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A Flexible Student Assessment System for Continuous Performance Monitoring

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Abstract

Students' continuous academic assessment over time and development of a general customizable computerized system framework for students' assessment are two interesting research areas that are given little attention in Uganda's secondary school institutions. Assessment of students particularly in Uganda starts right away from when the student joins education institutions. This assessment is normally done by grading students' performance in various assessment modules set by the institution such as beginning of term examinations, mid-term examinations, end of term examinations and various tests done along the term period. A quantitative research done using observation, interviews and studying existing systems revealed that though a number of schools/institutions have embraced the use of automated report card systems, the concentration has been only on termly assessment, report production and development of specialized systems for individual schools. Accurate and appropriate decision making by the school management and academic performance quality enhancement are both driven by accurate students' continuous assessment over time. This project aims at the analysis, design and development of a web based computerized decision support system that assists its users to track the performance of students over time, view students' performance statistics in form of graphs and numerical information for accurate decision-making process. Apart from that, this project looks at also developing a general customizable computerized system that can be used by a wider number of institutions. After this research, a suitable and effective web-based decision support system that can be fully customized and determine students' continuous assessment was developed. Though this system is not yet a stand-alone system since there is a number of schools have limitations in internet connectivity, efforts need to be made in order to make it fit the institutions that have poor or no internet connectivity. This paper also looks at related researches, the extensions that would result into more powerful systems, advantages, challenges and limitations of the web-based system developed arranged in fully explained six chapters which include Introduction, Literature review, Methodology, Results, Discussion and Conclusion. It is therefore visible that this project eases, fastens and simplifies the decision-making process by the institutions' management by availing reliable, timely and accurate statistical students' performance records.

Key words: *Performance Monitoring, Student Assessment*

Introduction

Student Assessment starts right away from the time a student joins education institution like schools. Various assessments and grading systems are used to assess the progress of students in different ways. In academics for example, begging of term, various tests, mid-term and end of term assessments are used to test students' learning process which are later aggregated to produce general termly student assessment reports. In the past and in early days of schools before notable technological development, the use of manual system to aggregate and process students' assessment reports was quite applicable and affordable. However, it became more complex and more expensive schools that went on developing with arbitrarily increasing number of students in terms of staff payment, materials used and manually calculating students' marks and totals. Due to technological advancements that has evolved, a number of assessment systems have been developed which can generally ease the aggregation of the various assessments. Some of these are manual and others are automated. Under automated systems, there is the use of computerized termly report card systems for example which takes the students marks of the various assessments as inputs and produce the students' termly report cards with the grading and aggregation process done automatically. The school management mostly put into consideration the performance of the students in making and implementation of decisions that affect directly or indirectly the operation of the school. For example, board of governors setting criteria for employing teachers, allowance payments to teachers based on students' performance among other decisions. Though technology has enhanced students termly assessment, less concern is given to **continuous students' assessment** over a given period of time yet making and implementing better and proper decisions is largely influenced by the availability of academic historical aggregated information for some time not only termly results. Therefore, this creates yet more need to develop a computerized system that can further manipulate the termly results/assessments and produce graphical statistical performance information over time to give management an upper hand in making decisions and implementing strategies that develop and transform the school. **Smart School System** is a is a decision support system that majorly provides statistical information like bar graphs, line graphs and pie charts about the progress of an institution like a high school and technical schools. At the operational level, the teachers and other responsible people register students' details, enter students' marks and the system automatically calculates and aggregates the candidates results according to the set limits, compile them and draft and create students' reports. It is also able to output reports for the candidates either one report or all the class reports depending on the user's demand. It also allows the management to retrieve the statistical students' performance information in form of graphs and numerical progress statistics of the school over time which help them correctly make decisions in areas that needs greater efforts and probably if a decrease is detected, find causes and address the issue.

