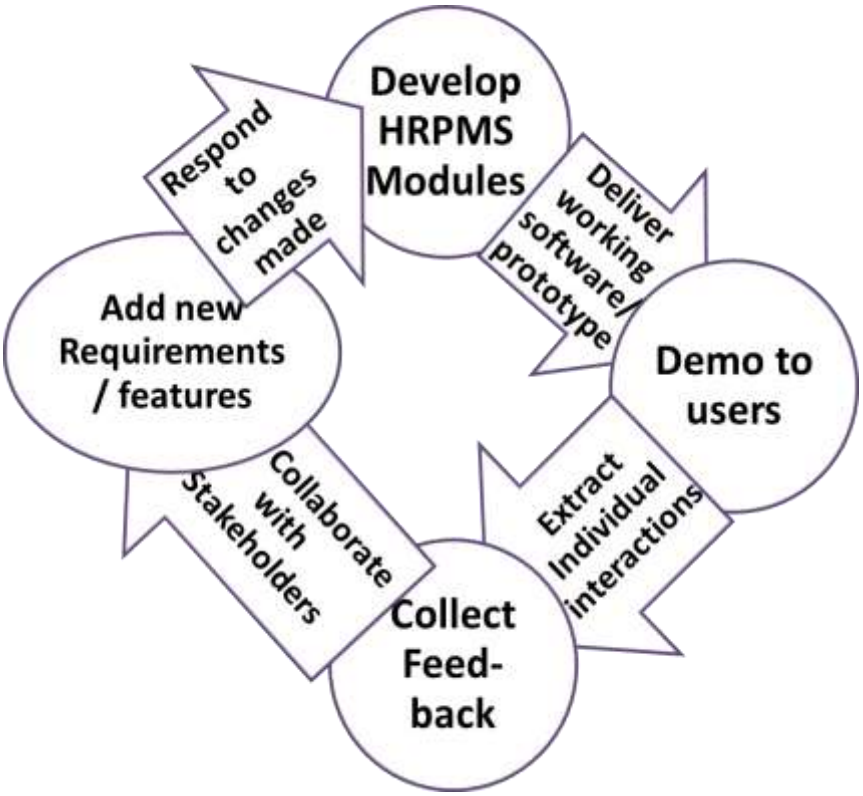


Figure 3.8: Agile-Scrum Development Cycle for the HRPMS (Michaels, 2013)

In line with the Agile procedure, the Unified Modeling Language (UML) was used to create structural, behavioral, logical, and physical models of the HRPMS modules and database, using the High-Level Model, Use case, Flowchart, class, entity-relations, and deployment diagrams (see Figure 3.9). According to Ahmed (2010), these diagrams were used because of their simplicity in system representation, apt to communicating system logic, efficiency in problem analysis, and ease of documentation.

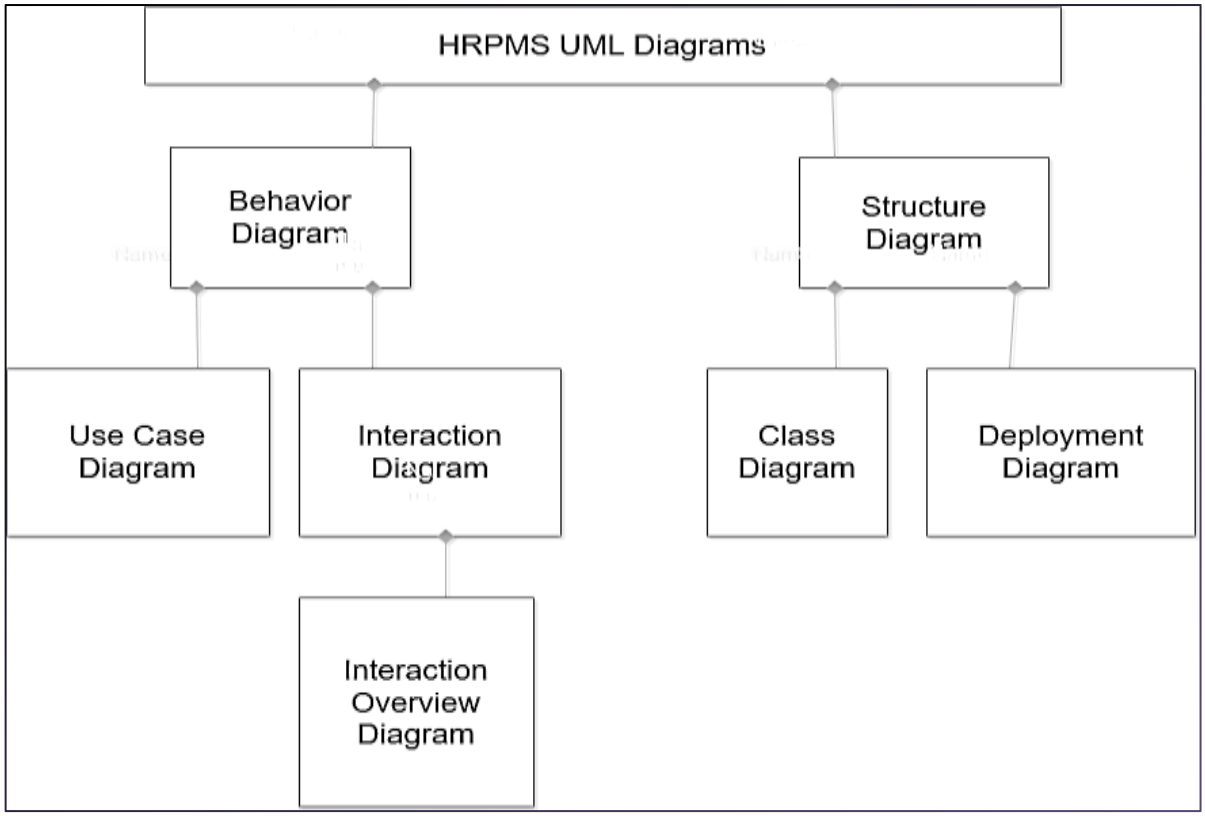


Figure 3.9: The UML Diagrams used in HRPMS Design (Ahmed, 2010)

3.2.3 HRPMS Development and Deployment Tools and Materials

The hardware tools are personal computers and modems, while the software tools include the Excel VBA, JDK8.0, JRE (SE), MS-Excel POIs, Browsers, FTP Server, MYSQL DBMS, and Apache/PHP web application servers in Wamp (local) and GoDaddy (live) server platforms. Following the top-down technique, the HRPMS modules were developed. Thus, Excel Visual Basic Application programming was used to develop the standalone modules, the Java programming (NetBeans 8.0, JDKv8.0 development kit, and MS POIs/API library) was used to develop the socket middleware, MySQL5.4 DBMS was used to create the database tables, and PHP was used to develop the web page for results checking. Also, the MySQL connect, Hypertext Transfer Protocol (HTTP), and File Transfer Protocol (FTP) were used to link, manage and transfer result files and data between the middleware and the servers.

3.2.4 HRPMS Functional and Non-functional Requirements

From the pilot survey and contents review of the user requirements, the nine (9) HRPMS functional (Operational) requirements are: Course Details Capturing, Student Details Capturing, Results Computation, Reports Generation, Reference Tracking, Results Retention Processing, Results Checking, Transcripts Processing, and System Administration. These are described in Table 3.1. These represent the basic functionalities of the HRPMS.

Table 3.1: Description of HRPMS Functional (Operational) Requirements

S/N	OPERATIONAL DRIVERS	DESCRIPTIONS
1.	Course Details Capturing	System captures all core, elective, and borrowed courses and units for all students for all sessions
2.	Student Details Capturing	System captures all student's personal and academic clearance details for all student levels.
3.	Results Computation	System auto-computes all student's GPAs and CGPAs from their grade results per semester
4.	Reports Generation	System auto-generates summaries per semester and graduating students' status list per class
5.	Reference Tracking	System auto-tracks all omitted and carryover outstanding courses per student for advisory use
6.	Results Retention Processing	System forwards results to management for routine vetting and final approval and retention
7.	Results Checking	Stakeholders use system to access approved results
8.	Transcripts Processing	Management uses system to generate and transmit academic transcripts to return addresses both offline and online
9.	System Administration	Administrator manages database, users, and PINs to forestall total data loss and ensure good control

(Fieldwork)

Also, from the pilot survey and literature review of the system quality requirements (Mangin, Bourgault, Guerrero, & Egea, 2011; Mana & Kanthawongs, 2012), the five (5) nonfunctional (performance) drivers of the HRPMS are Usefulness, Ease of Access and Use, Security and Confidentiality, Processing Speed, and Computation Accuracy; as described in Table 3.2. These represent the basic capability constraints or qualities of the HRPMS.

Table 3.2: Description of HRPMS Non-Functional (Performance) Requirements

S/N	PERFORMANCE VARIABLES	DESCRIPTIONS
1.	Usefulness	degree to which user productivity is enhanced by the system
2.	Ease of Access and Use	the degree to which accessing and using the system is free of much effort and skills
3.	Security and Confidentiality	the degree to which the system, its data, and users privacy cannot be compromised by preserving its integrity
4.	Processing Speed	degree to which the system use conserves time and reduces delay by reducing computation, vetting, and approval times
5.	Computation Accuracy	the degree to which system processes and outputs can be trusted to be correct and free from errors

(Fieldwork)

3.3 System Hybridization Method

3.3.1 jMeme Metaheuristic Optimization Framework

The HRPMS development leveraged on the jMeme Metaheuristic Optimization Framework (MOF) to optimize the objective functions of the standalone and client-server by implementing parallel independent executions of Evolutionary Algorithm and Genetic Algorithm (EA-GA) hybrid metaheuristic in distributed master–sub-model for the fitness function evaluation convergence using branch and bounds time budget. Hence, using the jMeme in HRPMS development produced multi-objective hybrid optimization of the offline-online cluster platforms cooperation, and the synchronization of distributed computing platforms (a cluster of peer-to-peer P2P computers, grids, and cloud computing environments), and decentralized results processing and management. The hybrid design with jMeme performs better than Memetic Algorithms designed conventionally, as shown by experiments with well-known benchmark functions (Gherbi, Lakdja, Bouzeboudja, & Gherbi, 2019), as well as by HRPMS testing.

3.3.2 Programming Approach in jMeme

The hybridization of HRPMS parallel metaheuristics in jMeme is a composition of (m,s) where: (i) $m, s \in M$ are different algorithms from the set of parallel

metaheuristics $M = \{a_1, a_2, \ldots, a_n\}$. The parameters m and s are devoted to master-metaheuristics and sub-metaheuristics respectively in which only one m can be integrated with more than one s. Each metaheuristic M is composed of general components $G = (S, f, \Omega)$, and proprietary components $C = \{x_1, x_2, \ldots, x_n\}$. While general components are common to all M algorithms, they have a distinction from proprietary components. S is one of the general components that define solution representation in a search space. The search space consists of a finite set of decision variables $\mathbf{V_i}$ where $i = \{1, \ldots, n\}$. The type of variables can be in discrete, continuous, or mixed form.

Another general component for M is objective function $f = S \rightarrow R^+$ that assigns a cost value *MIN* and *MAX* to each solution of S. The set of constraints among the variables is defined in a set of penalty functions $\Omega = \{f_1, f_2, \ldots, f_n\} | f_x : V_i \rightarrow C$ where $i = \{1, \ldots, n\}$. The proprietary components C are exclusive of their respective metaheuristics M which can be a crossover into the routine of other metaheuristics M. It creates specific metaheuristics paradigms and characteristics comprising different parameters with different types T. The parameters can be associated with a dynamic or constant value. The dynamic values can be determined by dynamic behaviour either self-adaptive A or time-varying V. The sets of $A = \{a_1, a_2, \ldots, a_n\}$ and $V = \{v_1, v_2, \ldots, v_n\}$ consist of different functions with different types T. Each function calculates an appropriate parameter value in relation to a particular metaheuristics condition. The following steps suffice:

i. Master metaheuristics declaration
ii. Sub-metaheuristic declaration
iii. Parameters declaration
iv. Select behavior for parameters, if (behavior is not available) → create new
v. Select the solution representation, If (solution is not available) → create new
vi. Select the neighborhood structure, If (structure is not available) → create new
vii. Select the problem function, If (problem function is not available) → create new
viii. Select constraints for the problem
ix. Select components from master-metaheuristics, If (components not available) → create new
x. Select components from sub-metaheuristics, If (components not available) → create new

xi. Construct algorithm flows
- *Must begin with solutions initiation*
- *Must consist of fitness function evaluation*
- *Must consist of master specific components*
- *Must consist of subspecific components*

xii. Save/end operations

3.4 System Validation Method

3.4.1 Source of Data for Statistical Analysis

The data for this research was collected from nine (9) universities in South-East Nigeria. As shown in Table 3.3, nine (9) out of the 23 universities in South-East Nigeria were purposively selected using one-stage cluster and stratified sampling technique to cover all mix of three (3) classifications, namely: generation (1st, 2nd, and 3rd generations), specialty (conventional, science-tech, agriculture, and education), and ownership (federal, state, and private).

Table 3.3: Classification-based selection of nine (9) Nigerian Universities

S/N	UNIVERSITY	OWNER-SHIP	GENER-ATION	SPECIALTY
1	University of Nigeria Nsukka (UNN)	Federal	First	Conventional
2	Nnamdi Azikiwe University Awka (NAU)	Federal	Second	Conventional
3	Federal University of Tech. Owerri (FUTO)	Federal	Second	Science/Tech
4	Michael Okpara Uni.of Agric.Umudike (MOUA)	Federal	Second	Agriculture
5	Federal University Ndufu-Alike (FUNA)	Federal	Third	Conventional
6	Imo State University (IMSU)	State	Second	Conventional
7	Enugu State Uni. of Science and Tech (ESUST)	State	Second	Science/Tech
8	Anambra State University Uli (ASU)	State	Third	Conventional
9	Madonna University Okija (MUO)	Private	Third	Conventional

(Fieldwork)

These were selected for: (i) faster data collection due to proximity to the researcher, and (ii) their educational advancement, and (iii) their fair representation of others. Using the Krejcie and Morgan's table (**Appendix I**) for finite but stratified population (Krejcie & Morgan, 1970, as cited in Hill, 1998), the population was reduced from 9,144 (Table 3.4) to 2009 (Table 3.5). The target respondents were academic and registry staff who produce results.

Table 3.4: Population (N) Definition Based on Selected Nigerian Universities

STAFF	UNN	NAU	FUTO	MOUA	FUNA	IMSU	ESUST	ASU	MUO	Total
Academic	1,450	1,400	1205	1,200	1,100	1.050	650	400	300	8,755
Registry	60	55	52	45	42	40	35	30	30	389
Total	1,510	1,455	1,257	1,245	1,142	1,090	685	430	330	9,144

(Fieldwork)

Table 3.5: Sample Population (n) Definition Based on Selected Nigerian Universities

STAFF	UNN	NAU	FUTO	MOUA	FUNA	IMSU	ESUST	ASU	MUO	Total
Academic	252	248	235	234	225	221	176	127	108	1,826
Registry	28	26	25	20	20	19	17	14	14	183
Total	280	274	260	254	245	240	193	141	122	2,009

(Fieldwork)

As established by Gay and Diehl (1992), (as cited in Hashim, 2010) and supported by Hill (1998), 30 respondents per group was the minimum needed for correlational and experimental research. This left us with a minimum population sample of 270 respondents. Also, as suggested by Baltar & Brunet (2012), the researcher used the stratified random sampling technique to select class advisers and result processors, result vetters, and transcript processors, as the best-fit respondents in matters of students' results production.

3.4.2 Primary Data

Our interest in this study was to find whether there was a significant difference between the Existing System and the proposed HRPMS system. A study of this nature requires primary data obtained (with departmental official written permission) from a survey of respondents since such data was not recorded anywhere. Hence, the data used was collected and compiled by the researcher himself. Stratified random sampling was used to draw a sample of 360 respondents from the population, and questionnaires were distributed to them. Out of the 360 questionnaires distributed by the two-round Delphi technique (Bernice, 1968), 290 were duly returned and used. This represents 81% return.

3.4.3 Questionnaire Design and Validation

Following the standard for questionnaire design (Ritchie et al., 2013; Barua, 2013; Murray, 2013), a Likert summated five-point scale questionnaire was designed for data collection with the performance variables (**see Appendix II**). To validate the questionnaire design as opined by Csikszentmihalyi and Larson (2014), it was subjected to vetting by IT professionals and statisticians; to ensure that its structure, framing, content, and language reflect the study objectives. The questionnaire reliability was done using Cronbach Alpha Technique for establishing its internal consistency, having rated each response accordingly. The researcher administered the instrument to 30 respondents from Federal Polytechnic Nekede Owerri, outside the research area of this study (**see Appendix III**), and the reliability coefficient (α**)** of the questionnaire instrument was calculated using Equation 3.1:

$$\alpha = \frac{N.\bar{c}}{\bar{v} + (N-1).\bar{c}} \qquad \textbf{(3.1)}$$

Where: N = number of respondents; $\bar{c}$ = average inter-item covariance among respondents; and $\bar{v}$ = average variance among respondents. For the calculation, N= 30; $\bar{c}$ = 0.124; $\bar{v}$ = 0.8027; hence, $\alpha \cong 0.85$ (**See details and SPSS sample outputs in Appendix IV**). Since, instruments with a reliability index of 0.60 and above are said to be reliable (Nkwocha, 2010); the questionnaire can be said to be reliable. This validates the questionnaire both in framing and content.

3.5 System Test Method

The HRPMS development was tested and validated following the Agile four-quadrant testing approach (Khanani, & Tayyab, 2014), using technicalities and statistics based on the functional and non-functional variables as requirements (Shahzad, 2012). Thus, the HRPMS modules were tested individually and collectively for system construction, operations or functionalities, cost-effectiveness, and development improvement.

Based on Figure 3.10, The technology-facing test to support the efforts of the development team is done in the first quadrant. There, the integration of the system components and units is tested using test cases developed to verify the system construction (codes). This is such that the test cases only pass or fail. Also, the Business-facing test to support the efforts of the development team is done in the second quadrant. There, the system end-to-end interoperability or overall operations are tested using test scripts to verify the system functional requirements. This is such that if the functional requirements can be test scripted, then the operations are workable (passable).

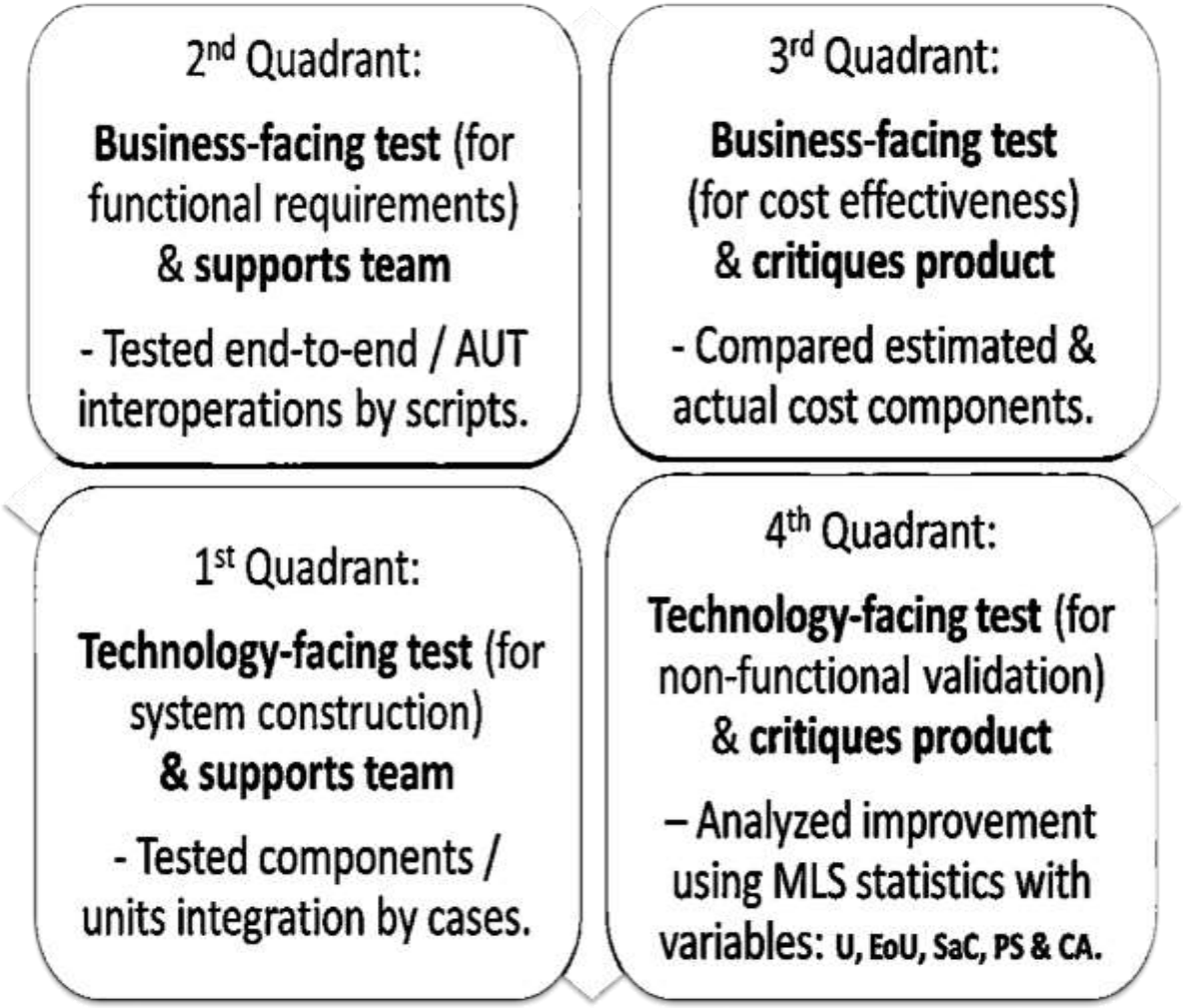


Figure 3.10: Agile Four-Quadrant Test Approach for HRPMS (Khanani & Tayyab, 2014)

Again, the Business-facing test to critique the product (HRPMS) is done in the third quadrant. There, the estimated cost and the actual cost of developing the system are compared to verify its cost-effectiveness. This is such that if the actual cost is within the estimate, then the system is cost-effective. Finally, the technology-facing test to critique the product (HRPMS) is done in the fourth quadrant. There, the development of the proposed system (HRPMS) is validated using the multivariate linear system statistics (with some non-functional performance variables like U, EoU, SaC, PS & CA), to verify the improvement of the proposed system from the existing system. This is such that if the alternative hypotheses are the case, then HRPMS is an improvement. The first and second quadrant tests were done following the test-driven technique described in the next section.

3.5.1 Test-Driven Development (TDD) Technique

According to Peltz (2003), among the steps taken to validate the HRPMS was the testing of its modular units, its integrated modules, and the entire system; testing for the acceptance of the user-defined requirements. The agile testing technique involves testing the user-defined system functional requirements for each modular unit being developed (Scot, 2007). It ensures that each module is tested for their user-defined requirements and their architectural and object designs (see Figure 3.11); hence, ensuring that the actual final product matches the expected final product as closely as possible. This was such that after each module was certified to be working properly, it was immediately integrated into the rest of the system already developed. The modular test and the incrementally integrated software framework were comprehensive and cost-effective. By it, source codes were checked for bugs, system structure and interfaces were checked for loading stress and boundary conditions, and system environments and their connections stability were checked.

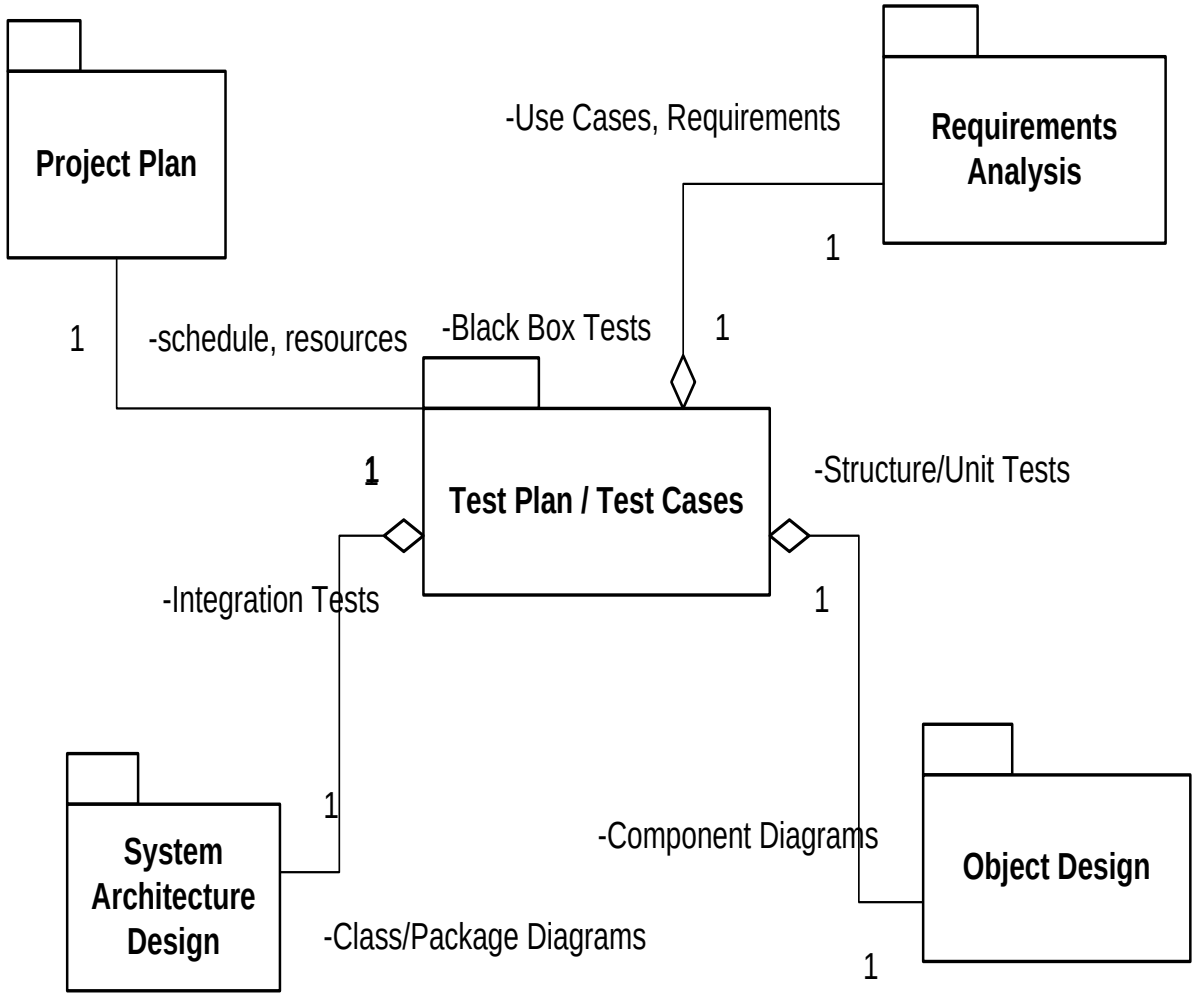


Figure 3.11: HRPMS Agile TDD Technique (Scot, 2007)

The test approach covered the strategies employed in carrying out the test plan on the test cases using the test tools and materials, as specified:

a. **The test plan:** In the plan, the unit and component integration test cases represented the first quadrant, the end-to-end interoperability and overall system test scripts represented the second quadrant, evaluation of the cost-effectiveness represented the third quadrant, and the hypotheses test represented the fourth quadrant.
b. **The test case script format for each Application Under Test (AUT):** The test case script format contains the following sections:
    i. *Project ID - the unique project identifier.*
    ii. *AUT Name - the definitive name of the AUT.*
    iii. *AUT Version - the definitive version information for the AUT.*

iv. *Iteration ID - the iteration unique identifier for each test.*
v. *Date of Test - the planned start date of testing*
vi. *Test ID - the unique identifier for the test.*
vii. *Purpose of Test - a brief description of the purpose of the test including a reference (where appropriate) to the requirement that is to be tested as well as any dependencies from or to other test case scripts. The references include requirements specification, design specification, user guide, operations, and/or installation guide.*
viii. *Test Environment - a brief description of the test environment; which may include a description of the state of the AUT at the start of the test, details regarding the platform or operating system, as well as specific information about data used in the test.*
ix. *Test Steps - concise, accurate, and unambiguous instructions describing the precise steps the Tester must take to execute the test, including navigation through the AUT and its inputs and outputs.*
x. *Expected Result - a brief and unambiguous description of the expected result of executing the test.*

c. The test criteria: Indicated the test threshold, which showed either a Pass or a Fail. "Pass" means "successful/satisfactory test result", while "fail" means "unsuccessful/unsatisfactory test result". The tests passed only when they satisfied the signatures, constraints, and interfaces in their object and architectural designs or functional requirements, otherwise, they failed.

d. The test stages: The test stage used is the alpha and beta stages. During the alpha stage, the developer tests the system to determine if it truly aligns with the target objectives. During the beta stage, a group of respondent-users tested the system to check if it suits them and/or met their needs.

e. The test tools and materials: The hardware tools are the computer and the modem, while the software tools include a compiler, debugger, GUI builder, and code refactorer in MS Excel VBA binary application, Java runtime environment (JRE), MySQL DBMS, Core FTP 2.0 Server, and apache/ PHP web applications Servers. These were used for source codes verification, while the LoadRunner tool was used for system load and boundary conditions verification. These were deployed for the alpha test stage during development, and the beta test stage on a live database server.

3.5.2 Generative Direct Cost Modeling Technique

In the third Agile test quadrant, the cost estimation analysis was done using the tabular tool to model the cost of developing the HRPMS. Cost estimation is cost prediction before undertaking a project or activity (Roy, 2003). This was done to establish the viability and cost-effectiveness of the HRPMS. Cost estimation models can be categorized into about eight (8) broad methods, namely: parametric, neural network, expert judgment, function costing, group technology, case-based reasoning, knowledge-based systems, and generative (direct, operations-based, activity-based, feature-based) costing methods. The works of Rush and Roy (2000), Ben-Arieh and Qian (2003), and Schubel (2012) showed that the generative (roll-up) costing is suitable for estimating the cost of the full-scale product development stage. The method predicts cost by following the bottom-up approach to estimate each task, material, work, or infrastructure involved in product creation and then calculate aggregate or roll them up to arrive at a product's final cost for a detailed assessment (Roy, 2003). It is also called the engineering build-up method, analytic method, or technical cost modeling method (Esawi & Ashby, 2003; Schubel, 2012).

According to Hueber, Horejsi, and Schledjewski (2016), the generative (bottom-up) method is easily understandable, accurate and is the only method to apply to new technologies or products; hence, this technique was used to estimate the HRPMS development cost (see Table 3.6). The technique considered the following components, namely: hardware, software, running, documentation, training, travels, and efforts costs. The hardware cost covered the computer devices. The software cost covered the development tools. The running cost covered the cloud accounts, hosting, and subscriptions services. The documentation cost covered presentations and two publications made. The training cost covered the physical training sessions and video trainer production. The travels cost covered the local runs an inter-state transport. The effort cost

covered payments to the support individuals and the technical team. Other considerations used in selecting the computer resources and the personnel used include time and storage constraints, machine volatility, schedule constraint, analyst and programmer capabilities, and experience with the use of modern development platforms, programming languages, and other advanced tools.

Table 3.6: HRPMS Cost Estimation Showing Items, Units, Hours, Rate, and Totals

COST COMPONENTS	ITEMS	SPECIFICA-TIONS	UNITS	HOURS / TIMES	RATE (₦)	UNITS-TOTAL(₦)	SUB-TOTAL(₦)	TOTAL (₦)
Hardware Cost	Computer Hardware	PCs	2		120,000	240,000	240,000	410,000
		Modems	2		15,000	30,000	30,000	
		Ext. 4TB HDD	2		70,000	140,000	140,000	
Software Cost	Computer Software	Office 2013	1		45,000	45,000	45,000	160,000
		Java IDE	1		20,000	20,000	20,000	
		MS POIs	1		15,000	15,000	15,000	
		Matlab & PHPDesigner	1		60,000	60,000	60,000	
		Antivirus	2		10,000	20,000	20,000	
Running Cost	Accounts	Cloud Service		1 yr	50,000	50,000	50,000	533,500
	Subscriptions	Database Hosting		1yr	50,000	50,000	483,500	
		Bandwidth (wifi.co.ng)		1yr	342,000 +91,500	433,500		
Documentation Cost	Data Collection	Questionnaire Preparation	3pp	360	5	5,400	16,200	235,600
		Data collation	3pp	360	10	10,800		
	Type & print		150pp	10cps	30	45,000	45,000	
	Photocopies		150pp	30cps	10	45000	45000	
	Binding	Soft	30		80	2,400		
		Hard	10		700	7,000	9,400	
	Publication	Journals	2		60,000	120,000	120,000	
Training Cost	Physical session		1		100,000	100,000	100,000	150,000
	Video Tutorial		1		50,000	50,000	50,000	
Travels Cost	Local runs	Imo	5		10,000	50,000	78,000	117,200
		Abia	3		2,000	6,000		
		Anambra	4		2,000	8,000		
		Enugu	4		2,000	8,000		
		Ebonyi	3		2,000	6,000		
	Inter-state	To Abia	3		1,400	4,200	39,200	
		To Anambra	4		2,000	8,000		
		To Enugu	4		3,000	12,000		
		To Ebonyi	3		5,000	15,000		
Efforts Cost	Support Individuals	Project Manager	1	1800hr (5hr/day)	300	540,000	540,000	2,280,000
		Testers	360		2,000	720,000	720,000	
	Technical Teams	Development Team	2	1800hr coding	250	900,000	900,000	
		Statistical Team	2		60,000	120,000	120,000	
Grand Total								**3,886,300**

(Field Work)

The HRPMS development cost estimate was about three million eight hundred and eighty-six thousand three hundred naira (N3,886,300), while the yearly running cost estimated was about five hundred and thirty-three thousand five hundred naira (N533,500). These are affordable and the running cost may minimize with increase in years.

3.5.3 Multivariate Linear System Analysis Technique

In the fourth Agile test quadrant, the statistical analysis of performance was done using the multivariate linear system analysis to test the hypotheses and predict the performance difference verifying the HRPMS performance improvement. Based on the same variables ($\mathbf{X_1}$, $\mathbf{X_2}$, $\mathbf{X_3}$, $\mathbf{X_4}$, $\mathbf{X_5}$, and $\mathbf{X_6}$), two data samples were collected from the selected universities by the two-round Delphi technique (Bernice, 1968). The first sample of the variates needs to be analyzed at the same time, and their effects compared simultaneously with the second sample that has the same level. Therefore, multivariate linear system analysis provides the best model for this problem (Chukwu, 2007); which involves Hotelling's T^2 analysis, Mahalanobi's D^2 analysis, and determination of the F-Distribution. Hence, these analyses were carried out using MATLAB and Excel packages as computation tools; to test the null hypothesis that there is no significant difference in performance between the Existing System and the proposed HRPMS against the alternative hypothesis that HRPMS performs better. The test statistics are stated in Equation 3.2 as follows:

$$T^2 = \frac{n_1 n_2}{n_1 + n_2} D^2 \qquad \textbf{(3.2)}$$

Where: $\mathbf{T^2}$ is the Hotelling's T^2 distribution; $\mathbf{n_1}$ is the number of observations in the sample data for the Existing system; $\mathbf{n_2}$ is the number of observations in the sample data for the HRPMS, and $\mathbf{D^2}$ is the Mahalanobi's D^2 statistic, given by Equation 3.3, as follows:

$$D^2 = \left(\bar{X}_1 - \bar{X}_2\right)^T S^{-1}\left(\bar{X}_1 - \bar{X}_2\right) \quad \textbf{(3.3)}$$

Where: $\bar{X}_1$ denote the mean of the existing system (column vector); $\bar{X}_2$ denote the mean of the HRPMS (column vector); $\left(\bar{X}_1 - \bar{X}_2\right)$ is the difference in mean of the Existing system and that of the HRPMS (a column vector); $\left(\bar{X}_1 - \bar{X}_2\right)^T$ is the transpose of the difference in mean of both systems (row vector); S stands for the variance-covariance matrix or dispersion matrix or information matrix of the combined sample from the two (2) separate data samples of the existing system and the HRPMS; and S^{-1} denote the inverse of the information matrix.

The mean vector $\bar{X}_i$ of the individual samples ***i*** **;** for the six (6) variables under consideration is given by Equation 3.4, as follows:

$$\bar{X}_i = \begin{bmatrix} {}_i\bar{X}_1 \\ {}_i\bar{X}_2 \\ {}_i\bar{X}_3 \\ {}_i\bar{X}_4 \\ {}_i\bar{X}_5 \\ {}_i\bar{X}_6 \end{bmatrix} \quad \textbf{(3.4)}$$

Where i = 1 and 2 (for existing system and HRPMS data samples respectively); and ${}_i\bar{X}_1 = (\sum_1^{290} {}_iX_1)/290$; ${}_i\bar{X}_2 = (\sum_1^{290} {}_iX_2)/290$; ${}_i\bar{X}_3 = (\sum_1^{290} {}_iX_3)/290$; ${}_i\bar{X}_4 = (\sum_1^{290} {}_iX_4)/290$; ${}_i\bar{X}_5 = (\sum_1^{290} {}_iX_5)/290$; and ${}_i\bar{X}_6 = (\sum_1^{290} {}_iX_6)/290$, representing each of the six (6) variables under consideration. Where: X_1 = Usefulness, X_2 = Ease of Access and Use, X_3 = Security and Confidentiality, X_4 = Processing Speed, X_5 = Computation Accuracy, and X_6 = System Performance.

Laying out the variance-covariance (information) matrix for the separate and combined data samples containing the six (6) variables under consideration, we have Equation 3.5 as follows:

$$(n_i - 1)S_i^{\,2} = \begin{bmatrix} X_{11} & X_{12} & X_{13} & X_{14} & X_{15} & X_{16} \\ X_{21} & X_{22} & X_{23} & X_{24} & X_{25} & X_{26} \\ X_{31} & X_{32} & X_{33} & X_{34} & X_{35} & X_{36} \\ X_{41} & X_{42} & X_{43} & X_{44} & X_{45} & X_{46} \\ X_{51} & X_{52} & X_{53} & X_{54} & X_{55} & X_{56} \\ X_{61} & X_{62} & X_{63} & X_{64} & X_{65} & X_{66} \end{bmatrix} \qquad \textbf{(3.5)}$$

Where n_i and S_i are as earlier defined; and the variances are:

$$X_{11} = \sum_{1}^{290} X_1^{\,2} - n_i \overline{X}_1^{\,2}; \qquad X_{22} = \sum_{1}^{290} X_2^{\,2} - n_i \overline{X}_2^{\,2}; \qquad X_{33} = \sum_{1}^{290} X_3^{\,2} - n_i \overline{X}_3^{\,2};$$

$$X_{44} = \sum_{1}^{290} X_4^{\,2} - n_i \overline{X}_4^{\,2}; \qquad X_{55} = \sum_{1}^{290} X_5^{\,2} - n_i \overline{X}_5^{\,2}; \qquad X_{66} = \sum_{1}^{290} X_6^{\,2} - n_i \overline{X}_6^{\,2};$$

and the covariances are: $X_{12} = \sum_{1}^{290} X_1 X_2 - n_i \overline{X}_1 \overline{X}_2; \quad X_{13} = \sum_{1}^{290} X_1 X_3 - n_i \overline{X}_1 \overline{X}_3;$

$$X_{14} = \sum_{1}^{290} X_1 X_4 - n_i \overline{X}_1 \overline{X}_4; \qquad X_{15} = \sum_{1}^{290} X_1 X_5 - n_i \overline{X}_1 \overline{X}_5; \qquad X_{23} = \sum_{1}^{290} X_2 X_3 - n_i \overline{X}_2 \overline{X}_3;$$

$$X_{24} = \sum_{1}^{290} X_2 X_4 - n_i \overline{X}_2 \overline{X}_4; \qquad X_{25} = \sum_{1}^{290} X_2 X_5 - n_i \overline{X}_2 \overline{X}_5; \qquad X_{26} = \sum_{1}^{290} X_2 X_6 - n_i \overline{X}_2 \overline{X}_6;$$

$$X_{34} = \sum_{1}^{290} X_3 X_4 - n_i \overline{X}_3 \overline{X}_4; \qquad X_{35} = \sum_{1}^{290} X_3 X_5 - n_i \overline{X}_3 \overline{X}_5; \qquad X_{36} = \sum_{1}^{290} X_3 X_6 - n_i \overline{X}_3 \overline{X}_6;$$

$$X_{45} = \sum_{1}^{290} X_4 X_5 - n_i \overline{X}_4 \overline{X}_5; \qquad X_{46} = \sum_{1}^{290} X_4 X_6 - n_i \overline{X}_4 \overline{X}_6; \qquad X_{56} = \sum_{1}^{290} X_5 X_6 - n_i \overline{X}_5 \overline{X}_6;$$

and the symmetric covariances are: $X_{21} = X_{12}; \quad X_{31} = X_{13}; \quad X_{32} = X_{23}; \quad X_{41} = X_{14};$

$X_{42} = X_{24}; \quad X_{43} = X_{34}; \quad X_{51} = X_{15}; \quad X_{52} = X_{25}; \quad X_{53} = X_{35}; \quad X_{54} = X_{45}; \quad X_{61} = X_{16};$

$X_{62} = X_{26}; \quad X_{63} = X_{36}; \quad X_{64} = X_{46}; \quad X_{65} = X_{56}.$

However, pooling the two layout matrices from the separate data samples will give a combined layout matrix given by equation 3.6, thus:

$$(n_1+n_2-2)S=\begin{bmatrix}\sum X_{11} & \sum X_{12} & \sum X_{13} & \sum X_{14} & \sum X_{15} & \sum X_{16}\\ \sum\sum X_{21} & \sum\sum X_{22} & \sum\sum X_{23} & \sum\sum X_{24} & \sum\sum X_{25} & \sum\sum X_{26}\\ \sum\sum X_{31} & \sum\sum X_{32} & \sum\sum X_{33} & \sum\sum X_{34} & \sum\sum X_{35} & \sum\sum X_{36}\\ \sum\sum X_{41} & \sum\sum X_{42} & \sum\sum X_{43} & \sum\sum X_{44} & \sum\sum X_{45} & \sum\sum X_{46}\\ \sum\sum X_{51} & \sum\sum X_{52} & \sum\sum X_{53} & \sum\sum X_{54} & \sum\sum X_{55} & \sum\sum X_{56}\\ \sum X_{61} & \sum X_{62} & \sum X_{63} & \sum X_{64} & \sum X_{65} & \sum X_{66}\end{bmatrix} \qquad \textbf{(3.6)}$$

Where the elements $X_{qr}; q=1,...,6; r=1,...,6$ in the same position in the layout matrices $(n_1-1)S_1^{\,2}$ and $(n_2-1)S_2^{\,2}$ of samples 1 and 2 are added to get the elements X_{qr} of the pooled $(n_1+n_2-2)S$ layout matrix; while all other parameters retain their definitions.

From the combined layout matrix $(n_1+n_2-2)S$, the variance-covariance (information) matrix S is determined as given in Equation 3.7, thus:

$$S=\begin{bmatrix}\sum X_{11} & \sum X_{12} & \sum X_{13} & \sum X_{14} & \sum X_{15} & \sum X_{16}\\ \sum\sum X_{21} & \sum\sum X_{22} & \sum\sum X_{23} & \sum\sum X_{24} & \sum\sum X_{25} & \sum\sum X_{26}\\ \sum\sum X_{31} & \sum\sum X_{32} & \sum\sum X_{33} & \sum\sum X_{34} & \sum\sum X_{35} & \sum\sum X_{36}\\ \sum\sum X_{41} & \sum\sum X_{42} & \sum\sum X_{43} & \sum\sum X_{44} & \sum\sum X_{45} & \sum\sum X_{46}\\ \sum\sum X_{51} & \sum\sum X_{52} & \sum\sum X_{53} & \sum\sum X_{54} & \sum\sum X_{55} & \sum\sum X_{56}\\ \sum X_{61} & \sum X_{62} & \sum X_{63} & \sum X_{64} & \sum X_{65} & \sum X_{66}\end{bmatrix}/(n_1+n_2-2) \qquad \textbf{(3.7)}$$

To test hypothesis one, the probability distribution function of the pooled sample was fitted, and the inference was drawn from it. By fitting the generalized multivariate Probability Distribution Function (PDF), we obtained Equation 3.8 as the system performance density estimation model, as follows:

$$F(x_q,\mu,v)=(2\pi)^{-p/2}\,|S|^{-1/2}\exp[-1/2(\mu)^T S^{-1}(\mu)] \qquad \textbf{(3.8)}$$

Where: $(x_q)_{q=1,...,p}$ are the variables under consideration; p denotes the number of variates; $\mu=(\bar{X}_1-\bar{X}_2)$ is the difference in mean of the two data samples matrices $[S_1]$ and $[S_2]$ of the existing system and HRPMS; $v=S$ stands for the information matrix from the pooled or combined sample of $[S_1]$ and $[S_2]$ data; $|S|$ is the determinant of the information matrix; and the other notations retain their usual meanings as earlier defined.

This Probability Distribution Function (PDF) statistical model predicts the density or effect of the non-functional user requirement variables on the average performance of the information systems (existing and proposed), given that their data samples $[S_1]$ and $[S_2]$ are based on the same performance variables ($x_q; q = 1,...,6$; $p = 6$). Hence, hypothesis one is given in Equation 3.9 as follows:

$$H_{01}: F(x_q, \mu, \nu) = 0 \quad \textbf{VS} \quad H_{A1}: F(x_q, \mu, \nu) \neq 0 \qquad \textbf{(3.9)}$$

Where: $\mathbf{H_{01}}$ stands for the null hypothesis one, which states that the non-functional variables have no significant effect on system performance; $\mathbf{H_{A1}}$ stands for the alternate hypothesis one, which states that the non-functional variables have a statistical and significant effect on system performance; "**VS**" denotes contrast; other notations retain their definitions. Therefore, the decision rule is such that null hypothesis one (H_{01}) is accepted if $F(x_q, \mu, \nu) = 0$, otherwise, reject H_{01} and accept the alternate hypothesis one (H_{A1}); and we conclude that the non-functional variables have a statistical and significant effect on system performance – positive or negative. Positive effect means direct effect and negative effect means indirect effect. When Equation 3.9 tends to be one (i.e. $F(x_q, \mu, \nu) => \pm 1$), there exists a strong effect, but when it tends to zero (i.e. $F(x_q, \mu, \nu) => \pm 0$), there exists a weak effect.

To test hypothesis two, the F-distribution for this work was determined. The F-calculated ($\mathbf{F_{cal}}$) and the F-tabulated ($\mathbf{F_{tab}}$) of the pooled data sample, are given in Equations 3.10 and 3.11 as follows:

$$F_{cal} = \frac{(n_1 + n_2 - p - 1)}{p(n_1 + n_2 - 2)} . T^2 \qquad \textbf{(3.10)}$$

and $$F_{tab} = F_{p,(n_1+n_2-p-1)}(\alpha) \qquad \textbf{(3.11)}$$

Where: $\mathbf{F_{tab}}$ is F value in standard F-distribution table; (α) denote the level of significance; $p \& (n_1 + n_2 - p - 1)$ denotes the degree of freedom; other notations are as defined earlier. Hypothesis two was tested at 5% level of significance, the

performance correlation between the existing and proposed system was determined with inference. Hypothesis two is given in Equation 3.12:

$$H_{O2}: \bar{X}_1 = \bar{X}_2 \quad \textbf{VS} \quad H_{A2}: \bar{X}_1 \neq \bar{X}_2 \qquad \textbf{(3.12)}$$

Where: $\mathbf{H_{O2}}$: stands for the null hypothesis two, which says that there is no significant difference in the mean performance of the Existing System and HRPMS; $\mathbf{H_{A2}}$: stands for the alternate hypothesis two, which says that there is a significant difference in the mean performance of the Existing System and HRPMS; "**VS**" denotes contrast; other notations retain their earlier definitions.

To make inference and conclusion on hypothesis two, the decision rule in equation 3.13 says: Accept Null Hypothesis two ($\mathbf{H_{O2}}$) if:

$$F_{cal} < F_{tab} \qquad \textbf{(3.13)}$$

Otherwise, reject (H_{02}) and accept the alternative hypothesis two (H_{A2}); and conclude that there is a significant difference between the mean performances of both systems. Therefore, we state that the HRPMS is an improvement.

3.6 Analysis of the Existing Single-Platform System

This section showed the architectural and qualitative survey analysis of the existing single-platform system. The architectural analysis targets the functional (operational) requirements, while the quantitative analysis targets the non-functional (performance) requirements.

3.6.1 Analysis of the Existing Single-Platform Architecture

Figure 3.12 is the high-level model of the standalone single-platform system, showing its structure. It showed the result processing functions embedded in the modules integrating them in the offline platform. The levels show the system processes encapsulated in the functions of the modules representing the model. The existing standalone system can be used to register courses, generate

students list per course, compute results and generate reports, process results for approval, check results, and process transcripts. These processes or activities were mostly done semi-automated (manual but one-time inputs that replicates automatically at other points as appropriate) at the input modules, and fully automated (system-generated outputs) at the output modules.

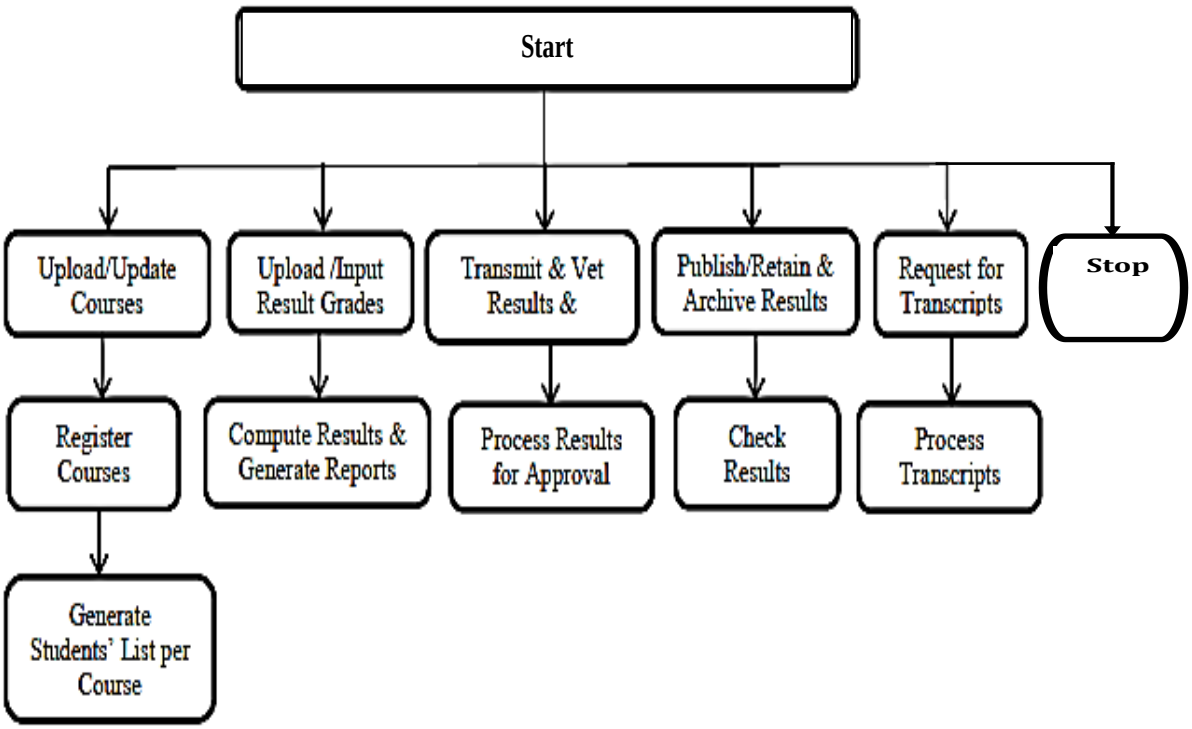


Figure 3.12: Existing Standalone Single-Platform System High-level Model Diagram (Magaji, 2015)

Figure 3.13 is the dataflow model of the client-server single-platform system. This showed its interactions among the major processing elements and mechanisms. The result processing functions are embedded in the system modules that integrate them within the internet-based (online) platform. The existing client-server system can be used to register courses, upload result scores, process results, check results, and generate reports. It can be deployed mostly as a web-based application that can run on both desktop and mobile systems and can work using two-factor authentication to boost its security.

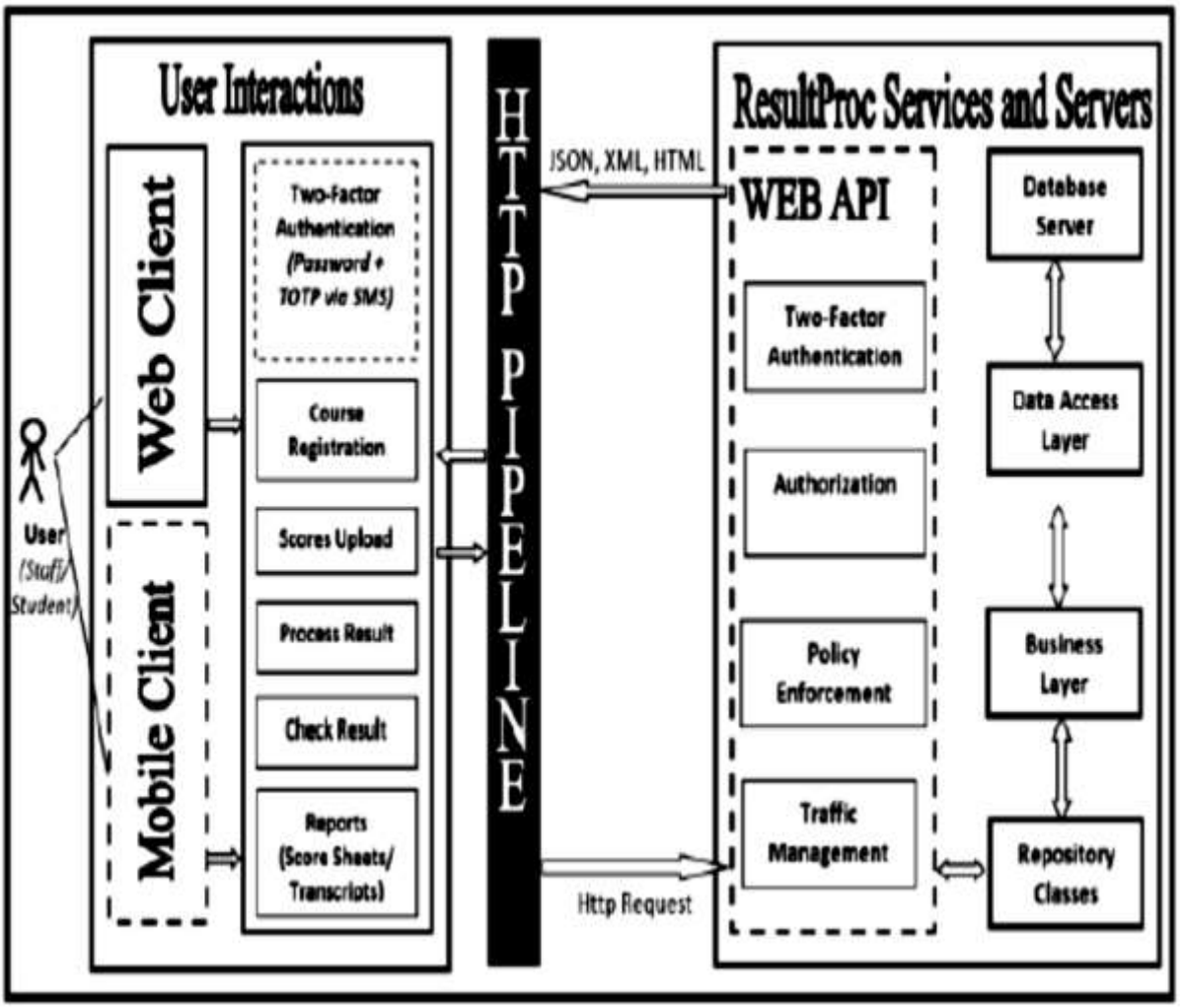


Figure 3.13: Existing Client-Server Single-Platform System Architectural Model Diagram (Anyiam, *et. al.*, 2020)

3.6.2 Survey Analysis of the Existing Single-Platform System

A pilot survey was conducted on the existing single-platform result system using interviews based on the performance variables. The survey was carried out on the standalone spreadsheet system as well as on the client-server result system. The data are as shown in **Appendix V**. The result shows that the existing system contains a mixture of strengths and weaknesses in terms of Usefulness (U), Ease of Access and Use (EoAU), Security and Confidentiality (SaC), Processing Speed (PS), and Computation Accuracy (CA).

Figure 3.14 shows the Strength-to-Weakness (S-W) qualitative survey analysis of the existing single-platform system carried out using the Clustered Column Chart on Excel. On average, the standalone system was strong in U, CA, EoAU, and SaC, but weak in PS; giving its S-W ratio as 5:1, which represents 80% sufficiency and 20% deficiency. Also on average, the client-server system was strong in PS and U, but weak in CA, EoAU, and SaC; giving its S-W ratio as 2:3, which represents 40% sufficiency and 60% deficiency. Cumulatively, the strength of the existing single-platform system was averagely **46.2%,** while its weakness was averagely **53.8%.** This implied that the single-platform result system was inherently deficient and incapable of adequate and complete handling of results processing and management independently.

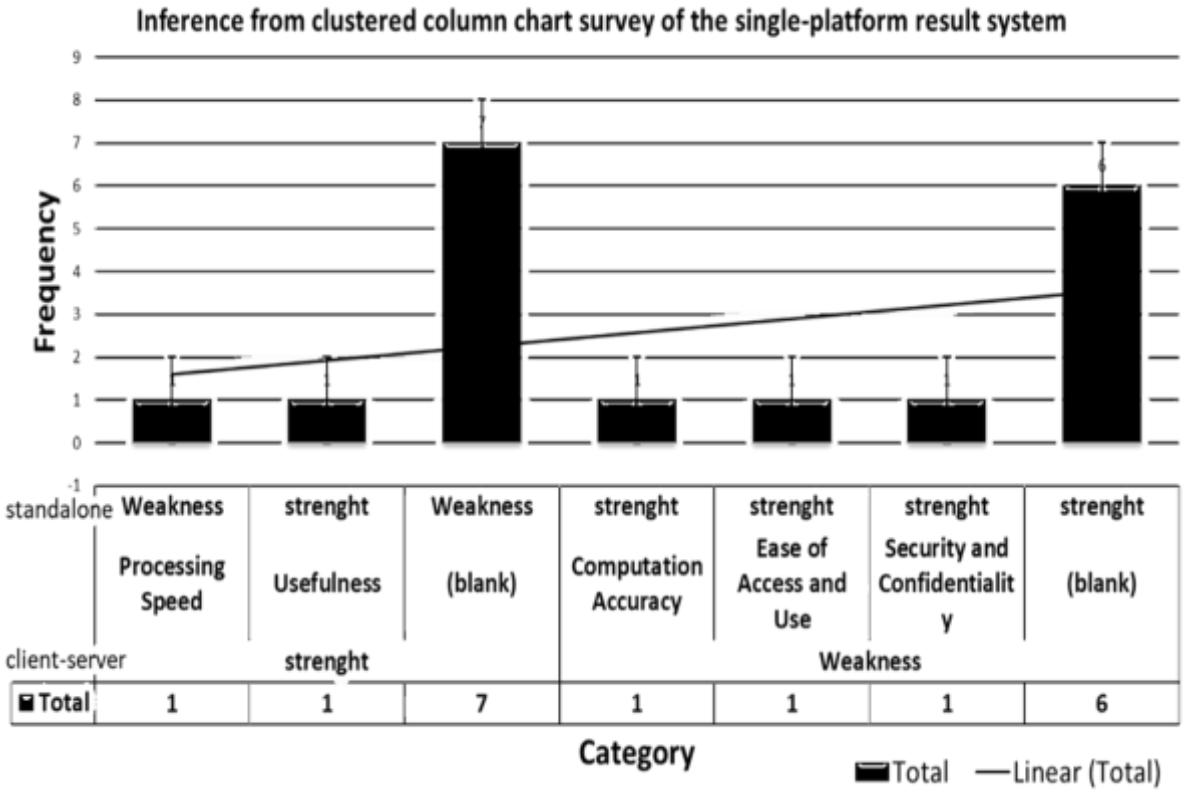


Figure 3.14: Clustered Column Chart of the Existing Single-Platform System

The weaknesses have been highlighted separately for both the standalone and client-server existing systems, and are also summarized in Table 3.7.

(a) **The standalone system:** (i) Does semi-automated courses and students update, which reduces PS. (ii) Uses semi-automated grades input, which reduces PS especially while handling large-size student classes. (iii) Uses manual results management, which reduces PS during results transmission, vetting, approval, storage, archival, and retrieval processes. (iv) Very useful (v) Easy to access and use (vi) Guarantees better security and confidentiality of data (devoid of cyber threats), and (vii) Delivers high computation accuracy, because of the mathematical capability and precision of the Excel Visual Basic for application software tool used.

(b) **The client-server system:** (i) Has difficulty computing legacy results, result corrections, and complexities of computing extra-year results with borrowed courses, and in detecting and correcting computation errors, which reduces its computation accuracy. (ii) Requires special permission by the system administrator for process reversals, and is less scalable to changing formats due to changing institutional policy standards and regulations, which reduces its ease of access and use. (iii) More susceptible to cyber threats online, which weakens its data security and confidentiality. (iv) Very useful (v) Fastens the result computation and management processes.

Table 3.7: Summary of the Deficiency of the Existing System

Weaknesses:	**Delayed results while processing with the standalone only**
	Security and confidentiality threats with the client-server: *privilege escalation, SOL injection, phishing, DoS, wireless cracking, back-door and blended attacks*
	Difficulty computing legacy, borrowed and corrected results online
	Poor scalability to formats and policy-standards/regulations
	Little or no computer database of past-year results
Effects:	**Poor usage, Incessant failures (partial or full), High rate of abandonment, and Loss of human and financial resources**
Implication:	**Single-platform result system is inadequate and incapable**

(Field Work)

3.7 HRPMS Design

The design shows the input-output, algorithm, logical, behavioral, and structural, and database designs using high-level model, algorithm statements, flowcharts, use-case, class, and entity-relationship models encapsulating the entities and attributes of the HRPMS subsystems, modules, and database.

3.7.1 Input-Output Design

The input-output design of the HRPMS was done using the high-level model diagram to identify and show its modules and subsystems, and their inter-relationships with each other. The model encapsulated the basic input-output system structure and processes into optimal hybrid subsystem modules. Based on the HRPMS structural model of Figure 3.15, the more security-critical result user-specific functional requirement processes (courses and students' details capturing/update, results computation, reports generation, and reference tracking) was implemented in the standalone / spreadsheet subsystem module. Also, the less security-critical processes (retention processing, results checking, transcripts processing, and system administration) were implemented on the client-server (socket middleware) subsystem modules. The socket application is for secured group communication (results transmission, verification, approval and upload to database and approved results folder), while the web application is for open communication (results checking & transcripts requesting).

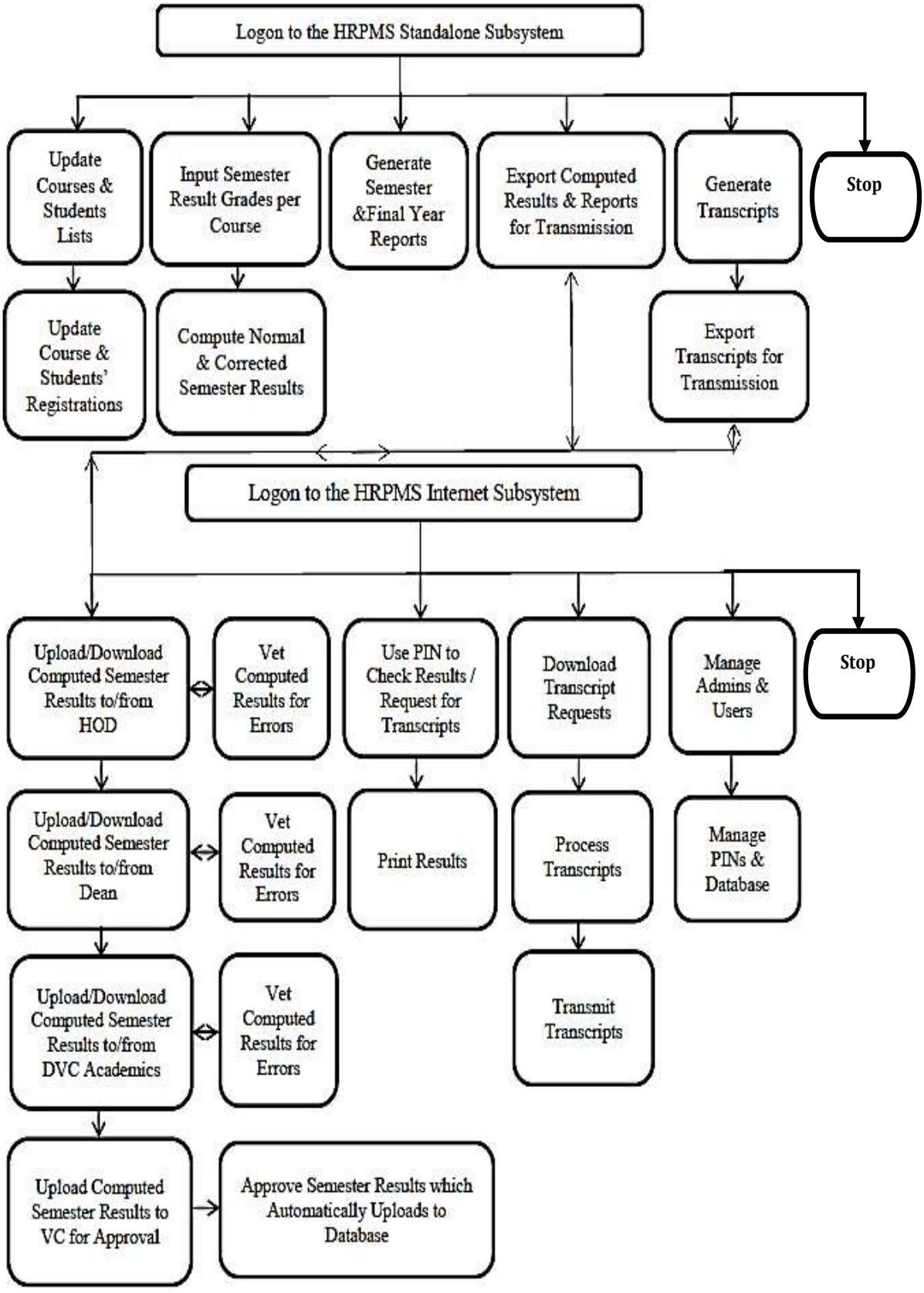


Figure 3.15: HRPMS High-Level Model Diagram

3.7.2 Algorithm Statements

A. For the Standalone Spreadsheet Application

Processor-only Login and Task Algorithm

(1) Display login screen
(2) Input login password
(3) Display worksheets for courses details update, students details update, semester results computation, semester summaries, final year summaries, transcripts generator, and class advisor.
(4) Select worksheet
(5) If courses details update worksheet is selected;
  a. Edit department, sessions, levels, and semesters
  b. Enter or edit courses and their units
  c. If courses are exhausted, save inputs or updates
  d. Format and print or export course details where necessary
(6) If students details update worksheet is selected;
  a. Enter or edit students names
  b. Enter or edit registration numbers
  c. Enter or edit other admission details
  d. If students are exhausted, save inputs or updates
  e. Format and print or export student details where necessary
(7) If semester results computation worksheet (either year one harmattan semester or year one rain semester or year two harmattan semester or year two rain semester or year three harmattan semester or year three rain semester or year four harmattan semester or year four rain semester or year five harmattan semester or year five rain semester or year six harmattan semester or year six rain semester or year seven harmattan semester or year seven rain semester) is selected;
  a. Enter or edit normal grades
  b. Enter or edit carryover or omitted grades
  c. If grades are exhausted, save inputs or updates
  d. Format and print or export semester results as required
(8) If semester summaries worksheet (with targets on any of the semesters from year one harmattan semester through to year seven rain semester extra year) selected;
  a. Edit semester summary headings or parameters where necessary
  b. Format and print or export semester summaries as required
(9) If final year summaries worksheet is selected;
  a. Edit final year summary headings or parameters where necessary
  b. Format and print or export final year summaries as required
(10) If transcript generator worksheet is selected;
  a. Enter student registration number and press <enter key>
  b. Edit transcript generator headings or parameters where necessary
  c. Format and print or export generated transcripts as necessary
(11) If class advisor worksheet is selected;
  a. Select student to advise and peruse through his/her academic record

b. Format and print or export student record

(12) Close and exit the application

B. For the Secured Group Socket Middleware

i. User Login Algorithm

(1) Display home page

(2) Display login screen

(3) Input login parameters (designation, username, password) with audit trail

(4) If result processor logged-in at any point, display processor's work area basic upload dashboard and privileges; goto A-subroutine

(5) If HOD logged in at any point, display HOD's work area file list dashboard and privileges; goto B-subroutine

(6) If Dean logged in at any point, display Dean's work area file list dashboard and privileges; goto C-subroutine

(7) If DVC Academics logged in at any point, display DVC Academic's work area file list dashboard and privileges; goto D-subroutine

(8) If VC logged in at any point, display VC's work area file list dashboard and privileges; goto E-subroutine

(9) If registry staff logged in at any point, display registry staff work area dashboard and privileges; goto F-subroutine

(10) If Admin logged-in at any point, display Admin's work area dashboard and privileges; goto G-subroutine

(11) Logout and display home page

(12) Close home page

ii. A-Subroutine: Result Processor Task Algorithm

(1) Choose task option (file upload, file download)

(2) If the option is file upload;

a. Select department

b. Select Session

c. Select level

d. Select Semester

e. Browse and attach a file

f. Attach processor forward-message

g. Upload result file to HOD

(3) If option is file download;

a. Select a file to download

b. View HOD/Dean/DVC Academics reject-message(s) of result files

c. View and download rejected file

(4) Close dashboard

iii. B-Subroutine: HOD Task Algorithm

(1) Choose task option (file download, file upload)

(2) If option is file download;

a. Select a file to download

b. *View processor forward-message*
c. *View and download the selected file*
d. *Forward file to the departmental vetting team member with HOD directive(s)*
e. *Receive file from a vetting team member with vetter comment(s)*

(3) If option is file upload, recommend or reject file;

a. *If the file is recommended, attach the HOD recommend message and upload it to Dean*
b. *If the file is rejected, attach the HOD reject the message and upload it back to the processor*

(4) Close dashboard

iv. C-Subroutine: Dean Task Algorithm

(1) Choose task option (file download, file upload)

(2) If option is file download;

a. *Select a file to download*
b. *View HOD recommend-message*
c. *View and download the selected file*
d. *Forward file to faculty vetting team member with Dean directive(s)*
e. *Receive file from a vetting team member with vetter comment(s)*

(3) If option is file upload, recommend or reject file;

a. *If the file is recommended, attach the Dean message and upload it to DVC Academics*
b. *If the file is rejected, attach the Dean reject the message and upload it back to the result processor with a reject-message copy sent to HOD*

(4) Close dashboard

v. D-Subroutine: DVC Academics Task Algorithm

(1) Choose task option (file download, file upload)

(2) If option is file download;

a. *Select a file to download*
b. *View Dean recommend-message*
c. *View and download the selected file*
d. *Forward file to university vetting team member with DVC Academics directive(s)*
e. *Receive file from a vetting team member with vetter comment(s)*

(3) If option is file upload, recommend or reject file;

a. *If the file is recommended, attach the DVC Academics recommend-message and upload it to VC for approval*
b. *If the file is rejected, attach the DVC Academics reject the message and upload it back to the result processor with a reject-message copy sent to HOD and Dean*

(4) Close dashboard

vi. E-Subroutine: VC Task Algorithm

(1) Choose task option (Make Approvals, Manage Users)

(2) If option is making approvals;

a. Select submitted file(s)
b. View or download selected file(s)
c. Approve and upload result data to database, result file to the approved folder
d. Approve and upload graduands list/transcript file(s) to approved folder

(3) If the option is to manage users;
a. Edit user(s)
b. Add user(s)
c. remove user(s)

(4) Close dashboard

vii. F-Subroutine: Registry Staff Task Algorithm

(1) Choose task option (Search for Result File, Search for Transcript File)
(2) If option is search for result file;
a. Enter result parameters (Dept., Session, Semester)
b. View and download selected result file(s)

(3) If option is search for transcript file;
a. Enter transcript parameters (student name, reg. number)
b. View and download selected transcript file(s)

(4) Close dashboard

viii. G-Subroutine: Admin Task Algorithm

(1) Choose task option (Manage Users, Administer Database, Generate PINs)
(2) If the option is to manage users;
a. Edit user(s)
b. Add user(s)
c. remove user(s)

(3) If option is administering database;
a. Manage database tables and data
b. Backup database
c. Restore database

(4) If the option is to generate pins;
a. Enter PINs amount and range and <click generate>
b. View PINs
c. Print or export PINs

(5) Close dashboard

C. For the Web Application (**Check Result Algorithm**)

(1) Display home page
(2) Display result checker screen
(3) Input required parameters (reg. number, dept., session, semester, pin) to select specific results
(4) If parameters are correct;
a. Display result or result not found
b. Print or export result

(5) If parameters are not correct;
a. Throw exception

b. Clear screen
(6) Close result checker and display home page
(7) Close home page

The HRPMS algorithm statements were followed to design the system flowchart, use case, class, and entity-relationship models encapsulating the system logics, behavior, and structure of the program and database modules.

3.7.3 Logical Design

This model flowchart diagram showed the logic behind the operations of the HRPMS offline and online subsystems as seen in Figure 3.16 and Figure 3.17 (a & b). In Figure 3.16, the HRPMS logical model diagram showed the computation of the results processing logics and the results management processing logics as they relate to the users and the system processes. The computation processing logics were implemented in the standalone subsystem and they include students and course registration updates processing, normal and corrected results computation, generation of the semester and final year summaries, transcripts generation (at the final year), and export of appropriate outputs in excel, XPS or PDF result and summary file formats, as appropriate. Figure 3.17 (a) and (b) showed the results management processing logics as implemented in the internet subsystem and they include result and summary files recommendation-upload from the processor through the HOD and Dean and DVC academics to the VC, its rejection-download from DVC academics through the Dean and HOD back to the processor, file transmissions between the HOD/Dean/DVC academics and their vetting teams for vetting purposes, VC's approval of results which automatically uploads result-data to the database and store result-files in the approved results folder, transcript requests processing from files in the approved results folder and its transmission by the registry staff, results-checking by students, and system administration of users, database and PINs management by the system administrator.

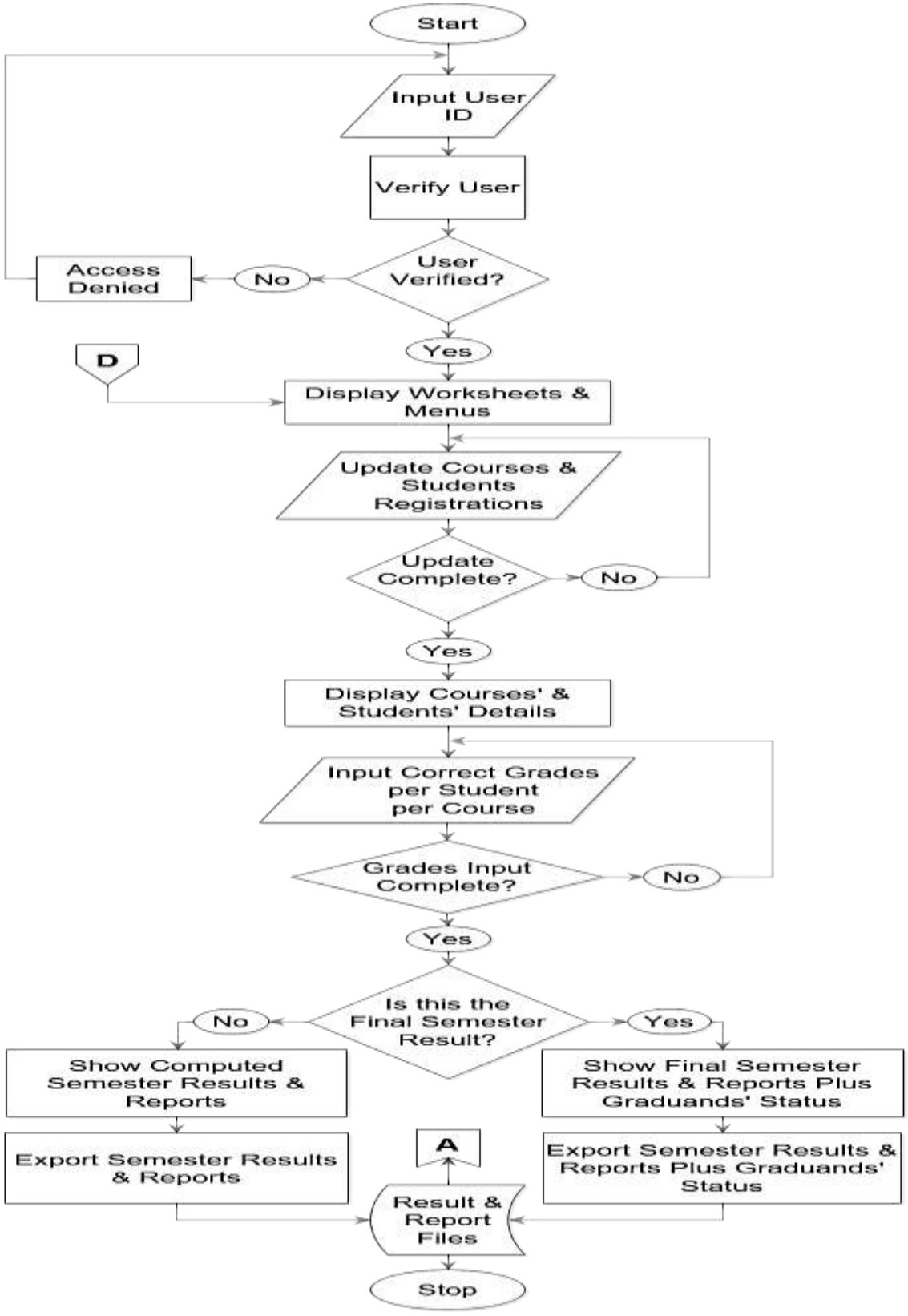


Figure 3.16: HRPMS Results Computation Processing Model Flowchart

Keys: A = outgoing files link from the export folder on result processor system, D = incoming rejected files link from circulation folder on the server.

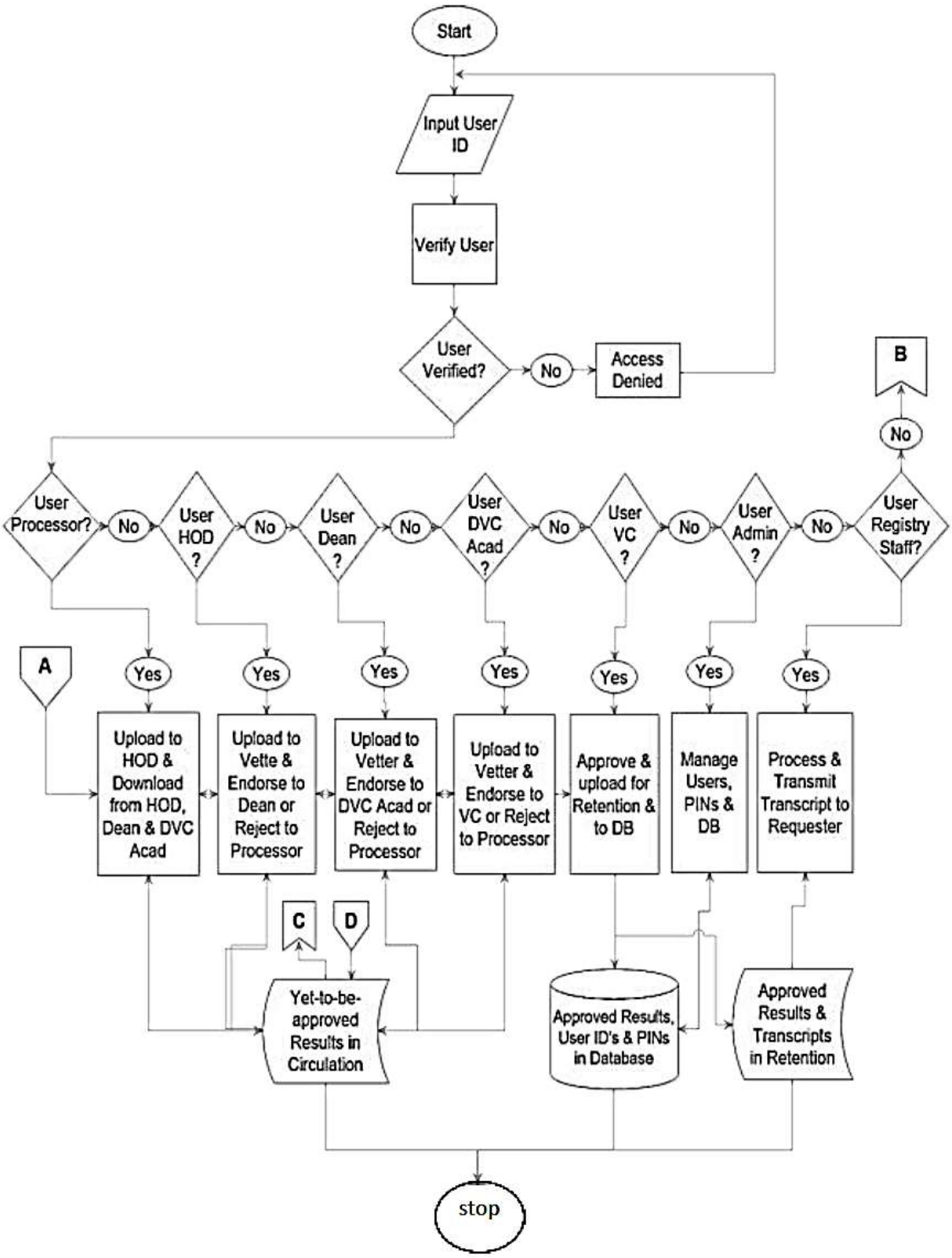


Figure 3.17 (a): HRPMS Results Management Processing Model Flowchart

Keys: A = incoming files link from the export folder on result processor system, B = link to other users, C & D = outgoing and incoming transit files links from and to circulation folder on the server.

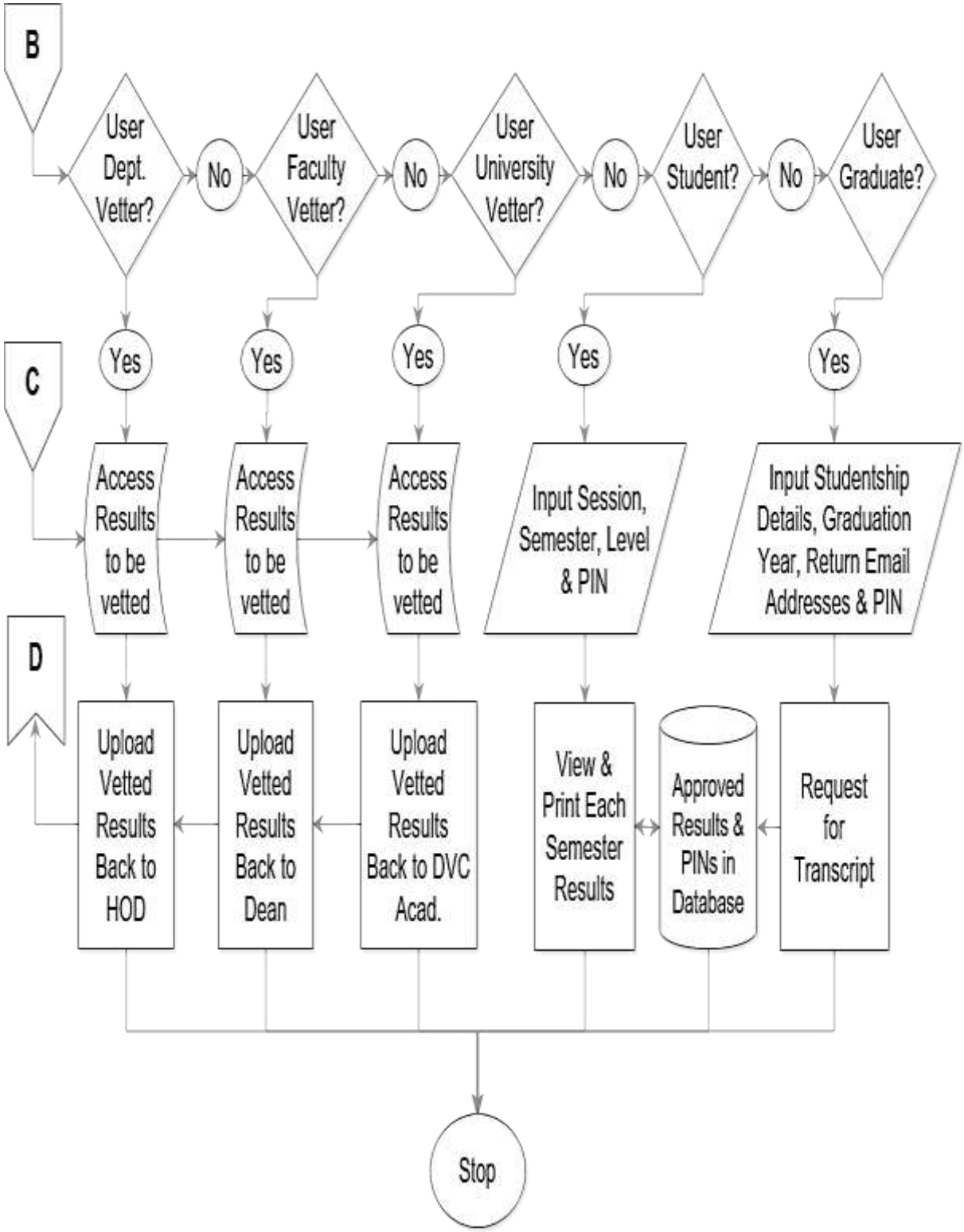


Figure 3.17 (b): HRPMS Results Management Processing Model Flowchart (Contd.)

Keys: B = link for other users, C & D = incoming and outgoing transit files links to and from circulation folder on the server.

3.7.4 *Behavioural Design*

Figure 3.18 and Figure 3.19 showed the HRPMS behavioral model diagrams for users and processes involved in the results processing and management activities. The cases were user-specific, showing the human-computer interactions. In Figure 3.18 use-case diagram, users of the standalone subsystem are the result processors only, who can be class advisers or represent them. The processes or activities done on the subsystem include login, updating courses and students' lists, updating course registration, input semester result grades per course, compute normal and corrected results, generate semester and final year reports, export computed results and reports for transmission, generate and export transcripts for transmission. It contains a reference tracking module that generates outstanding (omitted and carryover) courses and also indicates which of the outstanding references have been taken care of.

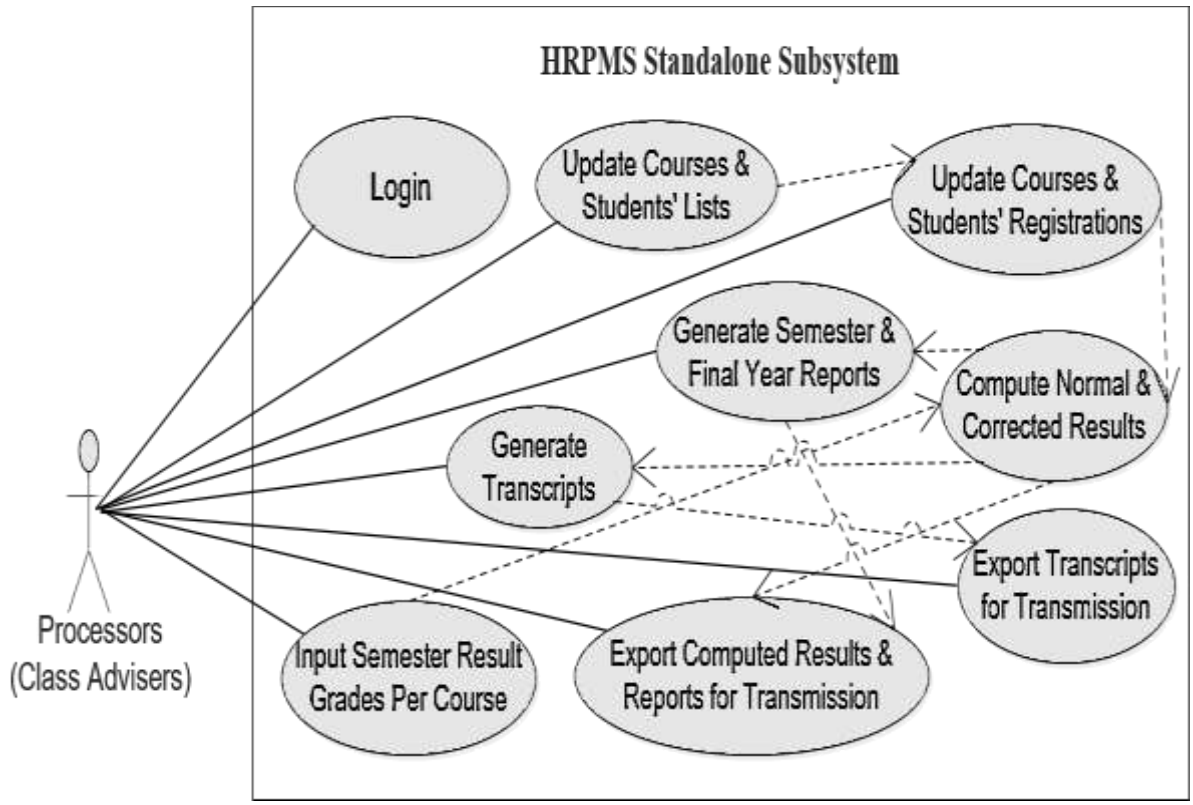


Figure 3.18: HRPMS Standalone Subsystem Use Case Model Diagram

Based on Figure 3.19 use case diagram, users and their activities as tracked on the client-server subsystem are: **(i)** The result processors (class advisers) who access the system to upload exported computed results and transcripts for submission to the HODs; **(ii)** The HODs who access the system to download submitted computed results and transcripts from the result processors, upload and download them to and from the departmental vetters for vetting, and submit vetted results and transcripts to the Deans; **(iii)** The departmental vetters who access the system to download results and transcripts to be vetted from the HODs, and return them to the HODs; **(iv)** The Deans who access the system to download submitted computed results and transcripts from the HODs, upload and download them to and from the faculty vetters for vetting, and submit vetted results and transcripts to the DVC Academic; **(v)** The faculty vetters who access the system to download results and transcripts to be vetted from the Deans, and returns them to the Deans; **(vi)** The DVC Academic who access the system to download submitted computed results and transcripts from the Deans, upload and download them to and from the university vetters for vetting, and submit vetted results to the VC; **(vii)** The university vetters who access the system to download submitted computed results and trancripts to be vetted from the DVC Academic, and return them to the DVC Academic; **(viii)** The VC who (on behalf of the Senate) access the system to download submissions from the DVC Academic and approves them, which automatically moves the results data to the database, send the approval message (memo) to the DVC Academic, Deans, HODs and results processors, and also archive the approved result files in the designated file server folder; **(ix)** The registry staff who access the system to get transcript requests from graduates and also get the approved results from the database or file server folder for transcript processing; **(x)** The students who access the system to check their semester results; **(xi)** The graduates who access the system to make transcript requests; **(xii)** and the system administrators who access the system to manage users, database and PINs.

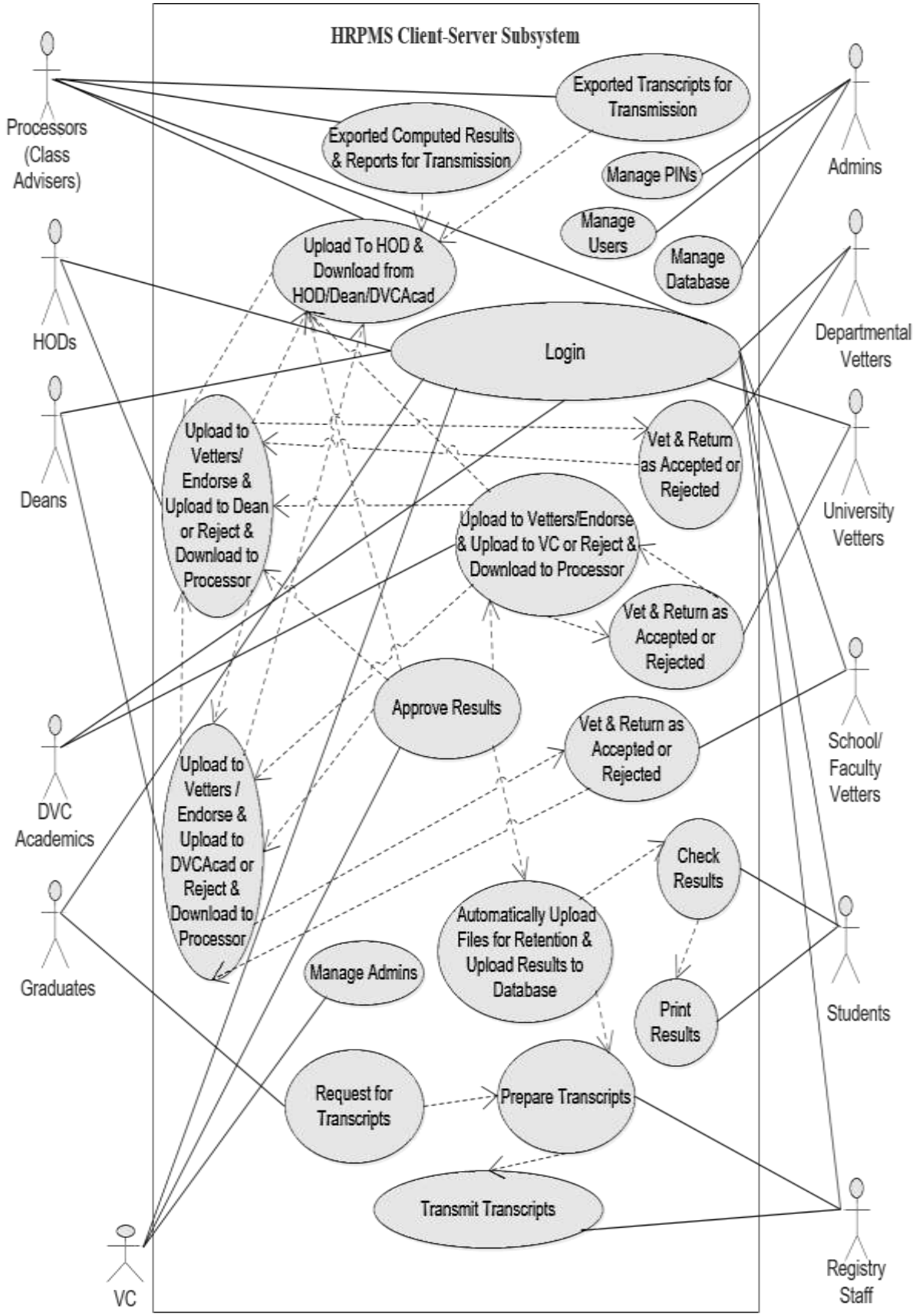


Figure 3.19: HRPMS Client-Server Subsystem Use Case Model Diagram

3.7.5 Structural Design

In Figure 3.20 and Figure 3.21, the HRPMS structural input-output class design model diagrams showing the entities and their attributes, which are the module parameters and characteristics of the standalone and Internet subsystems respectively. The standalone subsystem is comprised of the computation of the results processing modules, while the Internet subsystem is comprised of the results management modules. Whereas the offline modules are used only by the processor, the online modules are used by the processor, the management and their vetting teams, the registry staff, the students, and the system administrator.

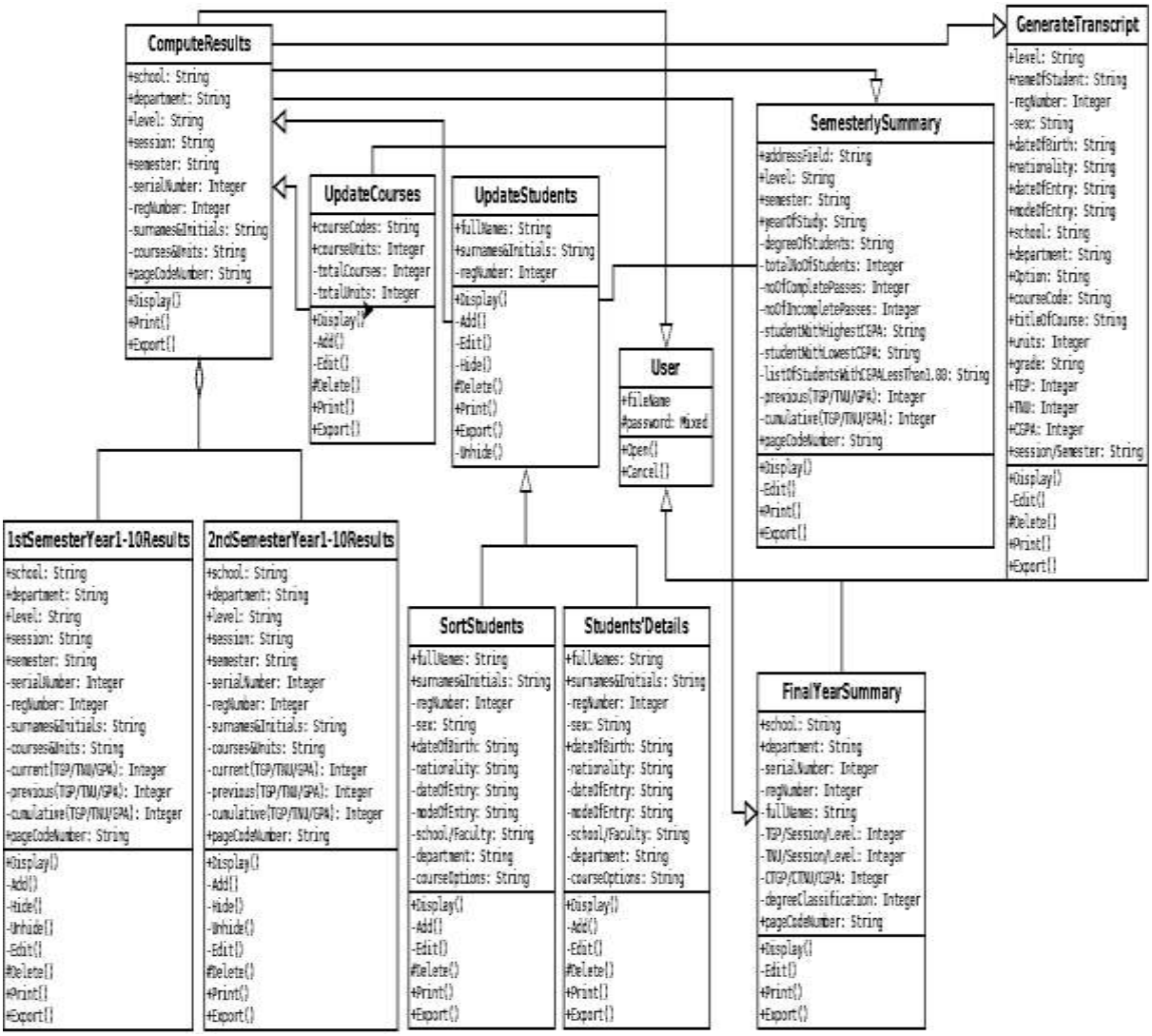


Figure 3.20: Class Model Diagram of HRPMS Standalone Subsystem

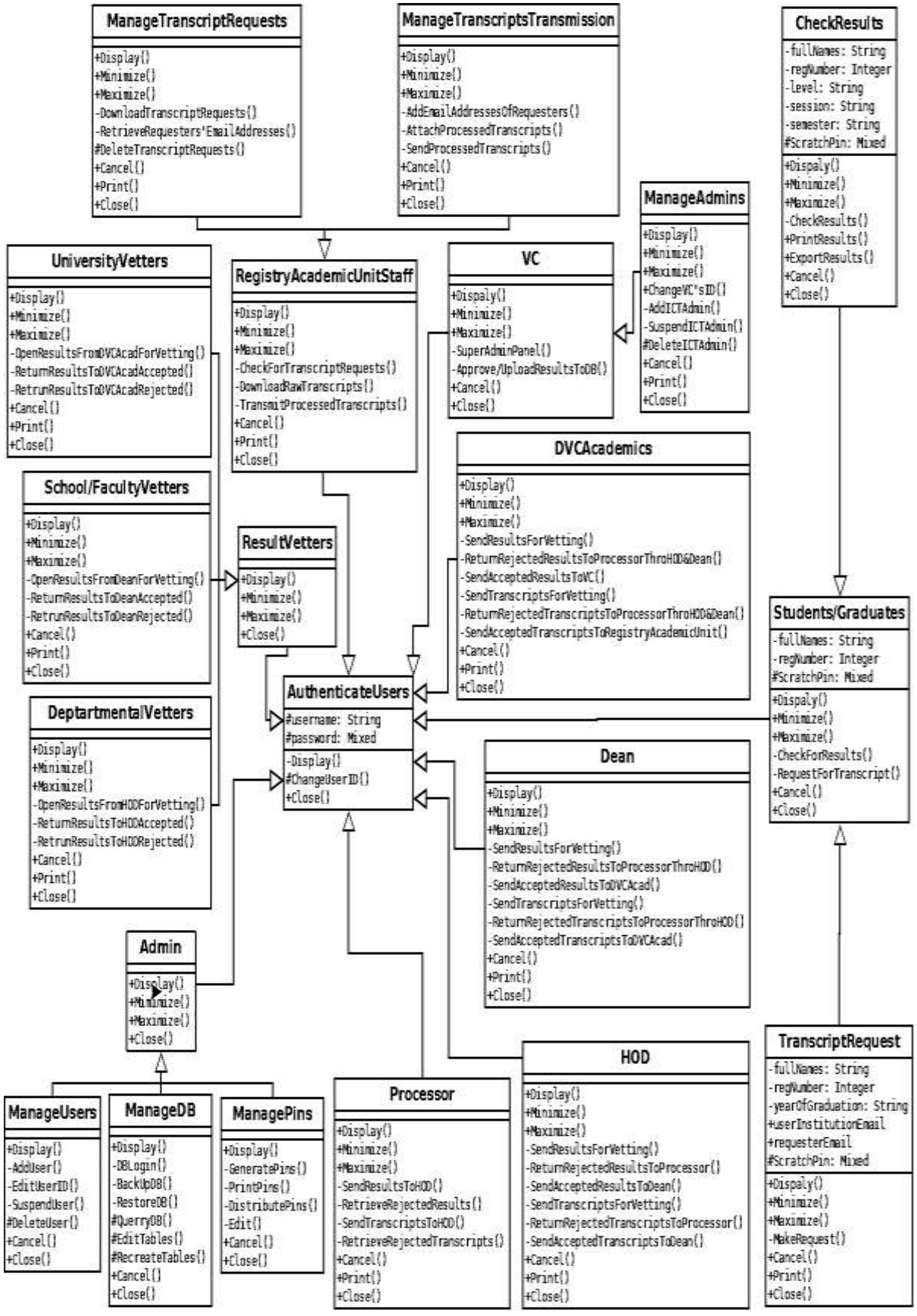


Figure 3.21: Class Model Diagram of HRPMS Client-Server Subsystem

3.7.6 Database Schema Design

The HRPMS database entity-relationship model encapsulated the functions and properties of data storage and retrievals. It has information on relational entities required to organize and manage the database tables to obtain the reports and support the system. Figure 3.22 shows the design specifications of tables that hold the users' details, results data, and generated PINs. The users' details are user IDs and designations. The results data include students' registration number, names, session, semester, faculty/school, department, option (if any), level (including extra years), courses and units, current TGP/TNU/GPA, previous TGP/TNU/GPA, cumulative TGP/TNU/GPA, and remark. These can be normal or corrected results data, as appropriate. The PINs data includes the PIN codes and other generation details like range and amount.