This research therefore focuses of two main objectives among other objectives;

i) To help the institutional management determine students' continuous assessment overtime. A number of high schools that have embraced computerized systems have mostly dealt with termly assessment only yet accurate decisions by management are greatly influenced by both individual and group student's assessment over a given period of time minimally four years.

ii) To develop an effective decision support system that can be customized to fit a number of high schools. Different high schools use different parameters from each other for example grading system, subjects offered most especially optional subjects, the combinations offered at A level among others. Therefore, a number of high schools go for specialized systems due to different parameters which in turn costs highly.

2 Literature Review

The school management (Board of governors, directors, head teachers and director of studies) is responsible of making decisions that affect the day to day running of the school. Among the decisions made include, criteria followed in employing subject teachers, recruitment of non-teaching staff, subject selection criteria followed

by students, grading system, and best students awarding process, various activities done in a school among many other decisions. Among these decisions a number of them directly affect the entire performance of the students at the school at a student level and the whole school at large. Decisions concerning employment of teaching staff, subject selection process, library stocking procedures, laboratory stoking activities, grading systems among others directly cause a general implication on the students' performance. Such decisions are done by the management majorly basing on the historical students' performance statistical information. Therefore, systems that provide this kind of information are needed by the management. Daniel J. Power in a Conference Paper (2001) pointed out that Modern Decision Support Systems (DSS) provide managers a wide range of capabilities. A Decision Support System describes any computerized system that supports decision making in order to improve the quality of decisions (Gao & Zhao, 2011). Power (1998b) defined a Web-Based Decision Support System as a computerized system that delivers decision support information or decision support tools to a manager or business analyst using a "thin-client" Web browser like Netscape Navigator or Internet Explorer. Therefore, Decision Support Systems for schools obtain the data from operational systems that manage the school operations, aggregates the data into meaningful statistical information that is used by the management to make decisions. School Management Systems have been done and have automated a number of operations like production of student's reports, calendar, timetabling among others. **School Management System** is a complete school management software designed to automate a school's diverse operations from classes, exams to school events and calendar according to Iolite organization (Web site: www.iolite.org.in). Performance statistics are mostly obtained from reports management systems used by the school. Most schools use manual reporting systems and a number of others use computerized systems to produce students' reports. **A report management system** is a complex system software system solution that produces high quality and legal reports more quickly and efficiently. **A students' report cards** communicate a student's performance academically. In most cases, the report card is issued by the school to a student or student's parents once to four times yearly. A typical report card uses a grading scale to determine the quality of student's work (Sumanuil and Spikenard. 2018). Students' report cards and termly or yearly performance analysis used to be made manually by the assistance of class teachers, subject teachers, director of studies and other employed staff for this job. The subject teacher marks the exams and produces a mark list which is given to the class teacher. The class teacher submits the mark list to the director of studies who then compiles and stores all the mark lists from various class teachers. He also drafts and produces report cards. On the report cards, the head teacher and class teacher had to manually write their comments on every student's report. The information for the next session or term had to also be written on every report by the concerned personnel. This way of producing report cards and determining performance analysis had a lot of challenges. Some of them included, Reports had a number of marks calculation errors due to human errors, time consuming, very costly due to a number of employed staff to complete the process, hardships in storage due to accumulated paper records. Due to development of computers, a number of researchers have done research on how to approach this process using computers in order to solve the above-mentioned challenges. Among these researches, some are briefly looked at bellow.

School Information Management System (SIMS) was the first management system developed for schools. It was initially developed by Philip Neal, a teacher at Lea Manor High School (1982 to 1983). Bedfordshire Country Council then further developed the product which began being used by other schools in 1984. In 1988, a commercial company, SIMS Ltd, was found to further develop the system that was adopted by capita group in 1994. SIMS was a system that used client-server architecture; the back-end services was based around Microsoft SQL Server with some business logic handled by a custom netFramework module. The client end was also built with .NET, and handles almost all the data manipulation and reporting workload. This system had functionalities like; producing students' reports, trucking students' records, sending reports to parents among others. The major drawback with this system was data update. A student would leave the school but the reports and the information would continuously be sent to the parents hence causing

challenges like, miss capturing of total students in school, challenges in finance planning and students' parents disturbing and causing more costs spent on reports for students that left the school.