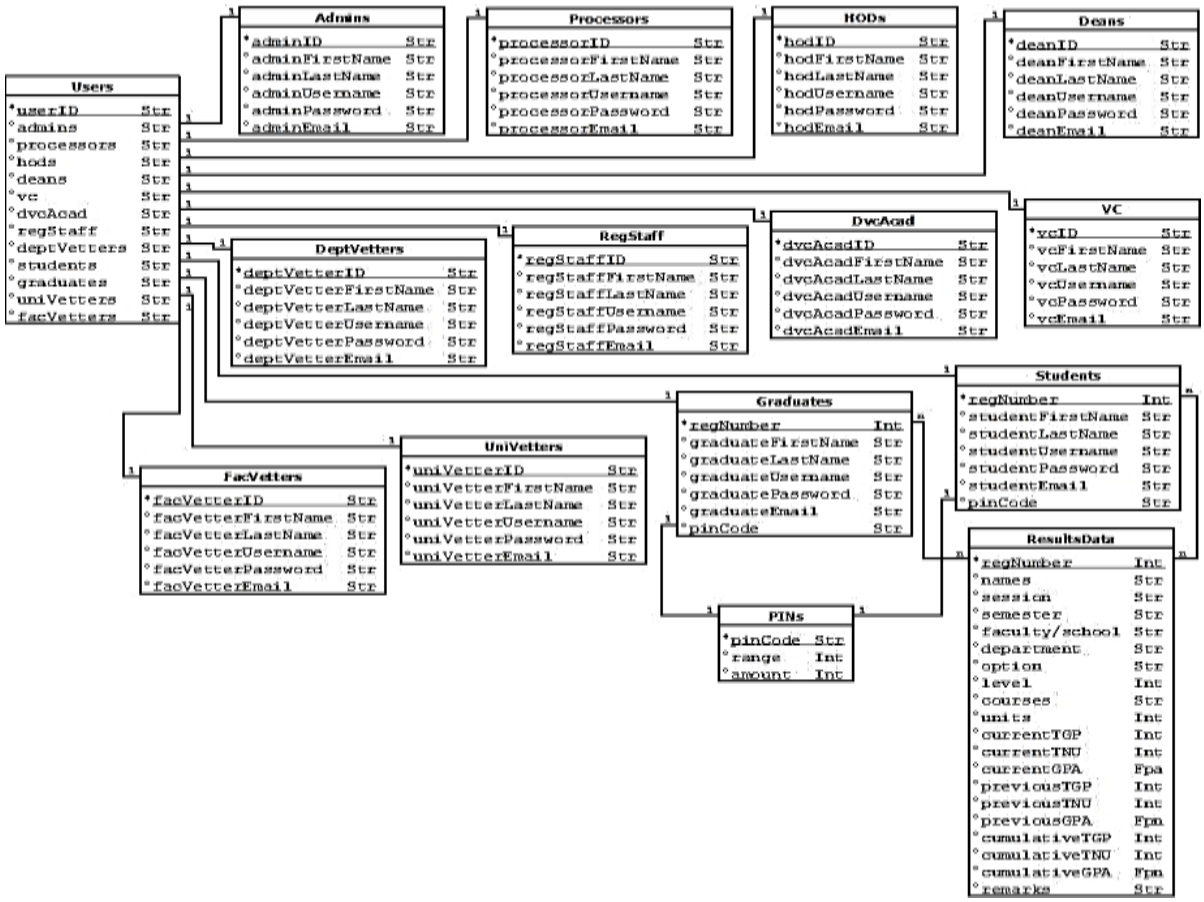


Figure 3.22: HRPMS Database Entity-Relationship Model Diagram

3.8 HRPMS Construction and Coding

The HRPMS design was structured and coded with appropriate development tools to get the system modules working. Excel visual basic for application programming was used to build, code, and configure the offline spreadsheet application modules to run on the desktop. Also, Java programming was used to build, code, and configure the online secured communication middleware socket application modules to run on a client-server platform environment. Again, web programming was used to build, code, and configure the open communication web application module to run on a client-server environment. However, the database was created and configured using MySQL5.4 database manager and MySQL connect programs. The program codes are in **Appendix IX** and other sample output screenshots of the modules are as shown in **Appendix VIII**.

3.8.1 Standalone Subsystem Modules Sample Outputs

Figure 3.23 shows the user login module with the user ID provided to gain access to the spreadsheet worksheet modules. This process verified the authenticity of the user, and grants access to on successful login.

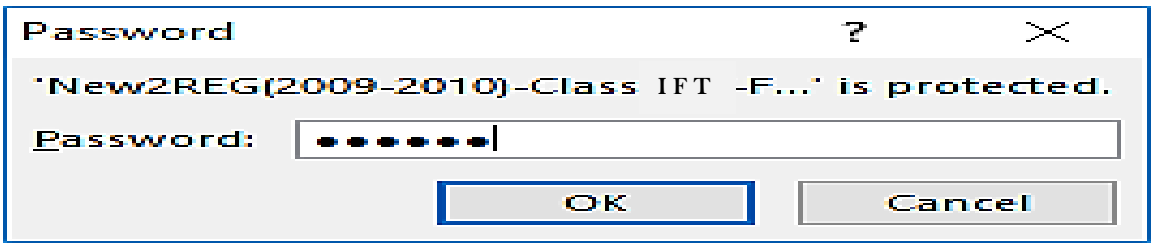


Figure 3.23: Standalone Subsystem User login Module Screenshot

Figure 3.24 shows the courses update module. This module receives all the courses and their details in readiness to computing results and generating transcripts. The course details include the course codes, course descriptions, course units, total units per semester, and grand total units (from year one to

year five, and for extra year borrowed courses), which each student in each department must take to graduate. The update helps the HRPMS to reconcile the courses and units done by each student and match the expected against the actual cumulative total units required per student, to determine when the students have each completed their course work. This ensures that no student graduate with any outstanding course, whether omitted or carryover course.

Figure 3.24: Courses Details Update Module Screenshot

Figure 3.25 shows the students' details update module. This module receives the students' personal and general details in readiness to computing results and generating transcripts. The students' details include their names, registration number, sex, date of birth, state, nationality, date of entry, mode of entry, school (faculty), department, and course options. The information is used to identify each student and enable the HRPMS to match each to his or her registered courses and exam grades per semester. This ensures that each student's academic performance is properly designated.

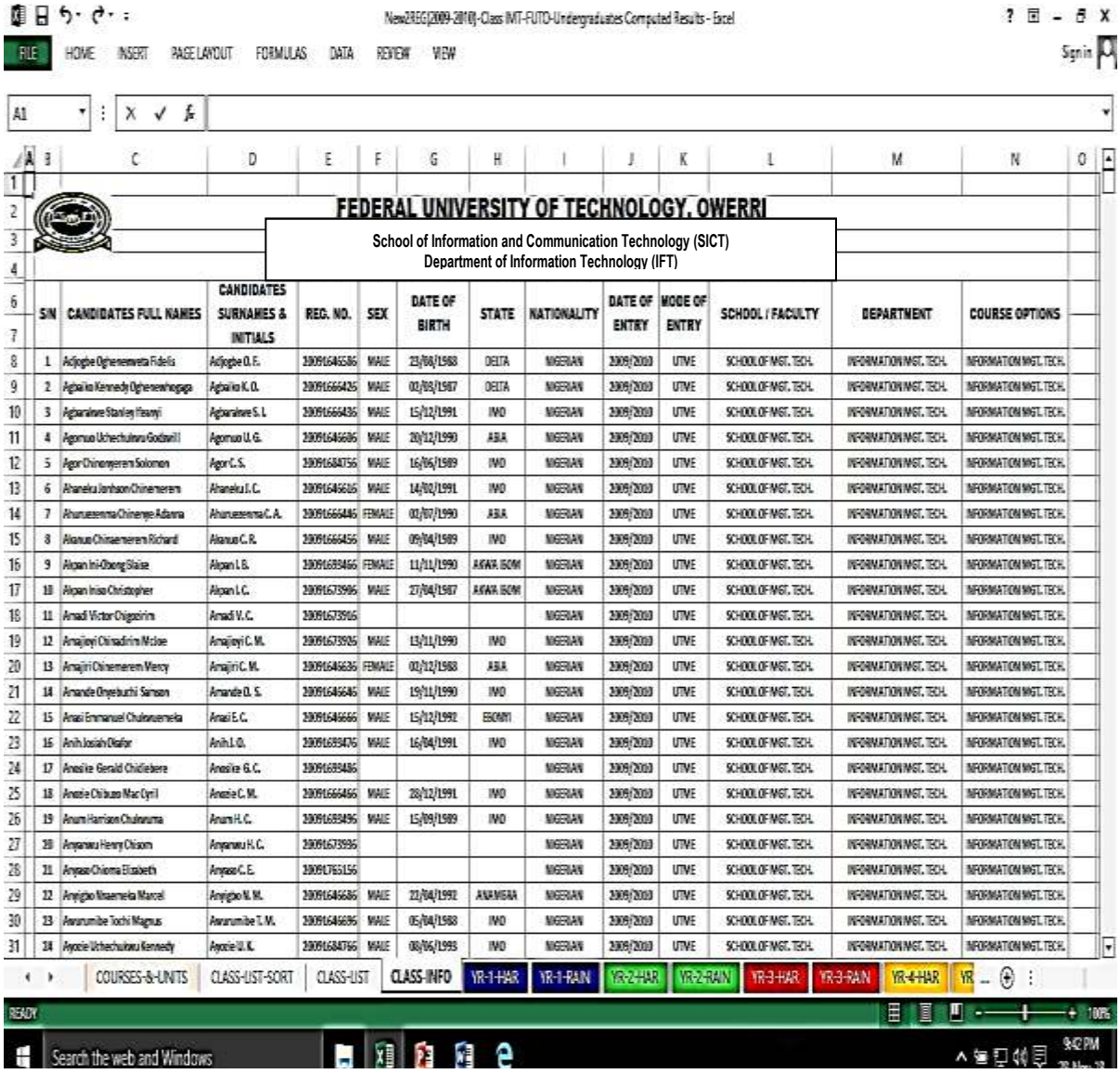


Figure 3.25: Students Details Update Module Screenshot

Figure 3.26 shows the results computation module. This module receives the grades per student and automatically generate the Total Grade Point, Total Number of Unit (TNU) and Grade Point Average (GPA) specifically for each semester, and the cumulative (CTGP, CTNU, and CGPA) collectively for a combination of two or more semesters as appropriate. In results computation, both the current semester courses and the outstanding courses (omissions and carryovers) from the previous semester(s) are computed as applicable to each student. These are done from year one to year five, and even to extra years as appropriate. Remarks are generated per semester, which shows how each student performed. The pass-remark shows that the student passed all his courses that semester, while 1F or 2F or more as a remark shows that the student failed one or two or more courses respectively. The results computation worksheets have proved to have maximum accuracy with little or no errors.

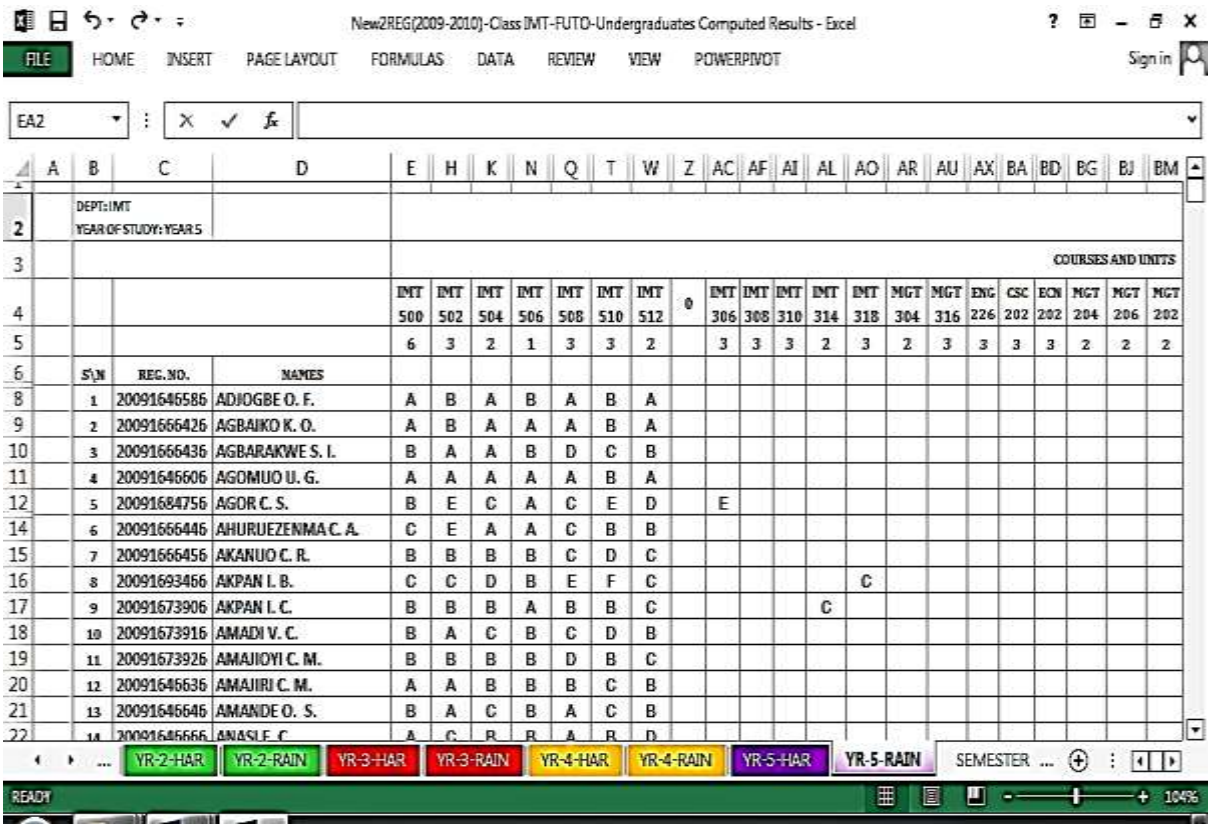


Figure 3.26: Results Computation Module Screenshot

Figure 3.27 shows the semester reports generator module. This module generates a semester summary of the student classes as appropriate. The semester report gives the statistics on the following: semester, session, degree in-view, the total number of students per semester, number of complete passes, and number of incomplete passes. Others are the best and the worst students with their registration numbers and CGPAs, and finally, the list of students whose CGPAs are less than 1.00 (academically deficient students). This report can help the university management to monitor the academic progress of all student levels, identify and appoint the class representatives from the best students per session per level, and also identify the students that should be withdrawn or re-positioned per session (those with CGPA below 1.00).

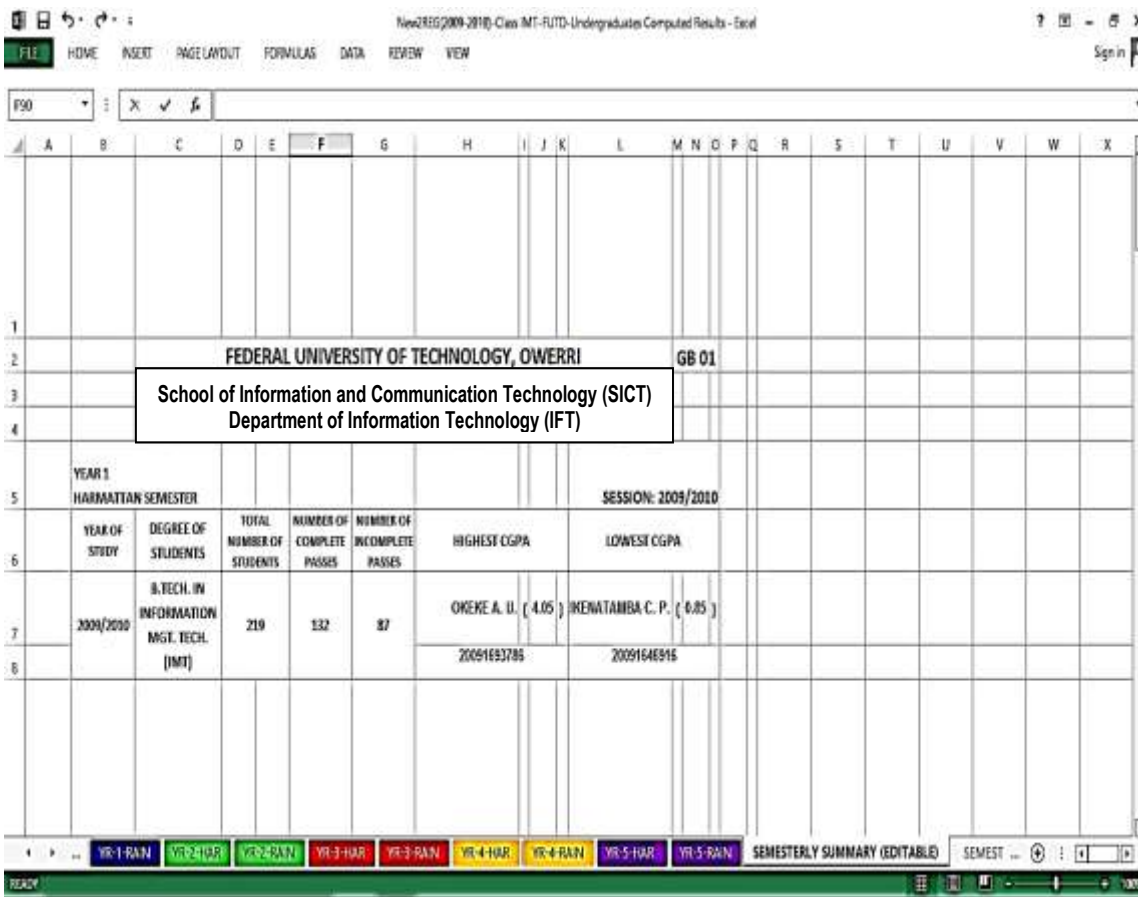
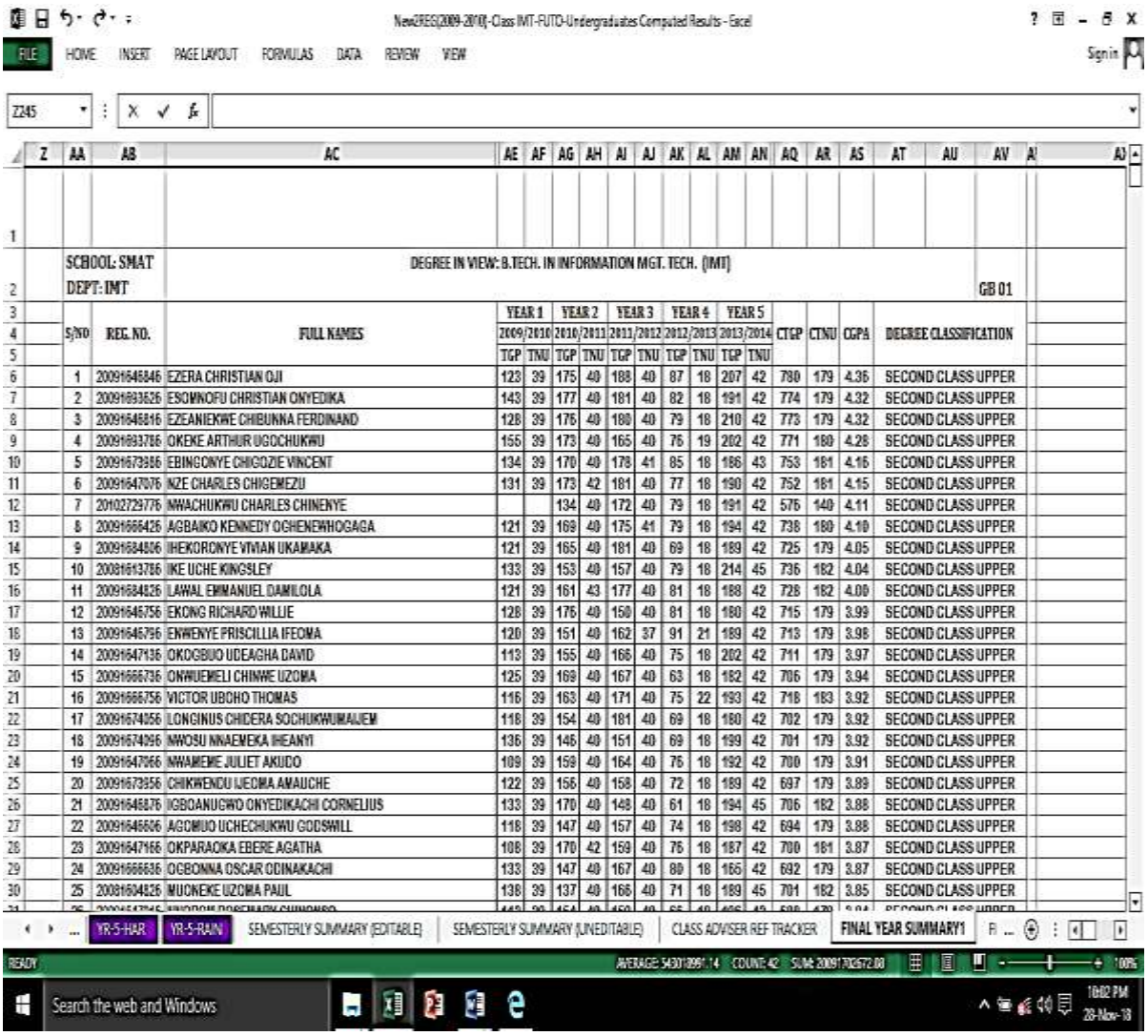


Figure 3.27: Semester Reports Generator Module Screenshot

Figure 3.28 shows the graduation status report generator module. This module generates an end-of-programme summary for the student classes as appropriate. The graduation report gives the list of the graduands from the best to the worst graduating students, with their TGP and TNU per session (from first to final year with or without extra years as appropriate), gives the final CTGP, CTNU, and CGPA for each student with their individual graduation status based on the final CGPA. This report can help the university management to identify and keep track of the best graduating students per session, per option, per department, per school or faculty, and the university.



S/NO	REG. NO.	FULL NAMES	YEAR 1 2009/2010 TGP	YEAR 1 2009/2010 TNU	YEAR 2 2010/2011 TGP	YEAR 2 2010/2011 TNU	YEAR 3 2011/2012 TGP	YEAR 3 2011/2012 TNU	YEAR 4 2012/2013 TGP	YEAR 4 2012/2013 TNU	YEAR 5 2013/2014 TGP	YEAR 5 2013/2014 TNU	CTGP	CTNU	CGPA	DEGREE CLASSIFICATION
1	20091646846	EZERA CHRISTIAN OJI	123	39	175	40	188	40	87	18	207	42	780	179	4.36	SECOND CLASS UPPER
2	20091693626	ESOMNOFU CHRISTIAN ONYEDIKA	143	39	177	40	181	40	82	18	191	42	774	179	4.32	SECOND CLASS UPPER
3	20091646816	EZEANIEKWE CHIBUNNA FERDINAND	128	39	176	40	180	40	79	18	210	42	773	179	4.32	SECOND CLASS UPPER
4	20091693786	OKEKE ARTHUR UGOCHUKWU	155	39	173	40	165	40	76	19	202	42	771	180	4.28	SECOND CLASS UPPER
5	20091673956	EBINGONYE CHIGOZIE VINCENT	134	39	170	40	178	41	85	18	186	43	753	181	4.16	SECOND CLASS UPPER
6	20091647076	NZE CHARLES CHIGEMEZU	131	39	173	42	181	40	77	18	190	42	752	181	4.15	SECOND CLASS UPPER
7	20102729776	NWACHUKWU CHARLES CHINENYE			134	40	172	40	79	18	191	42	576	140	4.11	SECOND CLASS UPPER
8	20091666426	AGBAIKO KENNEDY OGHENEWHOGAGA	121	39	169	40	175	41	79	18	194	42	738	180	4.10	SECOND CLASS UPPER
9	20091684806	IHEKORONYE VIVIAN UKAMAKA	121	39	165	40	181	40	69	18	189	42	725	179	4.05	SECOND CLASS UPPER
10	20091613786	IKE UCHE KINGSLEY	133	39	153	40	157	40	79	18	214	45	736	182	4.04	SECOND CLASS UPPER
11	20091684826	LAWAL EMMANUEL DAMILOLA	121	39	161	43	177	40	81	18	188	42	728	182	4.00	SECOND CLASS UPPER
12	20091646756	EKONG RICHARD WILLIE	128	39	176	40	150	40	81	18	180	42	715	179	3.99	SECOND CLASS UPPER
13	20091646796	ENWENYE PRISCILLIA IFEOMA	120	39	151	40	162	37	91	21	189	42	713	179	3.98	SECOND CLASS UPPER
14	20091647136	OKOGBUO UDEAGHA DAVID	113	39	155	40	166	40	75	18	202	42	711	179	3.97	SECOND CLASS UPPER
15	20091666736	ONWUEMELI CHINWE UZOMA	125	39	169	40	167	40	63	18	182	42	706	179	3.94	SECOND CLASS UPPER
16	20091666756	VICTOR UBOHO THOMAS	116	39	163	40	171	40	75	22	193	42	718	183	3.92	SECOND CLASS UPPER
17	20091674056	LONGINUS CHIDERA SOCHUKWUMAIJEM	118	39	154	40	181	40	69	18	180	42	702	179	3.92	SECOND CLASS UPPER
18	20091674096	NWOSU NNAEMEKA IHEANYI	136	39	146	40	151	40	69	18	199	42	701	179	3.92	SECOND CLASS UPPER
19	20091647066	NWAMEME JULIET AKUDO	109	39	159	40	164	40	76	18	192	42	700	179	3.91	SECOND CLASS UPPER
20	20091673956	CHIKWENDU IJEOMA AMAUCHE	122	39	156	40	158	40	72	18	189	42	697	179	3.89	SECOND CLASS UPPER
21	20091646876	IGBOANUGWO ONYEDIKACHI CORNELIUS	133	39	170	40	148	40	61	18	194	45	706	182	3.88	SECOND CLASS UPPER
22	20091646606	AGOMUO UCHECHUKWU GODSWILL	118	39	147	40	157	40	74	18	198	42	694	179	3.88	SECOND CLASS UPPER
23	20091647166	OKPARAOKA EBERE AGATHA	108	39	170	42	159	40	76	18	187	42	700	181	3.87	SECOND CLASS UPPER
24	20091666636	OGBONNA OSCAR ODINAKACHI	133	39	147	40	167	40	80	18	166	42	692	179	3.87	SECOND CLASS UPPER
25	20091604826	MUONEKE UZOMA PAUL	138	39	137	40	166	40	71	18	189	45	701	182	3.85	SECOND CLASS UPPER

Figure 3.28: Graduation Reports Generator Module Screenshot

Figure 3.29 shows the class advisor module. This tracks all-semester academic outstandings of all students per class per department till their graduation. The academic issues monitored include omissions, carryovers, rectifications of outstandings, a summary of outstandings, the benchmark-against-graduation-threshold analysis per student, and the current CGPA per student. This worksheet can help the class adviser in guiding the students in their semester course registrations, especially to identify and rectify the prerequisites, the omissions, and the carryovers before registering fresh courses. It will also help the class advisers to follow the students' academic progress and analyze their final outstandings for management consumption, and academic forecasts.

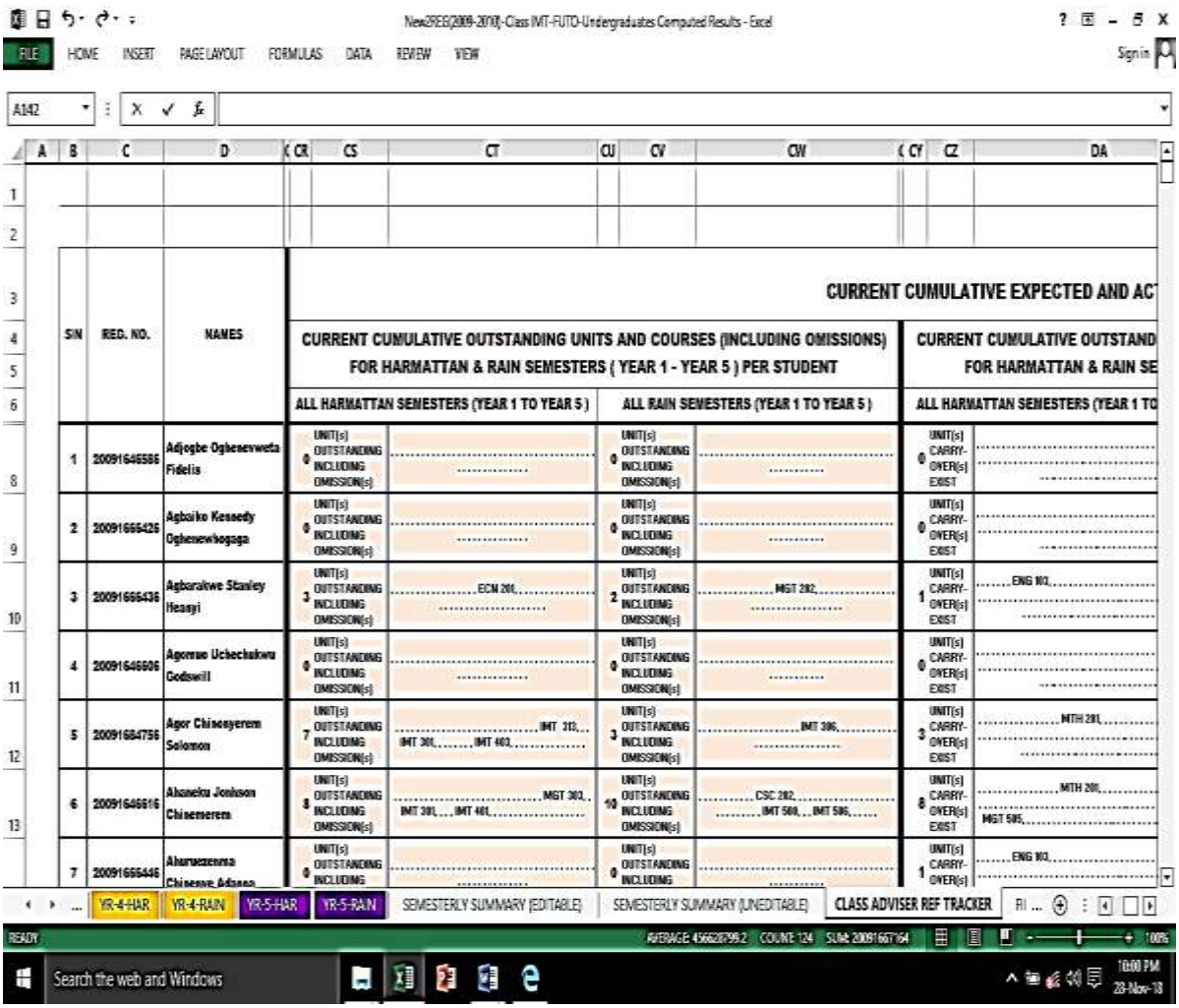


Figure 3.29: Class Advisor Module Screenshot

Figure 3.30 shows the transcript generator module. This module instantly generates each student's academic transcript with one click. The transcript generator requires inputting only the student's registration number and then pressing the enter key. This instantly matches the registration number to all the student's personal and academic details required on a transcript and displays them on the transcript template. The generated transcripts can be edited and formatted for printing or export to other document formats, especially to the Portable Document Format (PDF). The transcripts can be saved in appropriate directories for onward transmissions as softcopies or retrievals and re-processing, as the case may be.

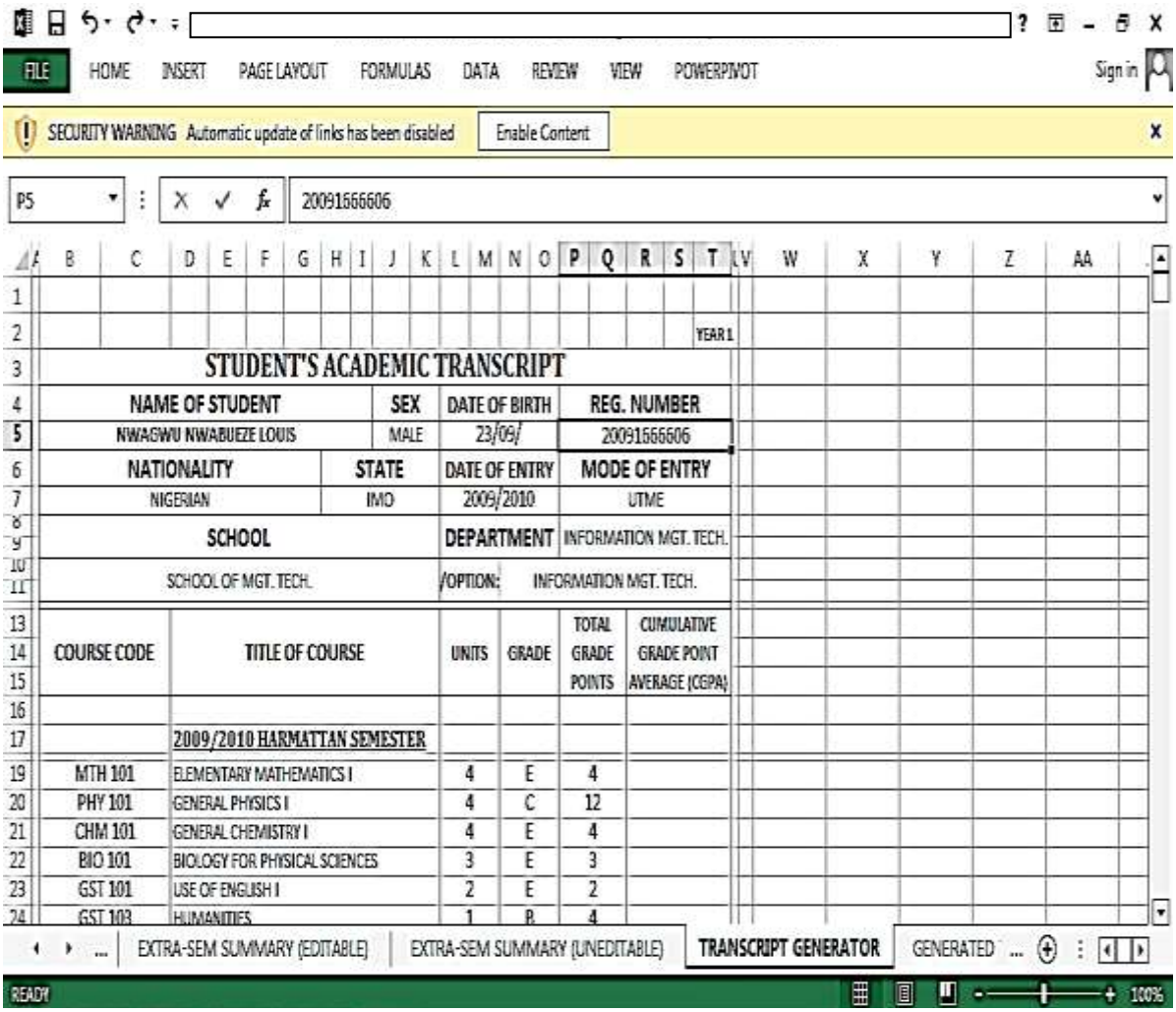


Figure 3.30: Transcript Generator Module Screenshot

3.8.2 Client-Server Subsystem Modules Sample Outputs

Figure 3.31 shows the middleware-socket application home page module. It provides the user access to the login module when run, and contains some background information about the system. **Appendix VIII** shows some other modules of the internet subsystem.

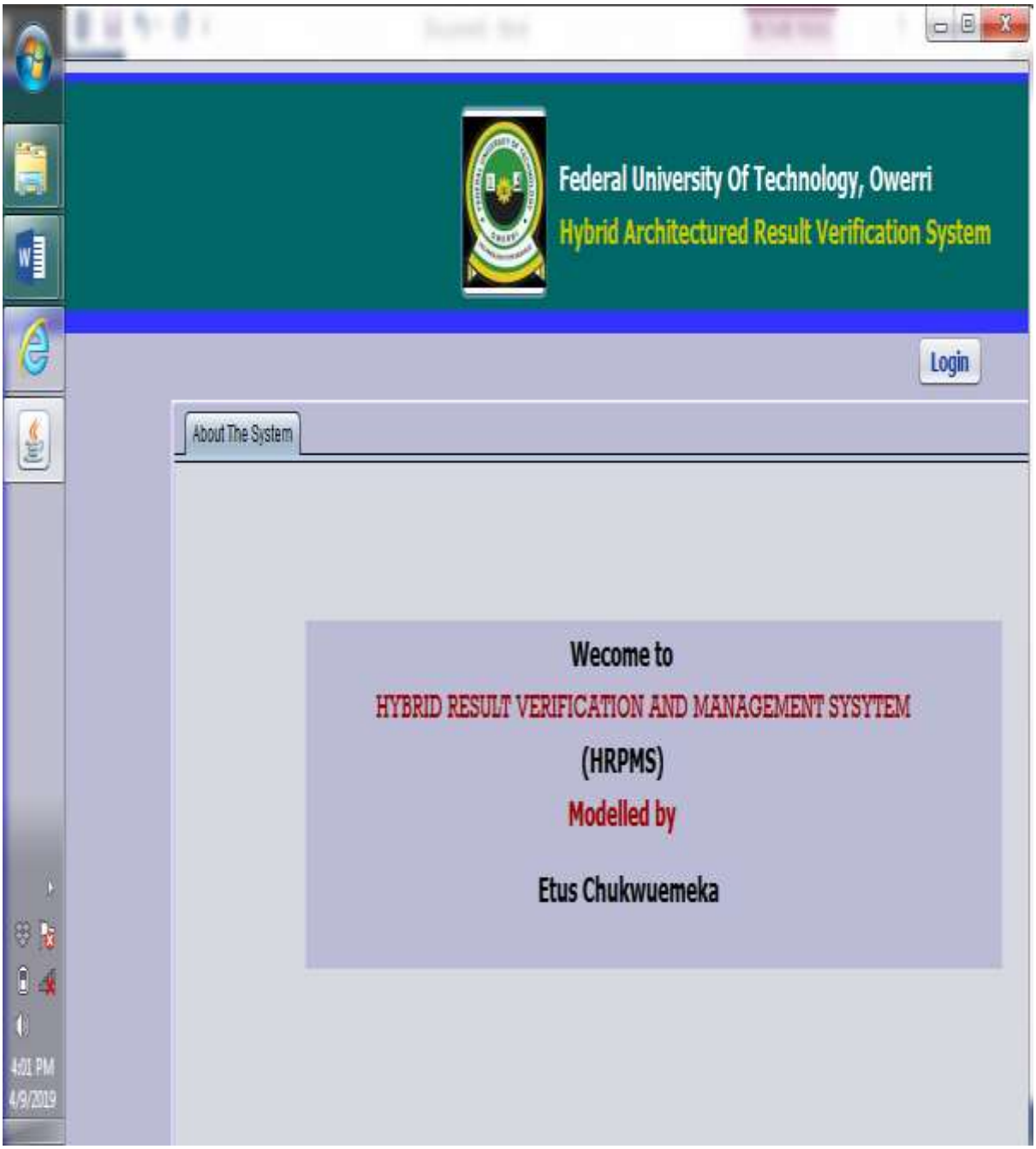


Figure 3.31: Socket Application Home Page Screen Module Screenshot

Figure 3.32 shows the middleware-socket application user login module. It verifies the authenticity of the user, and grants access on successful login. Based on Figure 3.34 to Figure 3.37, the secured group socket middleware modules are used by the Processors, HODs, Deans, DVC Academics, VC, Registry Staff, and the system administrator to access, transmit and manage results. To access their dashboard privileges and transmit results, they first log in with their user ID. On behalf of the Senate, the Vice-Chancellor finally approves results certified by the HODs, Deans, DVC Academics, and their vetting teams, and then uploads the results data to the database while the result and transcript files upload to the approved results and approved transcripts folders respectively, for retention. Hence, only certified and approved results and transcripts can be found in the database and retention folders from where semester results can be checked by students and transcripts processed for requesters by the registry staff.

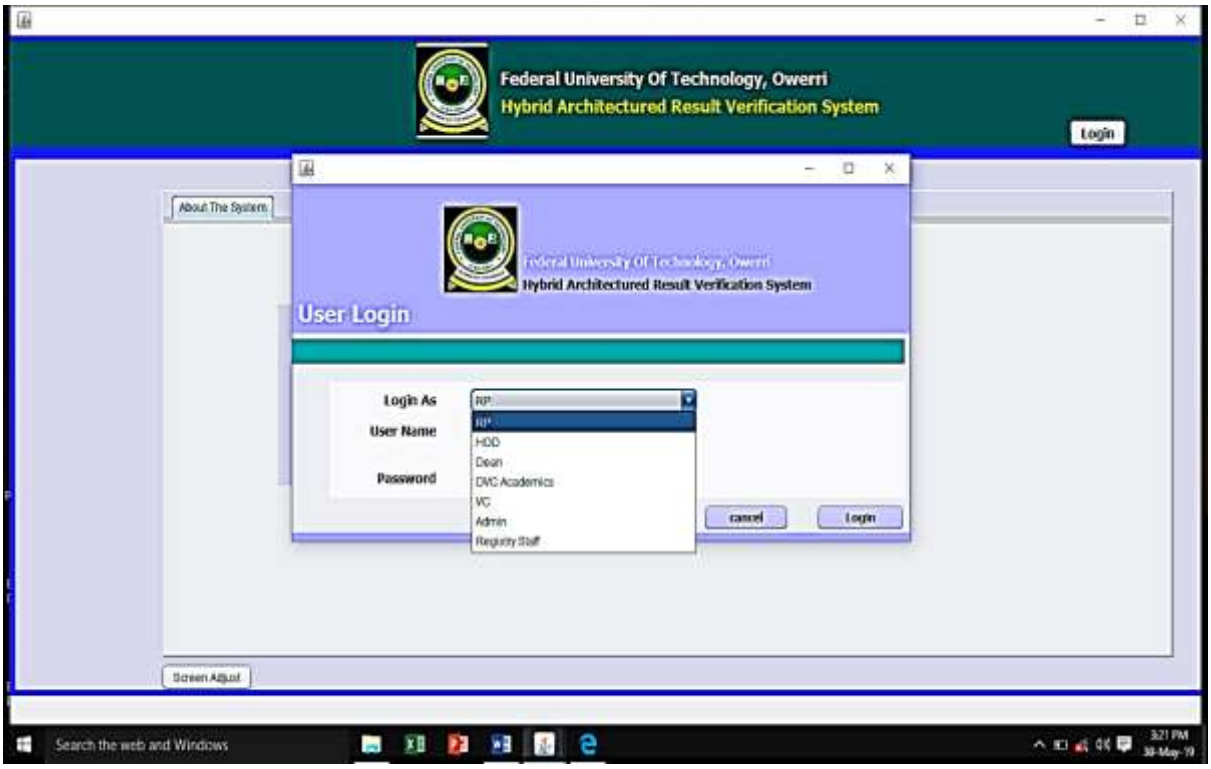


Figure 3.32: Socket Application User login Module Screenshot

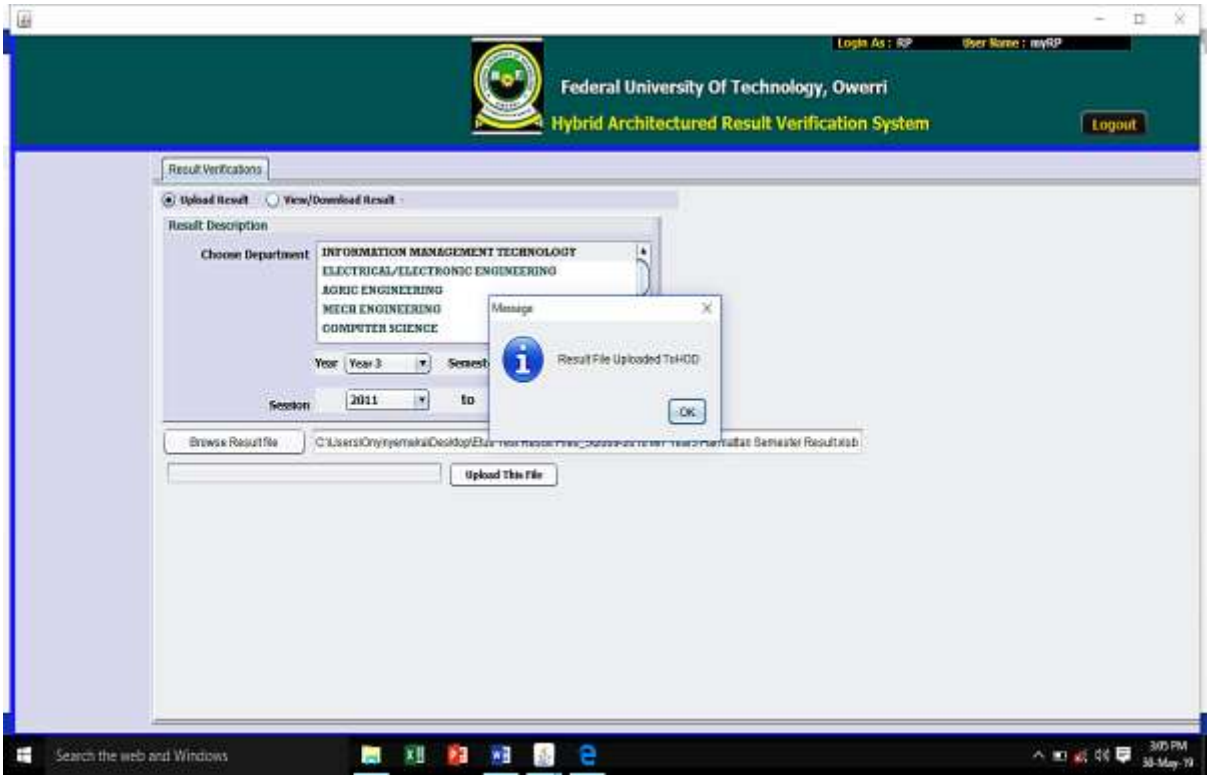


Figure 3.33: Result Processor Dashboard Module Screenshot

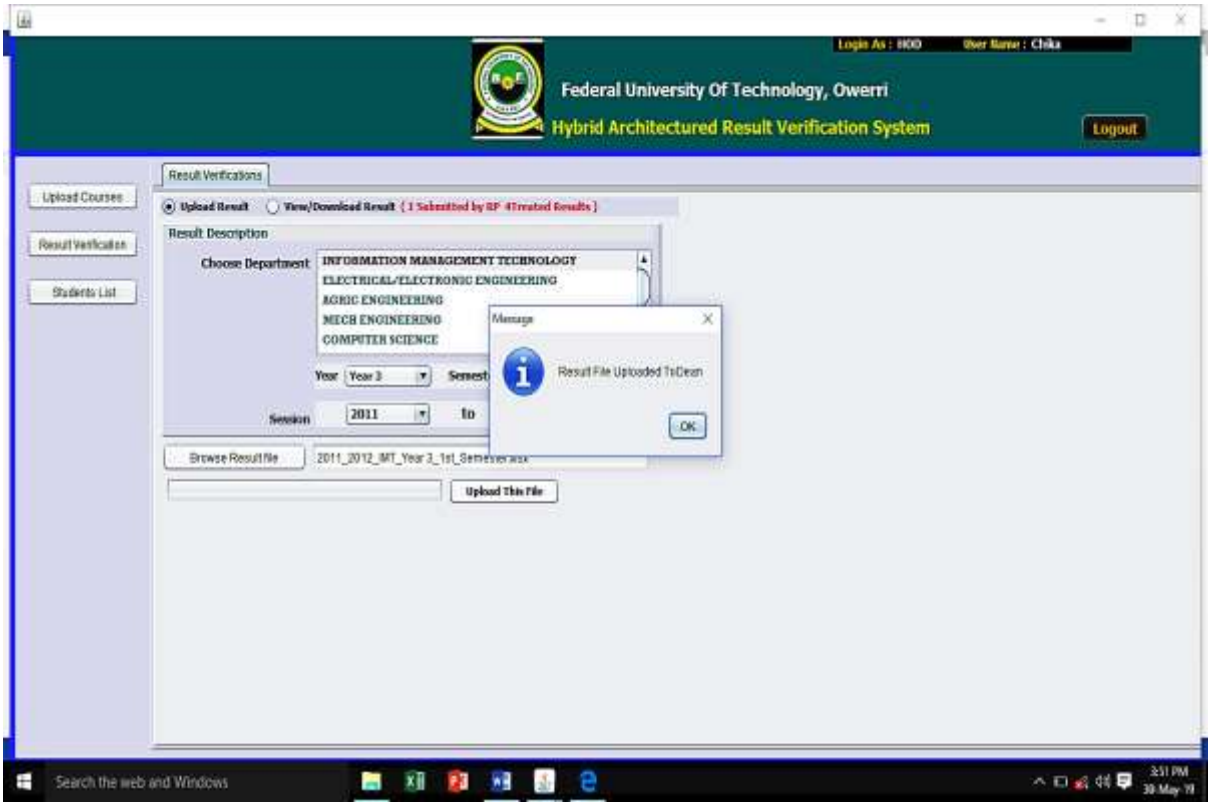


Figure 3.34: HOD Dashboard Module Screenshot

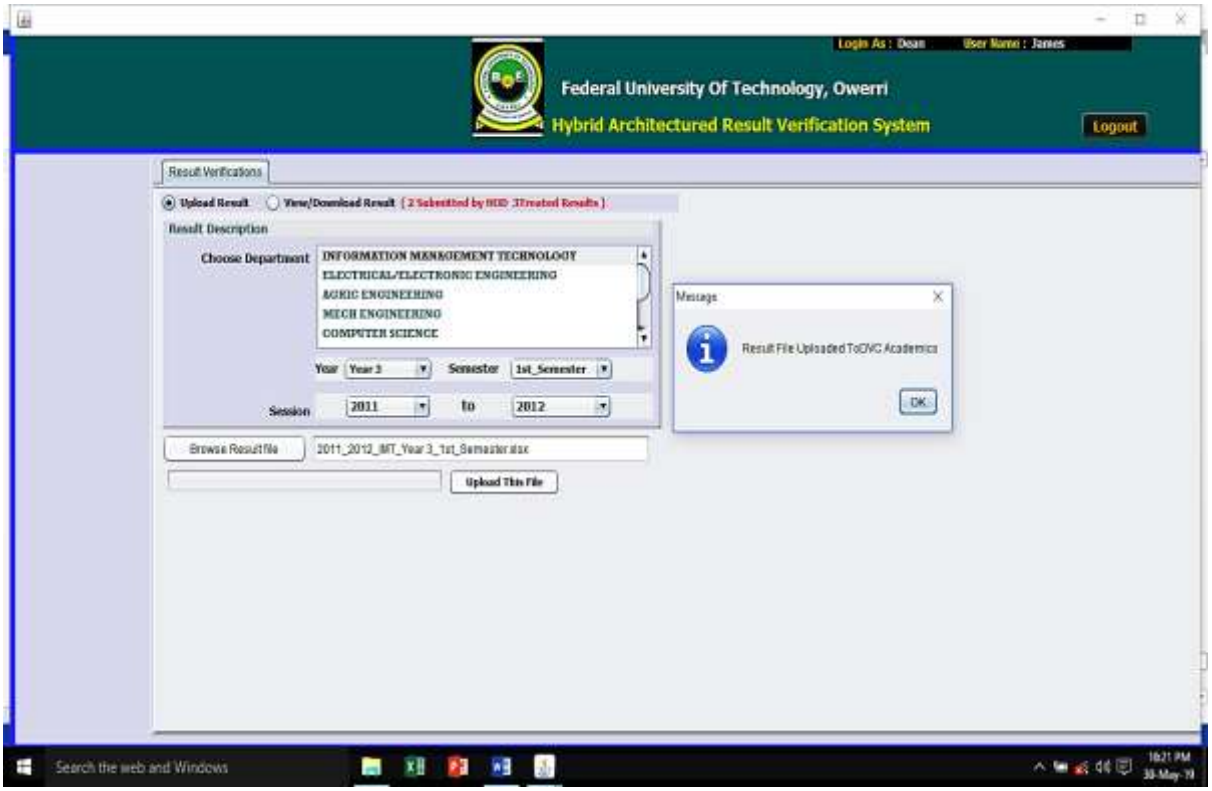


Figure 3.35: Dean Dashboard Module Screenshot

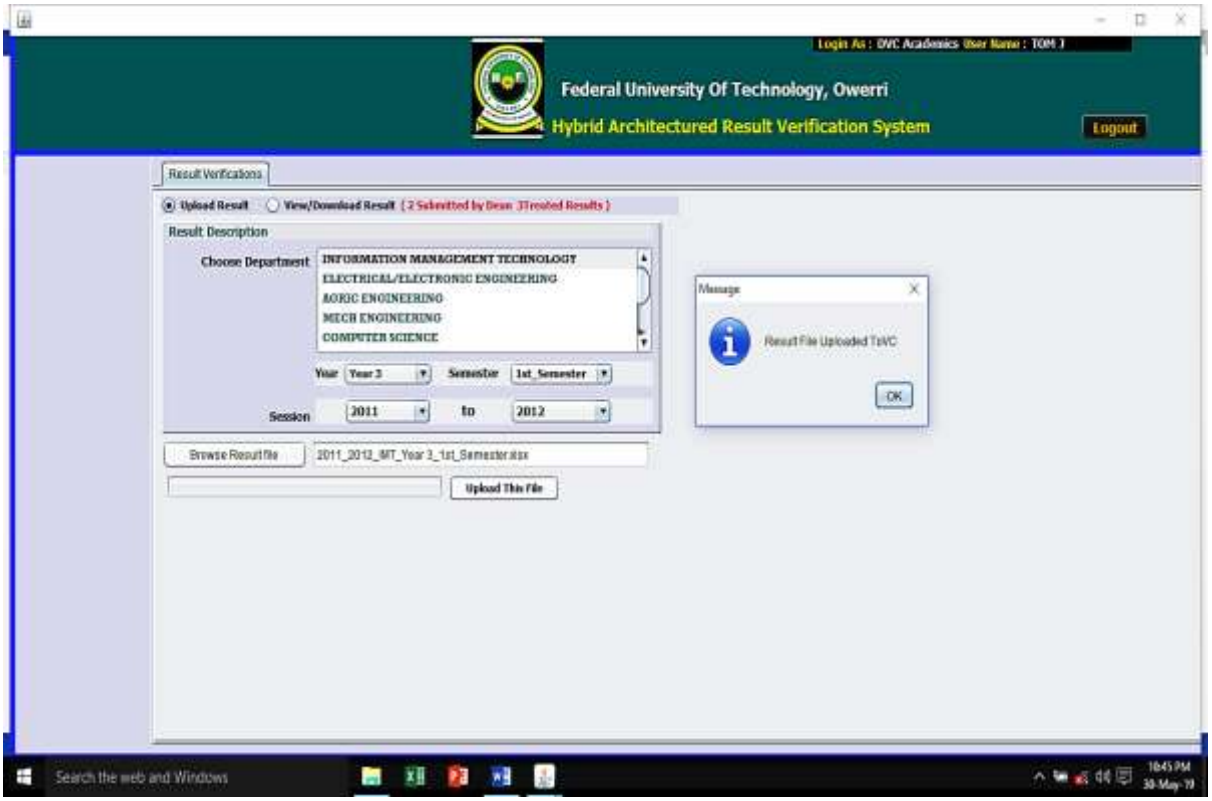


Figure 3.36: DVC Academics Dashboard Module Screenshot

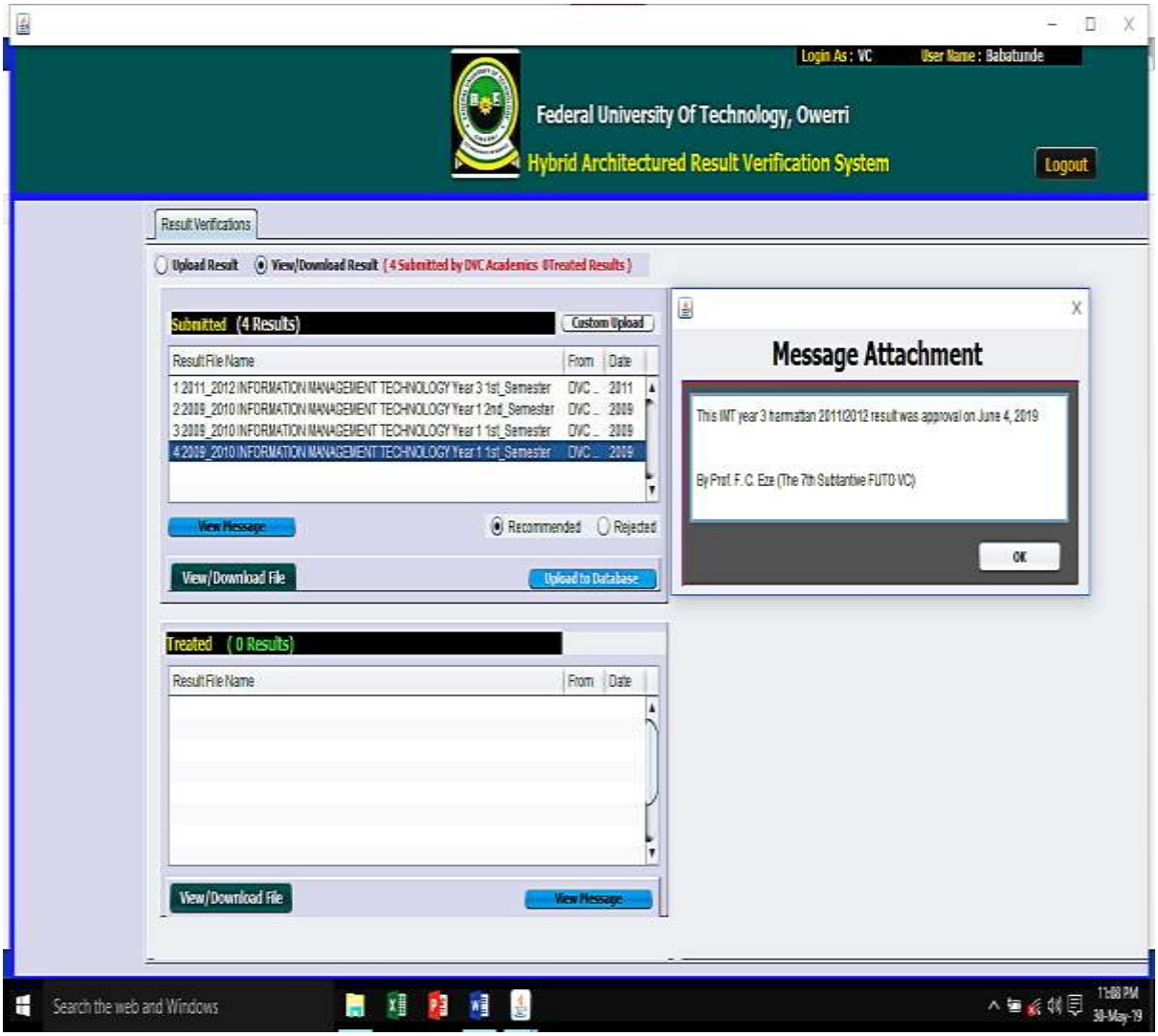


Figure 3.37: VC Dashboard Module Screenshot

The database was created and managed using MySQL Database Management System (DBMS), which is a Relational DBMS, see Figure 3.38. In the alpha development stage (that is, the developer testing stage), the database (sql3231408) was deployed on a local server (WAMP Server) in the host machine, such that the HRPMS client programs automatically connects to the database on the same machine whenever it runs. However, in the Beta development stage (that is, the user testing stage), the database was deployed on the live remote (GoDaddy) server, such that the database automatically connects to the HRPMS client programs on the user machine whenever it runs.

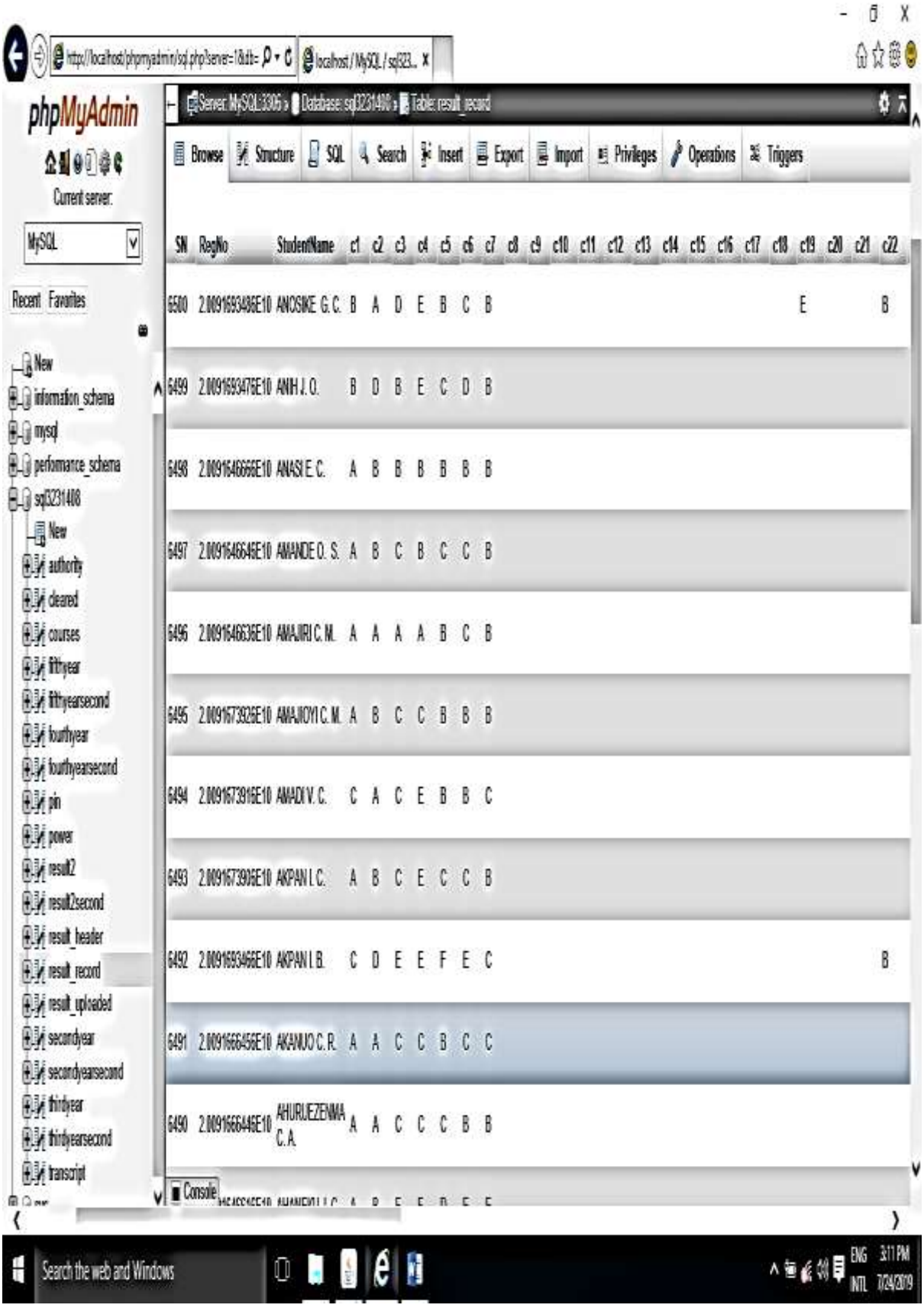


Figure 3.38: Database Module Screenshot

Figure 3.39 shows the registry staff dashboard module. The registry staff logs in to access the results and transcripts retention folders (approved results and approved transcripts folders) to search and extract each student's results or transcript and prepares the student's transcript, processes them for approval, and transmits the transcripts to the requesting graduates.

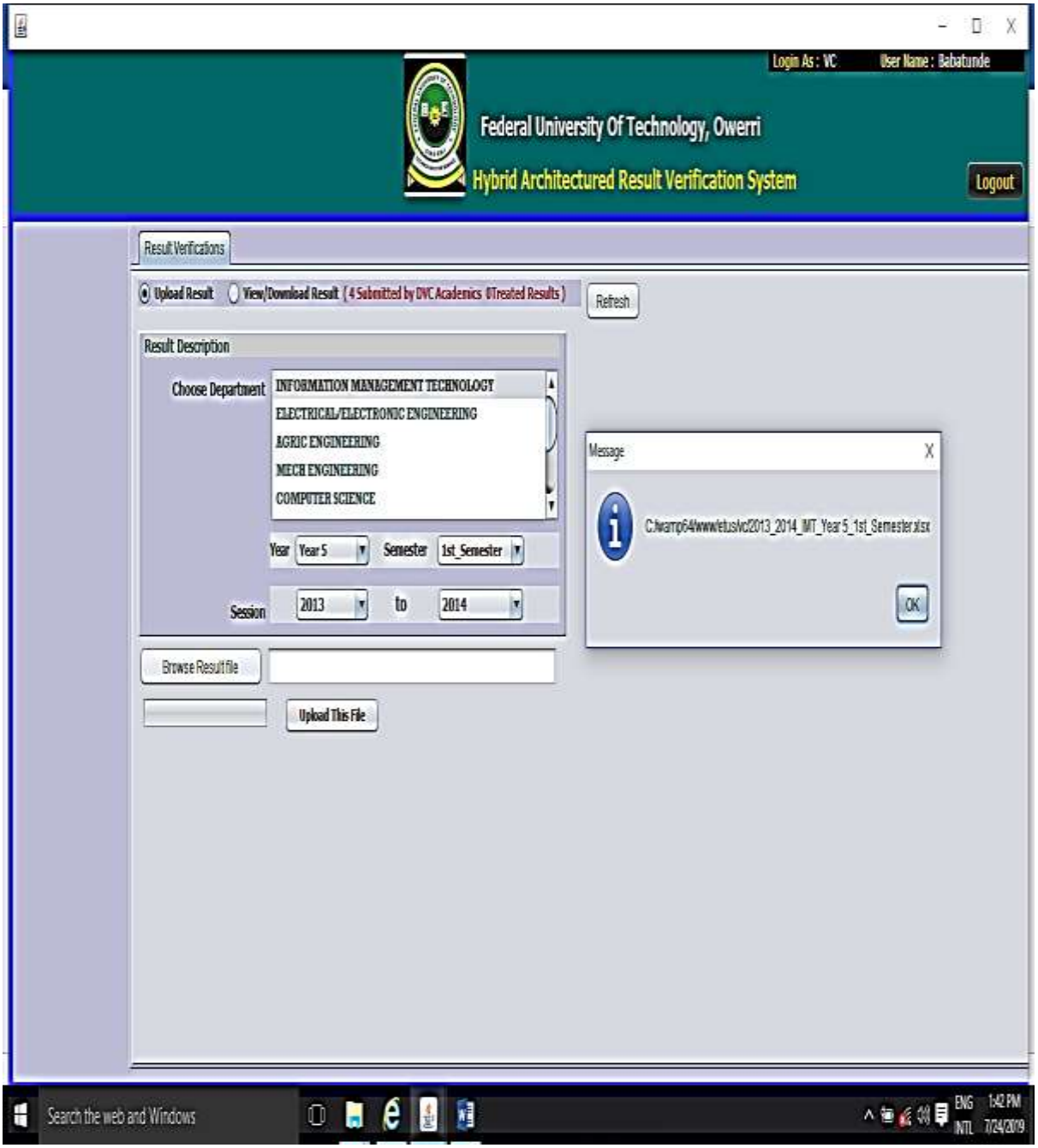


Figure 3.39: Registry Staff Dashboard Module Screenshot

Figure 3.40 shows the system administrator dashboard module. The administrator modules are used by the system administrator to generate the PINs for results checking through the HRPMS. The PINs can be of varied ranges and amounts. The PINs are generated by inputting the range (digits) and the amount (number) of PINs required within each range. He also uses it to manage the users in the secured group, and also manage the database.

Figure 3.40: System Administrator Dashboard Module Screenshot

Figure 3.41 shows the students' dashboard module. This is the open group communication module used to check and view or print results by students. To do these, they require some personal details (as necessary), and PIN codes earlier generated by the system administrator. However, transcript requests submitted by graduates with e-mail addresses of both the institutions (where the transcript will be sent) and that of the graduates concerned, facilitates the return of the processed transcripts to them through institutional email addresses.

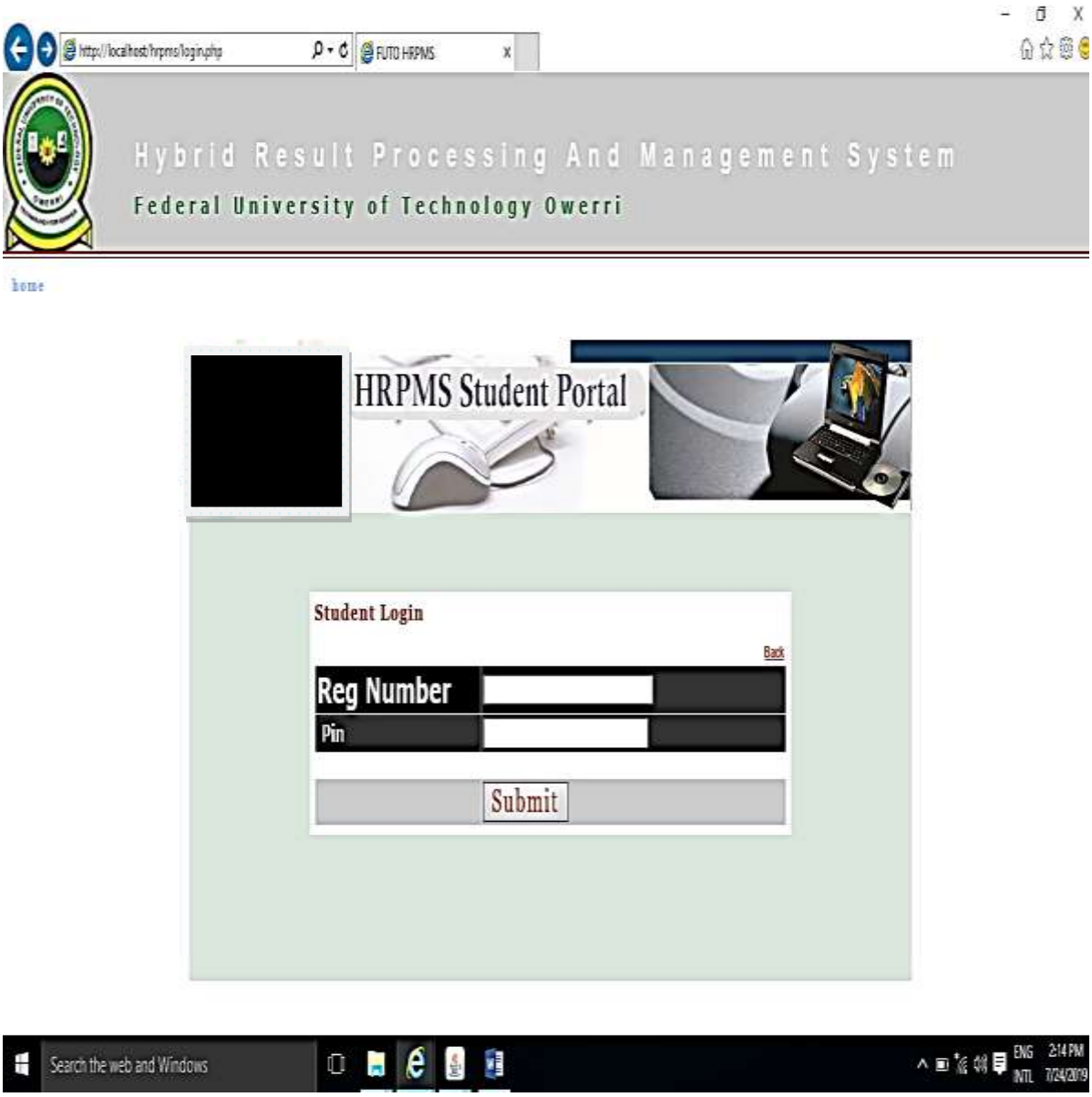


Figure 3.41: Students Dashboard Module Screenshot

3.9 HPRPMS Deployment

To deploy the HRPMS, the implementation considerations include but are not limited to using the specified minimum hardware and software requirements, installing and running its application and utility programs (see Figure 3.42), and using a system conversion method to implement the system. Installing and running the programs avails the HRPMS standalone and network subsystems the platform to work. Using at least the minimum specified hardware and software resources for the HRPMS makes it function optimally. Using a particular conversion method to implement the HRPMS makes it available for use and helps integrate it properly to the rest of the university systems as a campus enterprise system.

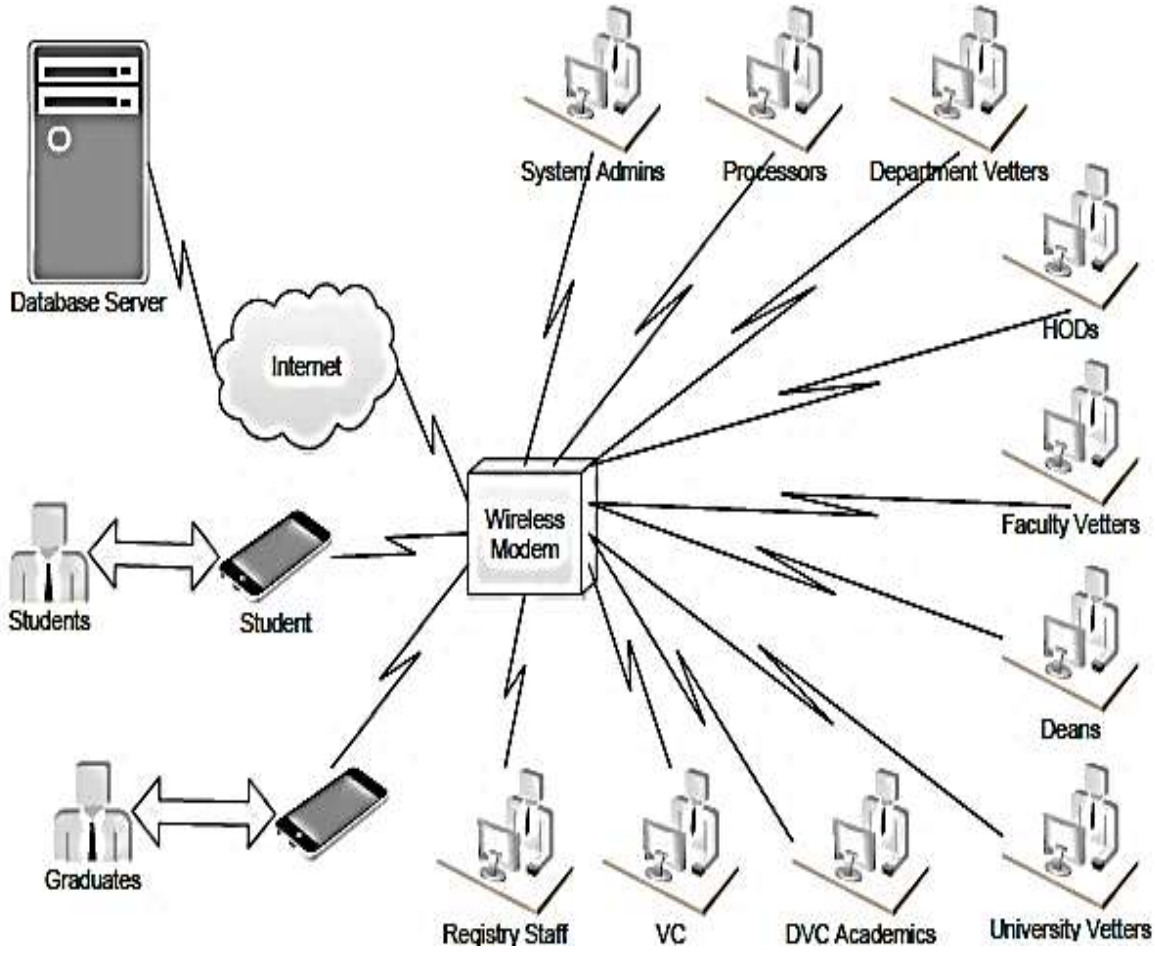


Figure 3.42: HRPMS Deployment Model Diagram

3.9.1 HRPMS Hardware and Software Minimum Requirements

The basic and minimum hardware and software, hosting resource, conversion, skills, and training, and maintenances required to deploy and use the HRPMS for optimum performance are as presented:

i. Laptop Computer (with a minimum of 1.8GHz processor speed, 4.0GB Ram, 250GB Hard drive, 1024 x 768 screen resolution) and fast Modem (56 Mbps and above).

ii. Windows 7 Operating System or Linux Red hat 8.0 or Mac OS X 10.3, Microsoft Office 2013, Java Standard Edition Runtime Environment 8 (JRE8), MySQL 5.7.31 DBMS, Apache 2.3.7 and PHP 5.6.40 web servers, Core FTP 2.0 file, and Anti-virus.

iii. Database server account subscription for database hosting facility use.

3.9.2 HRPMS Database Hosting

In the Alpha stage, the HRPMS database was deployed on a local server host platform (WAMP Server). However, in the Beta stage, the database was deployed on the GoDaddy remote server, which operates pay-as-you-go. The service is Platform-as-a-Service (PaaS), where the MySQL database (sql3231408) was exported and link to the middleware program. This is such that as soon as the frontend runs on the client system, it automatically connects and interacts with the database on the live server. Hence, the HRPMS runs on a hybrid platform.

3.9.3 HRPMS Conversion

Implementing and Integrating the HRPMS to make it available for use in the university community can be done by pilot, parallel, or direct (crash) conversion. The crash conversion may be too risky to be used with the HRPMS because of the danger of a total system collapse in case anything goes wrong.

Also, the parallel conversion may be more time and resource-consuming (due to double the time and resources used to process on two systems separately) and affect productivity adversely. Therefore, pilot conversion is recommended to deploy the HRPMS, because it supports batch or phase deployment, especially where resources like finances and facilities, are limited.

3.9.4 HRPMS User Skills and Training

The following stakeholders can operate the HRPMS: system administrator, management, staff, students, parents, or guardians. This means that the system has to be very user-friendly (easy to use once a user is authenticated), so that there will be little or no need for training, especially for students and their parents or guardians. The management and staff need little training once they are computer literate and can also use the Microsoft Excel Office application. With this, they are only required to familiarize themselves with the HRPMS environment. This can be done through a physical training session or a video tutorial for about an hour. The administrators should be people knowledgeable in ICT and may not need further training but to only understand how the system functions and operates. This will help them to take proper care of the system, especially, database maintenance.

3.9.5 HRPMS Maintenance

The HRPMS needs some back-end and front-end maintenances to keep its operations running. The back-end maintenance includes database back-ups and retrievals. This can be done through distributed database computing and archiving or scheduled external operations for preventive and corrective purposes. Again, the front-end maintenance is mainly the link error corrections, where such occurs. Others would have to do with keeping the user computers up and running, also for preventive and corrective purposes.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 HRPMS Test Results

This section presented the system test and validation results following the Agile test approach. It also discussed the findings made in this work in terms of test and validation analyses, deployment, and conversion.

4.1.1 First Quadrant Test Result: System Construction

The HRPMS construction was tested following code iterations and plugins in each module and their integration into a whole system. Table 4.1 shows the test case and result for its first module code iteration. See others in **Appendix X**.

Table 4.1: Agile Test Case and Result for HRPMS Module One Code Iteration

HRPMS Project Test Case Script			(front sheet)
Project ID	FUTO IMT Ph.D. Work		
AUT Title	HRPMS	Version	v1.0
Iteration	01	Date of Test	07/07/2018
Test ID	01-Team-Standalone-01		
Purpose of Test	To ensure that: i. It is possible to navigate to the courses-&-units worksheet ii. It is possible to update all courses and units, view the whole update, and that it is legible		
Test Environment	The test environment is as follows: i. Client Hardware: Dell Inspiron Mini Laptop ii. Server: Nil iii. No other applications should be running on the laptop iv. The application should run with the login dialog box visible v. Prepared "login data" is held in C:\document\IMT\ handbook		
Test Steps	In the login dialog box, the tester should: i. Select the "Password" field and enter "admin" ii. Select the "OK" button or press the "Enter" key iii. Once the next screen appears, select the courses-&-units worksheet in the navigation pane		
Expected Result	On completing above steps, courses-&-units worksheet should display. i. Verify that all course codes, titles, units, semester totals, and program cumulative total are correct. ii. Verify that the contents of the courses-&-units worksheet are visible on the screen and legible		

Table 4.1 shows an example of test cases generated following standardized format from Cognizant Technology Solutions (CTS) to independently test the module units. Also, the integrated modules and subsystems were cumulatively tested. The test results are as recorded in Table 4.2 and Table 4.3.

Table 4.2: HRPMS Construction Test Results

S N	TESTS DONE	UNITS TESTED	TEST PROCEDURE	RESULTS OBTAINED
1	Component Test	Courses Update Module	-Input semester, sessions & Levels to associate with particular courses = done -Input course codes, titles, units based on LTP ratings = done -Save data = done	Passed
		Students Update Module	-Input students' names (full & with initials), reg. numbers, sex, date of birth, state, nationality, date of entry mode of entry, school or faculty, department & options = done -Sort alphabetically = done -Save data = done	Passed
		Results Comput-ation Module	-Input letter grades (A–F) for all students & courses (current & carryover) & auto-compute results = done -Save data = done -Prepare results for submission = done	Passed
		Reports Generat-ing Module	-Check auto-generated semester reports for the correctness of details = done -Prepare semester reports = done -Prepare graduation report = done	Passed
		Advisory Module	-Check generated omissions, carryovers & rectifications for advisory use = done -Match generated omissions, carryovers & rectifications for reference assessment = done	Passed
		Secured Group Socket Middle-ware Module	-Enter processor access password = done -Upload computed/corrected results/reports to HOD = done -Download rejected results and reports from HOD for corrections = done -Enter HOD password for access = done -Download results/reports from processors for vetting = done -Upload endorsed results/reports to Dean = done -Download rejected results/reports from Dean to correct = done -Enter Dean password for access = done -Download results/reports from HOD for vetting = done -Upload endorsed results/reports to DVCA = done -Download rejected results/reports from DVCA to correct = done -Upload rejected results/reports to HOD for correction = done -Enter DVC Acad. access password = done -Download results/reports from Dean for vetting = done -Upload endorsed results/reports to VC = done -Enter VC password for access = done -Download results/reports from DVCA = done -Approve Results/reports which auto-uploads to database = done	Passed
		Web Page Module	-Enter student reg. number to access semester results = done -View or print result = done	Passed

		Transcript Module	-Enter student's reg.no/generate transcript in one click = done -Process and return transcript = done	Passed
2	Subsystem Integration Test	Sub-system 1	-Check auto-transfer of courses and units from module 1 to modules 3, 4 & 5 where they are needed or used = done -Check auto-transfer of students' details from module 2 to modules 3, 4 & 5 where they are needed or used = done -Check auto-transfer between modules 3 for CGPAs from lower semester sub-modules to higher semester sub-modules as the previous GPAs = done	Passed
		Sub-system 2	-Upload results from module 6 to DB = done -Download results from DB to modules 7 & 8 = done	Passed
		DBMS Sub-Syst.	-Upload approved results data from subsystem 1 to DB thro subsystem 2 = done -Retrieve data from DB to subsystem 2 = done	Passed
3	Overall Integration Test	HRPMS	-Courses, students, and results data computed by subsystem 1 processed/managed through subsystem 2 to DBMS = done -Academic transcripts are end-products of HRPMS = done	Passed

Table 4.2 shows the results of the HRPMS module units and subsystems tested independently and collectively for their construction to see whether or not they are satisfactory. Where satisfactory, then they successfully passed. Table 4.3 gives the summary of the construction test.

Table 4.3: Summary of HRPMS Construction Test

TESTS DONE	UNITS TESTED	TEST PROCEDURE	REMARK
Component Test	Modules	Evaluate function-by-function components of modules 1, 2, 3, 4, 5, 6, 7 & 8 = done & passed	Codes & Plugins Construction Verified
Subsystem Integration Test	Subsystems 1, 2 & DBMS	Evaluate module-to-module input-output = done & passed	Subsystem Input-output Construction Verified
Overall System Integration Test	HRPMS	Evaluate final input-output operations of HRPMS subsystem 1, 2 & DBMS = done & passed	Final input-output Construction Verified
Component + Subsystem Integration + Overall System Integration tests all-done & all-passed = HRPMS Construction Verified; hence a Success,			

4.1.2 Second Quadrant Test Result: Functional Requirements

The HRPMS functional requirements were verified by testing. This was done by scripting them to show their workability. Where each was workable, it passed. Table 4.4 summarized the functional requirements test results, which show that the HRPMS user-based functional requirements passed as implemented.

Table 4.4: Summary of the HRPMS Functional Requirements Test Results

FUNCTIONAL REQUIREMENTS TESTED	TEST PROCEDURE	RESULT OBTAINED	REMARK
Courses Details Capturing	Evaluate whether course details are imputable and updatable = done	Input, update and verify the visibility of course codes, titles, units, and totals.	Passed
Students Details Capturing	Evaluate whether students details are imputable and updatable = done	Input, update, and visibility of students personal and academic details verified	Passed
Results Computation	Evaluate whether grades are imputable and updatable, and current, previous, cumulative TGP, TNU, GPA were auto-generated and correct = done	Input and update of grades, correctness, and visibility of the current, previous, and cumulative TGPs, TNUs and GPAs verified	Passed
Reports Generation	Evaluate whether semester and graduation reports are correctly generated = done	Correctness and visibility of semester and graduation reports verified	Passed
Reference Tracking	Evaluate whether omissions, carryovers, and rectifications are correctly generated=done	Correctness and visibility of omissions, carryovers, and rectifications verified	Passed
Results Retention Processing	Evaluate whether result files are transmittable through result processor, HOD, Dean, DVC Academics, and VC to the database and approved result retention folder = done	Transmission of results through result processor, HOD, Dean, DVC Academics, and VC to database and approved result folder verified	Passed
Results Checking	Evaluate whether results can be checked and printed using student details & PINs =done	Results checking and printing using students details and PINs verified	Passed
Transcripts Processing	Evaluate whether transcripts are generated, authenticated, and returned to emails supplied by graduates = done	Generation, authentication, and return of transcripts to emails supplied by graduates verified	Passed
System Administration	Evaluate whether system admin manages users, backs up the database, and generates PINs = done	User management, database backup, and PINs generation by system admin verified	Passed
The system user requirements test all-done & all-passed = All system functional requirements verified; and hence, technically validated.			

4.1.3 Third Quadrant Test Result: Cost Estimation

Using the generative (bottom-up) direct costing technique, the actual cost of the HRPMS development was determined. See the breakdown in Table 4.5.

Table 4.5: The HRPMS Development Actual Costing

COST COMPONENTS	ITEMS	SPECIFICA -TIONS	UNITS	HOURS / TIMES	RATE (₦)	UNITS-TOTAL(₦)	SUB-TOTAL(₦)	TOTAL (₦)
Hardware Cost	Computer Hardware	PCs	2		120,000	240,000	240,000	310,000
		Modems	2		15,000	30,000	30,000	
		Ext. 500GB HDD	2		20,000	40,000	40,000	
Software Cost	Computer Software	Office 2013	1		25,000	25,000	25,000	100,000
		Java IDE	1		20,000	20,000	20,000	
		MS POIs	1		15,000	15,000	15,000	
		Matlab & PHPDesigner	1		20,000	20,000	20,000	
		Antivirus	2		10,000	20,000	20,000	
Running Cost	Accounts	Cloud Service		1 yr	45,000	45,000	45,000	239,500
	Subscriptions	DB Hosting		1yr	45,000	45,000	194,500	
		Bundles		1yr	114,000 +30,500	144,500		
Documentation Cost	Data Collection	Questionnaire Preparation	3pp	360	5	5,400	16,200	223,600
		Data collation	3pp	360	10	10,800		
	Type & Print		150pp	10cps	30	45,000	45,000	
	Photocopies		150pp	30cps	10	45000	45000	
	Binding	Soft	30		80	2,400	9,400	
		Hard	10		700	7,000		
	Publication	Journals	2		54,000	108,000	108,000	
Training Cost	Physical Session		1		50,000	50,000	50,000	75,000
	Video Tutorial		1		25,000	25,000	25,000	
Travels Cost	Local runs	Imo	5		5,000	25,000	35,100	64,500
		Abia	3		500	1,500		
		Anambra	4		1,000	4,000		
		Enugu	4		1,000	4,000		
		Ebonyi	3		700	2,100		
	Inter-state Transport	To Abia	3		1,000	3,000	29,400	
		To Anambra	4		1,600	6,400		
		To Enugu	4		2,000	8,000		
		To Ebonyi	3		4,000	12,000		
Efforts Cost	Support Individuals	Project Manager	1	1800hr (5hr/da)	250	450,000	450,000	1,590,000
		Testers	360		1,000	360,000	360,000	
	Technical Teams	Development Team	2	1800hr coding	200	720,000	720,000	
		Stat. Team	2		30,000	60,000	60,000	
Grand Total								**2,602,600**

Comparing Table 4.5 (actual cost) with Table 3.6 (estimated cost), it can be seen that the actual development cost stood at about two million, six hundred and two thousand, six hundred naira (N2,602,600) as against the estimated cost of about three million, eight hundred and eighty-six thousand, three hundred naira (N3,886,300), while the annual running cost stood at about two hundred and thirty-nine thousand five hundred naira (N239,500) as against five hundred

and thirty-three thousand five hundred naira (N533,500). The costs were determined using the following cost components: hardware, software, running, documentation, training, travel, and efforts costs. The items costs are computer hardware and software devices and tools, accounts, subscriptions, data collection, typing and printing, photocopies, binding, publications, physical training session, video trainer, local runs, inter-state transport, support individuals, and technical teams. Table 4.6 presents the full comparison of the actual and estimated costs, while Figure 4.1 gives its analysis.

Table 4.6: Comparison of the HRPMS Estimated and Actual Development Cost

COST COMPONENTS	ESTIMATED COST (₦)	ACTUAL COST (₦)	REMARK
Hardware Cost	410,000	310, 000	Within estimate = Effective Cost
Software Cost	160,000	100,000	Within estimate = Effective Cost
Running Cost	533,500	239,500	Within estimate = Effective Cost
Documentation Cost	235,600	223,600	Within estimate = Effective Cost
Training Cost	150,000	75,000	Within estimate = Effective Cost
Travels Cost	117,200	64,500	Within estimate = Effective Cost
Efforts Cost	2,280,000	1,590,000	Within estimate = Effective Cost
Grand Total	3,886,300	2,602,600	**Effective Costs = Valid Cost**

The clustered bar chart analysis of cost validation results in Figure 4.1 shows that the HRPMS actual development and running costs are within the estimate. Therefore, the HRPMS development is cost-effective.

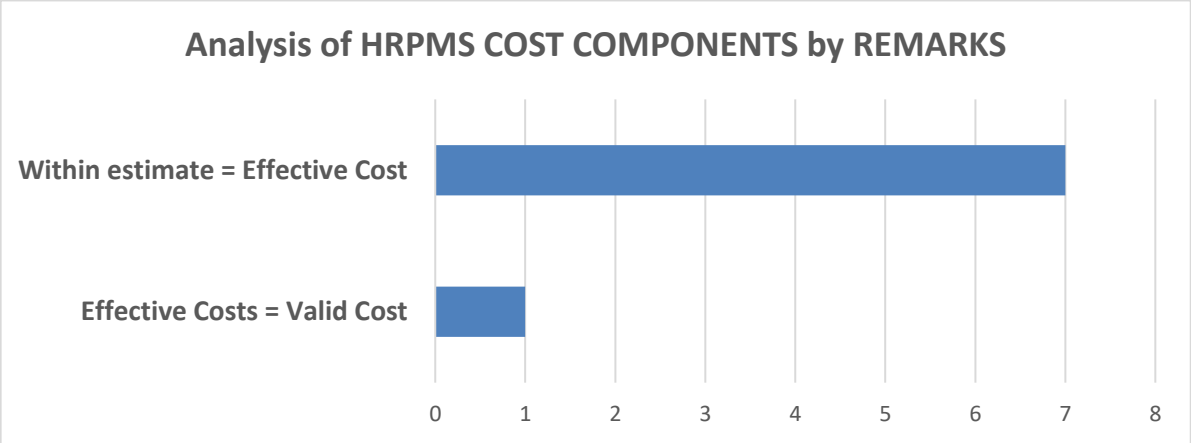


Figure 4.1: Clustered Bar Chart analysis of the HRPMS Cost Estimation

4.1.4 Fourth Quadrant Test Result: Improvement Validation

In the fourth or technology-facing test quadrant to critique the product, the HRPMS performance test was done through multivariate linear system statistical analysis and test of hypotheses. From the beta test stage, the multivariate linear system analysis of the HRPMS performance variables was done using: X_1 = Usefulness, X_2 = Ease of Access and Use, X_3 = Security and Confidentiality, X_4 = Processing Speed, X_5 = Computation Accuracy, X_6 = System Performance, and n_1 = 290 observations. The primary data sample obtained from the first round of the Delphi technique for the existing system (**see Appendix VI**), represents 81% of questionnaire returns. Thus, for i = 1, the mean vector ($\bar{X}_1$) of the existing system became:

$$\bar{X}_1 = \begin{bmatrix} {}_1\bar{X}_1 \\ {}_1\bar{X}_2 \\ {}_1\bar{X}_3 \\ {}_1\bar{X}_4 \\ {}_1\bar{X}_5 \\ {}_1\bar{X}_6 \end{bmatrix} = \begin{bmatrix} 14.77509 \\ 14.77855 \\ 14.77163 \\ 14.37370 \\ 14.95843 \\ 14.03460 \end{bmatrix}; \text{ and}$$

The layout matrix $(n_i - 1)S_i^2$ of the Existing system became:

$$(n_1 - 1)S_1^2 = \begin{bmatrix} 1788 & 350.2222 & 353.8728 & 272.9138 & -572.5234 & -508.1187 \\ 350.2222 & 1745.4 & 1310.1 & 1058.5 & -477.5326 & -266.201 \\ 353.8728 & 1310.1 & 1784.7 & 1079.3 & -475.5141 & -268.0363 \\ 272.9138 & 1058.5 & 1079.3 & 1317.1 & -469.3157 & -314.4477 \\ -572.5234 & -477.5326 & -475.5141 & -469.3157 & 2140.2 & -849.3187 \\ -508.1187 & -266.201 & -268.0363 & -314.4477 & -849.3187 & 974.7008 \end{bmatrix}$$

Again, with the same performance variables (X_1, X_2, X_3, X_4, X_5, X_6), and n_2 = 290 observations, another primary data sample was obtained from the second round of the Delphi technique for the HRPMS (**see Appendix VII**), and it also represents 81% questionnaire returns. Thus, for i = 2, the mean vector ($\bar{X}_1$) of the HRPMS became:

$$\bar{X}_2 = \begin{bmatrix} {}_2\bar{X}_1 \\ {}_2\bar{X}_2 \\ {}_2\bar{X}_3 \\ {}_2\bar{X}_4 \\ {}_2\bar{X}_5 \\ {}_2\bar{X}_6 \end{bmatrix} = \begin{bmatrix} 15.40138 \\ 17.43945 \\ 17.51557 \\ 16.86851 \\ 17.26644 \\ 17.22145 \end{bmatrix}; \text{ and}$$

The layout matrix $(n_i - 1)S_i^{\,2}$ of the HRPMS became:

$$(n_2 - 1)S_2^{\,2} = \begin{bmatrix} 2798.3 & -63.5630 & -61.5454 & -17.5164 & 1130.2 & -361.8877 \\ -63.5630 & 309.0193 & 254.0469 & 145.5144 & -51.9929 & -114.4587 \\ -61.5454 & 254.0469 & 245.3942 & 105.1454 & -55.1462 & -126.6188 \\ -17.5164 & 145.5144 & 105.1454 & 52.4774 & -56.1436 & -173.0584 \\ 1130.2 & -51.9929 & -55.1462 & -56.1436 & 2422.3 & -73.4086 \\ -361.8877 & -114.4587 & -126.6188 & -173.0584 & -73.4086 & 455.2814 \end{bmatrix}$$

The pooled (combined) data sample layout matrix $(n_1 + n_2 - 2)S$ for both the Existing system and the HRPMS with $n_1 = n_2 = 290$ observations became:

$$(n_1 + n_2 - 2)S = \begin{bmatrix} 4586.3 & 286.659 & 292.327 & 255.397 & 557.677 & -870.006 \\ 286.659 & 2054.419 & 1564.147 & 1204.014 & -529.526 & -380.66 \\ 292.327 & 1564.147 & 2030.094 & 1184.445 & -530.66 & -394.655 \\ 255.397 & 1204.014 & 1184.445 & 1369.577 & -525.459 & -487.506 \\ 557.677 & -529.526 & -530.66 & -525.459 & 4562.5 & -922.727 \\ -870.006 & -380.66 & -394.655 & -487.506 & -922.727 & 1429.982 \end{bmatrix}$$

The variance-covariance (information) matrix S for the pooled sample is thus:

$$S = \begin{bmatrix} 7.9348 & 0.4960 & 0.5058 & 0.4419 & 0.9648 & -1.5052 \\ 0.4960 & 3.5544 & 2.7061 & 2.0831 & -0.9161 & -0.6586 \\ 0.5058 & 2.7061 & 3.5123 & 2.0492 & -0.9181 & -0.6828 \\ 0.4419 & 2.0831 & 2.0492 & 2.3695 & -0.9091 & -0.8434 \\ 0.9648 & -0.9161 & -0.9181 & -0.9091 & 7.8936 & -1.5964 \\ -1.5052 & -0.6586 & -0.6828 & -0.8434 & -1.5964 & 2.4740 \end{bmatrix}$$

The inverse S^{-1} of the information matrix S became:

$$S^{-1} = \begin{bmatrix} 0.1429 & -0.00911 & -0.00774 & 0.02061 & 0.001185 & 0.09017 \\ -0.00911 & 0.7998 & -0.41447 & -0.35306 & -0.00054 & -0.02773 \\ -0.00774 & -0.41447 & 0.79136 & -0.31435 & 0.00910 & 0.00206 \\ 0.02061 & -0.35306 & -0.31435 & 1.14866 & 0.11203 & 0.29569 \\ 0.001185 & -0.00054 & 0.00910 & 0.11203 & 0.17112 & 0.15170 \\ 0.09017 & -0.02773 & 0.00206 & 0.29569 & 0.15170 & 0.65094 \end{bmatrix}$$

And, the determinant $|S|$ of the information matrix S gave: $|S| = 458.3894$.

Also, the difference in mean vector $(\bar{X}_1 - \bar{X}_2)$ of the two data samples became:

$$(\bar{X}_1 - \bar{X}_2) = \begin{bmatrix} -0.62629 \\ -2.66090 \\ -2.74394 \\ -2.49481 \\ -2.30801 \\ -3.18685 \end{bmatrix}; \text{ and}$$

$$(\bar{X}_1 - \bar{X}_2)^T = [-0.62629 - 2.66090 - 2.74394 - 2.49481 - 2.30801 - 3.18685]$$

i. Testing Hypothesis One

Fitting the Probability Distribution Function (PDF) density estimation model for this study gave:

$F(x_1,...,x_6,\mu,v) = (2\pi)^{-3} |S|^{-1/2} \exp[-1/2(\mu)^T S^{-1}(\mu)]$ = 1.043458X10^{-8}

Where: $-\infty < x < \infty$; $x_q; q = 1,...,6$; $p = 6$; $\mu = (\bar{X}_1 - \bar{X}_2) > 0$; $v = S$; $|S| = 458.3894$;

$$(\bar{X}_1 - \bar{X}_2)^T = [-0.62629 - 2.66090 - 2.74394 - 2.49481 - 2.30801 - 3.18685];$$

$$S^{-1} = \begin{bmatrix} 0.1429 & -0.00911 & -0.00774 & 0.02061 & 0.001185 & 0.09017 \\ -0.00911 & 0.7998 & -0.41447 & -0.35306 & -0.00054 & -0.02773 \\ -0.00774 & -0.41447 & 0.79136 & -0.31435 & 0.00910 & 0.00206 \\ 0.02061 & -0.35306 & -0.31435 & 1.14866 & 0.11203 & 0.29569 \\ 0.001185 & -0.00054 & 0.00910 & 0.11203 & 0.17112 & 0.15170 \\ 0.09017 & -0.02773 & 0.00206 & 0.29569 & 0.15170 & 0.65094 \end{bmatrix}; \text{ and}$$

$$(\bar{X}_1 - \bar{X}_2) = \begin{bmatrix} -0.62629 \\ -2.66090 \\ -2.74394 \\ -2.49481 \\ -2.30801 \\ -3.18685 \end{bmatrix}$$

Since: $F(x_q,\mu,v) = 1.043458X10^{-8} \neq 0$, $H_{O1} : F(x_q,\mu,v) = 0$ was rejected and $H_{A1} : F(x_q,\mu,v) \neq 0$ accepted; and it was concluded that the non-functional variable has a statistical and significant effect on system performance - though positive (direct) but slightly weak. Consequently, this confirmed that the non-functional requirement variables actually drive system performance.

Again, $PDF = F(x_q, \mu, v) = (2\pi)^{-p/2} \mid S \mid^{-1/2} \exp[-1/2(\mu)^T S^{-1}(\mu)] = 1.043458X10^{-8}$ is a prediction of the performance difference (P_D) of the HRPMS (from the existing system) based on a set of performance variables $(x_q; q = 1,..., p; p > 1)$ with dual-sample data (S_1 and S_2). The predicted P_D value ($1.043458X10^{-8}$); showed a positively performing (or improved) HRPMS. This validated the HRPMS non-functional requirements and system performance improvement statistically.

ii. Testing Hypothesis Two

Following from the already found and defined statistics and values, which includes: difference in mean $(\bar{X}_1 - \bar{X}_2)$, the inverse of the information matrix (S^{-1}), the difference in mean transpose $(\bar{X}_1 - \bar{X}_2)^T$, n_1, n_2, p and α;

Mahalanobi's D^2 statistic gave: $D^2 = \left(\bar{X}_1 - \bar{X}_2\right)^T S^{-1}\left(\bar{X}_1 - \bar{X}_2\right) = 19.6013$; and Hotelling's T^2 statistic gave: $T^2 = \frac{n_1 n_2}{n_1 + n_2} D^2 = \frac{290 \times 290}{580}(19.6013) = 2842.1885$

Thus, the calculated F statistic (F_{cal}) gave:

$$F_{cal} = \frac{n_1 + n_2 - p - 1}{p(n_1 + n_2 - 2)}.T^2 = \frac{290 + 290 - 6 - 1}{6(290 + 290 - 2)} \times 2842.1885 = 469.6004$$

Also, the Tabulated F statistic (F_{tab}) gave:

$$F_{tab} = F_{p,(n_1+n_2-p-1)}(\alpha) = F_{6,573}(0.05) = F_{6,600}(0.05) = 2.50$$

Comparing $F_{cal} = 469.6004$ and $F_{tab} = 2.50$, it was seen that $F_{cal} > F_{tab}$; hence $H_{O2} : \bar{X}_1 = \bar{X}_2$ was rejected, and $H_{A2} : \bar{X}_1 \neq \bar{X}_2$ accepted; and it was concluded that there is a significant difference between the mean performance of the existing single-platform system and the HRPMS. Therefore, the HRPMS is an improvement from the existing single-platform result system.

4.1.5 Summary of HRPMS Development Test Results

The final results and summary of the Agile quadrants testing and validation of the HRPMS development are as given in Table 4.7.

Table 4.7: Summary of the Agile Four-Quadrant Tests of HRPMS Development

AGILE TEST QUADRANTS	AREAS TESTED	RESULT OBTAINED	REMARK
First Test Quadrant	System Construction	Components and units integration & Interoperability tests all-done and all-passed	HRPMS is satisfactory in construction
Second Test Quadrant	System Functionalities	User needs/requirements test all-done and all-passed	HRPMS operations satisfy its functional requirements
Third Test Quadrant	System Cost Effectiveness	Actual development cost (₦2,602,600) is within estimate (₦3,886,300)	HRPMS development is cost effective
Fourth Test Quadrant	System Improvement	Mean P_D (HRPMS) is both positive and significant, and the non-functional variables actually drive its performance	HRPMS is improved, and its development is statistically valid

Cumulating the results of the Agile four-quadrant test on the HRPMS as shown in Table 4.7 implies that the HRPMS development was satisfactorily successful in terms of construction, functionality, cost-effectiveness, and improvement. Therefore the HRPMS development stands validated: $HRPMS_{\mathbf{Development}} = HRPMS_{\mathbf{Construction}} + HRPMS_{\mathbf{Functionlity}} + HRPMS_{\mathbf{Cost}} + HRPMS_{\mathbf{Improvement}}$ = valid.

4.2 Discussion of Findings

The findings made in the course of this work as discussed, are as follows:

i. Survey analysis of the existing result systems using the performance variables showed that the standalone system generally has a 5:1 strength-to-weakness ratio or 80% sufficiency and 20% deficiency. Also, the client-server system generally has a 2:3 strength-to-weakness ratio or 40% sufficiency and 60% deficiency. Cumulatively, the strength of the existing single-platform system is averagely 46.2%, while its weakness is averagely 53.8%. Conclusively, it implies that the single-platform result system is inherently deficient and none

of the two can independently carry out result processing and management adequately, but as a hybrid (**see section 3.1.2 & Figures 3.13-3.14**).

ii. The HRPMS framework was conceptualized, and the outcome was a metaheuristic hybrid (cross-platform) model that optimized and improved the deficiencies of the single platform model (**see section 3.1.2 & Figures 3.1-3.6**).

iii. The HRPMS modules were designed using the UML diagrams, producing high-level models, flowcharts, use case, class, and entity-relationship diagrams of the system input-output modules (**see section 3.7.1-3.7.6 & Figures 3.15-3.22**).

iv. The HRPMS modules were coded and configured using Excel VBA 2013, NetBeans 8.0 (a Java 8.0 IDE), PHPDesigner 8.0, and MySQL DBMS 5.4 program development platforms, which produced usable standalone and client-server modules input-output forms (**see section 3.3.1-3.3.2, 3.8.1-3.8.2, & Figures 3.23-3.41**).

v. Fitting the system Probability Distribution Function (PDF) gave a predicted value of $1.043458X10^{-8}$ which showed a positively performing (or improved) HRPMS (**see section 4.1.4 (i)**).

vi. Testing hypothesis one (1) showed that: $F(x_q, \mu, v) = 1.043458X10^{-8} \neq 0$, so $H_{O1} : F(x_q, \mu, v) = 0$ was rejected and $H_{A1} : F(x_q, \mu, v) \neq 0$ was accepted; and it was concluded that the non-functional variables have a significant positive but the slightly weak effect on system performance. Thus, confirming that the non-functional requirements actually drive system performance (**see section 4.1.4 (i)**).

vii. Also, testing hypothesis 2 compared $F_{cal} = 469.6004$ and $F_{tab} = 2.50$, and it was seen that $F_{cal} > F_{tab}$; hence $H_{O2} : \overline{X}_1 = \overline{X}_2$ was rejected and $H_{A2} : \overline{X}_1 \neq \overline{X}_2$ was accepted; and it was concluded that there is a significant difference between the mean performance of the existing single-platform system and the HRPMS. Thus, the HRPMS performed better (**see section 4.1.4 (ii)**).

viii. Consequently, cumulating the results of the Agile four-quadrant test on the HRPMS showed that the HRPMS development was successful in terms of construction, functionality, cost-effectiveness, and improvement:

$HRPMS_{Development}$ = $HRPMS_{Construction}$ + $HRPMS_{Functionlity}$ + $HRPMS_{Cost}$ + $HRPMS_{Improvement}$ = valid. Therefore the HRPMS development stand valid (**see section 4.1.1-4.1.4, Tables 4.1-4.7, & Figure 4.1**).