Another solution is EDUMATE. This is an education management system that was developed to enhance the way how schools, families and students' access, store and process information. It was released in 2002 and developed from Australia. The features of EDUMATE include; Electric Roll making, Smartphone Application, Student tracking, Curriculum Mapping, Timetable Management and Progressive reporting. EDUMATE was developed by Bluesky Technologies located in Thiruvananthapuram. It is a web-based solution for schools creating a virtual network between Students, teachers, parents and administrators. The major challenge with this system is that the school needs strong internet connection, it costly (about 2000 USD per given period). Besides this, the system deals in a huge number of aspects and therefore it requires large space to install, extended time to learn it and may not be easy to customize to a single school requirement. Edumate can be accessed through www.edumate.com. There are a greater number of school management systems which include;

Fedina This is an open-source school administration software that largely focuses on handling records. Some of its features includes; course management, Attendance tracking, Student information and Examination management. The major challenge with this system is that its free version lucks a lot of features that might be so crucial for the school.

As for this research, the literature will focus on gathering a comprehensive understanding of school reports management system mainly for high schools. Analysing and making compulsions on similar projects that solves the same challenges in high schools, critically observe and understand the decision-making process in high schools majorly on decisions that have a direct impact on the school students' performance. It will help in studying the frameworks, methods, procedures, tools and techniques used by other researchers on similar topic in investigation. The literature review will also help to analyse and understand the scope of the research, determine major drawbacks of the existing systems.

2.1 Development of smart school system.

(Bhargava & Power, 2001) observe that wwww technologies have rapidly transformed the entire design and implementation process for all types of decision support systems. He further notes that web technologies have provided a new media for sharing information about decision support and new means of delivering decision and support capability. He researched on the prevailing status of decision support system in the context of development in Web technologies. This study is also on development of decision support system in the context of student performance improvement. Decision makers such top management committees, board of governor, director studies are concerned with ensuring performance quality in a school.

2.1.1 History of DSS

Decision support research began in the late 1960s. A study by (Gorry & Morton, 1989) demonstrated that managers benefited from using a computer-based management decision system. According to Klein and Methlie (1995) "… the first DSS papers were published by Ph.D. students or professors in business schools, who had access to the first time-sharing computer system: Project MAC at the Sloan School, the Dartmouth Time Sharing Systems at the Tuck School" and in France at HEC. In the early 1990s, a shift occurred from mainframe-based DSS to client/server DSS. In November 1995, Power, Bhargava and Quek submitted the Decision Support Systems Research page to ISWorld. Its goal was to provide a useful starting point for accessing Web-based material related to the design, development, evaluation, and implementation of Decision Support Systems. Nine months later, a DSS/WWW Workshop was held as part of the IFIP Working Group 8.3 Conference on "Implementing Systems for Supporting Management Decisions: Concepts, Methods and Experiences", July 21-24, 1996 in London, UK. In 1996-97, corporate intranets were developed to support information exchange and knowledge management. The primary decision support tools in use included ad hoc query and reporting tools, optimization and simulation models, online analytical processing (OLAP), data mining and data visualization (cf., Powell, 2001). Enterprise-wide DSS using database technologies were especially popular in Fortune 2000 companies. (Bhargava & Power, 2001) continued to discuss and experiment with electronic markets for decision technologies. In 1998, innovative enterprise performance management and the balanced scorecard systems were introduced. Vendors promoted these tools as updated executive information systems. 1999 was the year of the Web! The rush was on by laggards to introduce new Web-based analytical applications. Many DBMS vendors shifted their focus to Web-based analytical applications and business intelligence solutions. Last year, 2000, application service providers (ASPs) began hosting the application software and technical infrastructure for decision support capabilities. DSS technology had gone full-circle and we again have time-sharing DSS. 2000 was also the year of the portal. More sophisticated "enterprise knowledge portals" were introduced by vendors that combined information portals, knowledge management, business intelligence, and communications-driven DSS in an integrated Web environment.