Conclusively, the contrast between the existing system and the HRPMS has been done in Table 4.8, which shows the areas of enhancement that differentiated the two of them (**see section 2.3.1-2.3.7 & Table 2.3**).

Table 4.8: Enhancements differentiating the HRPMS from the Existing System

S/N	EXISTING SYSTEM DEFICIENCIES OR SHORTFALLS	HRPMS ENHANCEMENTS
1	Youh (2010), Obiniyi, and Ezugwu (2010) used distributed database configuration	HRPMS used normalized and distributed database configuration
2	Eludire (2011) built a standalone system with MS-access DB that does not operate on the internet and has no global presence	HRPMS is a hybrid of standalone and client-server subsystems with relational DB that is more robust, operates over the internet, and has a global presence.
3	Ukem and Ofoegbu (2012) built a system that has online editing privileges, making it vulnerable to cyber-attacks	HRPMS has only offline editing privileges, making it much safer to cyber-attacks.
4	Obasi, *et. al.*, (2013) and Anyiam, *et. al.*, (2020) developed completely web-based systems, making it possible to track the URL address of the server thereby making it susceptible to cyber-attacks	HRPMS is based on a socket middleware application that does not work with URLs making it much safer to use.
5	Akinmosin (2014) developed a system that uses Oracle DBMS GUI, making it less user-friendly and requires more skills to operate or use	HRPMS uses MySQL DBMS / Java client program, making it more user-friendly and requires less skill to operate or use.
6	The web-based existing systems generally have difficulty computing legacy results and other complex computations involving borrowed courses and results correction	HRPMS can process legacy results, do complex extra year result computations and also compute current results

General comparisons of the development of the HRPMS against the development of the existing system reveals the following:

1. The HRPMS database normalization made it possible to host different database tables on different (two or more) database servers such that access to tables containing user details, PIN codes, and file upload details on one or

more servers will authenticate access to tables containing results data on another server. This will minimize if not eliminate the desperation for database injection attacks, by directing access to only databases that contain authenticating data while hiding the results data which are the main target of cybercriminals. These are not the case with the existing systems whose databases were not normalized to authenticate their access from each other.

2. The development of the cross-platform three-tier HRPMS subsystems comprising the results spreadsheet application (computation engine), the results transmission/vetting and approval application (socket middleware), and the results checking application (web page/portal) subsystems, conforms with the blockchain technology standard and principle. This boosts the system usability, ease of access and use by authentic users, processing speed of results, computation accuracy of results, and security and confidentiality of online systems by minimizing the vulnerability of the system to cyber-attacks based on decentralized processing with decentralized storage. These were not the considerations in the development of the existing systems.
3. The HRPMS development applied the four-quadrant system evaluation with the Multivariate Linear System (MLS) statistics for system performance improvement validation, based on two-sample Delphi data collected on both the existing systems and the HRPMS, showing a system performance improvement analysis based on both data combined. This is unlike the existing systems that used other evaluations like accuracy, precision, recall, and f1-score validations which are based on separate but comparable analyses of the existing and proposed systems.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Motivated by the problem statement that the available single-platform system models are seriously deficient and inadequate to drive the NUC's objective of attaining higher global ranking and competitiveness, this work set out to develop a hybrid result processing and management system for Nigerian universities. The study established some non-functional (performance) criteria by survey, for analyzing the existing and proposed systems. The jMeme MOF was used to hybridize and optimize the HRPMS standalone-internet objective functions (functionalities). The logical and physical structures of the HRPMS input-output modules were designed using UML objects. Some IDE tools were used to create, code, configure, link, and deploy the HRPMS subsystem modules, namely: Excel Binary VBA, Java 8.0 IDE, PHP 8.0 IDE, MySQL 5.7.31 DBMS, Apache 2.3.7 and PHP 5.6.40 web servers, and Core FTP 2.0 server. The HRPMS development was tested using the Agile four-quadrant test approach, featuring tests for system construction, functionality, cost-effectiveness, and system improvement by statistical validation.

Conclusively, the HRPMS provided an efficient, more secured, and improved process automation model for students' result processing and management in Nigerian universities. This model can stimulate a higher ranking of the Nigerian universities for global competitiveness. HRPMS offered a decentralized processing and management system, which is hard-to-crash, and produced redundant outputs that aids data recovery or comparison where necessary, especially in case of system or database compromise or data corruption. This minimized if not eliminate the risk of total system failure and data loss.

5.2 Recommendations

To deploy the HRPMS and get the best out of its use, the researcher made the following recommendation:

i. That, for best practice and maintenance of high data security, while deploying the HRPMS for use, Nigerian universities should make provision for both private and public servers to implement the normalized HRPMS database - where user authentication database is installed on the private server while results database is installed on the public server.

5.3 Contributions to Knowledge

The researcher made some achievements as contributions to the body of knowledge in the field of ICT and around the subject area. They are:

i. Developed and implemented a hybrid cross-platform socket middleware application model using JMeme metaheuristics optimization framework based on Java IDE and library, to optimize the process automation and management of students' results.
ii. Developed and applied a hybrid database emulator using MS POI and API plugins in Java IDE to map, parse & upload flat-file spreadsheet data into relational MySQL database.
iii. Leveraged the Agile methodology (both the Agile-Scrum software development model and the Agile four-quadrant test strategy), to develop and test the HRPMS construction, functionality, cost-effectiveness, and improvement validity.
iv. Validated the HRPMS as an improved development using the multivariate linear system statistics by fitting its Probability Distribution Function (PDF) model and using it to predict the mean Performance Difference ($P_D = 1.043458x10^{-8}$) of the HRPMS based on a set of variables (x_1-x_6) & Delphi dual-sample data.

v. Generally, enhanced students' result processing and management by reducing to the barest minimum, if not eliminate avoidable human errors and unnecessary delays inherent in result computation and transcript generation.

5.4 Suggested Areas of Further Work

This thesis work recognized the convergence of technologies, services, and processes as information system integration and process automation swiftly erode boundaries that separate functional platform groupings. Based on this, the following research areas are hereby suggested for further work:

i. Next Generation AI-Based Hybrid Enterprise Result System for Nigerian universities.

Furthermore, it is suggested that the modules and functionalities not yet developed become areas of continuing research. They include but not limited to:

i. The module for inputs emulation to achieve auto-uploads and updates of courses and students lists, match courses registered to students and grades.
ii. The module to notify vetters of receipt of results to vet in their inbox.
iii. The module to carry out automated system vetting of results.
iv. The module to generate automated outstanding reference report per student for academic monitoring and advisory purposes.
v. The module to carry out online archival and retrieval of students and graduates records to automatically verify students' admission and graduation records, even many years after school.

REFERENCES

Acampora, G., & Vitiello, A. (2016). jMeme: a Java library for designing competent memetic algorithms. In 2016 IEEE International Conference on Fuzzy Systems, 386-393.

Agile Alliance (2001). Manifesto for Agile Software Development. 1-70, https://www.agilealliance.org/agilemanifesto

Ahmed M. Z. (2010). Basic Concepts of UML. Lecture notes on Unified Modeling Language, MCA III, 1-20.

Akinmosin, J. (2014). Automated Students Result Management System Using Oracle's Database, Forms, and Reports. Journal of Information Engineering and Applications, 4 (11), 1-11. ISSN 2224-5782 (print), ISSN 2225-0506 (online), www.iiste.org.

Alba, E., Luque, G., & Nesmachnow, S. (2013). Parallel metaheuristics: recent advances and new trends. International Transactions in Operational Research, 20(1), 1-48.

Anyiam, O. O., Anyiam, F. N., Okengwu, U. A. (2020). An Enhanced Result Processing and Checking System for Public Universities using 2FA and TOTP. International Journal of Engineering Research and Technology (IJERT), 9(2), 261-266.

Asproth, V. (2012). Information technology challenges for long-term preservation of electronic information, International Journal of Public Information Systems, 1(1), 20-22.

Aveling, B. (2004). XP Lite Considered Harmful? Proceedings of the 5th International Conference of Extreme Programming and Agile Processes in Software Engineering, Springer, 94-103.

Avison, D., Lau, F., Myers, M., & Nielsen, P. (1999). Action Research. Communications of the Association of Computing Machinery (ACM), 42(1), 94-97.

Baltar, F., & Brunet, I. (2012). Social research 2.0: virtual snowball sampling method using Facebook. Internet Research, 22(1), 57-74.

Barua, A. (2013). Methods for decision-making in survey questionnaires based on the Likert scale. Journal of Asian Scientific Research, 3(1), 35.

Battiston, S., Farmer, J. D., Flache, A., Garlaschelli, D., Haldane, A. G., Heesterbeek, H., & Scheffer, M. (2016). Complexity theory and financial regulation. Science, 351(6275), 818-819.

Beka, A. P. & Beka, F. T. (2015). Automated Result Processing System: A Case Study of Nigerian University. International Journal for Research in Emerging Science and Technology (IJREST), 2(9), 51-68, E-ISSN: 2349-7610.

Ben-Arieh, P., & Qian, L. (2003). Activity-based Cost Management for Design and Development Stage. Int. J. Prod. Econ., 83 (2), 169-183.

Bernice B. (1968): Delphi Process: "A Methodology Used for the Elicitation of Opinions of Experts". RAND, 3925, 1-15. Retrieved on Oct 15th, 2017 from https://en.wikipedia.org/wiki/ Delphi_method

Boehm, B., & Turner, R. (2005). Management challenges to implement agile processes in traditional development organizations. IEEE Software, 22(5), 30-40.

Bolu, C., Adewumi, A. O., & Egbo, K. (2014). Towards Making World-Class Universities: Case Study of the role of Information and Communication Technology. International Journal of Advanced Research in IT and Engineering, 3(2), 9-25. ISSN: 2278-6244, www.garph.co.uk.

Boons, F., & Lüdeke-Freund, F. (2013). Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. Journal of Cleaner Production, 45, 9-19.

Chettri, B., Prasad, S. K., Sharma, B., & Manger, N. (2016). Accessing a Portion of MIS: Result Management, International Journal of Engineering Trends and Technology (IJETT), 34(5), 205-208, ISSN: 2231-5381, http://www.ijettjournal.org.

Chukwu, B. A. (2007). Panel data analysis of determinants of trade in Africa and Asia. Nigerian Journal of Economic and Social Studies, 49 (3), 1-15.

Cicirello, V. A. (2020). Chips-n-Salsa: A Java Library of Customizable, Hybridizable, Iterative, Parallel, Stochastic, and Self-Adaptive Local Search Algorithms. Journal of Open Source Software, 5(52), 1-5.

Costa, B. G., & Solis, P. (2018). Risk Perception of Migrating Legacy Systems to the Cloud. In CLOSER, 634-642.

Cover, T. M., & Thomas, J. A. (2012). Elements of information theory. John Wiley & Sons, 15-20.

Creswell, J. W. (2013). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications, 22-34.

Csikszentmihalyi, M., & Larson, R. (2014). Validity and reliability of the experience-sampling method, inflow, and the foundations of positive psychology. Springer Netherlands, 35-54.

Dada O., Raji A., Oyedepo F., Yusuf I., and Saka T. (2017). "Design and implementation of an integrated result processing system in a networked environment". British Standards Institution, 2 (5), 131-137.

DaSilva, I. F., Neto, P. A. D. M. S., O'Leary, P., de Almeida, E. S., & de LemosMeira, S. R. (2015). Using a multi-method approach to understand Agile software product lines. Information and Software Technology, 57, 527-542.

Deemer, P., Benefield, G., Larman, C., & Vodde, B. (2012). The Scrum Primer: A Lightweight Guide to the Theory and Practice of Scrum, Version 2.0. 3-16. http://www.infoq.com/minibooks/Scrum_Primer.

Demirkan, H., & Delen, D. (2013). Leveraging the capabilities of service-oriented decision support systems: Putting analytics and big data in the cloud. Decision Support Systems, 55 (1), 412-421.

Desouza, K. (2003). Facilitating Tacit Knowledge Exchange, Communications of the ACM, 46 (6), 85-88.

Douglas, D. & Glen, A. (2000). Planning Extreme Programming. Reading, MA: Addison-Wesley, 20-45.

Eke, B. O., & Nweke, O. E. (2016). An Efficient Cloud-Based Result Security System Using Digital Certificate. International Journal, 6 (3), 1-10.

Eludire, A. A. (2011). The Design and Implementation of Student Academic Record Management System. Research Journal of Applied Sciences, Engineering, and Technology, Maxwell Scientific Organization, 3 (8), 707-712, ISSN: 2040-7467.

Esawi, A., & Ashby, M. F. (2003). Cost Estimates to guide Pre-selection of Processes. Mater. Des. 24, (8), 605-616, DOI: 10.1016/50261-3069(03)00136-6.

Esiefarienrhe B. M., Adeiza, M. R., & Ejura, A. G. (2015). Development of Commuter Booking Software for Road Transport Company. Development, 120 (19), 10-17.

Ferro, E., Loukis, E. N., Charalabidis, Y., & Osella, M. (2013). Policymaking 2.0: From theory to practice. *Government Information Quarterly*, *30*(4), 359-368.

Fowler, M., & Highsmith, J. (2014). The agile manifesto (2001), 1-25, www. pmp-projects. org/Agile-Manifesto. pdf.

Givehchi, O., Landsdorf, K., Simoens, P., & Colombo, A. W. (2017). Interoperability for industrial cyber-physical systems: An approach for legacy systems. IEEE Transactions on Industrial Informatics, 13(6), 3370-3378.

Graham, C. R., Woodfield, W., & Harrison, J. B. (2013). A framework for institutional adoption and implementation of blended learning in higher education. The internet and higher education, 18, 4-14.

Griffiths, P. E., & Tabery, J. (2013). Developmental systems theory: What does it explain, and how does it explain it. Adv Child Dev Behav, 44, 65-94.

Grossman, T. A. (2006). Integrating Spreadsheet Engineering in a Management Science Course - A Hierarchical Approach". INFORMS Transactions on Education 7(1), 18-36, http://www.informs.org/Journal/ITE/Archive/Volume-7/Integrating Spreadsheet-Engineering-in-a-Management-Science-Course-A-Hierarchical-Approach.

Grossman, T. A., & Özlük, Ö. (2011). Spreadsheets Grow Up: Three Spreadsheet Engineering Methodologies for Large Financial Planning Models. San Francisco CA, 117-145.

Grossman, T. A., Mehrotra, V. & Özlük Ö. (2007). Lessons from Mission-Critical Spreadsheets, Communications of the Association for Information Systems 20(60), 1009-1042.

Gruler, A., Armas Adrián, J. D., Juan, A. A., & Goldsman, D. (2019). Modeling human network behavior using simulation and optimization tools: the need for hybridization. SORT: statistics and operations research transactions, 43(2), 193-222.

Gupta, S., Suhail, S., & Kumar, A. (2018). Migration from Standalone Legacy Systems to Thin Client-Server Architecture. In 2018 IEEE Second International Conference on Green Computing and Internet of Things (ICGCIoT), 414-417.

Hashim, Y., A. (2010). Determining Sufficiency of Sample Size in Management Survey Research Activities. International Journal of Organizational Management & Entrepreneurship Development, 6 (1), 119-130.

Hastie, S., & Wojewoda, S. (2017). Standish Group 2015 Chaos Report-Q & A with Jennifer Lynch, 1-25.

Hemmatian, H., Fereidoon, A., Sadollah, A., & Bahreininejad, A. (2013). Optimization of laminate stacking sequence for minimizing weight & cost using elitist & system optimization. Advances in Engineering Software, 57, 8-18.

Herzberg, B., & Sisombat, L. (2013). An Attempt to Develop a Global Indicator on Private-Sector Involvement in Public Policies and Strategies, State-Business Relations and Industrial Policy: Current Policy and Research Debates. London: Growth Research Prog., 1-25, https://static.squarespace.com/static/5167f6a2e4 b0f1 cbdee 8d 1c0,520.

Hill, R. (1998). What Sample Size is 'Enough' in Internet Survey Research? Interpersonal Computing and Technology: An electronic. Journal for the 21st Century, 2 (1), 15-30, http://www.emoderators.com/ipct-j/1998/n3-4/hill.hmtl

Hueber, C., Horejsi, K., & Schledjewski, R. (2016). Review of Cost Estimation: Methods and Models for Aerospace Manufacturing. Advanced Manufacturing Polymer and Composite Science (AMPCS), Vol. 2, No. 1, 1-13. ISSN: 2055-0340 (Print) 2055-0359 (Online). https://www.tandfonline.com/loi/yadm20.

International Records Management Trust (1999), "Preserving Records", 5(2), 12-21, http://www.irmt.org/documents/educ_training/...rec/IRMTpreserve_recs.doc

Isaias, P., & Issa, T. (2015). Information Systems Development Methodologies in High-Level Models and Methodologies for Information Systems. Springer New York, 41-61.

Ise, O. (2015). "A novel framework for student result computation as a cloud computing service". American Journal of Systems and Software, 3(1), 13-19.

Jarke, M., Lenzerini, M., Vassiliou, Y., & Vassiliadis, P. (2013). Fundamentals of data warehouses. Springer Science & Business Media, 11-20.

Karagiannis, D. (2015). Agile modeling method engineering. In Proceedings of the 19th Panhellenic Conference on Informatics, Association of Computing Machinery (ACM), 5-10.

Khan, P. M., & Beg, M. S. (2013). Extended decision support matrix for selection of SDLC models on traditional and agile software development projects. In 2013 Third International Conference on Advanced Computing and Communication Technologies (ACCT), 8-15.

Khanani, A. A., & Tayyab, M. E. (2014). Enhancement in existing agile methodology to counter the issues and challenges in the QA process. Journal of Independent Studies and Research, 12(1), 18-24.

Krejcie, R.V. & Morgan, D.W. (1970). Determining Sample Size for Research Activities. In Hill, R. (1998): "What Sample Size is 'Enough' in Internet Survey Research"? Interpersonal Computing and Technology: An Electronic Journal for the 21st Century, 13-25, http://www.emoderators.com/ipct-j/1998/n3-4/hill.hmtl.

Kroeneke, K., & Hattach F. (2000). SCRUM: A Pattern Language for Hyper productive Software Development, Pattern Languages of Program Design. Reading, MA: Addison-Wesley, 1-4.

Kronfeld, M., Planatscher, H., & Zell, A. (2010). The EvA2 optimization framework. In International Conference on Learning and Intelligent Optimization, Springer, Berlin, Heidelberg, 247-250.

Kumar, N., Zadgaonkar, A. S., & Shukla, A. (2013). Evolving a new software development life cycle model SDLC-2013 with client satisfaction. International Journal of Soft Computing and Engineering (IJSCE), 3 (1), 2231-2307.

Labra, J. G. B., Brewster, M., Tang, Z., Jimenez-Salgado, R., Waldman, L. F., Woo, J. W. Y., & Henderson, J. T. (2016). U.S. Patent No. 9, 292, 360. Washington, DC: U.S. Patent and Trademark Office, 20-35.

Leau, Y. B., Loo, W. K., Tham, W. Y., & Tan, S. F. (2012). Software development life cycle AGILE vs. traditional approaches. In International Conference on Information and Network Technology, 37(1), 162-167.

Madukosiri, C. H., & Bawo, D. S. (2012). Illness pattern and the relationship between the Prevalence of malaria and other infections in Niger Delta University. Agriculture and Biology Journal of North America, 2151-7525.

Magaji, A. S. (2015). An excel template for processing examination results for higher institutions in Nigeria. Science World Journal, 10(3), 22-31.

Mana, W., & Kanthawongs, P. (2012). Perceived Ease Of Use, Perceived Usefulness, and Self-Efficacy toward Course Quality of Hybrid Instruction Model. In IABE-2012 Venice-Summer Conference, 330-335.

Mangin, J. P. L., Bourgault, N., Guerrero, M. M., & Egea, J. M. (2011). Modeling perceived usefulness on adopting online banking through the tam model in a Canadian banking environment. Journal of Internet Banking and Commerce, 16 (1), 1-23.

Masila, C. K. (2014). Integrating Item Response Theory of testing for Quality Tests by Implementing an Online Item Development and Banking System for the Kenya National Examinations Council. Doctoral dissertation, University of Nairobi, 35-55.

Masrom S, Abidin SZZ, Omar N, Rizman ZI, Rahman ASA (2018). Scripting language design and the implementation test for pso-ga hybridizations. J. Fundam. Appl. Sci., 10(1S), 869-883.

Masrom, S., Abidin, S. Z., & Omar, N. (2012). Rapid and Flexible User-Defined Low-Level Hybridization for Metaheuristics Algorithm in Software Framework. International Journal of Software Engineering and Its Applications, 5(1), 873-882.

Masrom, S., Abidin, S. Z., Hashimah, P. N., & Rahman, A. A. (2011). Towards rapid development of user-defined metaheuristics hybridization. International Journal of Software Engineering and Its Applications, 5(2), 1-12.

Masrom, S., Rahman, A. S. A., Abidin, S. Z. Z., Omar, N., & Rizman, Z. I. (2017). The implementation frameworks of meta-heuristics hybridization with dynamic parameterization. Journal of Fundamental and Applied Sciences, 9(6S), 558-576.

Maxwell, J. A. (2012). Qualitative research design: An interactive approach: An interactive approach. Sage Publication, 22-43.

McKemmish, S. (2001). Placing records continuum theory and practice. Archival science, 1(4), 333-359.

Michaels, D. (2013). Scrum Agile framework for completing complex projects, Version 0.9. By Tutorials Point, 1-41, http://tutorialspoint.com.

Mills, J. A., Teplitsky, C., Arroyo, B., Charmantier, A., Becker, P. H., Birkhead, T. R., & Bushuev, A. (2015). Archiving primary data: solutions for long-term studies, Trends in ecology & evolution, 30 (10), 581-589.

Murray, J. (2013). Likert data: What to use, parametric or non-parametric? International Journal of Business and Social Science, 4 (11), 13-14.

Musil, J., Musil, A., & Biffl, S. (2013). Elements of software ecosystem early-stage design for collective intelligence systems. In Proceedings of the 2013 International Workshop on Ecosystem Architectures, Association of Computing Machinery (ACM), 21-25.

Nelson, M. R. (2009). Briefing Paper On Cloud Computing And Public Policy, Prepared For The Iccp Technology Foresight Forum1, 170-172.

Ngoepe, M. S. (2008). An exploration of records management trends in the South African public sector: A case study of the department of provincial and local government. M.Sc. Thesis submitted to Information Science department at the University of South Africa, 29-54, http://uir.unisa.ac.za/bitstream/handle/10500/2705/dissertation.ngoepe %20m.pdf?

Nkwocha, P. C. (2010). Educational research: Principles and applications. Owerri, Imo State: Kandid Gold Publishers, 40-45.

NUC Monday Bulletin (2020). A Publication of the Office of the Executive Secretary. 12 (23), 19-20, ISSN: 0795-3089.

Nwaomah, A. E. (2015). Information And Communication Technology (ICT) Usage on Students Records Management Effectiveness in the Nigerian Universities. IJournals: Int. Journal of Social Relevance & Concern (IJSRC) ISSN: 2347-9698, 3(6), 15-22.

Obasi N., Nwachukwu E. O., & Ugwu C. (2013). A Novel Web-Based Student Academic Records Information System, West African Journal of Industrial and Academic Research, 7 (1), 31-47.

Obiniyi, A. A., & Ezugwu, E., A. (2010). Design and Implementation of Students' Information System for Universities using Neural Networks: An Open Source Approach. International Journal of Green Computing, 1 (1), 1-15.

Okebukola, P., (2010). Fifty Years of Higher Education in Nigeria: Trends in Quality Assurance. Presentation at the International Conference on the Contributions of Nigerian Universities to the 50th Independence Anniversary of Nigeria, 27-29.

Oliveira, T., Thomas, M., & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors. Information & Management, 51 (5), 497-510.

Padakuu (2017): "Difference Between Manual and Automated System, Manual System vs Automated System". Padakuu online study center, 1-10. Retrieved on October 15th, 2017 from http://www.padakuu.com/article/1-difference-between-manual-and-automated-system-manual-system-vs-automated-system

Parejo, J. A., Ruiz-Cortés, A., Lozano, S., & Fernandez, P. (2012). Metaheuristic optimization frameworks: a survey and benchmarking. Soft Computing, 16(3), 527-561.

Peltz, C. (2003). Applying Design Issues and Patterns in Web Services. Dev. Resource Journal, 10-15, http://devresource.hp.com/drc/technical_articles/WSsuccess1.pdf.

Persson, V., & Nouri, J. (2018). A Systematic review of second language learning with mobile technologies. International Journal of Emerging Technologies in Learning, 13(2), 16-24.

Petroshius, S. M. (2015). The Marketing Research Principles Course: An Alternative Approach to the Client-Sponsored Project. In Proceedings of the 1987 Academy of Marketing Science (AMS) Annual Conference, Springer Inter. Publishing, 222-226.

Philips, S. (2014). The basics of the scrum; an introduction to the framework. By Scrum Inc., 2-9, http://scruminc.com.

Popovič, A., Hackney, R., Coelho, P. S., & Jaklič, J. (2012). Towards business intelligence systems success: Effects of maturity and culture on analytical decision making. Decision Support Systems, 54(1), 729-739.

Powell, S. & Baker, K. (2009). Management Science: The Art of Modeling with Spreadsheets. 2nd edition, John Wiley & Sons, 23-25.

Power, D. J., Sharda, R., & Burstein, F. (2015). Decision support systems. John Wiley & Sons, Ltd, 31-38.

Rad, N. K. & Turley, F. (2013). The Scrum Master Training Manual, A Guide to Passing the Professional Scrum Master (PSM) Exam, version 1.2. Published by Management Plaza, iPlazza N.V. Barbarastraat13 bus 1, 3120 Tremelo, Belgium, 10-84, http://mplaza.pm/product/scrum-master-training-manual/

Raffensperger, J. F. (2001). New Guidelines for Spreadsheets. Proceedings of the European Spreadsheet Risks Interest Group, Amsterdam, 61-76. http://arxiv4.library.cornell.edu/ftp/arxiv/papers/0807/0807.3186.pdf.

Reeder, L. (2014). Core Scrum v2014.08.15. By Scrum Alliance, 7401 Church Ranch Blvd. #210, Westminster, CO 80021 USA, 1-13, https://www.scrumalliance.org/why-scrum /core-scrum-values-roles

Reeder, L. (2015). What is Scrum Backgrounder? By Scrum Alliance, 7401 Church Ranch Blvd. #210, Westminster, CO 80021 USA, 1-2, https://www.scrumalliance.org/scrum/media/ScrumAllianceMedia/Public%20 Relations_2/What-is-Scrum-Backgrounder-2015.pdf

Ritchie, J., Lewis, J., Nicholls, C. M., & Ormston, R. (2013). Qualitative research practice: A guide for social science students and researchers. Sage Publications,12-16.

Roberge, V., Tarbouchi, M., & Okou, F. (2015). gpuMF: a framework for parallel hybrid metaheuristics on GPU with application to the minimization of harmonics in multilevel inverters. International Journal of Process Systems Engineering, 3(1-3), 20-41.

Roy, R. (2003). Cost Engineering: Why, What, and How? Decision Engineering Report (DEG) series, Cranfield, UK, 1-34. https://www.dspace.lib.cranfield.ac. uk/handle/1826/64.

Rush, C., & Roy, R. (2000). Analysis of cost estimating processes used within a concurrent engineering environment throughout a product life cycle. In 7th ISPE International Conference on Concurrent Engineering: Research and Applications, Lyon, France, July 17th-20th, Technomic Inc., Pennsylvania USA, 58-67.

Sagiroglu, S., & Sinanc, D. (2013). Big data: A review. In 2013 International Conference on Collaboration Technologies and Systems (CTS), 42-47.

Schubel, P., J. (2012). Cost Modelling in Polymer Composite Applications: Case study – Analysis of Existing and Automated Manufacturing Processes for a Large Wind Turbine Blade. Composites Part B, 43(3), 953-960, doi:10.1016/j.compositesb. 2011.11.036.

Schwaber, K., & Sutherland, J. (2014). Scrum Guide. By Scrum.org., 2-21, https://www. scrum.org/Resources/What-is-Scrum

Schwaber, K., & Sutherland, J. (2015). The Scrum Guide; The Definitive Guide to Scrum: The Rules of the Game. By Scrum.org and Scrum Inc., 3-16, https://www.scrum.org/ Resources/What-is-Scrum

Scot, R. (2007). Software Project Test Plan, Project: ADS – Ambulance Dispatch System. Software Development Journal, 5 (5), 21-31.

Shahzad, K. (2012). Requirements Prioritization In Sprint Via Time Quadrants. Journal of Independent Studies and Research, 10(2), 14.

Shepherd, E., & Yeo, G. (2011). Managing Records: A Handbook of Principles and strategic resource in the Government Ministries of Tanzania. Information Development, 27 (4), 264-278.

Shin, D. H. (2016). Cross-Platform Users' Experiences Toward Designing Interusable Systems. International Journal of Human-Computer Interaction, 1-12.

Sommerville, I. (2016). IEEE Software and Professional Development. IEEE Software, 33 (2), 90-92.

Sörensen, K., & Glover, F. (2013). Metaheuristics. *Encyclopedia of operations research and management science*, *62*, 960-970.

Spee, P., Jarzabkowski, P., & Smets, M. (2016). The influence of routine interdependence and skillful accomplishment on the coordination of standardizing and customizing. Organization Science, 27 (3), 759-781.

Spreadsheet Analytics (2010). Checking & Auditing in Spreadsheet Analytics: Resources for Spreadsheet Analysts. 1-25, http://www.usfca.edu/bps/ spreadsheet-analytics/development-management /checking-auditing.

Sun Microsystems (2004). Designing Web Services with the J2EE(TM) 1.4 Platform: JAX-RPC, SOAP, and XML Technologies. Sun Publications, 4 (6), 17-30. http://java.sun.com/blueprints/guidelines/designing_ webservices/html/

Theunissen, W., Boake, A., & Kourie, D. (2005). In search of the sweet spot: Agile open collaborative corporate software development. Proceedings of the 2005 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists on IT Research in Developing Countries, White River, South Africa, 268-277.

Ukem, E., O., & Ofoegbu, F., A. (2012). A Software Application for University Students Result Processing. Journal of Theoretical and Applied Information Technology, 35(1), 14-34. ISSN: 1992-8645 (print), E-ISSN: 1817-3195, www.jatit.org.

Upward, F. (1997). Structuring the records continuum, part two structuration theory, and record keeping. Archives and Manuscripts, 25 (1), 1-11.

Upward, F. (2000). Modeling the continuum as a paradigm shift in record keeping and archiving processes and beyond – a personal reflection. Records Management Journal, 10 (3), 115-139.

Urli, T. (2014). Hybrid metaheuristics for combinatorial optimization. A Ph.D. Thesis, 10-12. https://www.air.uniud.it.

Ward, J., & Peppard, J. (2016). The Strategic Management of Information Systems: Building a Digital Strategy. John Wiley & Sons, 18-23.

Wright, S., & Parchoma, G. (2011). Technologies for learning? An actor-network theory critique of 'affordances' in research on mobile learning. Research in Learning Technology, 19(3), 1-48.

Xu, X. (2012). From cloud computing to cloud manufacturing. Robotics and computer-integrated manufacturing, 28 (1), 75-86.

Yin, R. K. (2013). Case study research: Design and methods. Sage publications, 23-35.

Youh, D. X. (2010). Design and Implementation of a Client-Server Distributed Database for Student Result Processing. The Pacific Journal of Science and Technology, 11 (2), 288-295. http://www.akamaiUniversity.us/PJST.htm.

Zhang, Y., Wang, S., Dong, Z., Phillip, P., Ji, G., & Yang, J. (2015). Pathological brain detection in magnetic resonance imaging scanning by wavelet entropy and hybridization of biogeography-based optimization and particle swarm optimization. Prog Electromagn Res, 152, 41-58.

APPENDIX I

Krejcie and Morgan Table for Determining sample size from a finite population

N-----n	N-----n	N-----n	N-----n	N-----n
10-----10	100-----80	280-----162	800-----260	2800-----338
15-----14	110-----86	290-----165	850-----265	3000-----341
20-----19	120-----92	300-----169	900-----269	3500-----346
25-----24	130-----97	320-----175	950-----274	4000-----351
30-----28	140-----103	340-----181	1000-----278	4500-----354
35-----32	150-----108	360-----186	1100-----285	5000-----357
40-----36	160-----113	380-----191	1200-----291	6000-----361
45-----40	170-----118	400-----196	1300-----297	7000-----364
50-----44	180-----123	420-----201	1400-----302	8000-----367
55-----48	190-----127	440-----205	1500-----306	9000-----368
60-----52	200-----132	460-----210	1600-----310	10000-----370
65-----56	210-----136	480-----214	1700-----313	15000-----375
70-----59	220-----140	500-----217	1800-----317	20000-----377
75-----63	230-----144	550-----226	1900-----320	30000-----379
80-----66	240-----148	600-----234	2000-----322	40000-----380
85-----70	250-----152	650-----242	2200-----327	50000-----381
90-----73	260-----155	700-----248	2400-----331	75000-----382
95-----76	270-----159	750-----254	2600-----335	100000-----384

Source: Krejcie and Morgan (1970:608)

Where N= Population size and n= sample size required.

APPENDIX II

QUESTIONNAIRE (To be completed by UNIVERSITY STAFF only**)**

Dear Respondent,
I am a post-graduate student of Federal University of Technology Owerri (FUTO), carrying out a research survey on the title "**Hybrid Result Processing and Management System (HRPMS) for Nigerian Universities**". This questionnaire is to evaluate the performance of the existing students' result processing and management system in your university and this proposed system (HRPMS). Please carefully complete the questionnaire using your own university result system or the HRPMS as a reference point. The survey takes about 5minutes and we assure you that your responses will be kept strictly confidential and used for academic purposes only, and will be kept strictly confidential. Thank you for your cooperation.
Yours Sincerely,
Etus, Chukwuemeka (chukwuemeka.etus@futo.edu.ng; +2348066020623)

SECTION A: PERSONAL DATA OF RESPONDENT (Please Tick ✓ As Appropriate)

Your University is: Federal ☐ State ☐ Private ☐

Your Gender is: Male ☐ Female ☐

Your Age is: 18 – 25 years ☐ 26 – 33 years ☐ 34 - 41 years ☐
42 – 49 years ☐ 50 – 57 years ☐ Above 58 years ☐

Your Highest Educational status is: O'level & equivalent ☐ OND/NCE & equivalent ☐
HND/B.Sc./BA/BED or equiv. ☐ M.Sc./MA/MED or equiv. ☐ Ph.D. or equiv. ☐

You Work as: Data Processing Staff ☐ ICT Staff ☐ Registry Staff ☐
Academic/Class Adviser ☐ Administrative Staff ☐ Management Staff ☐

Your Years of Experience on the Job is:
Less than 1 Year ☐ 1 – 5 Years ☐ 6 – 10 Years ☐ 11 – 15 Years ☐
16 -20 Years ☐ 21 – 25 Years ☐ 26 – 30 Years ☐ Above 31 Years ☐

You can use your Institution's Result Processing & Management System /HRPMS for:
Doing Nothing ☐ Student Details Upload ☐ Course Details Upload ☐
OGR Result Upload ☐ Result Computation ☐ Course Advising ☐
Result Vetting ☐ Result Approval ☐ Transcript Processing ☐
School Fees Processing ☐ Course Registration ☐ Result Checking ☐

Others (Specify):…….....

.....

.....

SECTION B: ASSESSMENT OF YOUR INSTITUTION'SEXISTING STUDENTS' RESULT SYSTEM PLATFORM / THE HRPMS.

Please Tick ✓ to express your degree of agreement with each statement under each variable. There is no right or wrong answer. Just tick your answer in the corresponding box using scale of 1-5 below: Strongly Agree **(SA) = 5**, Agree **(A) = 4**, Undecided **(U) = 3**, Disagree **(D) = 2**, Strongly Disagree **(SD) = 1**.

X1	**Usefulness**	**SA**	**A**	**U**	**D**	**SD**
1	The system is useful for holding students' details & course details.					
2	The system is useful in computing students' all-semester results.					
3	The system is useful in vetting & approving students' results.					
4	The system is used in tracking student issues for academic advising.					
5	The system is used to prepare/access students' results & transcripts.					
X2	**Ease of Access & Use**	**SA**	**A**	**U**	**D**	**SD**
1	The system environments are easy to access & user-friendly.					
2	The system functions are easy to manipulate & use.					
3	The applications require simple IT skills & Training.					
4	The system makes all results computation & summary easy.					
5	The system makes transcript generation a one-click easy process.					
X3	**Security & Confidentiality**	**SA**	**A**	**U**	**D**	**SD**
1	The system is less vulnerable to Information Systems security threats.					
2	Data redundancy implemented in the system ensures data integrity.					
3	There is little or no possibility of grounding this system completely.					
4	The system is scalable to new security risks & new policies/standards.					
5	The system is completely secure and reliable to use.					
X4	**Processing Speed**	**SA**	**A**	**U**	**D**	**SD**
1	The system minimizes time wastage in results computation.					
2	The system quickens results transmission for vetting & approval.					
3	The system ensures faster tracking of students' outstandings.					
4	The system ensures prompt notifications to stakeholders.					
5	The system fastens students' transcripts preparation & processing.					
X5	**Computation Accuracy**	**SA**	**A**	**U**	**D**	**SD**
1	Using the system eliminated all common human errors.					
2	Using the system introduced little or no machine errors.					
3	The system guides users to ensure that valid inputs are made.					
4	The system guides users to ensure that valid outputs are received.					
5	The system computations/processes can always be trusted for accuracy.					
X6	**Existing System Performance or HRPMS Performance**	**SA**	**A**	**U**	**D**	**SD**
1	The system & its services are working well & its uptime is ok.					
2	The system is user-friendly & requires simple IT skills to operate it.					
3	The system is scalable & ensures good security & confidentiality.					
4	The system ensures faster results processing and management.					
5	The system ensures consistent computation accuracy & valid results.					

SECTION C: NEED FOR MORE PERFORMANCE IMPROVEMENT ON YOUR INSTITUTION'S STUDENTS' RESULT PROCESSING & MANAGEMENT SYSTEM OR THE HRPMS.

If you were asked to improve or further improve the performance of your Institution's students' result processing and management system platform / the HRPMS, you will:

1. Add more features & modules to the system platform to track course registration for stricter compliance, & result SMS notification to students & parents/guardians.
Yes ☐ No ☐

2. Develop and maintain in-house the students' result processing and management system for universities in Nigeria, to improve the results. Yes ☐ No ☐

3. Outsource the development and maintenance of the students' result processing and management system for universities in Nigeria, to improve the results.
Yes ☐ No ☐

4. Make the students' result processing and management system for universities in Nigeria an enterprise system, to improve the system and the results overall.
Yes ☐ No ☐

5. Develop a Community Cloud Network System for universities in Nigeria, to improve students' result processing and management in Nigerian universities.
Yes ☐ No ☐

6. Others (Specify):…….

.……...

……

……

……

……...

……

Again, thank you for your very kind corporation!

APPENDIX III

DATA FOR THE CALCULATION OF THE QUESTIONNAIRE RELIABILITY

Column Data Representing the 30 (Thirty) Statements of all the 6 (Six) Variables of the questionnaire instrument																															
Row Data Representing the 30 Respondents to the Questionnaire instrument for Validation	S/N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	1	4	3	2	3	4	3	4	4	1	4	4	3	4	3	3	3	4	3	2	4	4	3	4	3	3	3	4	3	2	4
	2	3	3	3	3	4	3	4	3	4	3	4	3	4	3	4	4	4	3	4	4	4	3	4	3	4	4	4	3	4	4
	3	3	4	4	2	1	4	3	4	4	3	3	4	4	4	4	3	4	4	4	3	3	4	4	4	4	3	4	4	4	3
	4	3	4	3	2	2	3	3	2	3	2	2	3	2	2	3	2	2	3	2	3	2	3	2	2	3	2	2	3	2	3
	5	3	4	3	3	4	4	4	3	4	4	3	2	3	3	3	3	4	4	3	4	3	2	3	3	3	3	4	4	3	4
	6	3	4	3	4	4	4	3	4	3	4	4	3	4	2	4	3	4	4	4	3	4	3	4	2	4	3	4	4	4	3
	7	4	3	1	3	1	4	2	3	1	4	4	3	4	2	4	3	4	3	2	4	4	3	4	2	4	3	4	3	2	4
	8	4	3	3	2	1	4	3	2	4	3	3	3	2	2	2	4	3	3	4	4	3	3	2	2	2	4	3	3	4	4
	9	4	4	4	3	4	3	3	2	3	3	3	3	2	2	1	3	4	3	2	2	3	3	2	2	1	3	4	3	2	2
	10	3	4	3	3	3	3	3	2	3	3	3	4	4	3	4	3	2	3	4	4	3	4	4	3	4	3	2	3	4	4
	11	4	4	3	3	4	4	4	3	4	2	4	4	3	3	3	2	3	4	4	3	4	4	3	3	3	2	3	4	4	3
	12	4	3	1	2	1	4	2	3	1	4	4	3	4	2	4	3	4	3	2	4	4	3	4	2	4	3	4	3	2	4
	13	4	3	1	2	1	4	2	3	1	4	4	3	4	2	4	3	4	3	2	4	4	3	4	2	4	3	4	3	2	4
	14	4	3	1	2	1	4	2	3	1	4	4	3	4	1	4	3	4	3	2	4	4	3	4	1	4	3	4	3	2	4
	15	4	3	1	2	1	4	2	3	1	4	4	3	4	2	4	3	4	2	3	4	4	3	4	2	4	3	4	2	3	4
	16	4	3	3	3	4	3	4	1	3	1	3	2	2	2	1	1	3	2	2	1	3	2	2	2	1	1	3	2	2	1
	17	4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	3	4	3	3	4	3	4	4	4	4	3	4	3	3	4
	18	4	3	4	3	4	4	3	4	3	4	1	3	2	1	1	4	3	2	1	4	1	3	2	1	1	4	3	2	1	4
	19	3	3	3	4	3	4	4	3	4	4	4	3	4	3	4	3	3	4	3	3	4	3	4	3	4	3	3	4	3	3
	20	4	4	3	3	4	4	4	3	4	2	1	3	1	1	4	2	3	4	3	4	1	3	1	1	4	2	3	4	3	4
	21	4	3	1	2	1	4	2	3	1	4	4	3	4	2	4	3	4	3	2	4	4	3	4	2	4	3	4	3	2	4
	22	4	3	4	3	2	3	3	3	3	3	4	4	3	4	3	4	3	3	4	4	4	4	3	4	3	4	3	3	4	4
	23	4	3	2	3	1	3	4	2	4	3	3	4	3	2	4	4	3	2	1	4	3	4	3	2	4	4	3	2	1	4
	24	4	4	3	3	2	4	3	2	2	1	3	1	3	1	4	3	3	3	2	2	3	1	3	1	4	3	3	3	2	2
	25	1	4	4	4	4	2	4	4	3	3	3	3	3	4	3	3	3	3	2	2	3	3	3	4	3	3	3	3	2	2
	26	4	4	2	1	4	4	4	3	3	3	3	2	2	2	4	4	3	4	4	1	3	2	2	2	4	4	3	4	4	1
	27	3	3	3	3	3	3	3	3	3	3	4	4	3	4	3	4	4	3	3	3	4	4	3	4	3	4	4	3	3	3
	28	4	4	4	4	4	4	4	4	3	4	4	3	3	4	4	4	3	4	4	3	4	3	3	4	4	4	3	4	4	3
	29	3	4	3	4	4	3	4	3	4	2	2	2	1	4	1	1	1	4	1	1	2	2	1	4	1	1	1	4	1	1
	30	3	4	3	4	3	4	4	3	4	3	4	3	4	3	3	4	3	3	3	3	4	3	4	3	3	4	3	3	3	3

APPENDIX IV

FORMULAR AND SAMPLE OUTPUTS OF QUESTIONNAIRE RELIABILITY VALIDATION BY CRONBACH ALPHA TECHNIQUE

$$\text{Cronbach's Alpha Reliability Coefficient } (\alpha) = \frac{N.\bar{c}}{\bar{v} + (N-1).\bar{c}}$$

Where: N = number of respondents = 30; $\bar{c}$ = average inter-item covariance among respondents = 0.124; and $\bar{v}$ = average variance among respondents = 0.8027.

$$\text{Therefore, } \alpha = \frac{N.\bar{c}}{\bar{v} + (N-1).\bar{c}} = \frac{30X0.124}{0.8027 + (30-1)X0.124} = \frac{3.72}{0.8027 + 3.596} = \frac{3.72}{4.3987} \cong 0.85$$

SPSS OUTPUT CONFIRMING RELIABILITY COEFFICIENT CALCULATION

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.846	.848	30

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum /Minimum	Variance	No. of Items
Item Variances	.803	.259	1.771	1.513	6.849	.110	30
Inter-Item Covariances	.124	-.564	1.099	1.663	-1.947	.075	30

APPENDIX V

EXISTING SINGLE-PLATFORM SYSTEM QUALITATIVE SURVEY OUTCOME TABLE

s/n	Performance Drivers	Survey Results	
		Microsoft-Based (Standalone) System Results	**Web-Based (Network) System Results**
1	Usefulness	a. Most useful in results computation than results transmission and storage. b. More useful in managing results correction and other extra year issues that are complex. c. Generally has equally high individual and institutional acceptance and usage.	a. Most useful in results transmission and storage than results computation. b. Less useful in managing results correction and other extra year issues that are complex. c. Generally has low Individual but high institutional acceptance and usage.
2	Ease of Access and Use	a. Easy to access any time and any day, all things being equal. b. Handles results of small-size student classes with ease. c. Less user-friendly. d. Requires more skills, time, and effort in training for users to be proficient. e. Easily Scalable. f. Needs the developer as supports staff for customized system maintenances.	a. Ease of access is limited by the availability of network connections for browsing. b. Handles results of large-size student classes with ease. c. More user-friendly. d. Requires less skills, time, and effort in training for users to be proficient. e. Not easily scalable. f. Needs database administrator for database and other backend maintenances.
3	Security and Confidentiality	a. System and data are highly secured since the system is not networked, and thrives on distributed results processing and distributed system administration. b. System and data are highly confidential since their security does not rely on third-party apparatus.	a. Relatively secured, since it is bedeviled by many online security threats, and thrives on centralized results processing and centralized system administration. b. System and data are relatively confidential since their security relies mostly on third-party apparatus.
4	Processing Speed	a. Speed of course registration depends on class advisers' and students' input speeds. b. Speed of results computation depends on grades input speed. c. Speed of results transmission and management depends on the speed of the bureaucratic processes of results vetting, approval, and retention. d. Reporting speed of results summaries, and transcript processing are automatically fast, with little delays.	a. Speed of course registration depends on class advisers' and students' input speeds. b. Speed of results computation depends on grades upload speed. c. Speed of results transmission and management depends on the speed of the bureaucratic processes of results vetting and approval only. d. Reporting speed of results summaries, and transcript processing are automatically very fast, with no delay.

5	Computation Accuracy	a. The accuracy of the computed results and the generated summaries and transcripts is very high. b. Distributed students' results processing and management, with distributed system administration, makes for better and more accurate error detection and correction c. Compliance with regulations and policy standards by the system processes and output formats can be trusted to be correct and free from errors to a very high degree.	a. The accuracy of the computed results and the generated summaries and transcripts is relatively high. b. Centralized students' results processing and management, with centralized system administration, makes for less good and less accurate error detection and correction. c. Compliance with regulations and policy standards by the system processes and output formats can be trusted to be correct and free from errors to a relatively high degree.

(Fieldwork)

SUMMARY IN TERMS OF STRENGTHS AND WEAKNESSES

Performance Drivers	**Microsoft-Based (Standalone) System Results**	**Web-Based (Internet) System Results**
Usefulness	strength	strength
	strength	Weakness
	strength	Weakness
Ease of Access and Use	strength	Weakness
	Weakness	strength
	Weakness	strength
	Weakness	strength
	strength	Weakness
	Weakness	strength
Security and Confidentiality	strength	Weakness
	strength	Weakness
Processing Speed	Weakness	strength
	Weakness	strength
	Weakness	strength
	Weakness	strength
Computation Accuracy	strength	Weakness
	strength	Weakness
	strength	Weakness

APPENDIX VI

DATA COLLECTED FOR THE EXISTING SYSTEM

S/N	Usefulness (X1)	Ease Access & Use (X2)	Security & Confidentiality (X3)	Processing Speed (X4)	Computation Accuracy (X5)	Existing System Performance (Y)
1	17	19	19	18	17	16
2	10	12	12	12	18	15
3	17	13	13	13	12	15
4	17	15	15	15	13	14
5	14	17	17	16	9	13
6	12	16	16	15	12	15
7	14	14	14	14	13	13
8	14	14	14	14	13	15
9	18	15	15	15	17	14
10	14	14	14	14	13	15
11	15	16	16	15	20	16
12	17	19	19	18	17	16
13	15	17	17	16	15	16
14	10	10	10	10	14	11
15	17	17	17	16	20	16
16	11	18	18	17	16	15
17	17	17	17	16	11	13
18	13	14	14	14	19	16
19	11	11	11	11	16	10
20	13	6	4	4	14	15
21	13	18	18	17	19	16
22	17	19	19	18	17	16
23	14	14	14	14	13	15
24	15	16	16	15	20	16
25	17	19	19	18	17	16
26	17	18	18	17	19	15
27	16	17	17	16	19	16
28	14	14	14	14	13	15
29	15	16	16	15	20	16
30	17	19	19	18	17	16
31	15	15	15	15	18	6
32	10	15	15	15	19	15
33	17	16	16	15	13	16
34	14	14	14	14	15	15
35	15	18	18	17	14	16
36	15	18	18	17	14	16
37	16	18	18	17	15	16
38	18	14	14	14	19	10
39	19	18	18	17	17	15
40	15	15	15	15	19	16
41	19	15	15	15	15	16
42	17	19	19	18	18	16
43	14	14	14	14	13	15
44	15	16	16	15	20	16
45	17	19	19	18	17	16
46	12	11	11	11	19	10
47	15	14	14	14	11	16
48	18	17	17	16	16	12
49	18	16	16	15	15	14
50	13	16	16	15	18	13

51	12	12	12	12	12	15
52	18	13	13	13	13	13
53	16	17	17	16	12	15
54	14	16	16	15	13	15
55	16	14	14	14	19	16
56	14	14	14	14	13	15
57	15	16	16	15	20	16
58	17	19	19	18	17	16
59	17	19	19	18	17	16
60	15	16	16	15	20	16
61	18	15	15	15	17	14
62	17	19	19	18	17	16
63	17	19	19	18	17	16
64	10	12	12	12	18	15
65	17	13	13	13	12	15
66	17	15	15	15	13	14
67	14	17	17	16	9	13
68	12	16	16	15	12	15
69	14	14	14	14	13	13
70	14	14	14	14	13	15
71	18	15	15	15	17	14
72	14	14	14	14	13	15
73	10	10	10	10	14	11
74	17	19	19	18	17	16
75	10	10	10	10	14	11
76	17	17	17	16	20	16
77	11	18	18	17	16	15
78	17	17	17	16	11	13
79	11	11	11	11	16	10
80	13	4	5	4	14	15
81	14	14	14	14	13	15
82	17	18	18	17	19	15
83	16	17	17	16	19	16
84	14	14	14	14	13	15
85	15	15	15	15	18	6
86	10	15	15	15	19	15
87	14	14	14	14	15	15
88	18	14	14	14	19	10
89	19	18	18	17	17	15
90	14	14	14	14	13	15
91	12	11	11	11	19	10
92	18	17	17	16	16	12
93	18	16	16	15	15	14
94	13	16	16	15	18	13
95	12	12	12	12	12	15
96	18	13	13	13	13	13
97	16	17	17	16	12	15
98	14	16	16	15	13	15
99	14	14	14	14	13	15
100	18	15	15	15	17	14
101	20	19	19	18	16	13
102	10	12	12	12	18	15
103	17	13	13	13	12	15
104	17	15	15	15	13	14
105	14	17	17	16	9	13
106	12	16	16	15	12	15
107	14	14	14	14	13	13
108	14	14	14	14	13	15
109	18	15	15	15	17	14
110	14	14	14	14	13	15
111	10	10	10	10	14	11

112	10	12	12	12	18	15
113	17	13	13	13	12	15
114	17	15	15	15	13	14
115	14	17	17	16	9	13
116	12	16	16	15	12	15
117	14	14	14	14	13	13
118	14	14	14	14	13	15
119	18	15	15	15	17	14
120	14	14	14	14	13	15
121	10	10	10	10	14	11
122	11	18	18	17	16	15
123	17	17	17	16	11	13
124	11	11	11	11	16	10
125	13	4	4	5	14	15
126	14	14	14	14	13	14
127	17	18	18	17	19	15
128	20	19	19	18	16	13
129	14	14	14	14	13	15
130	15	15	15	15	18	6
131	10	15	15	15	19	15
132	14	14	14	14	15	15
133	18	14	14	14	19	10
134	14	14	14	14	13	15
135	12	11	11	11	19	10
136	18	17	17	16	16	12
137	18	16	16	15	15	14
138	13	16	16	15	18	13
139	12	12	12	12	12	15
140	18	13	13	13	13	13
141	16	17	17	16	12	15
142	14	16	16	15	13	15
143	14	14	14	14	13	15
144	18	15	15	15	17	14
145	20	19	19	18	16	13
146	17	13	13	13	12	15
147	17	15	15	15	13	14
148	14	17	17	16	9	13
149	12	16	16	15	12	15
150	14	14	14	14	13	13
151	14	14	14	14	13	15
152	18	15	15	15	17	14
153	20	19	19	18	16	13
154	14	14	14	14	13	15
155	10	10	10	10	14	11
156	17	19	19	18	17	16
157	10	10	10	10	14	11
158	17	17	17	16	20	16
159	11	18	18	17	16	15
160	17	17	17	16	11	13
161	13	14	14	14	19	16
162	11	11	11	11	16	10
163	13	5	4	4	14	15
164	14	14	14	14	13	15
165	17	18	18	17	19	15
166	16	17	17	16	19	16
167	14	14	14	14	13	15
168	15	15	15	15	18	6
169	10	15	15	15	19	15
170	17	16	16	15	13	16
171	14	14	14	14	15	15
172	18	14	14	14	19	10

173	19	18	18	17	17	15
174	14	14	14	14	13	15
175	12	11	11	11	19	10
176	15	14	14	14	11	16
177	18	17	17	16	16	12
178	18	16	16	15	15	14
179	13	16	16	15	18	13
180	12	12	12	12	12	15
181	18	13	13	13	13	13
182	16	17	17	16	12	15
183	14	16	16	15	13	15
184	16	14	14	14	19	16
185	14	14	14	14	13	15
186	18	15	15	15	17	14
187	10	12	12	12	18	15
188	17	13	13	13	12	15
189	17	15	15	15	13	14
190	14	17	17	16	9	13
191	12	16	16	15	12	15
192	14	14	14	14	13	13
193	14	14	14	14	13	15
194	18	15	15	15	17	14
195	14	14	14	14	13	15
196	10	10	10	10	14	11
197	10	12	12	12	18	15
198	17	13	13	13	12	15
199	17	15	15	15	13	14
200	14	17	17	16	9	13
201	12	16	16	15	12	15
202	14	14	14	14	13	13
203	14	14	14	14	13	15
204	15	16	16	15	20	16
205	18	15	15	15	17	14
206	14	14	14	14	13	15
207	10	10	10	10	14	11
208	17	17	17	16	20	16
209	11	18	18	17	16	15
210	17	17	17	16	11	13
211	13	14	14	14	19	16
212	11	11	11	11	16	10
213	13	4	4	4	13	15
213	14	14	14	14	13	15
215	15	15	15	15	18	6
216	10	15	15	15	19	15
217	17	16	16	15	13	16
218	14	14	14	14	15	15
219	18	14	14	14	19	10
220	19	18	18	17	17	15
221	14	14	14	14	13	15
222	12	11	11	11	19	10
223	15	14	14	14	11	16
224	18	17	17	16	16	12
225	18	16	16	15	15	14
226	13	16	16	15	18	13
227	12	12	12	12	12	15
228	18	13	13	13	13	13
229	16	17	17	16	12	15
230	14	16	16	15	13	15
231	16	14	14	14	19	16
232	14	14	14	14	13	15
233	18	15	15	15	17	14

234	10	12	12	12	18	15
235	17	13	13	13	12	15
236	17	15	15	15	13	14
237	14	17	17	16	9	13
238	12	16	16	15	12	15
239	14	14	14	14	13	13
240	14	14	14	14	13	15
241	18	15	15	15	17	14
242	14	14	14	14	13	15
243	10	10	10	10	14	11
244	10	10	10	10	14	11
245	11	18	18	17	16	15
246	17	17	17	16	11	13
247	13	14	14	14	19	16
248	11	11	11	11	16	10
249	17	18	18	17	19	15
250	20	19	19	18	16	13
251	14	14	14	14	13	15
252	15	15	15	15	18	6
253	10	15	15	15	19	15
254	17	16	16	15	13	16
255	14	14	14	14	15	15
256	18	14	14	14	19	10
257	19	18	18	17	17	15
258	14	14	14	14	13	15
259	12	11	11	11	19	10
260	15	14	14	14	11	16
261	18	17	17	16	16	12
262	18	16	16	15	15	14
263	13	16	16	15	18	13
264	12	12	12	12	12	15
265	18	13	13	13	13	13
266	16	17	17	16	12	15
267	14	16	16	15	13	15
268	16	14	14	14	19	16
269	14	14	14	14	13	15
270	18	15	15	15	17	14
271	20	19	19	18	16	13
272	10	12	12	12	18	15
273	17	13	13	13	12	15
274	17	15	15	15	13	14
275	14	17	17	16	9	13
276	12	16	16	15	12	15
277	14	14	14	14	13	13
278	14	14	14	14	13	15
279	18	15	15	15	17	14
280	14	14	14	14	13	15
281	10	10	10	10	14	11
282	10	12	12	12	18	15
283	17	13	13	13	12	15
284	17	15	15	15	13	14
285	14	17	17	16	9	13
286	12	16	16	15	12	15
287	14	14	14	14	13	13
288	14	14	14	14	13	15
289	15	16	16	15	20	16
290	18	15	15	15	17	14

APPENDIX VII

DATA COLLECTED FOR THE HRPMS

S/N	Usefulness (X1)	Ease & Access & Use (X2)	Security & Confidentiality (X3)	Processing Speed (X4)	Computation Accuracy (X5)	HRPMS Performance (Y)
1	17	19	19	18	17	16
2	14	15	15	15	18	17
3	18	17	17	17	19	18
5	18	16	16	16	19	17
6	17	18	18	17	19	19
7	17	17	17	17	20	17
8	13	18	18	17	16	18
9	15	20	20	19	24	18
10	19	18	18	17	23	18
11	18	19	19	18	19	17
12	19	19	19	18	16	18
13	10	18	18	17	17	18
14	13	15	16	15	18	17
15	12	16	16	16	16	17
16	15	18	18	17	15	19
17	9	18	18	17	13	17
`18	14	16	16	16	15	19
19	10	12	12	12	18	15
20	17	13	13	13	12	15
21	17	15	15	15	13	14
22	14	17	17	17	9	13
23	12	16	16	16	12	15
24	14	14	14	14	13	13
25	16	19	19	18	19	20
26	20	19	19	18	16	13
27	14	14	14	14	13	15
28	17	17	17	17	17	17
29	15	16	16	16	20	16
30	6	18	18	17	9	18
31	18	15	15	15	17	14
32	6	18	18	17	17	17
33	16	15	15	15	18	17
34	15	18	18	17	15	19
35	9	18	18	17	13	17
36	14	16	16	16	15	19
37	16	19	19	18	19	20
38	20	19	19	18	16	13
39	14	14	14	14	13	15
40	17	17	17	17	17	17
41	15	16	16	16	20	16
42	6	18	18	17	9	18
43	17	19	19	18	17	16
44	14	15	15	15	18	17
45	18	17	17	17	19	18
46	18	16	16	16	19	17
47	17	18	18	17	19	19
48	17	17	17	17	20	17
49	13	18	18	17	16	18
50	15	20	20	19	24	18
51	19	18	18	17	23	18

51	18	19	19	18	19	17
53	19	19	19	18	16	18
54	10	18	18	17	17	18
55	16	19	19	18	18	19
56	17	18	18	17	20	17
57	11	15	15	15	19	17
58	15	17	17	17	15	16
59	10	18	17	17	14	18
60	17	17	17	17	20	16
61	14	16	16	16	7	18
62	11	18	18	17	16	15
63	17	17	17	17	11	13
64	13	14	14	14	19	16
65	11	18	17	17	16	17
66	20	19	20	18	20	20
67	13	18	18	17	19	16
68	13	18	18	17	16	18
69	15	20	20	19	24	18
70	19	18	18	17	23	18
71	18	19	19	18	19	17
72	19	19	19	18	16	18
73	10	18	18	17	17	18
74	17	19	19	18	17	16
75	14	15	18	15	18	17
76	18	17	17	17	19	18
77	18	16	16	16	19	17
78	17	18	18	17	19	19
79	17	17	17	17	20	17
80	15	18	18	17	15	19
81	9	18	18	17	13	17
82	14	16	16	16	15	19
83	16	19	19	18	19	20
84	20	19	19	18	16	13
85	14	14	16	14	13	15
86	17	17	17	17	17	17
87	15	16	16	16	20	16
88	6	18	18	17	9	18
89	17	19	19	18	17	16
90	14	15	17	15	18	17
91	18	17	17	17	19	18
92	18	16	16	16	19	17
93	17	18	18	17	19	19
94	17	17	17	17	20	17
95	13	18	18	17	16	18
96	15	20	20	19	20	18
97	19	18	18	17	23	18
98	18	19	19	18	19	17
99	19	19	19	18	16	18
100	10	18	18	17	17	18
101	19	18	18	17	19	19
102	17	18	18	17	19	15
103	17	18	18	17	18	18
104	20	17	17	17	18	17
105	16	18	18	17	16	18
106	16	19	19	18	18	19
107	19	17	17	17	18	18
108	16	17	17	17	19	19
109	16	17	17	17	19	16
110	19	19	19	18	17	18
111	17	20	20	19	18	18
112	15	18	18	17	15	17

113	17	19	19	18	18	18
114	18	19	19	18	19	18
115	19	17	17	17	18	17
116	15	18	18	17	15	19
117	9	18	18	17	13	17
118	14	16	16	16	15	19
119	16	19	19	18	19	20
120	20	19	19	18	16	13
121	14	16	16	16	16	15
122	17	17	17	17	17	17
123	15	16	16	16	20	16
124	6	18	18	17	9	18
125	17	19	19	18	17	16
126	14	15	17	15	18	17
127	18	17	17	17	19	18
128	18	16	16	16	19	17
129	17	18	18	17	19	19
130	17	17	17	17	20	17
131	13	18	18	17	16	18
132	15	20	20	19	24	18
133	19	18	18	17	23	18
134	18	19	19	18	19	17
135	19	19	19	18	16	18
136	10	18	18	17	17	18
137	19	19	19	18	17	18
138	18	17	17	17	18	17
139	15	18	18	17	18	19
140	17	18	18	17	15	17
141	14	16	16	16	18	17
142	14	19	19	18	15	18
143	15	15	17	15	18	17
144	10	15	15	15	19	15
145	15	17	17	17	14	18
146	17	16	16	16	13	16
147	14	16	17	16	15	17
148	15	18	18	17	14	16
149	12	17	17	17	15	18
150	18	15	17	15	15	19
151	15	18	18	17	14	16
152	16	18	18	17	15	16
153	18	16	16	16	19	10
154	19	17	17	17	18	18
155	16	18	18	17	20	18
156	18	17	17	17	15	17
157	19	18	18	17	17	15
158	18	19	19	18	19	19
159	15	15	15	15	19	16
160	16	15	17	15	17	18
161	19	15	15	15	15	16
162	18	17	17	17	24	18
163	19	18	18	17	23	18
164	17	19	19	18	19	17
165	18	19	19	18	17	18
166	17	19	19	18	18	16
167	15	18	18	17	15	19
168	9	18	18	17	13	17
169	14	16	16	16	15	19
170	16	19	19	18	19	20
171	20	19	19	18	16	13
172	14	16	17	16	13	15
173	17	17	17	17	17	17

174	15	16	16	16	20	16
175	6	18	18	17	9	18
176	17	19	19	18	17	16
177	14	15	15	15	18	17
178	18	17	17	17	19	18
179	18	16	16	16	19	17
180	17	18	18	17	19	19
181	17	17	17	17	20	17
182	13	18	18	17	16	18
183	15	20	20	19	24	18
184	19	18	18	17	23	18
185	18	19	19	18	19	17
186	19	19	19	18	16	18
187	10	18	18	17	17	18
188	17	17	17	17	19	18
189	17	18	18	17	19	17
190	18	18	18	17	19	19
191	12	17	17	17	16	17
192	10	18	18	17	16	18
193	12	17	18	17	19	10
194	15	16	16	16	15	16
195	18	17	17	17	16	12
196	18	16	16	16	15	14
197	17	18	18	17	15	18
198	13	16	16	16	18	13
199	16	17	17	17	15	15
200	18	17	18	17	16	17
201	14	15	15	15	9	20
202	16	17	17	17	12	15
203	14	16	16	16	13	15
204	16	18	17	17	19	19
205	20	19	19	18	16	18
206	15	18	18	17	15	19
207	9	18	18	17	13	17
208	14	16	16	16	15	19
209	16	19	19	18	19	20
210	20	19	19	18	16	13
211	14	14	14	14	13	15
212	17	17	17	17	17	17
213	15	16	17	16	20	16
214	6	18	18	17	9	18
215	17	19	19	18	17	16
216	14	15	16	15	18	17
217	18	17	17	17	19	18
218	18	16	16	16	19	17
219	17	18	18	17	19	19
220	17	17	17	17	20	17
221	13	18	18	17	16	18
222	15	20	20	19	24	18
223	19	18	18	17	23	18
224	18	19	19	18	19	17
225	19	19	19	18	16	18
226	10	18	18	17	17	18
227	17	19	19	18	17	16
228	14	15	15	15	18	17
229	18	17	17	17	19	18
230	18	16	16	16	19	17
231	17	18	18	17	19	19
232	17	17	17	17	20	17
233	13	18	18	17	16	18
234	15	20	20	19	24	18

235	19	18	18	17	23	18
236	18	19	19	18	19	17
237	19	19	19	18	16	18
238	10	18	18	17	17	18
239	13	15	16	15	18	17
240	12	16	16	16	16	17
241	15	18	18	17	15	19
242	9	18	18	17	13	17
243	14	16	16	16	15	19
244	17	17	17	17	17	17
245	15	16	16	16	20	16
246	16	18	18	17	19	18
247	18	18	19	17	17	19
248	6	18	18	17	17	17
249	16	15	15	15	18	17
250	15	18	18	17	15	19
251	9	18	18	17	13	17
252	14	16	16	16	15	19
253	16	19	19	18	19	20
254	20	19	19	18	16	13
255	6	18	18	17	9	18
256	17	19	19	18	17	16
257	14	15	15	15	18	17
258	18	17	17	17	19	18
259	18	16	16	16	19	17
260	17	18	18	17	19	19
261	17	17	17	17	20	17
262	13	18	18	17	16	18
263	15	20	20	19	24	18
264	19	18	18	17	23	18
265	18	19	19	18	19	17
266	19	19	19	18	16	18
267	10	18	18	17	17	18
268	10	18	17	17	17	17
269	17	18	18	17	20	17
270	11	15	15	15	19	17
271	13	18	18	17	16	18
272	15	20	20	19	24	18
273	19	18	18	17	23	18
274	18	19	19	18	19	17
275	19	19	19	18	16	18
276	10	18	18	17	17	18
277	17	19	19	18	17	16
278	14	15	15	15	18	17
279	18	17	17	17	19	18
280	18	16	16	16	19	17
281	17	18	18	17	19	19
282	17	17	17	17	20	17
283	15	18	18	17	15	19
284	9	18	18	17	13	17
285	14	16	16	16	15	19
286	16	19	19	18	19	20
287	6	18	18	17	9	18
288	17	19	19	18	17	16
289	14	15	16	15	18	17
290	18	17	17	17	19	18

APPENDIX VIII

SAMPLE SOURCE CODES OF THE HRPMS MODULES

A. Excel VBA Program Sample Source Codes

```
=IF(OR(B9="",C9="",D9="",E9="",F9=""),"",SUM(D9,E9,F9))

=IF(COUNTA(B9:B23)=0,"",COUNTA(B9:B23))

=IF(COUNTA(B9:B23)=0,"",SUM(G9:G23))

=IF(SUM(B24,I24,B45,I45,B66,I66,B87,I87,B108,I108,B129,I129,B150,I150,B171,I171)=0,"",SUM(B24,I24,B45,I45,B66,I66,B87,I87,B108,I108,B129,I129,
B150,I150,B171,I171))-2

=IF('CLASS-LIST'!$E13=0, "", 'CLASS-LIST'!$E13)

=IF(AND(F8="",I8="",L8="",O8="",R8="",U8="",X8="",AA8="",AD8="",AG8="",AJ8="",AM8="",AP8="",AS8="",AV8="",AY8=""),"",IF(SUM(H8,K8,N
8,Q8,T8,W8,Z8,AC8,AF8,AI8,AL8,AO8,AR8,AU8,AX8,BA8)>=0,SUM(H8,K8,N8,Q8,T8,W8,Z8,AC8,AF8,AI8,AL8,AO8,AR8,AU8,AX8,BA8),""))

=IFERROR(BB8+BE8,IF(AND(BB8="",BE8=""),"",BE8))

='CLASS-INFO'!$M$8&"  ("&'COURSES-&-UNITS'!$H$3&")"

=IF(D8="","",IF(EC8=EA8,"FINAL YEAR",IF('YR-7-2ND'!DW8="",IF('YR-7-1ST'!EF8="",IF('YR-6-2ND'!DW8="",IF('YR-6-1ST'!EF8="",IF('YR-5-
2ND'!DW8="",IF('YR-5-1ST'!EF8="",IF('YR-4-2ND'!V8="",IF('YR-4-1ST'!CY8="",IF('YR-3-2ND'!CJ8="",IF('YR-3-1ST'!CG8="",IF('YR-2-
2ND'!BU8="",IF('YR-2-1ST'!BC8="",IF('YR-1-2ND'!BC8="",IF('YR-1-1ST'!BD8="","NONE YET","YR-1-1ST"),"YR-1-2ND"),"YR2-1ST"),"YR-2-
2ND"),"YR-3-1ST"),"YR-3-2ND"),"YR-4-1ST"),"YR-4-2ND"),"YR-5-1ST"),"YR-5-2ND"),"YR-6-1ST"),"YR-6-2ND"),"YR-7-1ST"),"YR-7-2ND")))

=IF(D8="","",IF('YR-1-1ST'!$BD8="",(SUMIF(('YR-1-1ST'!F8:'YR-1-1ST'!BA8),"",('YR-1-1ST'!F$5:'YR-1-1ST'!BA$5))+SUMIF(('YR-2-1ST'!E8:'YR-2-
1ST'!AB8),"",('YR-2-1ST'!E$5:'YR-2-1ST'!AB$5))+SUMIF(('YR-3-1ST'!E8:'YR-3-1ST'!AB8),"",('YR-3-1ST'!E$5:'YR-3-1ST'!AB$5))+SUMIF(('YR-4-
1ST'!E8:'YR-4-1ST'!Y8),"",('YR-4-1ST'!E$5:'YR-4-1ST'!Y$5))+SUMIF(('YR-5-1ST'!E8:'YR-5-1ST'!Y8),"",('YR-5-1ST'!E$5:'YR-5-
1ST'!Y$5))+SUMIF(('YR-6-1ST'!E8:'YR-6-1ST'!Y8),"",('YR-6-1ST'!E$5:'YR-6-1ST'!Y$5))+SUMIF(('YR-7-1ST'!E8:'YR-7-1ST'!Y8),"",('YR-7-
1ST'!E$5:'YR-7-1ST'!Y$5))-'COURSES-&-UNITS'!$D$24),IF(AND('YR-1-1ST'!$BD8="",'YR-2-1ST'!$BC8=""),(SUMIF(('YR-1-1ST'!F8:'YR-1-
1ST'!BA8),"",('YR-1-1ST'!F$5:'YR-1-1ST'!BA$5))+SUMIF(('YR-2-1ST'!E8:'YR-2-1ST'!AB8),"",('YR-2-1ST'!E$5:'YR-2-1ST'!AB$5))+SUMIF(('YR-3-
1ST'!E8:'YR-3-1ST'!AB8),"",('YR-3-1ST'!E$5:'YR-3-1ST'!AB$5))+SUMIF(('YR-4-1ST'!E8:'YR-4-1ST'!Y8),"",('YR-4-1ST'!E$5:'YR-4-
1ST'!Y$5))+SUMIF(('YR-5-1ST'!E8:'YR-5-1ST'!Y8),"",('YR-5-1ST'!E$5:'YR-5-1ST'!Y$5))+SUMIF(('YR-6-1ST'!E8:'YR-6-1ST'!Y8),"",('YR-6-
1ST'!E$5:'YR-6-1ST'!Y$5))+SUMIF(('YR-7-1ST'!E8:'YR-7-1ST'!Y8),"",('YR-7-1ST'!E$5:'YR-7-1ST'!Y$5))-SUM('COURSES-&-
UNITS'!$D$24,'COURSES-&-UNITS'!$D$45)),(SUMIF(('YR-1-1ST'!F8:'YR-1-1ST'!BA8),"",('YR-1-1ST'!F$5:'YR-1-1ST'!BA$5))+SUMIF(('YR-2-
1ST'!E8:'YR-2-1ST'!AB8),"",('YR-2-1ST'!E$5:'YR-2-1ST'!AB$5))+SUMIF(('YR-3-1ST'!E8:'YR-3-1ST'!AB8),"",('YR-3-1ST'!E$5:'YR-3-
1ST'!AB$5))+SUMIF(('YR-4-1ST'!E8:'YR-4-1ST'!Y8),"",('YR-4-1ST'!E$5:'YR-4-1ST'!Y$5))+SUMIF(('YR-5-1ST'!E8:'YR-5-1ST'!Y8),"",('YR-5-
1ST'!E$5:'YR-5-1ST'!Y$5))+SUMIF(('YR-6-1ST'!E8:'YR-6-1ST'!Y8),"",('YR-6-1ST'!E$5:'YR-6-1ST'!Y$5))+SUMIF(('YR-7-1ST'!E8:'YR-7-
1ST'!Y8),"",('YR-7-1ST'!E$5:'YR-7-1ST'!Y$5))))))

=IF(D8="","",IF(AND('YR-1-1ST'!$BD8="",'YR-1-1ST'!$F8="",'YR-1-1ST'!$I8="",'YR-1-1ST'!$L8="",'YR-1-1ST'!$O8="",'YR-1-1ST'!$R8="",'YR-1-
1ST'!$U8="",'YR-1-1ST'!$X8="",'YR-1-1ST'!$AA8=""),"ALL YR1 1ST SEMESTER COURSES NOT DONE",IF(AND('YR-1-1ST'!F8="",NOT('COURSES-
&-UNITS'!$G$9="")),'YR-1-1ST'!F$4,"")&", "&IF(AND('YR-1-1ST'!I8="",NOT('COURSES-&-UNITS'!$G$10="")),'YR-1-1ST'!I$4,"")&", "&IF(AND('YR-
1-1ST'!L8="",NOT('COURSES-&-UNITS'!$G$11="")),'YR-1-1ST'!L$4,"")&", "&IF(AND('YR-1-1ST'!O8="",NOT('COURSES-&-UNITS'!$G$12="")),'YR-
1-1ST'!O$4,"")&", "&IF(AND('YR-1-1ST'!R8="",NOT('COURSES-&-UNITS'!$G$13="")),'YR-1-1ST'!R$4,"")&", "&IF(AND('YR-1-
1ST'!U8="",NOT('COURSES-&-UNITS'!$G$14="")),'YR-1-1ST'!U$4,"")&", "&IF(AND('YR-1-1ST'!X8="",NOT('COURSES-&-UNITS'!$G$15="")),'YR-1-
1ST'!X$4,"")&", "&IF(AND('YR-1-1ST'!AA8="",NOT('COURSES-&-UNITS'!$G$16="")),'YR-1-1ST'!AA$4,"")&", "&IF(AND('YR-1-
1ST'!AD8="",NOT('COURSES-&-UNITS'!$G$17="")),'YR-1-1ST'!AD$4,"")&", "&IF(AND('YR-1-1ST'!AG8="",NOT('COURSES-&-
UNITS'!$G$18="")),'YR-1-1ST'!AG$4,"")&", "&IF(AND('YR-1-1ST'!AJ8="",NOT('COURSES-&-UNITS'!$G$19="")),'YR-1-1ST'!AJ$4,"")&",
"&IF(AND('YR-1-1ST'!AM8="",NOT('COURSES-&-UNITS'!$G$20="")),'YR-1-1ST'!AM$4,"")&", "&IF(AND('YR-1-1ST'!AP8="",NOT('COURSES-&-
UNITS'!$G$21="")),'YR-1-1ST'!AP$4,"")&", "&IF(AND('YR-1-1ST'!AS8="",NOT('COURSES-&-UNITS'!$G$22="")),'YR-1-1ST'!AS$4,"")&",
"&IF(AND('YR-1-1ST'!AV8="",NOT('COURSES-&-UNITS'!$G$23="")),'YR-1-1ST'!AV$4,"")))&IF(D8="","",", ")&IF(D8="","",IF(AND('YR-1-
1ST'!$BD8="",'YR-1-1ST'!$F8="",'YR-1-1ST'!$I8="",'YR-1-1ST'!$L8="",'YR-1-1ST'!$O8="",'YR-1-1ST'!$R8="",'YR-1-1ST'!$U8="",'YR-1-
1ST'!$X8="",'YR-1-1ST'!$AA8="",'YR-2-1ST'!$BC8="",'YR-2-1ST'!$E8="",'YR-2-1ST'!$H8="",'YR-2-1ST'!$K8="",'YR-2-1ST'!$N8="",'YR-2-
1ST'!$Q8="",'YR-2-1ST'!$T8="",'YR-2-1ST'!$W8="",'YR-2-1ST'!$Z8=""),"ALL YR2 1ST SEMESTER COURSES NOT DONE",IF(AND('YR-2-
1ST'!E8="",NOT('COURSES-&-UNITS'!$G$30="")),'YR-2-1ST'!E$4,"")&", "&IF(AND('YR-2-1ST'!H8="",NOT('COURSES-&-UNITS'!$G$31="")),'YR-2-
1ST'!H$4,"")&", "&IF(AND('YR-2-1ST'!K8="",NOT('COURSES-&-UNITS'!$G$32="")),'YR-2-1ST'!K$4,"")&", "&IF(AND('YR-2-
1ST'!N8="",NOT('COURSES-&-UNITS'!$G$33="")),'YR-2-1ST'!N$4,"")&", "&IF(AND('YR-2-1ST'!Q8="",NOT('COURSES-&-UNITS'!$G$34="")),'YR-2-
1ST'!Q$4,"")&", "&IF(AND('YR-2-1ST'!T8="",NOT('COURSES-&-UNITS'!$G$35="")),'YR-2-1ST'!T$4,"")&", "&IF(AND('YR-2-
1ST'!W8="",NOT('COURSES-&-UNITS'!$G$36="")),'YR-2-1ST'!W$4,"")&", "&IF(AND('YR-2-1ST'!Z8="",NOT('COURSES-&-UNITS'!$G$37="")),'YR-2-
1ST'!Z$4,"")&", "&IF(AND('YR-2-1ST'!AC8="",NOT('COURSES-&-UNITS'!$G$38="")),'YR-2-1ST'!AC$4,"")&", "&IF(AND('YR-2-
1ST'!AF8="",NOT('COURSES-&-UNITS'!$G$39="")),'YR-2-1ST'!AF$4,"")))&IF(D8="","",", ")&IF(D8="","",IF('YR-3-1ST'!$CG8="","ALL YR3 1ST
SEMESTER COURSES NOT DONE",IF(AND('YR-3-1ST'!E8="",NOT('COURSES-&-UNITS'!$G$51="")),'YR-3-1ST'!E$4,"")&", "&IF(AND('YR-3-
1ST'!H8="",NOT('COURSES-&-UNITS'!$G$52="")),'YR-3-1ST'!H$4,"")&", "&IF(AND('YR-3-1ST'!K8="",NOT('COURSES-&-UNITS'!$G$53="")),'YR-3-
1ST'!K$4,"")&", "&IF(AND('YR-3-1ST'!N8="",NOT('COURSES-&-UNITS'!$G$54="")),'YR-3-1ST'!N$4,"")&", "&IF(AND('YR-3-
1ST'!Q8="",NOT('COURSES-&-UNITS'!$G$55="")),'YR-3-1ST'!Q$4,"")&", "&IF(AND('YR-3-1ST'!T8="",NOT('COURSES-&-UNITS'!$G$56="")),'YR-3-
1ST'!T$4,"")&", "&IF(AND('YR-3-1ST'!W8="",NOT('COURSES-&-UNITS'!$G$57="")),'YR-3-1ST'!W$4,"")&", "&IF(AND('YR-3-
1ST'!Z8="",NOT('COURSES-&-UNITS'!$G$58="")),'YR-3-1ST'!Z$4,"")&", "&IF(AND('YR-3-1ST'!AC8="",NOT('COURSES-&-UNITS'!$G$59="")),'YR-
3-1ST'!AC$4,"")&", "&IF(AND('YR-3-1ST'!AF8="",NOT('COURSES-&-UNITS'!$G$60="")),'YR-3-1ST'!AF$4,"")))&IF(D8="","",",
")&IF(D8="","",IF('YR-4-1ST'!$CY8="","ALL YR4 1ST SEMESTER COURSES NOT DONE",IF(AND('YR-4-1ST'!E8="",NOT('COURSES-&-
UNITS'!$G$72="")),'YR-4-1ST'!E$4,"")&", "&IF(AND('YR-4-1ST'!H8="",NOT('COURSES-&-UNITS'!$G$73="")),'YR-4-1ST'!H$4,"")&", "&IF(AND('YR-
4-1ST'!K8="",NOT('COURSES-&-UNITS'!$G$74="")),'YR-4-1ST'!K$4,"")&", "&IF(AND('YR-4-1ST'!N8="",NOT('COURSES-&-UNITS'!$G$75="")),'YR-
4-1ST'!N$4,"")&", "&IF(AND('YR-4-1ST'!Q8="",NOT('COURSES-&-UNITS'!$G$76="")),'YR-4-1ST'!Q$4,"")&", "&IF(AND('YR-4-
1ST'!T8="",NOT('COURSES-&-UNITS'!$G$77="")),'YR-4-1ST'!T$4,"")&", "&IF(AND('YR-4-1ST'!W8="",NOT('COURSES-&-UNITS'!$G$78="")),'YR-4-
1ST'!W$4,"")&", "&IF(AND('YR-4-1ST'!Z8="",NOT('COURSES-&-UNITS'!$G$79="")),'YR-4-1ST'!Z$4,"")&", "&IF(AND('YR-4-
1ST'!AC8="",NOT('COURSES-&-UNITS'!$G$80="")),'YR-4-1ST'!AC$4,"")&", "&IF(AND('YR-4-1ST'!AF8="",NOT('COURSES-&-
UNITS'!$G$81="")),'YR-4-1ST'!AF$4,"")))&IF(D8="","",", ")&IF(D8="","",IF('YR-5-1ST'!$EF8="","ALL YR5 1ST SEMESTER COURSES NOT
```

DONE",IF(AND('YR-5-1ST'!E8="",NOT('COURSES-&-UNITS'!$G$93="")),'YR-5-1ST'!E$4,"")&", "&IF(AND('YR-5-1ST'!H8="",NOT('COURSES-&-UNITS'!$G$94="")),'YR-5-1ST'!H$4,"")&", "&IF(AND('YR-5-1ST'!K8="",NOT('COURSES-&-UNITS'!$G$95="")),'YR-5-1ST'!K$4,"")&", "&IF(AND('YR-5-1ST'!N8="",NOT('COURSES-&-UNITS'!$G$96="")),'YR-5-1ST'!N$4,"")&", "&IF(AND('YR-5-1ST'!Q8="",NOT('COURSES-&-UNITS'!$G$97="")),'YR-5-1ST'!Q$4,"")&", "&IF(AND('YR-5-1ST'!T8="",NOT('COURSES-&-UNITS'!$G$98="")),'YR-5-1ST'!T$4,"")&", "&IF(AND('YR-5-1ST'!W8="",NOT('COURSES-&-UNITS'!$G$99="")),'YR-5-1ST'!W$4,"")&", "&IF(AND('YR-5-1ST'!Z8="",NOT('COURSES-&-UNITS'!$G$100="")),'YR-5-1ST'!Z$4,"")&", "&IF(AND('YR-5-1ST'!AC8="",NOT('COURSES-&-UNITS'!$G$101="")),'YR-5-1ST'!AC$4,"")&", "&IF(AND('YR-5-1ST'!AF8="",NOT('COURSES-&-UNITS'!$G$102="")),'YR-5-1ST'!AF$4,"")))&IF(D8="","","", ")&IF(D8="","",IF('YR-6-1ST'!$EF8="","ALL YR6 1ST SEMESTER COURSES NOT DONE",IF(AND('YR-6-1ST'!E8="",NOT('COURSES-&-UNITS'!$G$114="")),'YR-6-1ST'!E$4,"")&", "&IF(AND('YR-6-1ST'!H8="",NOT('COURSES-&-UNITS'!$G$115="")),'YR-6-1ST'!H$4,"")&", "&IF(AND('YR-6-1ST'!K8="",NOT('COURSES-&-UNITS'!$G$116="")),'YR-6-1ST'!K$4,"")&", "&IF(AND('YR-6-1ST'!N8="",NOT('COURSES-&-UNITS'!$G$117="")),'YR-6-1ST'!N$4,"")&", "&IF(AND('YR-6-1ST'!Q8="",NOT('COURSES-&-UNITS'!$G$118="")),'YR-6-1ST'!Q$4,"")&", "&IF(AND('YR-6-1ST'!T8="",NOT('COURSES-&-UNITS'!$G$119="")),'YR-6-1ST'!T$4,"")&", "&IF(AND('YR-6-1ST'!W8="",NOT('COURSES-&-UNITS'!$G$120="")),'YR-6-1ST'!W$4,"")&", "&IF(AND('YR-6-1ST'!Z8="",NOT('COURSES-&-UNITS'!$G$121="")),'YR-6-1ST'!Z$4,"")&", "&IF(AND('YR-6-1ST'!AC8="",NOT('COURSES-&-UNITS'!$G$122="")),'YR-6-1ST'!AC$4,"")&", "&IF(AND('YR-6-1ST'!AF8="",NOT('COURSES-&-UNITS'!$G$123="")),'YR-6-1ST'!AF$4,"")))&IF(D8="","","", ")&IF(D8="","",IF('YR-7-1ST'!$EF8="","ALL YR7 1ST SEMESTER COURSES NOT DONE",IF(AND('YR-7-1ST'!E8="",NOT('COURSES-&-UNITS'!$G$156="")),'YR-7-1ST'!E$4,"")&", "&IF(AND('YR-7-1ST'!H8="",NOT('COURSES-&-UNITS'!$G$157="")),'YR-7-1ST'!H$4,"")&", "&IF(AND('YR-7-1ST'!K8="",NOT('COURSES-&-UNITS'!$G$158="")),'YR-7-1ST'!K$4,"")&", "&IF(AND('YR-7-1ST'!N8="",NOT('COURSES-&-UNITS'!$G$159="")),'YR-7-1ST'!N$4,"")&", "&IF(AND('YR-7-1ST'!Q8="",NOT('COURSES-&-UNITS'!$G$160="")),'YR-7-1ST'!Q$4,"")&", "&IF(AND('YR-7-1ST'!T8="",NOT('COURSES-&-UNITS'!$G$161="")),'YR-7-1ST'!T$4,"")&", "&IF(AND('YR-7-1ST'!W8="",NOT('COURSES-&-UNITS'!$G$162="")),'YR-7-1ST'!W$4,"")&", "&IF(AND('YR-7-1ST'!Z8="",NOT('COURSES-&-UNITS'!$G$163="")),'YR-7-1ST'!Z$4,"")&", "&IF(AND('YR-7-1ST'!AC8="",NOT('COURSES-&-UNITS'!$G$164="")),'YR-7-1ST'!AC$4,"")&", "&IF(AND('YR-7-1ST'!AF8="",NOT('COURSES-&-UNITS'!$G$165="")),'YR-7-1ST'!AF$4,"")))

=IF(D8="","",IF(D8="","",IF('YR-1-1ST'!F8="F",'YR-1-1ST'!F$4,"")&", "&IF('YR-1-1ST'!I8="F",'YR-1-1ST'!I$4,"")&", "&IF('YR-1-1ST'!L8="F",'YR-1-1ST'!L$4,"")&", "&IF('YR-1-1ST'!O8="F",'YR-1-1ST'!O$4,"")&", "&IF('YR-1-1ST'!R8="F",'YR-1-1ST'!R$4,"")&", "&IF('YR-1-1ST'!U8="F",'YR-1-1ST'!U$4,"")&", "&IF('YR-1-1ST'!X8="F",'YR-1-1ST'!X$4,"")&", "&IF('YR-1-1ST'!AA8="F",'YR-1-1ST'!AA$4,"")&", "&IF('YR-1-1ST'!AD8="F",'YR-1-1ST'!AD$4,"")&", "&IF('YR-1-1ST'!AG8="F",'YR-1-1ST'!AG$4,"")&", "&IF('YR-1-1ST'!AJ8="F",'YR-1-1ST'!AJ$4,"")&", "&IF('YR-1-1ST'!AM8="F",'YR-1-1ST'!AM$4,"")&", "&IF('YR-1-1ST'!AP8="F",'YR-1-1ST'!AP$4,"")&", "&IF('YR-1-1ST'!AS8="F",'YR-1-1ST'!AS$4,"")&", "&IF('YR-1-1ST'!AV8="F",'YR-1-1ST'!AV$4,"")&", "&IF('YR-1-1ST'!AY8="F",'YR-1-1ST'!AY$4,"")))&IF(D8="","","", ")&IF(D8="","",IF('YR-2-1ST'!E8="F",'YR-2-1ST'!E$4,"")&", "&IF('YR-2-1ST'!H8="F",'YR-2-1ST'!H$4,"")&", "&IF('YR-2-1ST'!K8="F",'YR-2-1ST'!K$4,"")&", "&IF('YR-2-1ST'!N8="F",'YR-2-1ST'!N$4,"")&", "&IF('YR-2-1ST'!Q8="F",'YR-2-1ST'!Q$4,"")&", "&IF('YR-2-1ST'!T8="F",'YR-2-1ST'!T$4,"")&", "&IF('YR-2-1ST'!W8="F",'YR-2-1ST'!W$4,"")&", "&IF('YR-2-1ST'!Z8="F",'YR-2-1ST'!Z$4,"")&", "&IF('YR-2-1ST'!AC8="F",'YR-2-1ST'!AC$4,"")&", "&IF('YR-2-1ST'!AF8="F",'YR-2-1ST'!AF$4,"")&", "&IF('YR-2-1ST'!AI8="F",'YR-2-1ST'!AI$4,"")&", "&IF('YR-2-1ST'!AL8="F",'YR-2-1ST'!AL$4,"")&", "&IF('YR-2-1ST'!AO8="F",'YR-2-1ST'!AO$4,"")))&IF(D8="","","", ")&IF(D8="","",IF('YR-3-1ST'!E8="F",'YR-3-1ST'!E$4,"")&", "&IF('YR-3-1ST'!H8="F",'YR-3-1ST'!H$4,"")&", "&IF('YR-3-1ST'!K8="F",'YR-3-1ST'!K$4,"")&", "&IF('YR-3-1ST'!N8="F",'YR-3-1ST'!N$4,"")&", "&IF('YR-3-1ST'!Q8="F",'YR-3-1ST'!Q$4,"")&", "&IF('YR-3-1ST'!T8="F",'YR-3-1ST'!T$4,"")&", "&IF('YR-3-1ST'!W8="F",'YR-3-1ST'!W$4,"")&", "&IF('YR-3-1ST'!Z8="F",'YR-3-1ST'!Z$4,"")&", "&IF('YR-3-1ST'!AC8="F",'YR-3-1ST'!AC$4,"")&", "&IF('YR-3-1ST'!AF8="F",'YR-3-1ST'!AF$4,"")&", "&IF('YR-3-1ST'!AI8="F",'YR-3-1ST'!AI$4,"")&", "&IF('YR-3-1ST'!AL8="F",'YR-3-1ST'!AL$4,"")&", "&IF('YR-3-1ST'!AO8="F",'YR-3-1ST'!AO$4,"")&", "&IF('YR-3-1ST'!AR8="F",'YR-3-1ST'!AR$4,"")&", "&IF('YR-3-1ST'!AU8="F",'YR-3-1ST'!AU$4,"")&", "&IF('YR-3-1ST'!BD8="F",'YR-3-1ST'!BD$4,"")&", "&IF('YR-3-1ST'!BG8="F",'YR-3-1ST'!BG$4,"")&", "&IF('YR-3-1ST'!BJ8="F",'YR-3-1ST'!BJ$4,"")&", "&IF('YR-3-1ST'!BM8="F",'YR-3-1ST'!BM$4,"")&IF(D8="","","")&IF(D8="","",IF('YR-4-1ST'!E8="F",'YR-4-1ST'!E$4,"")&", "&IF('YR-4-1ST'!H8="F",'YR-4-1ST'!H$4,"")&", "&IF('YR-4-1ST'!K8="F",'YR-4-1ST'!K$4,"")&", "&IF('YR-4-1ST'!N8="F",'YR-4-1ST'!N$4,"")&", "&IF('YR-4-1ST'!Q8="F",'YR-4-1ST'!Q$4,"")&", "&IF('YR-4-1ST'!T8="F",'YR-4-1ST'!T$4,"")&", "&IF('YR-4-1ST'!W8="F",'YR-4-1ST'!W$4,"")&", "&IF('YR-4-1ST'!Z8="F",'YR-4-1ST'!Z$4,"")&", "&IF('YR-4-1ST'!AC8="F",'YR-4-1ST'!AC$4,"")&", "&IF('YR-4-1ST'!AF8="F",'YR-4-1ST'!AF$4,"")&", "&IF('YR-4-1ST'!AI8="F",'YR-4-1ST'!AI$4,"")&", "&IF('YR-4-1ST'!AL8="F",'YR-4-1ST'!AL$4,"")&", "&IF('YR-4-1ST'!AO8="F",'YR-4-1ST'!AO$4,"")&", "&IF('YR-4-1ST'!AR8="F",'YR-4-1ST'!AR$4,"")&", "&IF('YR-4-1ST'!AU8="F",'YR-4-1ST'!AU$4,"")&", "&IF('YR-4-1ST'!AX8="F",'YR-4-1ST'!AX$4,"")&", "&IF('YR-4-1ST'!BA8="F",'YR-4-1ST'!BA$4,"")&", "&IF('YR-4-1ST'!BD8="F",'YR-4-1ST'!BD$4,"")&", "&IF('YR-4-1ST'!BG8="F",'YR-4-1ST'!BG$4,"")&", "&IF('YR-4-1ST'!BJ8="F",'YR-4-1ST'!BJ$4,"")&", "&IF('YR-4-1ST'!BM8="F",'YR-4-1ST'!BM$4,"")&","&IF('YR-4-1ST'!BP8="F",'YR-4-1ST'!BP$4,"")&", "&IF('YR-4-1ST'!BS8="F",'YR-4-1ST'!BS$4,"")&", "&IF('YR-4-1ST'!BV8="F",'YR-4-1ST'!BV$4,"")&", "&IF('YR-4-1ST'!BY8="F",'YR-4-1ST'!BY$4,"")&", "&IF('YR-4-1ST'!CB8="F",'YR-4-1ST'!CB$4,"")&", "&IF('YR-4-1ST'!CE8="F",'YR-4-1ST'!CE$4,"")&", "&IF('YR-4-1ST'!CH8="F",'YR-4-1ST'!CH$4,"")&", "&IF('YR-4-1ST'!CK8="F",'YR-4-1ST'!CK$4,"")&", "&IF('YR-4-1ST'!CN8="F",'YR-4-1ST'!CN$4,""))&IF(D8="","","", ")&IF(D8="","",IF('YR-5-1ST'!E8="F",'YR-5-1ST'!E$4,"")&", "&IF('YR-5-1ST'!H8="F",'YR-5-1ST'!H$4,"")&", "&IF('YR-5-1ST'!K8="F",'YR-5-1ST'!K$4,"")&", "&IF('YR-5-1ST'!N8="F",'YR-5-1ST'!N$4,"")&", "&IF('YR-5-1ST'!Q8="F",'YR-5-1ST'!Q$4,"")&", "&IF('YR-5-1ST'!T8="F",'YR-5-1ST'!T$4,"")&", "&IF('YR-5-1ST'!W8="F",'YR-5-1ST'!W$4,"")&", "&IF('YR-5-1ST'!Z8="F",'YR-5-1ST'!Z$4,"")&", "&IF('YR-5-1ST'!AC8="F",'YR-5-1ST'!AC$4,"")&", "&IF('YR-5-1ST'!AF8="F",'YR-5-1ST'!AF$4,"")&", "&IF('YR-5-1ST'!AI8="F",'YR-5-1ST'!AI$4,"")&", "&IF('YR-5-1ST'!AL8="F",'YR-5-1ST'!AL$4,"")&", "&IF('YR-5-1ST'!AO8="F",'YR-5-1ST'!AO$4,"")&", "&IF('YR-5-1ST'!AR8="F",'YR-5-1ST'!AR$4,"")&", "&IF('YR-5-1ST'!AU8="F",'YR-5-1ST'!AU$4,"")&", "&IF('YR-5-1ST'!AX8="F",'YR-5-1ST'!AX$4,"")&", "&IF('YR-5-1ST'!BA8="F",'YR-5-1ST'!BA$4,"")&", "&IF('YR-5-1ST'!BD8="F",'YR-5-1ST'!BD$4,"")&", "&IF('YR-5-1ST'!BG8="F",'YR-5-1ST'!BG$4,"")&", "&IF('YR-5-1ST'!BJ8="F",'YR-5-1ST'!BJ$4,"")&", "&IF('YR-5-1ST'!BM8="F",'YR-5-1ST'!BM$4,"")&","&IF('YR-5-1ST'!BP8="F",'YR-5-1ST'!BP$4,"")&", "&IF('YR-5-1ST'!BS8="F",'YR-5-1ST'!BS$4,"")&", "&IF('YR-5-1ST'!BV8="F",'YR-5-1ST'!BV$4,"")&", "&IF('YR-5-1ST'!BY8="F",'YR-5-1ST'!BY$4,"")&", "&IF('YR-5-1ST'!CB8="F",'YR-5-1ST'!CB$4,"")&", "&IF('YR-5-1ST'!CE8="F",'YR-5-1ST'!CE$4,"")&", "&IF('YR-5-1ST'!CH8="F",'YR-5-1ST'!CH$4,"")&", "&IF('YR-5-1ST'!CK8="F",'YR-5-1ST'!CK$4,"")&", "&IF('YR-5-1ST'!CN8="F",'YR-5-1ST'!CN$4,"")&","&IF('YR-5-1ST'!CQ8="F",'YR-5-1ST'!CQ$4,"")&", "&IF('YR-5-1ST'!CT8="F",'YR-5-1ST'!CT$4,"")&", "&IF('YR-5-1ST'!CW8="F",'YR-5-1ST'!CW$4,"")&", "&IF('YR-5-1ST'!CZ8="F",'YR-5-1ST'!CZ$4,"")&", "&IF('YR-5-1ST'!DC8="F",'YR-5-1ST'!DC$4,"")&", "&IF('YR-5-1ST'!DF8="F",'YR-5-1ST'!DF$4,"")&", "&IF('YR-5-1ST'!DI8="F",'YR-5-1ST'!DI$4,"")&", "&IF('YR-5-1ST'!DL8="F",'YR-5-1ST'!DL$4,"")&", "&IF('YR-5-1ST'!DO8="F",'YR-5-1ST'!DO$4,"")&", "&IF('YR-5-1ST'!DR8="F",'YR-5-1ST'!DR$4,"")&", "&IF('YR-5-1ST'!DU8="F",'YR-5-1ST'!DU$4,"")&", "&IF('YR-5-1ST'!DX8="F",'YR-5-1ST'!DX$4,"")&", "&IF('YR-5-1ST'!EA8="F",'YR-5-1ST'!EA$4,""))&IF(D8="","","", ")&IF(D8="","",IF('YR-6-1ST'!E8="F",'YR-6-1ST'!E$4,"")&", "&IF('YR-6-1ST'!H8="F",'YR-6-1ST'!H$4,"")&", "&IF('YR-6-1ST'!K8="F",'YR-6-1ST'!K$4,"")&", "&IF('YR-6-1ST'!N8="F",'YR-6-1ST'!N$4,"")&", "&IF('YR-6-1ST'!Q8="F",'YR-6-1ST'!Q$4,"")&", "&IF('YR-6-1ST'!T8="F",'YR-6-1ST'!T$4,"")&", "&IF('YR-6-1ST'!W8="F",'YR-6-1ST'!W$4,"")&", "&IF('YR-6-1ST'!Z8="F",'YR-6-1ST'!Z$4,"")&", "&IF('YR-6-1ST'!AC8="F",'YR-6-1ST'!AC$4,"")&", "&IF('YR-6-1ST'!AF8="F",'YR-6-1ST'!AF$4,"")&", "&IF('YR-6-1ST'!AI8="F",'YR-6-1ST'!AI$4,"")&", "&IF('YR-6-1ST'!AL8="F",'YR-6-1ST'!AL$4,"")&", "&IF('YR-6-1ST'!AO8="F",'YR-6-1ST'!AO$4,"")&", "&IF('YR-6-1ST'!AR8="F",'YR-6-1ST'!AR$4,"")&", "&IF('YR-6-1ST'!AU8="F",'YR-6-1ST'!AU$4,"")&", "&IF('YR-6-1ST'!AX8="F",'YR-6-1ST'!AX$4,"")&", "&IF('YR-6-1ST'!BA8="F",'YR-6-1ST'!BA$4,"")&", "&IF('YR-6-1ST'!BD8="F",'YR-6-1ST'!BD$4,"")&", "&IF('YR-6-1ST'!BG8="F",'YR-6-1ST'!BG$4,"")&", "&IF('YR-6-1ST'!BJ8="F",'YR-6-1ST'!BJ$4,"")&", "&IF('YR-6-1ST'!BM8="F",'YR-6-1ST'!BM$4,"")&","&IF('YR-6-1ST'!BP8="F",'YR-6-1ST'!BP$4,"")&", "&IF('YR-6-1ST'!BS8="F",'YR-6-1ST'!BS$4,"")&", "&IF('YR-6-1ST'!BV8="F",'YR-6-1ST'!BV$4,"")&", "&IF('YR-6-1ST'!BY8="F",'YR-6-1ST'!BY$4,"")&", "&IF('YR-6-1ST'!CB8="F",'YR-6-1ST'!CB$4,"")&", "&IF('YR-6-1ST'!CE8="F",'YR-6-1ST'!CE$4,"")&", "&IF('YR-6-1ST'!CH8="F",'YR-6-1ST'!CH$4,"")&", "&IF('YR-6-1ST'!CK8="F",'YR-6-1ST'!CK$4,"")&", "&IF('YR-6-1ST'!CN8="F",'YR-6-1ST'!CN$4,"")&","&IF('YR-6-1ST'!CQ8="F",'YR-6-1ST'!CQ$4,"")&", "&IF('YR-6-1ST'!CT8="F",'YR-6-1ST'!CT$4,"")&", "&IF('YR-6-1ST'!CW8="F",'YR-6-1ST'!CW$4,"")&", "&IF('YR-6-1ST'!CZ8="F",'YR-6-1ST'!CZ$4,"")&", "&IF('YR-6-1ST'!DC8="F",'YR-6-1ST'!DC$4,"")&", "&IF('YR-6-1ST'!DF8="F",'YR-6-1ST'!DF$4,"")&", "&IF('YR-6-1ST'!DI8="F",'YR-6-1ST'!DI$4,"")&", "&IF('YR-6-1ST'!DL8="F",'YR-6-1ST'!DL$4,"")&", "&IF('YR-6-1ST'!DO8="F",'YR-6-1ST'!DO$4,"")&", "&IF('YR-6-1ST'!DR8="F",'YR-6-1ST'!DR$4,"")&", "&IF('YR-6-1ST'!DU8="F",'YR-6-1ST'!DU$4,"")&", "&IF('YR-6-1ST'!DX8="F",'YR-6-1ST'!DX$4,"")&", "&IF('YR-6-1ST'!EA8="F",'YR-6-1ST'!EA$4,""))

=IF(D8="","",(SUM('YR-2-1ST'!AC$5:'YR-2-1ST'!AZ$5)-SUMIF(('YR-2-1ST'!AC8:'YR-2-1ST'!AZ8),"",('YR-2-1ST'!AC$5:'YR-2-1ST'!AZ$5)))+(SUM('YR-3-1ST'!AC$5:'YR-3-1ST'!CD$5)-SUMIF(('YR-3-1ST'!AC8:'YR-3-1ST'!CD8),"",('YR-3-1ST'!AC$5:'YR-3-1ST'!CD$5)))+(SUM('YR-4-1ST'!Z$5:'YR-4-1ST'!CV$5)-SUMIF(('YR-4-1ST'!Z8:'YR-4-1ST'!CV8),"",('YR-4-1ST'!Z$5:'YR-4-1ST'!CV$5)))+(SUM('YR-5-

1ST'!Z$5:'YR-5-1ST'!EC$5)-SUMIF(('YR-5-1ST'!Z8:'YR-5-1ST'!EC8),"",('YR-5-1ST'!Z$5:'YR-5-1ST'!EC$5)))+(SUM('YR-6-1ST'!Z$5:'YR-6-1ST'!EC$5)-SUMIF(('YR-6-1ST'!Z8:'YR-6-1ST'!EC8),"",('YR-6-1ST'!Z$5:'YR-6-1ST'!EC$5)))+(SUM('YR-7-1ST'!Z$5:'YR-7-1ST'!EC$5)-SUMIF(('YR-7-1ST'!Z8:'YR-7-1ST'!EC8),"",('YR-7-1ST'!Z$5:'YR-7-1ST'!EC$5))))

=IF(D8="","",IF('YR-2-1ST'!$BC8="","NO YR2 1ST SEMESTER RESULTS",IF(AND(NOT('YR-2-1ST'!AC8=""),NOT('YR-2-1ST'!AC8="F")),'YR-2-1ST'!AC$4,"")&", "&IF(AND(NOT('YR-2-1ST'!AF8=""),NOT('YR-2-1ST'!AF8="F")),'YR-2-1ST'!AF$4,"")&", "&IF(AND(NOT('YR-2-1ST'!AI8=""),NOT('YR-2-1ST'!AI8="F")),'YR-2-1ST'!AI$4,"")&", "&IF(AND(NOT('YR-2-1ST'!AL8=""),NOT('YR-2-1ST'!AL8="F")),'YR-2-1ST'!AL$4,"")&", "&IF(AND(NOT('YR-2-1ST'!AO8=""),NOT('YR-2-1ST'!AO8="F")),'YR-2-1ST'!AO$4,"")&", "&IF(AND(NOT('YR-2-1ST'!AR8=""),NOT('YR-2-1ST'!AR8="F")),'YR-2-1ST'!AR$4,"")&", "&IF(AND(NOT('YR-2-1ST'!AU8=""),NOT('YR-2-1ST'!AU8="F")),'YR-2-1ST'!AU$4,"")&", "&IF(AND(NOT('YR-2-1ST'!AX8=""),NOT('YR-2-1ST'!AX8="F")),'YR-2-1ST'!AX$4,"")))&IF(D8="","",", ")&IF(D8="","",IF('YR-3-1ST'!$CG8="","NO YR3 1ST SEMESTER RESULTS",IF(AND(NOT('YR-3-1ST'!AC8=""),NOT('YR-3-1ST'!AC8="F")),'YR-3-1ST'!AC$4,"")&", "&IF(AND(NOT('YR-3-1ST'!AF8=""),NOT('YR-3-1ST'!AF8="F")),'YR-3-1ST'!AF$4,"")&", "&IF(AND(NOT('YR-3-1ST'!AI8=""),NOT('YR-3-1ST'!AI8="F")),'YR-3-1ST'!AI$4,"")&", "&IF(AND(NOT('YR-3-1ST'!AL8=""),NOT('YR-3-1ST'!AL8="F")),'YR-3-1ST'!AL$4,"")&", "&IF(AND(NOT('YR-3-1ST'!AO8=""),NOT('YR-3-1ST'!AO8="F")),'YR-3-1ST'!AO$4,"")&", "&IF(AND(NOT('YR-3-1ST'!AR8=""),NOT('YR-3-1ST'!AR8="F")),'YR-3-1ST'!AR$4,"")&", "&IF(AND(NOT('YR-3-1ST'!AU8=""),NOT('YR-3-1ST'!AU8="F")),'YR-3-1ST'!AU$4,"")&", "&IF(AND(NOT('YR-3-1ST'!AX8=""),NOT('YR-3-1ST'!AX8="F")),'YR-3-1ST'!AX$4,"")&", "&IF(AND(NOT('YR-3-1ST'!BA8=""),NOT('YR-3-1ST'!BA8="F")),'YR-3-1ST'!BA$4,"")&", "&IF(AND(NOT('YR-3-1ST'!BD8=""),NOT('YR-3-1ST'!BD8="F")),'YR-3-1ST'!BD$4,"")&", "&IF(AND(NOT('YR-3-1ST'!BG8=""),NOT('YR-3-1ST'!BG8="F")),'YR-3-1ST'!BG$4,"")&", "&IF(AND(NOT('YR-3-1ST'!BJ8=""),NOT('YR-3-1ST'!BJ8="F")),'YR-3-1ST'!BJ$4,"")&", "&IF(AND(NOT('YR-3-1ST'!BM8=""),NOT('YR-3-1ST'!BM8="F")),'YR-3-1ST'!BM$4,"")&", "&IF(AND(NOT('YR-3-1ST'!BP8=""),NOT('YR-3-1ST'!BP8="F")),'YR-3-1ST'!BP$4,"")&", "&IF(AND(NOT('YR-3-1ST'!BS8=""),NOT('YR-3-1ST'!BS8="F")),'YR-3-1ST'!BS$4,"")&", "&IF(AND(NOT('YR-3-1ST'!BV8=""),NOT('YR-3-1ST'!BV8="F")),'YR-3-1ST'!BV$4,"")&", "&IF(AND(NOT('YR-3-1ST'!BY8=""),NOT('YR-3-1ST'!BY8="F")),'YR-3-1ST'!BY$4,"")&", "&IF(AND(NOT('YR-3-1ST'!CB8=""),NOT('YR-3-1ST'!CB8="F")),'YR-3-1ST'!CB$4,"")))&IF(D8="","",", ")&IF(D8="","",IF('YR-4-1ST'!$CY8="","NO YR4 1ST SEMESTER RESULTS",IF(AND(NOT('YR-4-1ST'!Z8=""),NOT('YR-4-1ST'!Z8="F")),'YR-4-1ST'!Z$4,"")&", "&IF(AND(NOT('YR-4-1ST'!AC8=""),NOT('YR-4-1ST'!AC8="F")),'YR-4-1ST'!AC$4,"")&", "&IF(AND(NOT('YR-4-1ST'!AF8=""),NOT('YR-4-1ST'!AF8="F")),'YR-4-1ST'!AF$4,"")&", "&IF(AND(NOT('YR-4-1ST'!AI8=""),NOT('YR-4-1ST'!AI8="F")),'YR-4-1ST'!AI$4,"")&", "&IF(AND(NOT('YR-4-1ST'!AL8=""),NOT('YR-4-1ST'!AL8="F")),'YR-4-1ST'!AL$4,"")&", "&IF(AND(NOT('YR-4-1ST'!AO8=""),NOT('YR-4-1ST'!AO8="F")),'YR-4-1ST'!AO$4,"")&", "&IF(AND(NOT('YR-4-1ST'!AR8=""),NOT('YR-4-1ST'!AR8="F")),'YR-4-1ST'!AR$4,"")&", "&IF(AND(NOT('YR-4-1ST'!AU8=""),NOT('YR-4-1ST'!AU8="F")),'YR-4-1ST'!AU$4,"")&", "&IF(AND(NOT('YR-4-1ST'!AX8=""),NOT('YR-4-1ST'!AX8="F")),'YR-4-1ST'!AX$4,"")&", "&IF(AND(NOT('YR-4-1ST'!BA8=""),NOT('YR-4-1ST'!BA8="F")),'YR-4-1ST'!BA$4,"")&", "&IF(AND(NOT('YR-4-1ST'!BD8=""),NOT('YR-4-1ST'!BD8="F")),'YR-4-1ST'!BD$4,"")&", "&IF(AND(NOT('YR-4-1ST'!BG8=""),NOT('YR-4-1ST'!BG8="F")),'YR-4-1ST'!BG$4,"")&", "&IF(AND(NOT('YR-4-1ST'!BJ8=""),NOT('YR-4-1ST'!BJ8="F")),'YR-4-1ST'!BJ$4,"")&", "&IF(AND(NOT('YR-4-1ST'!BM8=""),NOT('YR-4-1ST'!BM8="F")),'YR-4-1ST'!BM$4,"")&", "&IF(AND(NOT('YR-4-1ST'!BP8=""),NOT('YR-4-1ST'!BP8="F")),'YR-4-1ST'!BP$4,"")&", "&IF(AND(NOT('YR-4-1ST'!BS8=""),NOT('YR-4-1ST'!BS8="F")),'YR-4-1ST'!BS$4,"")&", "&IF(AND(NOT('YR-4-1ST'!BV8=""),NOT('YR-4-1ST'!BV8="F")),'YR-4-1ST'!BV$4,"")&", "&IF(AND(NOT('YR-4-1ST'!BY8=""),NOT('YR-4-1ST'!BY8="F")),'YR-4-1ST'!BY$4,"")&", "&IF(AND(NOT('YR-4-1ST'!CB8=""),NOT('YR-4-1ST'!CB8="F")),'YR-4-1ST'!CB$4,"")&", "&IF(AND(NOT('YR-4-1ST'!CE8=""),NOT('YR-4-1ST'!CE8="F")),'YR-4-1ST'!CE$4,"")&", "&IF(AND(NOT('YR-4-1ST'!CH8=""),NOT('YR-4-1ST'!CH8="F")),'YR-4-1ST'!CH$4,"")&", "&IF(AND(NOT('YR-4-1ST'!CK8=""),NOT('YR-4-1ST'!CK8="F")),'YR-4-1ST'!CK$4,"")&", "&IF(AND(NOT('YR-4-1ST'!CN8=""),NOT('YR-4-1ST'!CN8="F")),'YR-4-1ST'!CN$4,"")&", "&IF(AND(NOT('YR-4-1ST'!CQ8=""),NOT('YR-4-1ST'!CQ8="F")),'YR-4-1ST'!CQ$4,"")&", "&IF(AND(NOT('YR-4-1ST'!CT8=""),NOT('YR-4-1ST'!CT8="F")),'YR-4-1ST'!CT$4,"")))&IF(D8="","",", ")&IF(D8="","",IF('YR-5-1ST'!$EF8="","NO YR5 1ST SEMESTER RESULTS",IF(AND(NOT('YR-5-1ST'!Z8=""),NOT('YR-5-1ST'!Z8="F")),'YR-5-1ST'!Z$4,"")&", "&IF(AND(NOT('YR-5-1ST'!AC8=""),NOT('YR-5-1ST'!AC8="F")),'YR-5-1ST'!AC$4,"")&", "&IF(AND(NOT('YR-5-1ST'!AF8=""),NOT('YR-5-1ST'!AF8="F")),'YR-5-1ST'!AF$4,"")&", "&IF(AND(NOT('YR-5-1ST'!AI8=""),NOT('YR-5-1ST'!AI8="F")),'YR-5-1ST'!AI$4,"")&", "&IF(AND(NOT('YR-5-1ST'!AL8=""),NOT('YR-5-1ST'!AL8="F")),'YR-5-1ST'!AL$4,"")&", "&IF(AND(NOT('YR-5-1ST'!AO8=""),NOT('YR-5-1ST'!AO8="F")),'YR-5-1ST'!AO$4,"")&", "&IF(AND(NOT('YR-5-1ST'!AR8=""),NOT('YR-5-1ST'!AR8="F")),'YR-5-1ST'!AR$4,"")&", "&IF(AND(NOT('YR-5-1ST'!AU8=""),NOT('YR-5-1ST'!AU8="F")),'YR-5-1ST'!AU$4,"")&", "&IF(AND(NOT('YR-5-1ST'!AX8=""),NOT('YR-5-1ST'!AX8="F")),'YR-5-1ST'!AX$4,"")&", "&IF(AND(NOT('YR-5-1ST'!BA8=""),NOT('YR-5-1ST'!BA8="F")),'YR-5-1ST'!BA$4,"")&", "&IF(AND(NOT('YR-5-1ST'!BD8=""),NOT('YR-5-1ST'!BD8="F")),'YR-5-1ST'!BD$4,"")&", "&IF(AND(NOT('YR-5-1ST'!BG8=""),NOT('YR-5-1ST'!BG8="F")),'YR-5-1ST'!BG$4,"")&", "&IF(AND(NOT('YR-5-1ST'!BJ8=""),NOT('YR-5-1ST'!BJ8="F")),'YR-5-1ST'!BJ$4,"")&", "&IF(AND(NOT('YR-5-1ST'!BM8=""),NOT('YR-5-1ST'!BM8="F")),'YR-5-1ST'!BM$4,"")&", "&IF(AND(NOT('YR-5-1ST'!BP8=""),NOT('YR-5-1ST'!BP8="F")),'YR-5-1ST'!BP$4,"")&", "&IF(AND(NOT('YR-5-1ST'!BS8=""),NOT('YR-5-1ST'!BS8="F")),'YR-5-1ST'!BS$4,"")&", "&IF(AND(NOT('YR-5-1ST'!BV8=""),NOT('YR-5-1ST'!BV8="F")),'YR-5-1ST'!BV$4,"")&", "&IF(AND(NOT('YR-5-1ST'!BY8=""),NOT('YR-5-1ST'!BY8="F")),'YR-5-1ST'!BY$4,"")&", "&IF(AND(NOT('YR-5-1ST'!CB8=""),NOT('YR-5-1ST'!CB8="F")),'YR-5-1ST'!CB$4,"")&", "&IF(AND(NOT('YR-5-1ST'!CE8=""),NOT('YR-5-1ST'!CE8="F")),'YR-5-1ST'!CE$4,"")&", "&IF(AND(NOT('YR-5-1ST'!CH8=""),NOT('YR-5-1ST'!CH8="F")),'YR-5-1ST'!CH$4,"")&", "&IF(AND(NOT('YR-5-1ST'!CK8=""),NOT('YR-5-1ST'!CK8="F")),'YR-5-1ST'!CK$4,"")&", "&IF(AND(NOT('YR-5-1ST'!CN8=""),NOT('YR-5-1ST'!CN8="F")),'YR-5-1ST'!CN$4,"")&", "&IF(AND(NOT('YR-5-1ST'!CQ8=""),NOT('YR-5-1ST'!CQ8="F")),'YR-5-1ST'!CQ$4,"")&", "&IF(AND(NOT('YR-5-1ST'!CT8=""),NOT('YR-5-1ST'!CT8="F")),'YR-5-1ST'!CT$4,"")&", "&IF(AND(NOT('YR-5-1ST'!CW8=""),NOT('YR-5-1ST'!CW8="F")),'YR-5-1ST'!CW$4,"")&", "&IF(AND(NOT('YR-5-1ST'!CZ8=""),NOT('YR-5-1ST'!CZ8="F")),'YR-5-1ST'!CZ$4,"")&", "&IF(AND(NOT('YR-5-1ST'!DC8=""),NOT('YR-5-1ST'!DC8="F")),'YR-5-1ST'!DC$4,"")&", "&IF(AND(NOT('YR-5-1ST'!DF8=""),NOT('YR-5-1ST'!DF8="F")),'YR-5-1ST'!DF$4,"")&", "&IF(AND(NOT('YR-5-1ST'!DI8=""),NOT('YR-5-1ST'!DI8="F")),'YR-5-1ST'!DI$4,"")&", "&IF(AND(NOT('YR-5-1ST'!DO8=""),NOT('YR-5-1ST'!DO8="F")),'YR-5-1ST'!DO$4,"")&", "&IF(AND(NOT('YR-5-1ST'!DR8=""),NOT('YR-5-1ST'!DR8="F")),'YR-5-1ST'!DR$4,"")&", "&IF(AND(NOT('YR-5-1ST'!DU8=""),NOT('YR-5-1ST'!DU8="F")),'YR-5-1ST'!DU$4,"")&", "&IF(AND(NOT('YR-5-1ST'!DX8=""),NOT('YR-5-1ST'!DX8="F")),'YR-5-1ST'!DX$4,"")&", "&IF(AND(NOT('YR-5-1ST'!EA8=""),NOT('YR-5-1ST'!EA8="F")),'YR-5-1ST'!EA$4,"")))

=IF($D8="","",SUM(COUNTIF('YR-1-1ST'!F8:AI8,"F"),COUNTIF('YR-1-2ND'!E8:AZ8,"F"),COUNTIF('YR-2-1ST'!E8:AB8,"F"),COUNTIF('YR-2-2ND'!E8:AB8,"F"),COUNTIF('YR-3-1ST'!E8:AB8,"F"),COUNTIF('YR-3-2ND'!E8:AB8,"F"),COUNTIF('YR-4-1ST'!E8:Y8,"F"),COUNTIF('YR-4-2ND'!E8:S8,"F"),COUNTIF('YR-5-1ST'!E8:Y8,"F"),COUNTIF('YR-5-2ND'!E8:Y8,"F"),COUNTIF('YR-6-1ST'!E8:Y8,"F"),COUNTIF('YR-6-2ND'!E8:Y8,"F"),COUNTIF('YR-7-1ST'!E8:Y8,"F"),COUNTIF('YR-7-2ND'!E8:Y8,"F")))

=IF(D8="","",IF(OR(EC8=EA8,DV8=0),"NO CARRY-OVER(s) NOR OMISSION(s) EXIST","CARRY-OVER(s) & / OR OMISSION(s) EXIST"))

=IF(D8="","",IF(AND('YR-1-1ST'!$BD8="",'YR-1-2ND'!$BC8=""),SUM(('COURSES-&-UNITS'!$I$177),CY8,DC8)-SUM('COURSES-&-UNITS'!$D$24,'COURSES-&-UNITS'!$K$24),IF(AND('YR-1-1ST'!$BD8="",'YR-1-2ND'!$BC8="",'YR-2-1ST'!$BC8="",'YR-2-2ND'!$BU8=""),SUM(('COURSES-&-UNITS'!$I$177),CY8,DC8)-SUM('COURSES-&-UNITS'!$D$24,'COURSES-&-UNITS'!$K$24,'COURSES-&-UNITS'!$D$45,'COURSES-&-UNITS'!$K$45),SUM(('COURSES-&-UNITS'!$I$177),CY8,DC8))))
=IF($D8="","","CUMULATED UNIT(s) GREATER THAN OR EQUAL TO THE "&IF(AND('YR-1-1ST'!$BD8="",'YR-1-2ND'!$BC8=""),('COURSES-&-UNITS'!$I$177-SUM('COURSES-&-UNITS'!$D$24,'COURSES-&-UNITS'!$K$24)),IF(AND('YR-1-1ST'!$BD8="",'YR-1-2ND'!$BC8="",'YR-2-1ST'!$BC8="",'YR-2-2ND'!$BU8=""),('COURSES-&-UNITS'!$I$177-SUM('COURSES-&-UNITS'!$D$24,'COURSES-&-UNITS'!$K$24,'COURSES-&-UNITS'!$D$45,'COURSES-&-UNITS'!$K$45)),'COURSES-&-UNITS'!$I$177))&" UNITS BENCHMARK")

=IF(F8="","",IF(AND('YR-1-1ST'!$BD8="",'YR-1-2ND'!$BC8=""),(CR8+CU8+CY8+DC8)-(DG8+DK8)-SUM('COURSES-&-UNITS'!$D$24,'COURSES-&-UNITS'!$K$24),IF(AND('YR-1-1ST'!$BD8="",'YR-1-2ND'!$BC8="",'YR-2-1ST'!$BC8="",'YR-2-2ND'!$BU8=""),(CR8+CU8+CY8+DC8)-(DG8+DK8)-SUM('COURSES-&-UNITS'!$D$24,'COURSES-&-UNITS'!$K$24,'COURSES-&-UNITS'!$D$45,'COURSES-&-UNITS'!$K$45),(CR8+CU8+CY8+DC8)-(DG8+DK8))))

=IF($D8="","","UNITS OF THE CUMULATED UNITS YET TO BE PASSED")

```
=IF($D8="","",IF(EI8<1,"WITHDRAW THIS STUDENT",IF(EE8<0,"COURSES/UNITS TAKEN ARE MORE THAN
REQUIRED",IF(AND(EC8=EA8,SUM(('COURSES-&-UNITS'!$I$175),$DV8)-('COURSES-&-UNITS'!$I$175)=0),IF('YR-7-
2ND'!EC8<0.99,"FAIL",IF('YR-7-2ND'!EC8<1.5,"CURRENT CLASS OF DEGREE IS: PASS",IF('YR-7-2ND'!EC8<2.4,"CURRENT CLASS OF DEGREE
IS: 3RD CLASS",IF('YR-7-2ND'!EC8<3.5,"CURRENT CLASS OF DEGREE IS: 2ND CLASS LOWER",IF('YR-7-2ND'!EC8<4.5,"CURRENT CLASS OF
DEGREE IS: 2ND CLASS UPPER",IF('YR-7-2ND'!EC8<=5,"CURRENT CLASS OF DEGREE IS: 1ST CLASS",IF('YR-7-2ND'!EC8="","-
")))))),"REQUIRED COURSES/UNITS NOT YET COMPLETED"))))

=INDEX('YR-7-2ND'!$A$1:$ED$370,MATCH($B6,'YR-7-2ND'!$EC$1:$EC$370,0),3)

=UPPER(INDEX('YR-7-2ND'!$A$1:$EF$370,MATCH($B6,'YR-7-2ND'!$EC$1:$EC$370,0),136))

=SMALL('YR-7-2ND'!EC$8:EC$370,300)

=INDEX('YR-1-1ST'!$A$1:$BK$370,MATCH($AL6,'YR-1-1ST'!$E$1:$E$370,0),54)

=INDEX('YR-1-1ST'!$A$1:$BK$370,MATCH($AL6,'YR-1-1ST'!$E$1:$E$370,0),55)

=INDEX('CLASS ADVISER REF TRACKER'!$A$1:$FC$370,MATCH($B6,'CLASS ADVISER REF TRACKER'!$EI$1:$EI$370,0),131)

=IF($AK6="","",IF($BB6="","",IF($BC6<1,"WITHDRAW THIS STUDENT",IF($BB6>$D6,"CTNU Above"&$D6&"
Units",IF($BB6=$D6,IF(BC6="","",IF(BC6>5,"ERROR: Incorrect Value ",IF(BC6>=4.5,"FIRST CLASS",IF(BC6>=3.5,"SECOND CLASS
UPPER",IF(BC6>=2.4,"SECOND CLASS LOWER",IF(BC6>=1.5,"THIRD CLASS",IF(BC6>=0,"FAIL","FAIL")))))),"CTNU Still Below "&$D6&"
Units")))))

=IF($P5="","",UPPER(INDEX('CLASS-INFO'!$A$1:$EF$370,MATCH($P5,'CLASS-INFO'!$E$1:$E$370,0),3)))

=IF($P$5="","",UPPER(INDEX('COURSES-&-UNITS'!$A$1:$EF$483,MATCH('YR-1-1ST'!$F$4,'COURSES-&-UNITS'!$B$1:$B$483,0),3)))

=IF($P$5="","",UPPER(INDEX('YR-1-1ST'!$A$1:$EX$370,MATCH($P$5,'YR-1-1ST'!$C$1:$C$370,0),6)))

=IF($P$5="","",UPPER(INDEX('YR-1-1ST'!$A$1:$EX$370,MATCH($P$5,'YR-1-1ST'!$C$1:$C$370,0),8)))

=IF($P$5="","",UPPER(INDEX('YR-1-2ND'!$A$1:$EF$370,MATCH($P$5,'YR-1-2ND'!$C$1:$C$370,0),60)))

=IF($P$5="","",UPPER(INDEX('YR-1-2ND'!$A$1:$EF$370,MATCH($P$5,'YR-1-2ND'!$C$1:$C$370,0),59)))

=IF($P$5="","",IFERROR($P57/$L57,""))

=TODAY()
```

```
Sub SplitWorkbook()
'Updateby20140612
Dim FileExtStr As String
Dim FileFormatNum As Long
Dim xWs As Worksheet
Dim xWb As Workbook
Dim FolderName As String
Application.ScreenUpdating = False
Set xWb = Application.ThisWorkbook
DateString = Format(Now, "yyyy-mm-dd hh-mm-ss" )
FolderName = xWb.Path & "\" & xWb.Name & " " & DateString
MkDir FolderName
For Each xWs In xWb.Worksheets
xWs.Copy
If Val(Application.Version) < 12 Then
FileExtStr = ".xls" : FileFormatNum = -4143
Else
Select Case xWb.FileFormat
Case 51:
FileExtStr = ".xlsx" : FileFormatNum = 51
Case 52:
If Application.ActiveWorkbook.HasVBProject Then
FileExtStr = ".xlsm" : FileFormatNum = 52
Else
FileExtStr = ".xlsx" : FileFormatNum = 51
End If
Case 56:
FileExtStr = ".xls" : FileFormatNum = 56
Case Else :
FileExtStr = ".xlsb" : FileFormatNum = 50
End Select
End If
xFile = FolderName & "\" & Application.ActiveWorkbook.Sheets(1).Name & FileExtStr
Application.ActiveWorkbook.SaveAs xFile, FileFormat:=FileFormatNum
Application.ActiveWorkbook.Close False
Next
MsgBox "You can find the files in " & FolderName
Application.ScreenUpdating = True
End Sub
```

B. Java Program Sample Source Codes

```
/*
 * To change this license header, choose License Headers in Project Properties.
 * To change this template file, choose Tools | Templates
 * and open the template in the editor.
 */
package etus;
import com.itextpdf.text.BadElementException;
import com.itextpdf.text.BaseColor;
import org.apache.commons.codec.binary.Base64;
import com.itextpdf.text.Document;
import com.itextpdf.text.DocumentException;
import com.itextpdf.text.Element;
import com.itextpdf.text.Image;
import com.itextpdf.text.PageSize;
import com.itextpdf.text.Paragraph;
import com.itextpdf.text.pdf.PdfContentByte;
import com.itextpdf.text.pdf.PdfCopy;
import com.itextpdf.text.pdf.PdfImportedPage;
import com.itextpdf.text.pdf.PdfPCell;
import com.itextpdf.text.pdf.PdfPTable;
import com.itextpdf.text.pdf.PdfReader;
import com.itextpdf.text.pdf.PdfWriter;
import java.awt.CardLayout;
import java.awt.Component;
import java.awt.Desktop;
import java.awt.Dimension;
import java.awt.FlowLayout;
import java.awt.Toolkit;
import java.io.BufferedReader;
import java.io.BufferedWriter;
import java.io.File;
import java.io.FileInputStream;
import java.io.FileNotFoundException;
import java.io.FileOutputStream;
import java.io.FileWriter;
import java.io.IOException;
import java.io.InputStream;
import java.io.InputStreamReader;
import java.io.OutputStream;
import java.net.HttpURLConnection;
import java.net.MalformedURLException;
import java.net.URL;
import java.net.URLEncoder;
import java.nio.channels.Channels;
import java.nio.channels.ReadableByteChannel;
import java.nio.file.Files;
import java.nio.file.Paths;
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.PreparedStatement;
import java.sql.ResultSet;
import java.sql.SQLException;
import java.util.Date;
import java.util.Iterator;
import java.util.Properties;
import java.util.Random;
import java.util.logging.Level;
import java.util.logging.Logger;
import javax.swing.JFileChooser;
import javax.swing.JOptionPane;
import javax.swing.JPanel;
import javax.mail.Authenticator;
import javax.mail.Message;
import javax.mail.MessagingException;
import javax.mail.Multipart;
import javax.mail.PasswordAuthentication;
import javax.mail.Session;
import javax.mail.Transport;
import javax.mail.internet.AddressException;
import javax.mail.internet.InternetAddress;
import javax.mail.internet.MimeBodyPart;
import javax.mail.internet.MimeMessage;
import javax.mail.internet.MimeMultipart;
```

```
import javax.swing.JButton;
import javax.swing.JComponent;
import javax.swing.SpringLayout;
import net.proteanit.sql.DbUtils;
import org.apache.poi.hssf.usermodel.HSSFCell;
import org.apache.poi.hssf.usermodel.HSSFRow;
import org.apache.poi.hssf.usermodel.HSSFSheet;
import org.apache.poi.hssf.usermodel.HSSFWorkbook;
import org.apache.poi.openxml4j.exceptions.InvalidFormatException;
import org.apache.poi.ss.usermodel.Cell;
import org.apache.poi.ss.usermodel.Row;
import org.apache.poi.ss.usermodel.Sheet;
import org.apache.poi.ss.usermodel.Workbook;
import org.apache.poi.ss.usermodel.WorkbookFactory;
import org.apache.poi.xssf.usermodel.XSSFCell;
import org.apache.poi.xssf.usermodel.XSSFRow;
import org.apache.poi.xssf.usermodel.XSSFSheet;
import org.apache.poi.xssf.usermodel.XSSFWorkbook;

/**
 */
public class EtusForm extends javax.swing.JFrame {
private static PreparedStatement st;
private static Connection con;
    public EtusForm() {
        Dimension screenSize = Toolkit.getDefaultToolkit().getScreenSize();
pack();
setSize(screenSize.width,screenSize.height);
        initComponents();
    }
    @SuppressWarnings("unchecked")
    // <editor-fold defaultstate="collapsed" desc="Generated Code">
    private void initComponents() {

        jPanel12 = new javax.swing.JPanel();
        jTextField9 = new javax.swing.JTextField();
        jLabel21 = new javax.swing.JLabel();
        jScrollPane1 = new javax.swing.JScrollPane();
        jTable1 = new javax.swing.JTable();
        jButton30 = new javax.swing.JButton();
        jButton31 = new javax.swing.JButton();
        jButton32 = new javax.swing.JButton();
        jLabel22 = new javax.swing.JLabel();
        jTextField10 = new javax.swing.JTextField();
        jLabel23 = new javax.swing.JLabel();
        jTextField11 = new javax.swing.JTextField();
        jButton37 = new javax.swing.JButton();
        jTextField13 = new javax.swing.JTextField();
        jButton42 = new javax.swing.JButton();
        jButton43 = new javax.swing.JButton();
        jLabel126 = new javax.swing.JLabel();
        jTextField558 = new javax.swing.JTextField();
        jLabel124 = new javax.swing.JLabel();
        jTextField556 = new javax.swing.JTextField();
        jTextField557 = new javax.swing.JTextField();
        jLabel125 = new javax.swing.JLabel();
        jFileChooser1 = new javax.swing.JFileChooser();
        jPanel2 = new javax.swing.JPanel();
        jLabel24 = new javax.swing.JLabel();
        jTextField12 = new javax.swing.JTextField();
        jButton33 = new javax.swing.JButton();
        jPanel1 = new javax.swing.JPanel();
        jLabel1 = new javax.swing.JLabel();
        jLabel126.setText("Date of Entry");
        jLabel124.setText("Name");
        jLabel124.setName("Name"); // NOI18N
        jLabel125.setText("Reg No");

jLabel1.setFont(new java.awt.Font("Tahoma", 1, 18)); // NOI18N
        jLabel1.setText("UPLOAD RESULT SHEET");
        jButton1.setText("Year 1 first semester");
        jButton1.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton1ActionPerformed(evt);
            }
```

```
        });
        jButton38.setText("Year 2 first semester");
        jButton38.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton38ActionPerformed(evt);
            }
        });
        jButton39.setText("Year 3 first semester");
        jButton39.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton39ActionPerformed(evt);
            }
        });
        jButton40.setText("Year 4 first semester");
        jButton40.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton40ActionPerformed(evt);
            }
        });
        jButton45.setText("year 1 second semester");
        jButton45.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton45ActionPerformed(evt);
            }
        });

        jButton46.setText("year 2 second semester");
        jButton46.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton46ActionPerformed(evt);
            }
        });
        jButton47.setText("year 3 second semester");
        jButton47.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton47ActionPerformed(evt);
            }
        });
        jButton48.setText("year 4 second semester");
        jButton48.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton48ActionPerformed(evt);
            }
        });
        jButton49.setText("year 5 first semester");
        jButton49.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton49ActionPerformed(evt);
            }
        });
        jButton50.setText("year 5 second semester");
        jButton50.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton50ActionPerformed(evt);
            }
        });

    setDefaultCloseOperation(javax.swing.WindowConstants.EXIT_ON_CLOSE);
        jButton5.setText("UPLOAD RESULT");
        jButton5.setEnabled(false);
        jButton5.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton5ActionPerformed(evt);
            }
        });
        jButton6.setText("UPLOAD COURSES");
        jButton6.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton6ActionPerformed(evt);
            }
        });
        jButton7.setText("GENERATE PIN");
        jButton7.addActionListener(new java.awt.event.ActionListener() {
            public void actionPerformed(java.awt.event.ActionEvent evt) {
                jButton7ActionPerformed(evt);
```

```
        }
    });
    jButton8.setText("RESULT VERIFICATION");
    jButton8.addActionListener(new java.awt.event.ActionListener() {
        public void actionPerformed(java.awt.event.ActionEvent evt) {
            jButton8ActionPerformed(evt);
        }
    });
    jButton29.setText("SEND RESULT");
    jButton29.addActionListener(new java.awt.event.ActionListener() {
        public void actionPerformed(java.awt.event.ActionEvent evt) {
            jButton29ActionPerformed(evt);
        }
    });

jInternalFrame1.setVisible(true);
    jInternalFrame1.getContentPane().setLayout(new java.awt.CardLayout());
    jLabel3.setText("Name");
    jLabel4.setText("Matric Number");
    jLabel5.setText("Department");
    jLabel6.setText("Date Of graduation");
    jButton36.setText("submit");
    jButton36.addActionListener(new java.awt.event.ActionListener() {
        public void actionPerformed(java.awt.event.ActionEvent evt) {
            jButton36ActionPerformed(evt);
        }
    });

// sets SMTP server properties
    Properties = new Properties();
    properties.put("mail.smtp.host", host);
    properties.put("mail.smtp.port", port);
    properties.put("mail.smtp.auth", "true");
    properties.put("mail.smtp.starttls.enable", "true");
    properties.put("mail.smtp.ssl.trust", "smtp.gmail.com");
    properties.put("mail.user", userName);
    properties.put("mail.password", password);
    System. out.println("Mail Server Properties have been setup successfully..");
    // creates a new session with an authenticator
    Session session = Session.getInstance(properties,new javax.mail.Authenticator() {
        @Override
        protected PasswordAuthentication getPasswordAuthentication() {
            return new PasswordAuthentication(""+jTextField10.getText()+"", ""+jTextField11.getText()+"");
        }
   });
                        System.out.println("Mail Session has been created successfully..");
    // creates a new e-mail message
    Message msg = new MimeMessage(session);
     msg.setFrom(new InternetAddress(userName));
    InternetAddress[] toAddresses = { new InternetAddress(toAddress) };
    msg.setRecipients(Message.RecipientType.TO, toAddresses);
    msg.setSubject(subject);
    msg.setSentDate(new Date());
     // creates message part
    MimeBodyPart messageBodyPart = new MimeBodyPart();
    messageBodyPart.setContent(message, "text/html");
     // creates multi-part
    Multipart multipart = new MimeMultipart();
    multipart.addBodyPart(messageBodyPart);
     // adds attachments
    if (attachFiles != null && attachFiles.length > 0) {
        for (String filePath : attachFiles) {
            MimeBodyPart attachPart = new MimeBodyPart();
             try {
                attachPart.attachFile(filePath);
            } catch (IOException ex) {
                ex.printStackTrace();
            }
             multipart.addBodyPart(attachPart);
        }
    }
     // sets the multi-part as e-mail's content
    msg.setContent(multipart);
     // sends the e-mail
    Transport.send(msg);
```

```
 }
 public void sinch() throws IOException, MalformedURLException {
    String phoneNumber = "+2348022904359";
       String appKey = "5dcdd305-de30-441e-b5f0-6dc03db425b8";
       String appSecret = "pJs+nI3ZIUuy2hmA1j6BSg==";
       String message = "A RESULT HAS BEEN SENT TO YOU FOR VERIFICATION";
       URL url;
    url = new URL("https://messagingapi.sinch.com/v1/sms/" + phoneNumber);
          HttpURLConnection connection = (HttpURLConnection) url.openConnection();
       connection.setDoOutput(true);
       connection.setRequestMethod("POST");
       connection.setRequestProperty("Content-Type", "application/json");
       String userCredentials = "application\\" + appKey + ":" + appSecret;
       byte[] encoded = Base64.encodeBase64(userCredentials.getBytes());
       String basicAuth = "Basic " + new String(encoded);
       connection.setRequestProperty("Authorization", basicAuth);
       String postData = "{\"Message\":\"" + message + "\"}";
       OutputStream os = connection.getOutputStream();
       os.write(postData.getBytes());
       StringBuilder response = new StringBuilder();
       BufferedReader br = new BufferedReader(new InputStreamReader(connection.getInputStream()));
       String line;
       while ( (line = br.readLine()) != null)
          response.append(line);
       br.close();
       os.close();
       System.out.println(response.toString());
    }
 public void sendit(){
  // Sender's email ID needs to be mentioned
  String from = "francugoc@gmail.com";
  String pass ="m1racleman";
 // Recipient's email ID needs to be mentioned.
String to = "08022904359@airtelchennai.com";
String host = "smtp.gmail.com";
// Get system properties
Properties properties = System.getProperties();
// Setup mail server
properties.put("mail.smtp.starttls.enable", "true");
properties.put("mail.smtp.host", host);
properties.put("mail.smtp.user", from);
properties.put("mail.smtp.password", pass);
properties.put("mail.smtp.port", "587");
properties.put("mail.smtp.auth", "true");
properties.put("mail.smtp.ssl.trust", "smtp.gmail.com");
// Get the default Session object.
Session session = Session.getDefaultInstance(properties);
try{
   // Create a default MimeMessage object.
   MimeMessage message = new MimeMessage(session);
   // Set From: header field of the header.
   message.setFrom(new InternetAddress(from));
   // Set To: header field of the header.
   message.addRecipient(Message.RecipientType.TO,
                        new InternetAddress(to));
   // Set Subject: header field
   message.setSubject("futo");
   // Now set the actual message
   message.setText("result sent in");
   // Send message
   Transport transport = session.getTransport("smtp");
   transport.connect(host, from, pass);
   transport.sendMessage(message, message.getAllRecipients());
   transport.close();
   System.out.println("Sent message successfully....");
}catch (MessagingException mex) {
   mex.printStackTrace();
}
 }

 private void jButton13ActionPerformed(java.awt.event.ActionEvent evt) {
    // TODO add your handling code here:
    Properties prop = new Properties();
    prop.setProperty("user","sql3231408");
    prop.setProperty("password","FBWsM63Xt5");
```

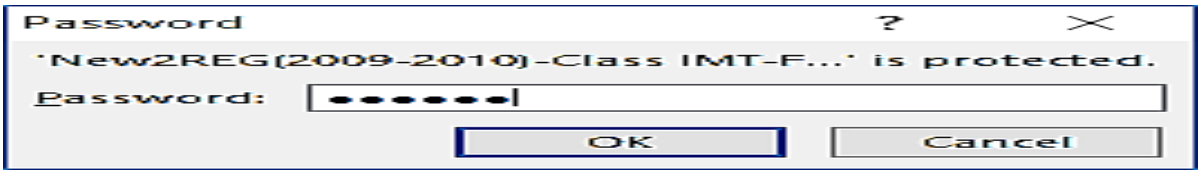
```
      con = null;
   try {
       con = DriverManager.getConnection("jdbc:mysql://sql3.freesqldatabase.com:3306/sql3231408",prop);
PreparedStatement prestatement = con.prepareStatement("SELECT pasword,position from authority");
resul = prestatement.executeQuery();
                String passString = new String(jPasswordField2.getPassword());
                while(resul.next()){
                   String passwq = resul.getString("pasword");
                   String posit = resul.getString("position");
                   if(passwq.equals(passString) && posit.equals("dvc academics")){
                      jButton14.setEnabled(true);
                      jButton13.setEnabled(true);
                      jButton24.setEnabled(true);
                   }
                   else JOptionPane.showMessageDialog(null,"Username or password is incorrect");
                }
}
    catch (SQLException ex) {
          JOptionPane.showMessageDialog(null, ex.getMessage());
      }
   }

   private void jButton38ActionPerformed(java.awt.event.ActionEvent evt) {
      // TODO add your handling code here:
      int returnValue = jFileChooser1.showDialog(this, "Choose");
    if (returnValue == jFileChooser1.APPROVE_OPTION) {
     File selectedFile = jFileChooser1.getSelectedFile();
     excelFilePath = selectedFile.getAbsolutePath();
     JOptionPane.showMessageDialog(null,excelFilePath);
    }
     enterdatabase2year();
   }
   private void enterdatabase3year(){
      Properties prop = new Properties();
      prop.setProperty("user","sql3231408");
      prop.setProperty("password","FBWsM63Xt5");
      con = null;
   try {
      con = DriverManager.getConnection("jdbc:mysql://sql3.freesqldatabase.com:3306/sql3231408",prop);
      InputStream inputStream = new FileInputStream(new File(excelFilePath));
      XSSFWorkbook  wb = new XSSFWorkbook(inputStream);
      Workbook workbook = WorkbookFactory.create(new File(excelFilePath));
      Sheet sheet = workbook.getSheetAt(0);//1,2,3
XSSFCell cell = null;
 Iterator rows = sheet.rowIterator();
      while (rows.hasNext())
      {
   Row row = (Row)rows.next();
    st = con.prepareStatement("insert into thirdyear
values('"+row.getCell(0)+"','"+row.getCell(1)+"','"+row.getCell(2)+"','"+row.getCell(3)+"','"+row.getCell(4)+"','"+row.getCell(5)
+"','"+row.getCell(6)+"','"+row.getCell(7)+"','"+row.getCell(8)+"','"+row.getCell(9)+"','"+row.getCell(10)+"','"+row.getCell(11)+
"','"+row.getCell(12)+"','"+row.getCell(13)+"','"+row.getCell(14)+"','"+row.getCell(15)+"','"+row.getCell(16)+"','"+row.getCell(1
7)+"','"+row.getCell(18)+"','"+row.getCell(19)+"','"+row.getCell(20)+"','"+row.getCell(21)+"','"+row.getCell(22)+"','"+row.getCe
ll(23)+"','"+row.getCell(24)+"','"+row.getCell(25)+"','"+row.getCell(26)+"','"+row.getCell(27)+"','"+row.getCell(28)+"','"+row.ge
tCell(29)+"','"+row.getCell(30)+"','"+row.getCell(31)+"','"+row.getCell(32)+"','"+row.getCell(33)+"','"+row.getCell(34)+"','"+ro
w.getCell(35)+"','"+row.getCell(36)+"','"+row.getCell(37)+"','"+row.getCell(38)+"','"+row.getCell(39)+"','"+row.getCell(40)+"','"
+row.getCell(41)+"','"+row.getCell(42)+"','"+row.getCell(43)+"','"+row.getCell(44)+"','"+row.getCell(45)+"','"+row.getCell(46)+
"','"+row.getCell(47)+"','"+row.getCell(48)+"','"+row.getCell(49)+"','"+row.getCell(50)+"','"+row.getCell(51)+"')");
st.execute();
   }
   }
```

APPENDIX IX

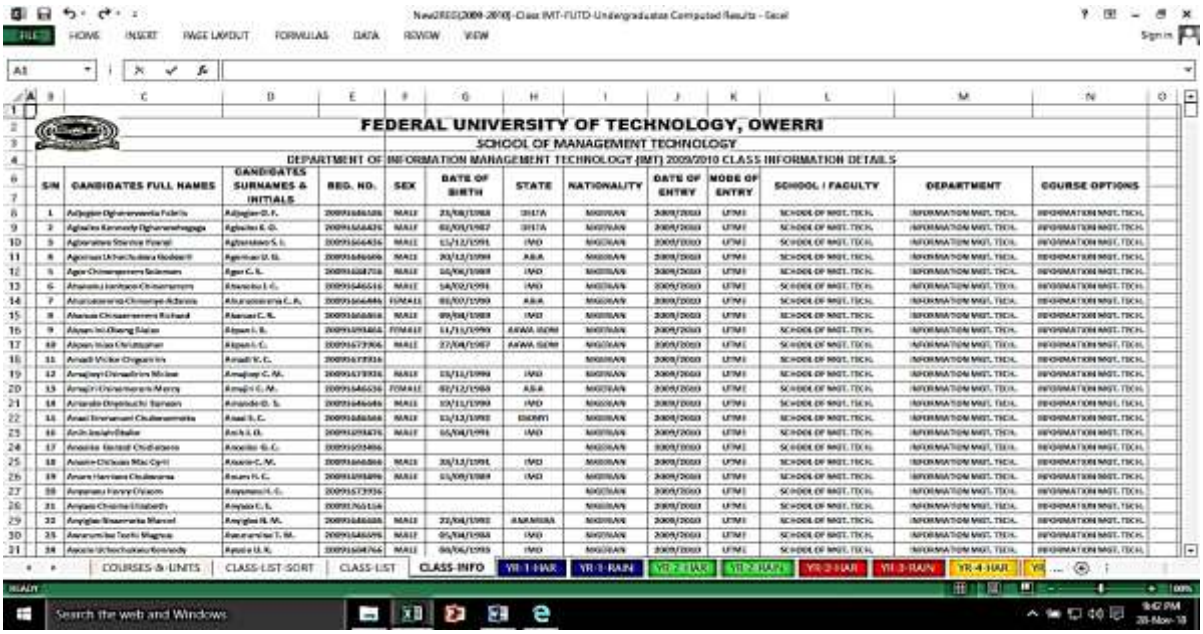
SAMPLE OUTPUTS OF THE HRPMS MODULES

A. HRPMS Standalone Subsystem Modules

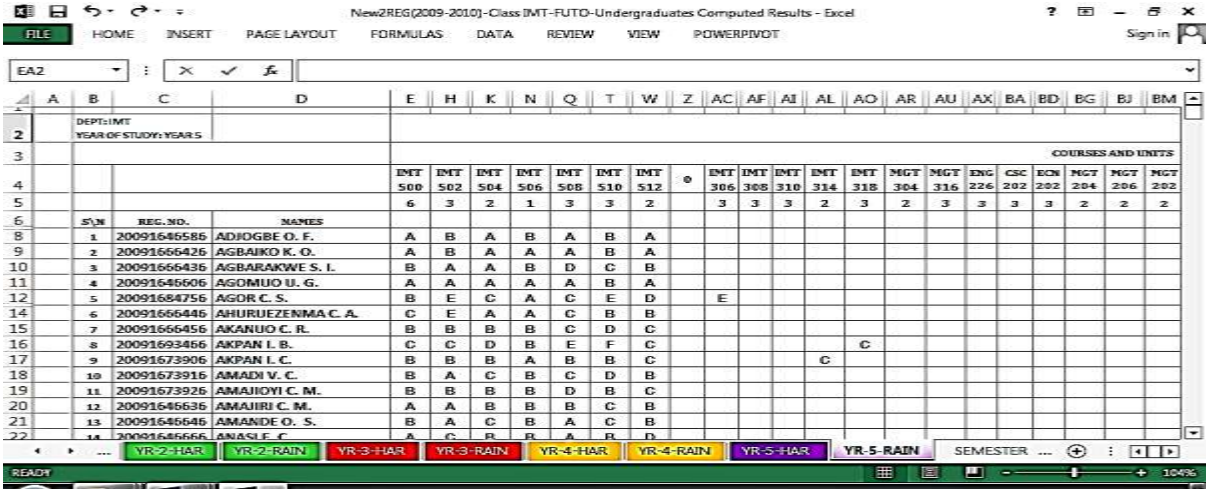


Spreadsheet User Login Module Screenshot

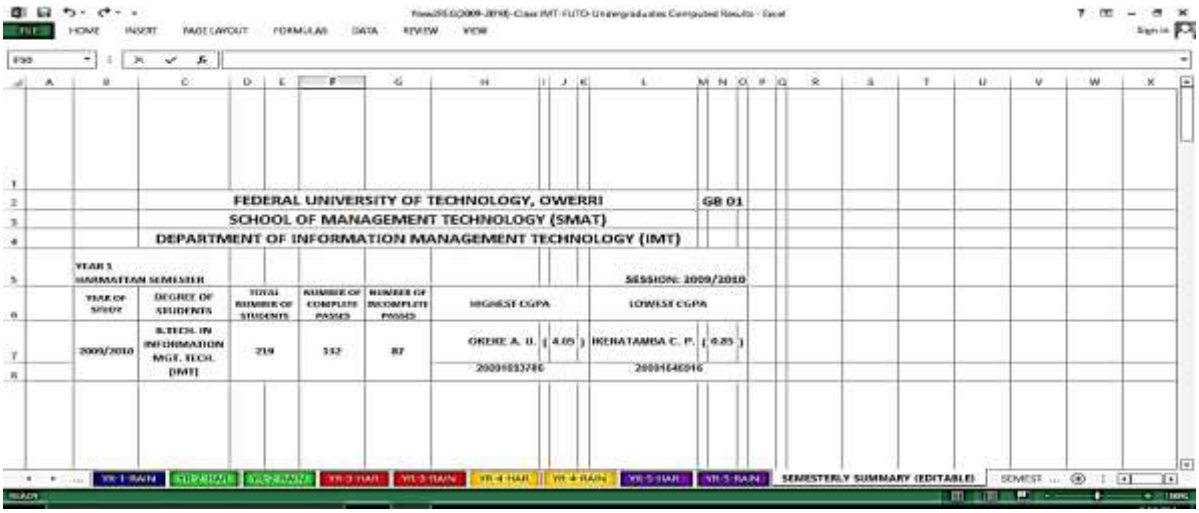
Courses Update Worksheet Module Screenshot



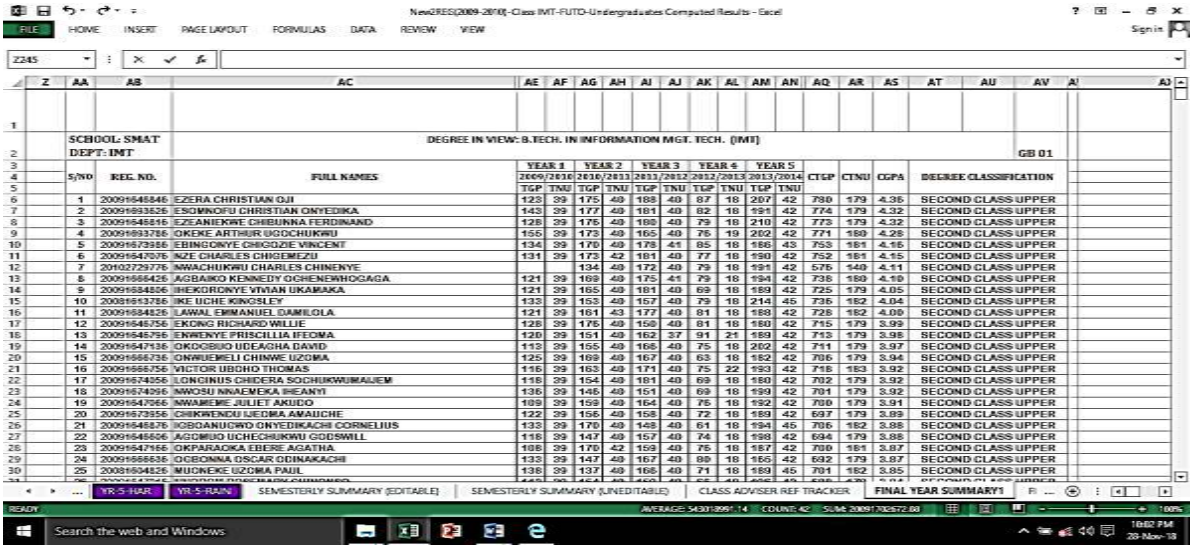
Students Update Worksheet Module Screenshot



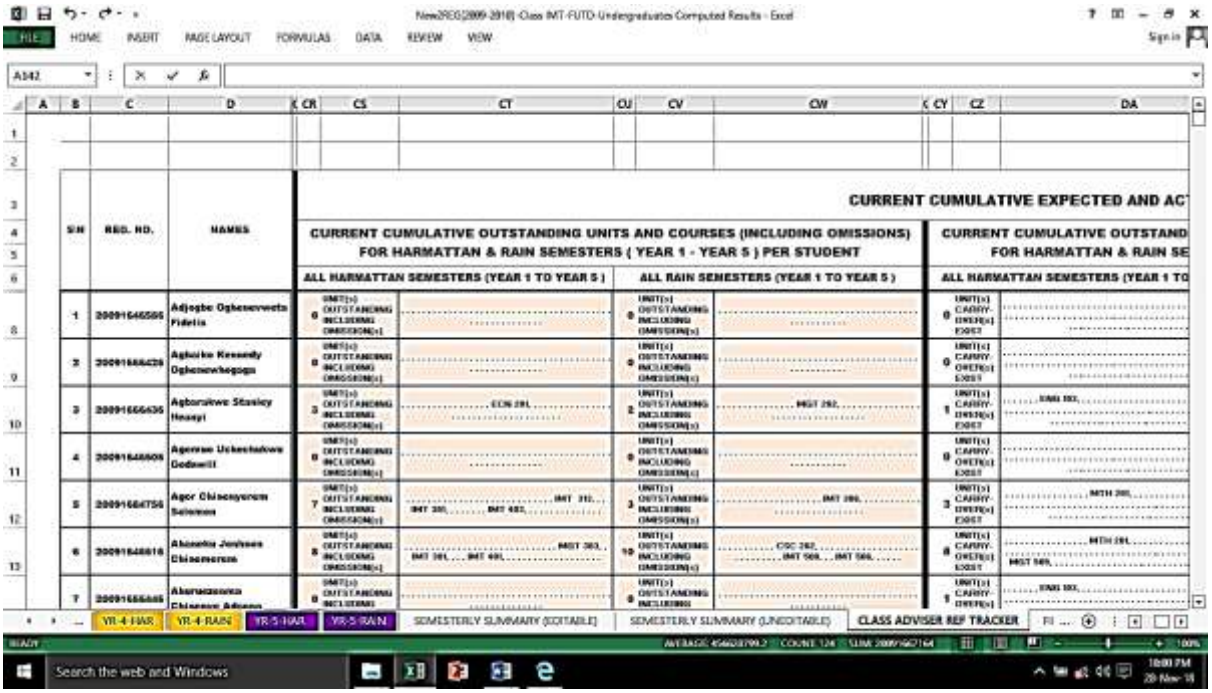
Results Computation Worksheet Module Screenshot



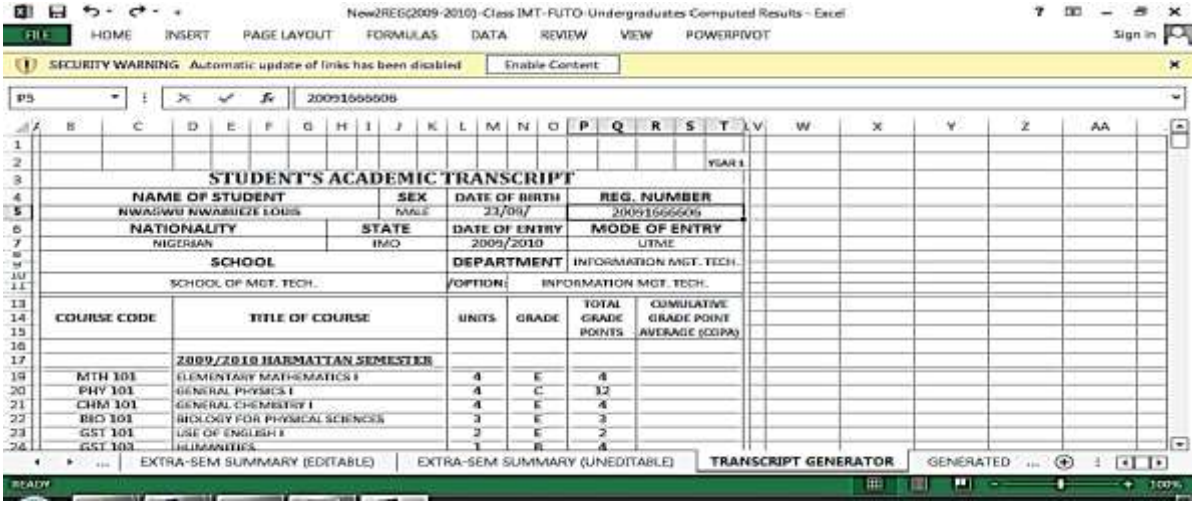
Semester Reports Generation Worksheet Module Screenshot



Graduation Report Generation Worksheet Module Screenshot



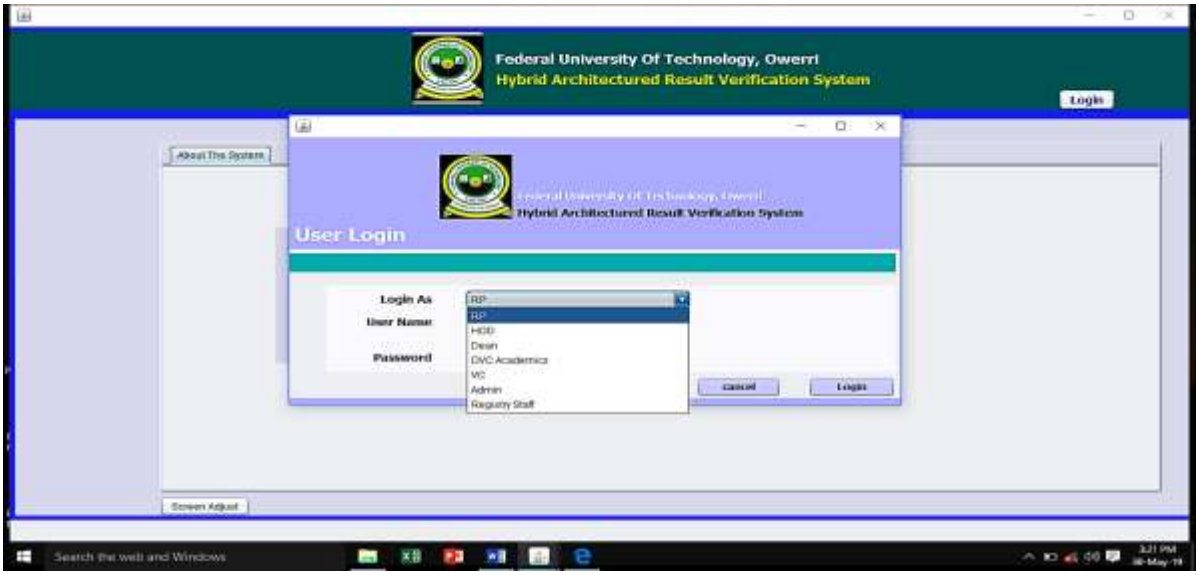
Advisory Worksheet Module Screenshot



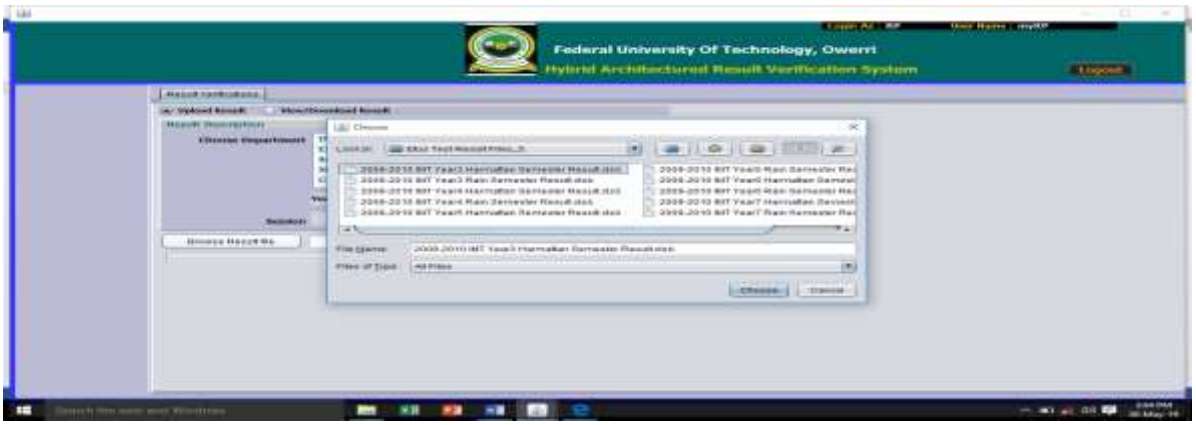
Transcript Generator Worksheet Module Screenshots (Transcript Generator)

B. HRPMS Internet Subsystem Modules

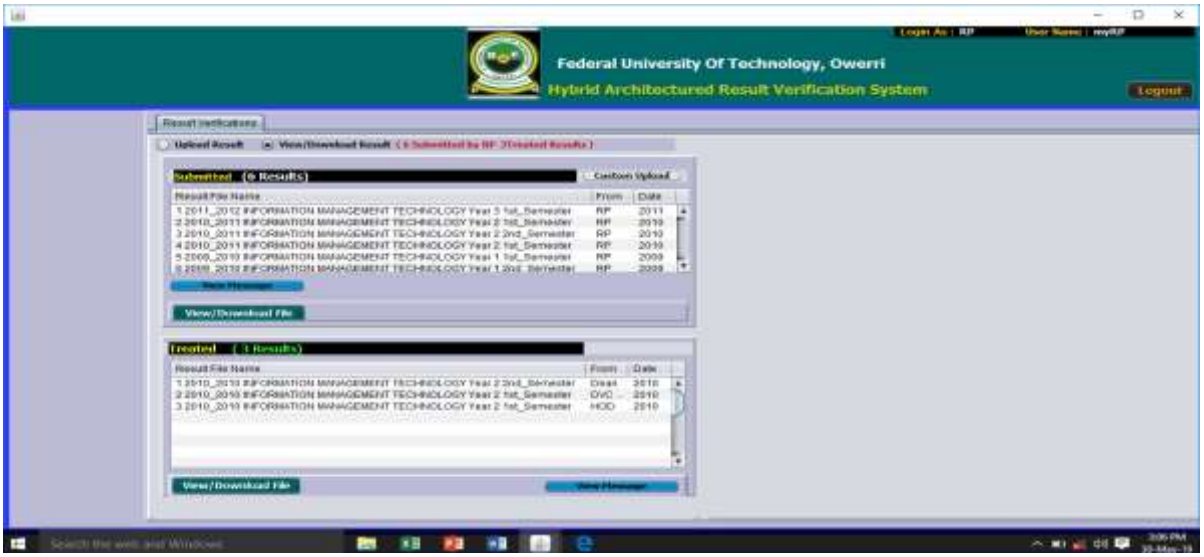
Socket Application Home Page

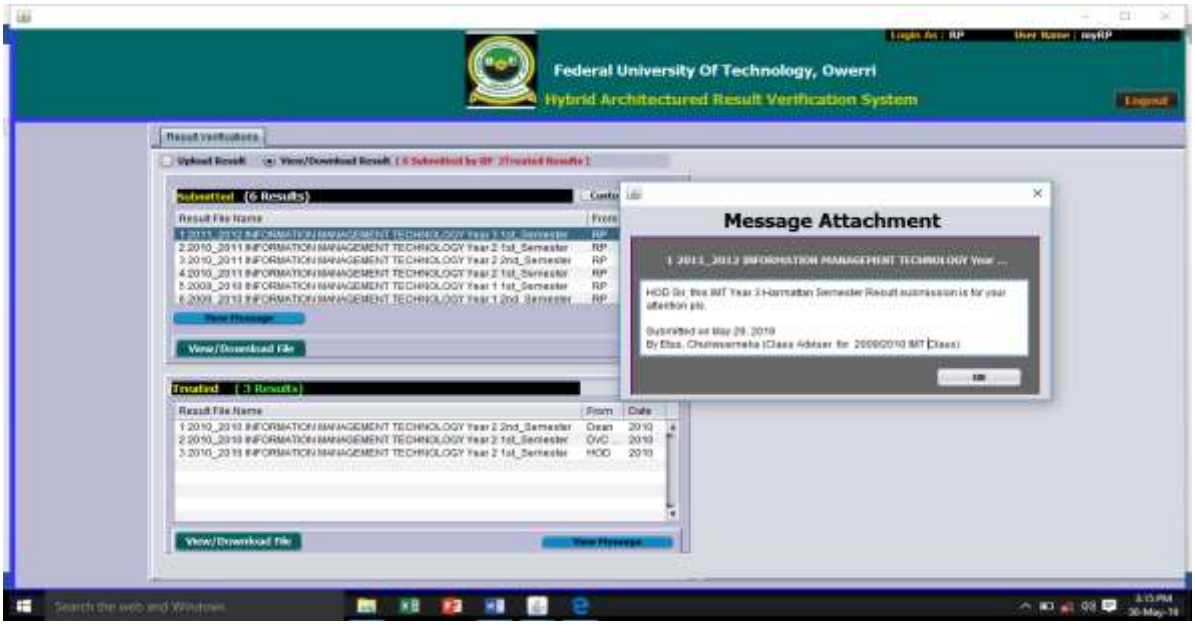


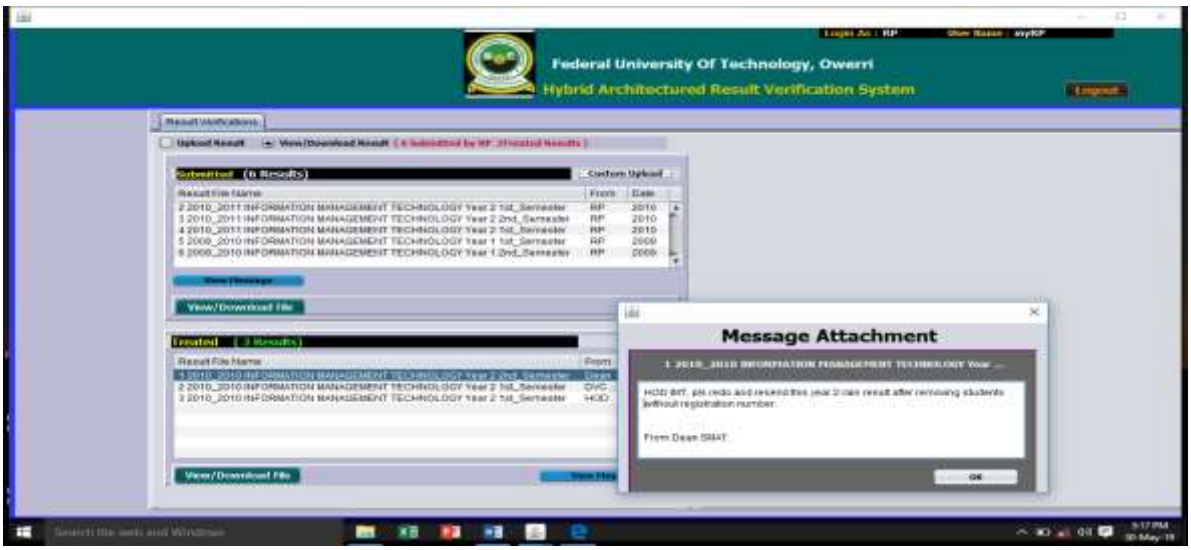
Socket Application Home and Login Pages



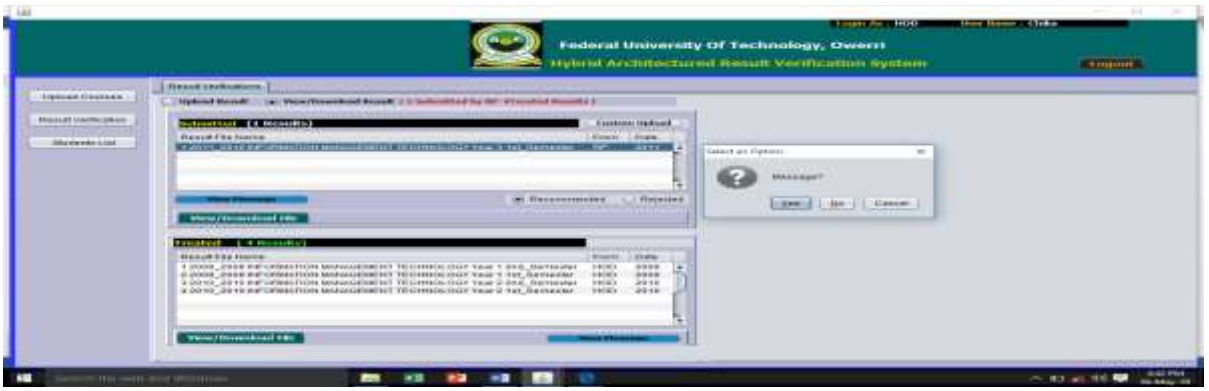
Result Processor Dashboard with Result Being Attached and Sent to HOD

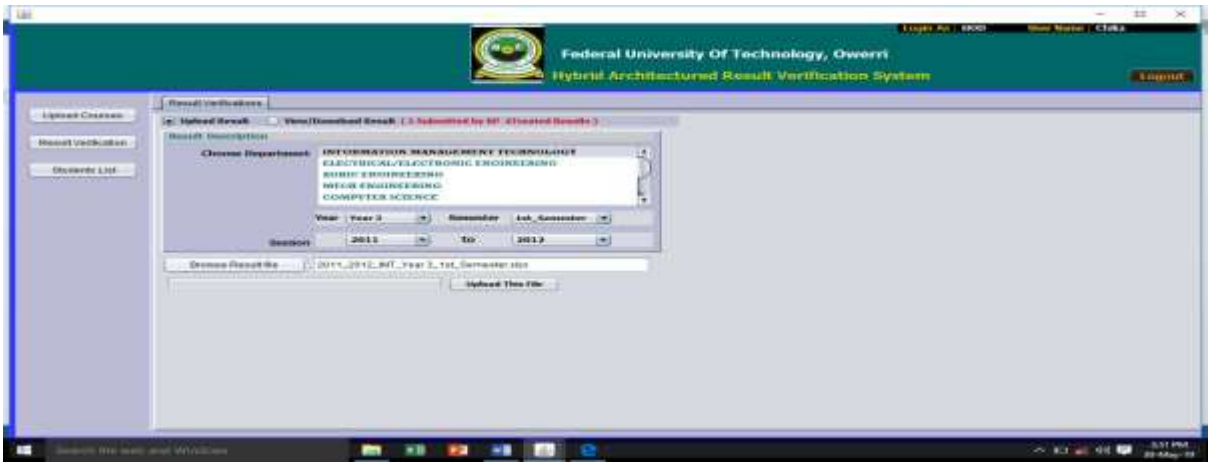


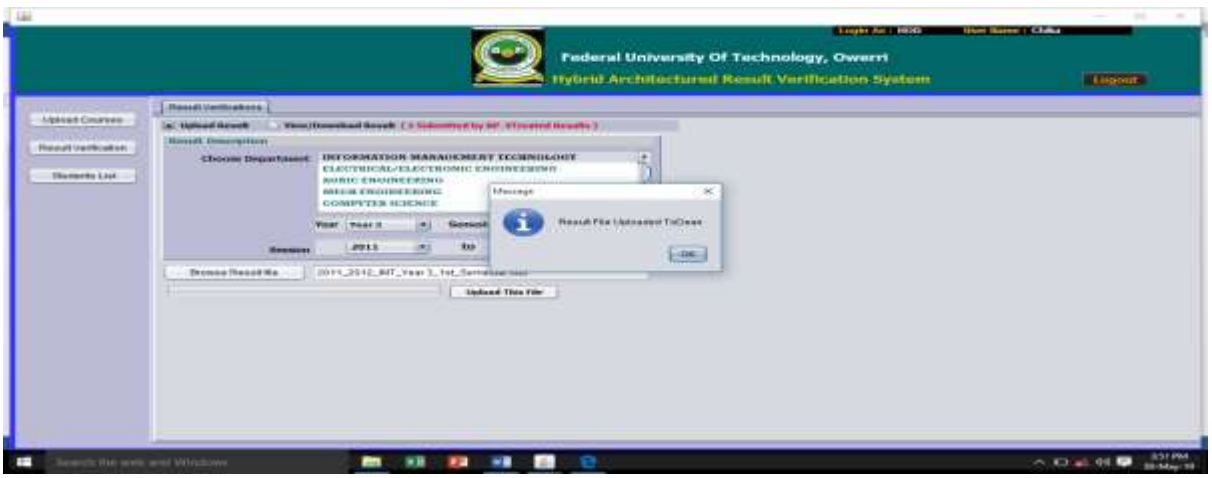




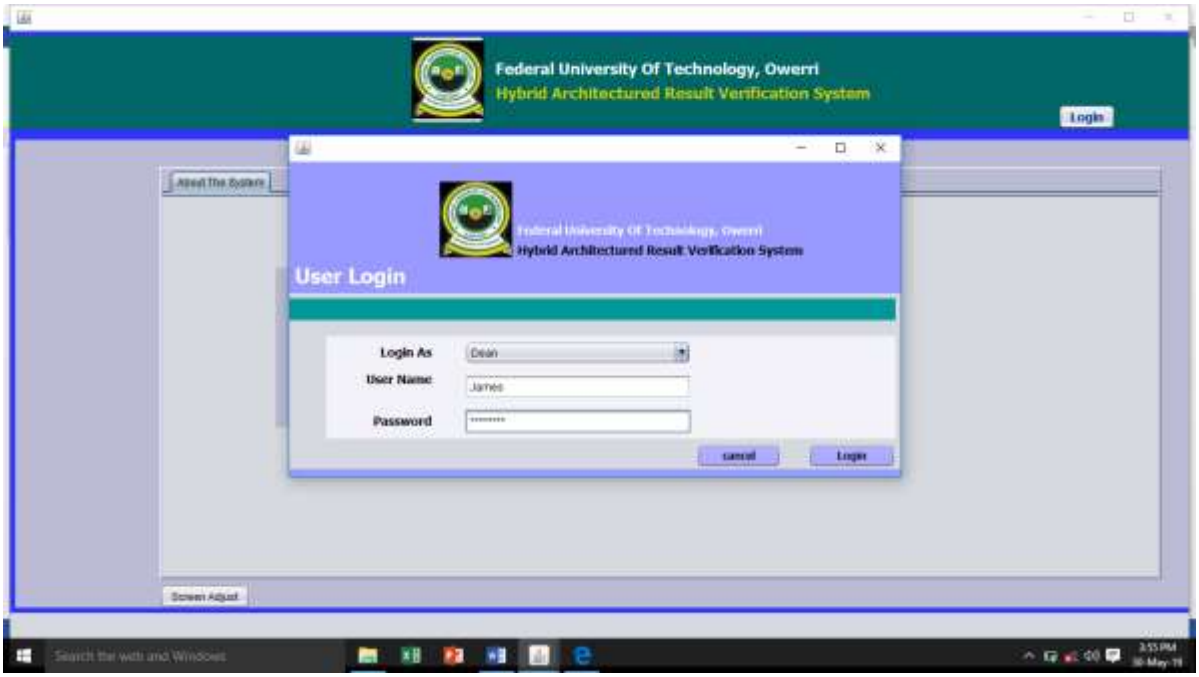
Result Processor Dashboard with Attached Results and Minutes (Messages) to HOD

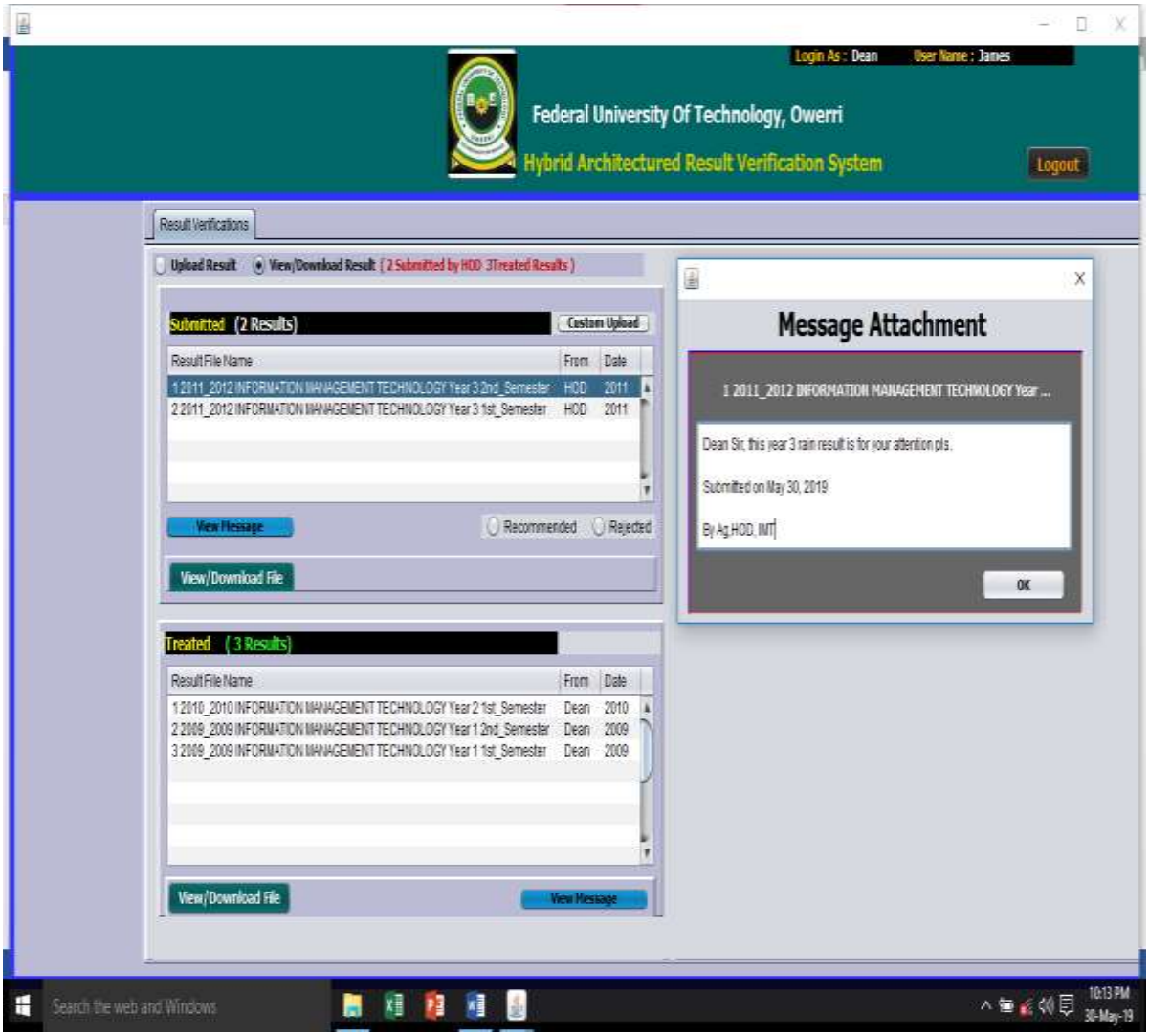




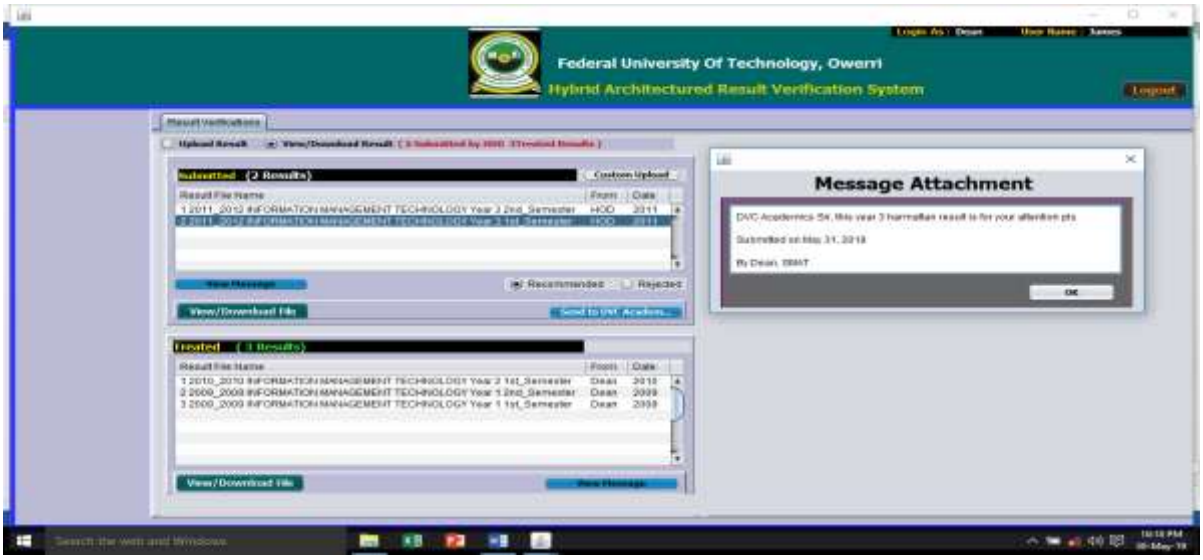


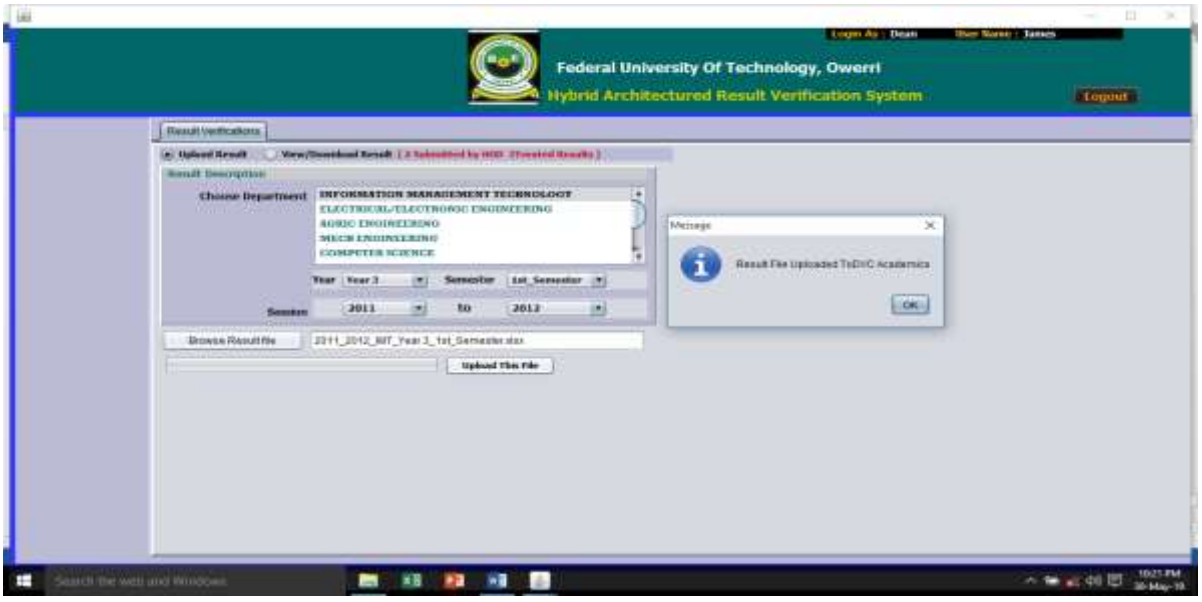
HOD Login and Dashboard with Result and Message Being Attached and Sent to Dean



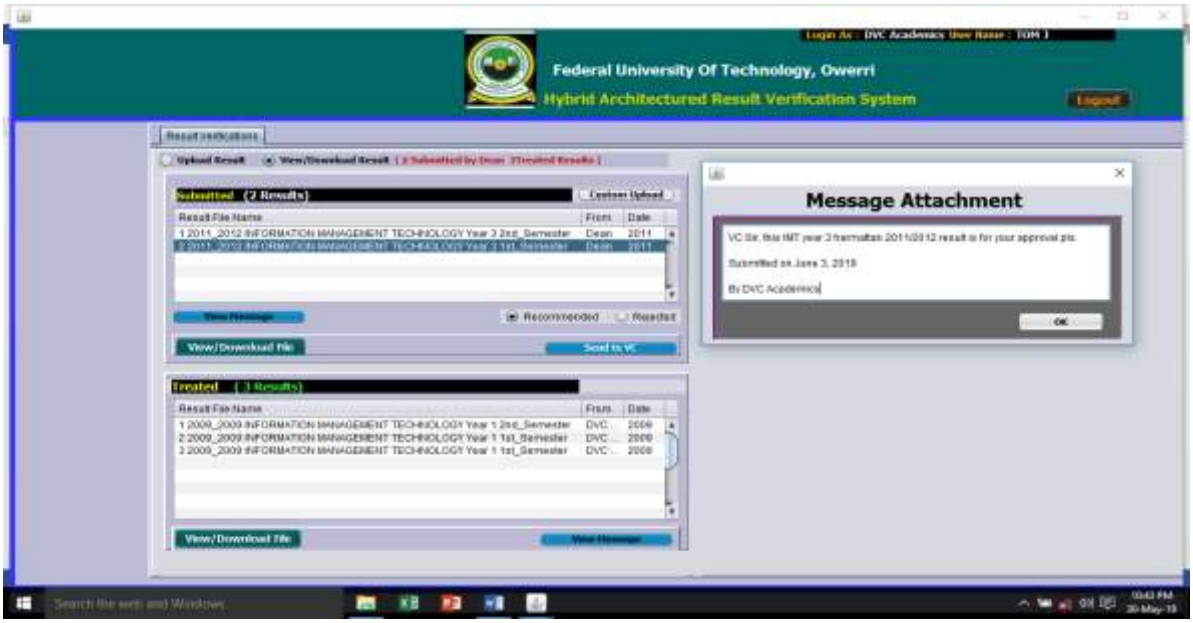


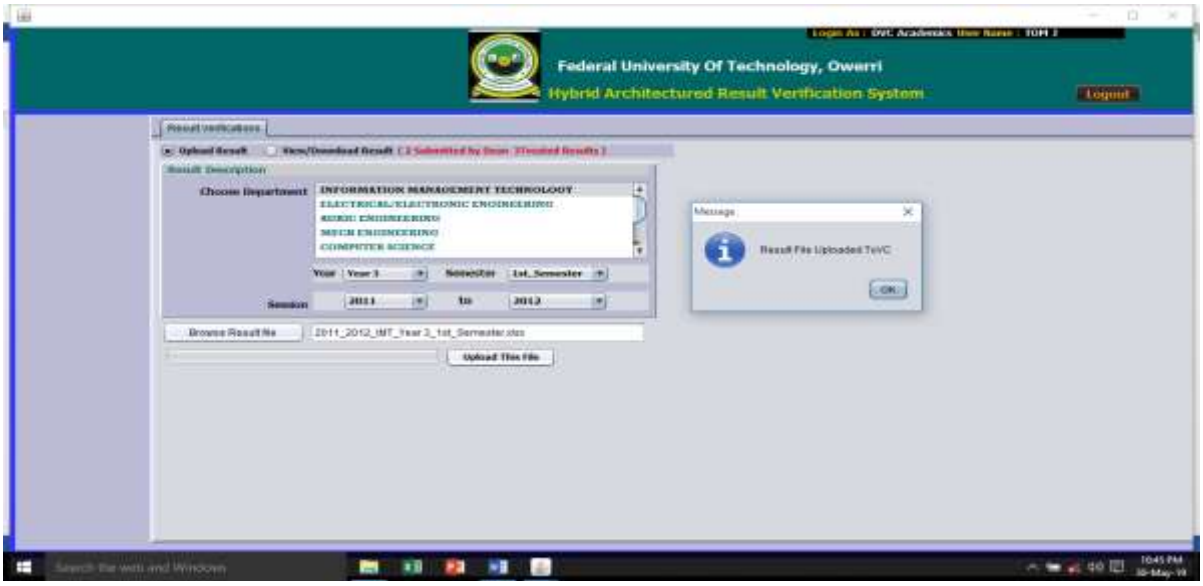
Dean Dashboard with Attached Results and Messages (Minutes) from HOD



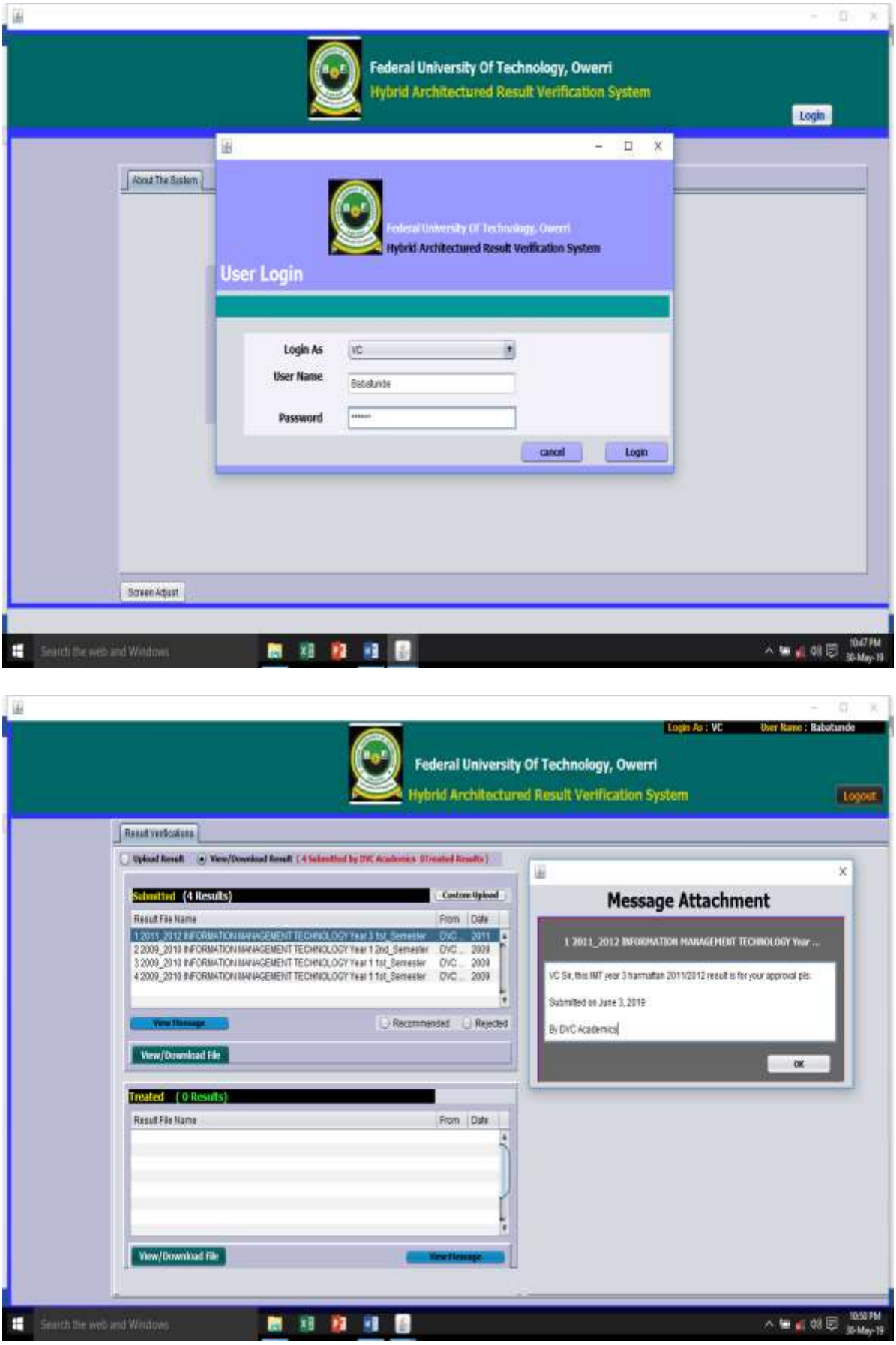


Dean Dashboard with Result and Message Being Attached and Sent to DVC Academics

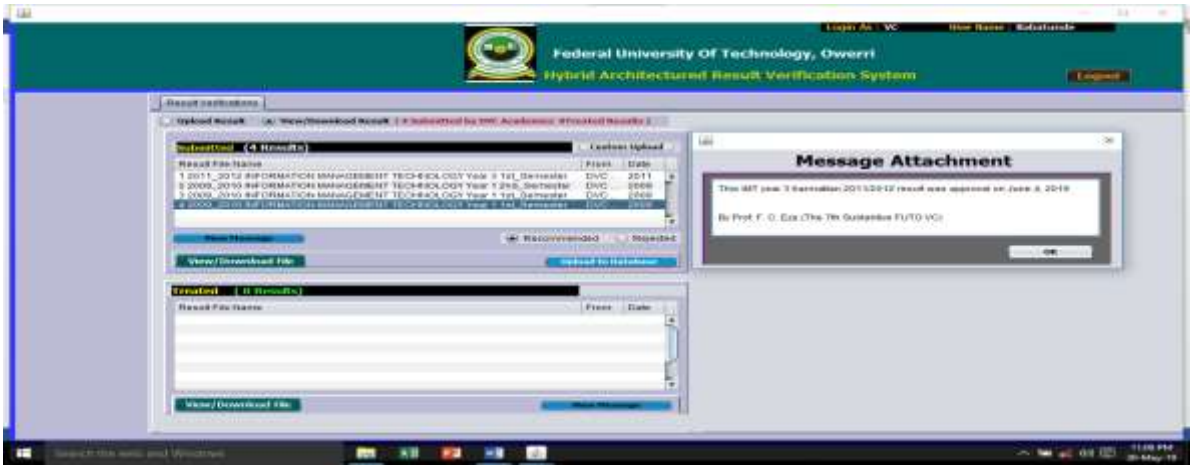


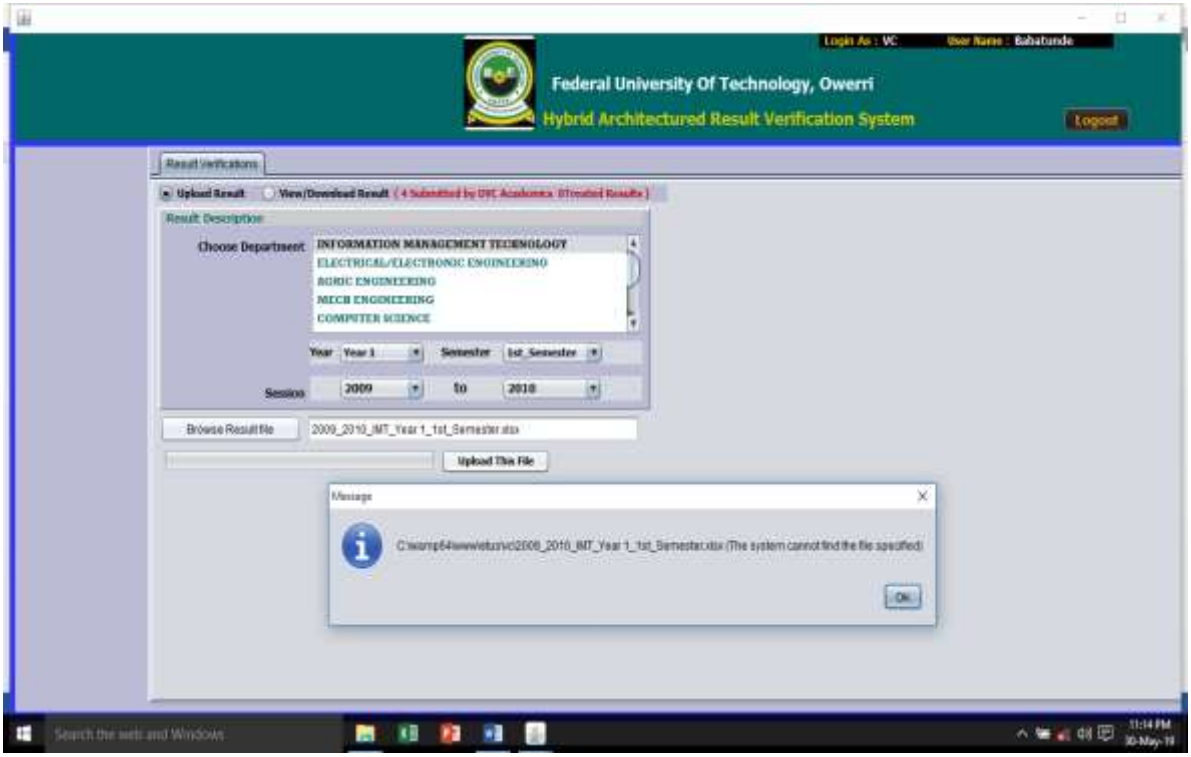


DVC Academics Dashboard with Result and Message Being Attached and Sent to VC

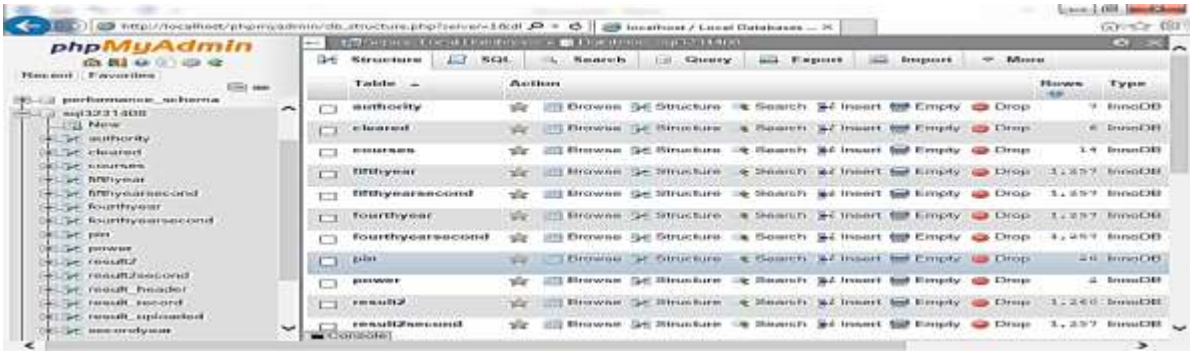


VC Dashboard with Attached Result and Message (Minute) From DVC Academics

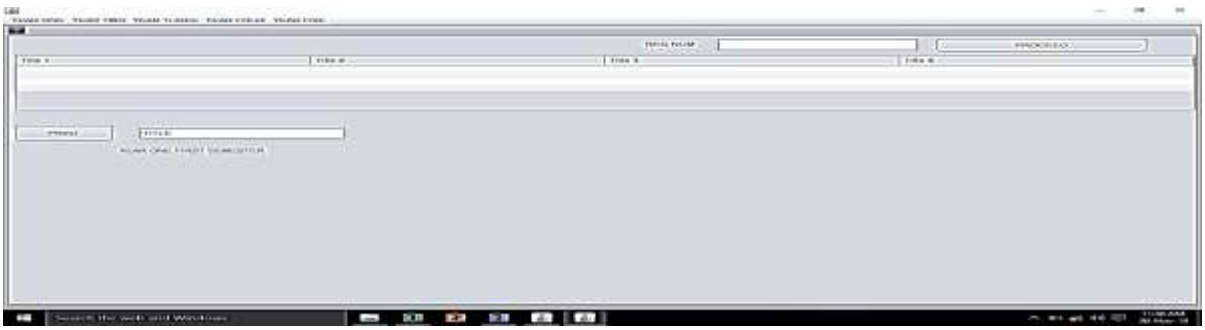




VC Dashboard with Approval Minute Attached and Result Being Uploaded to Database



Screenshot of Approved Students' Results in Database Module



Students' Results Checker Module Dashboard Screenshot

PIN Generator Module Screenshot

Screenshot of PINs Generated by the PIN Generator Module

APPENDIX X

SAMPLE AGILE TEST CASE SCRIPTS FOR THE HRPMS MODULES

i: For Iteration 01 and its Module:

HRPMS Project Test Script			(front sheet)
Project ID	FUTO IMT Ph.D. Work		
AUT Title	HRPMS	Version	v1.0
Iteration	01	Date of Test	07/07/2018
Test ID	01-Team-Standalone-01		
Purpose of Test	To ensure that: i. It is possible to navigate to the courses-&-units worksheet ii. It is possible to update all courses and units, view the whole update, and that it is legible		
Test Environment	The test environment is as follows: i. Client Hardware: Dell Inspiron Mini Laptop ii. Server: Nil iii. No other applications should be running on the laptop iv. The Application should be running with the login dialog box visible v. Prepared "login data" is held in C:\document\IMT\hand-book		
Test Steps	In the login dialog box, the tester should: i. Select the "Password" field and enter "admin" ii. Select the "OK" button or press the "Enter" key iii. Once the next screen appears, select the courses-&-units worksheet in the navigation pane		
Expected Result	On completing the above steps, the courses-&-units worksheet should be displayed. i. Verify that all course codes, titles, units, semester totals, and programme cumulative total are correct. ii. Verify that the contents of the courses-&-units worksheet are visible on the screen and legible		
Page 1 of 1 Page			

APPENDIX XI

DEFINITION OF TERMS

ABU – Ahmadu Bello University
AI – Artificial Intelligence
API – Application Programming Interface
ASU – Anambra State University Uli
AUT – Application Under Test
CA – Computation Accuracy
CCC – Clustered Column Chart
CGPA – Cumulative Grade Point Average
CGPA – Cumulative Grade Point Average
CMA – Competent Memetic Algorithm
COP – Combinatorial Optimization Problem
CRO – Chemical Reaction Optimization
CRPU – Central Record Processing Unit
CSA – Clonal Selection Algorithm
CTGP – Cumulative Total Grade Point
CTS – Cognizant Technology Solution
D^2 – Mahalanobi's D^2 Statistics
DB – Database
DBMS – Database Management System
DOS – Denial of Service
DSDM – Dynamic Systems Development Method
DVCA – Deputy Vice-Chancellor Academic
EA – Evolutionary Algorithm
EoAU – Ease of Access and Use
ER – Entity Relationship
ES – Evolution Strategies
ESUST – Enugu State University of Science and Technology
F_{cal} – F-Distribution Calculated
F_{tab} – F-Distribution Tabulated
FTP – File Transfer protocol
FUNA – Federal University Ndufu-Alike
FUTO – Federal University of Technology Owerri
GA – Genetic Algorithm
GC – Generative Costing
GPA – Grade Point Average
GPA – Grade Point Average
GSU – Gombe State University
GUI – Graphical User Interface
H_0 – Null Hypothesis
H_A – Alternate Hypothesis
HDD – Hard Disk
HLM – High-Level Model

HOD – Head of Department
HP – Hewlett Packard
HRPMS – Hybrid Results Processing and Management System
HS – Harmony Search
HTTP – Hypertext Transfer Protocol
IaaS – Infrastructure as a Service
ICT – Information and Communication Technology
IDE – Integrated Development Environment
IEEE – Institute of Electrical and Electronics Engineering
IIS – Internet Information Server
IMSU – Imo State University
IS – Information System
IT – Information Technology
JABU – Joseph Ayo Babalola University
JDBC – Java Database Connectivity
JDK – Java Development Kit
jMeme – Java Memetic Algorithm
JRE (SE) – Java Runtime Environment Standard Edition
LCO – League Championship Optimization
MA – Memetic Algorithm
MDF – Metaheuristic Development Framework
MIS – Management Information System
MLS – Multivariate Linear System
MOF – Metaheuristic Optimization Framework
MOUA – Michael Opara University of Agric Umudike
MUO – Madonna University Okija
MySQL – My Structured Query Language
NAU – Nnamdi Azikiwe University Awka
NSU – Nasarawa State University
NUC – Nigerian Universities Commission
OOADM – Object-Oriented Analysis and Design Methodology
PaaS – Platform as a Service
PC – Personal Computer
P_D - Performance Difference
PDF – Portable Document Format
PDF – Probability Distribution Function / Portable Document Format
PHP – Programmable Hypertext Preprocessor
PIN – Personal Identification Number
P-Metaheuristics – Population-based Metaheuristics
POI – Point of Internet
PS – Processing Speed
PSO – Particle Swarm Optimization
RMI – Remote Method Invocation
SA – Simulated Annealing
SaaS – Software as a Service
SaC – Security and Confidentiality

SCA – Sine Cosine Algorithm
SDLC – Software Development Life Cycle
SPSS – Statistical Package for Social Sciences
SQL – Structured Query Language
SSADM – Structured System Analysis Development Methodology
S-W – Strenght-to-Weakness
T^2 – Hotelling's T^2 Statistics
TCP – Transmission Control Protocol
TDD – Test Driven Development
TGP – Total Grade Point
TLBO – Teaching-Learning Based Optimization
TNU – Total Number of Units
TS – Tabu Search
U – Usefulness
UML – Unified Modelling Language
UNICAL – University of Calabar
UNIPORT – University of Portharcourt
UNN – University of Nigeria Nsukka
VBA – Visual Basic for Applications
VC – Vice-Chancellor
VNS – Variable Neighbourhood Search
WAMP – Web Application MySQL PHP
WWO – Water Waves Optimization
XML – eXtensible Markup Language
XP – eXtreme Programming
XPS – eXtreme Performance System