2.2 Related Researches

2.2.1 The conference paper September 2007

(Veis Šerifi, Siniša Ranđić, 2007) made a research on the examples of software tools for decision support systems (DSS) based on modern technologies. In the conference paper September 2007, it is clearly noted that application of modern manufacturing philosophies (CIM, EMS, JAT, JIT, PLM, SAT etc) in manufacturing conditions, demands greater speed and accuracy in information management, which cannot be done without modern system for decision support (DSS). It adds that today, they imply a system which is supported by powerful computer technique, which is more acceptable from the aspect of price as of performance it offers and its goal is to create good information that can be managed and to make a decision

based on that information. In the same context, **Smart School System** was developed to create good information based on historical students' performance so as it can output the best information that can help the management to make appropriate decisions, discover areas that need improvement and maintain better performance in an institution. This paper continues to show that unlike the Management Information Systems (MIS) that provide greater help in analysis and decision making, the basic goal of Decision Support Systems (DSS) is to ensure quality information for process of decision making in cause of increasing decision efficiency and to help decision makers to solve unstructured or weakly structured problems (decision making). It continues to elaborate more about the main characteristics of DSS which included; Orientation to decision making, orientation to solving weakly structured problems decision making and orientation on end user, they give help in decision making on all levels of decision, but are of special importance for higher levels, and unlike MIS systems who mostly simplify horizontal flow of information's, DSS systems support vertical informational flows and by that help information integration that are used on different organization and managing levels, they ease synthesis of information from certain subsystems for strategic decision making and contribute atomization of strategic planning and prediction. In the similar way, **Smart School System** has a number of characteristics that are not far different from the ones listed above. It gives the management an automatic synthesis of students' performance information to enable them accurately predict the effect of decisions made in the coming future. It also supports vertical information flow from teaching staff that enter students' marks, head of departments and director of studies who produce students' report cards to the top school management who use aggregated data in form of statistical information to make decisions. Additionally, **Smart School System** provides general storage services where all the reports and documents from the system are stored for future use. The basic components of DSS as seen from this paper include; Users with user interfaces, Databases, Models of decision making and bases of prediction, planning and decision making, communication components and special software which links users with data and data models. Smart School System too has similar components like those discussed above with more advancements in a number of them. These advancements include; A more generic and customizable database that can be generally used by a number of schools/institutions, User interface that comply to users' dynamic views and themes and customizable framework that can be used by any school according to its system settings. The conceptual model of a DSS was given as in following image in the paper. (Veis Šerifi, Siniša Randić, 2007)

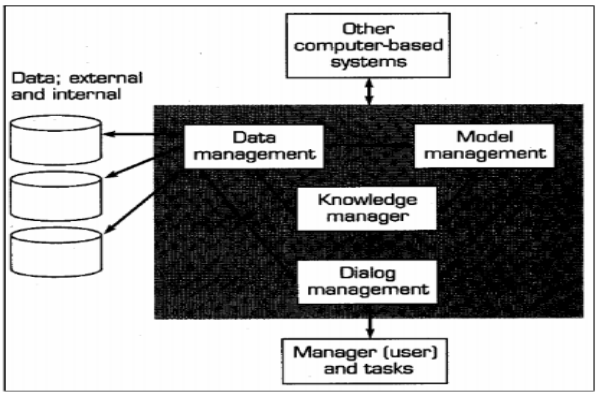


Figure 1 Conceptual Model of DSS

In conclusion of this paper, it is noted that modern business demands more and more speed and accuracy with information movement, which cannot be done without modern IS. In area of IS there is no, some common methodology of DSS classification, so different authors can differently classify them.

2.2.2 Singaporean journal of business economics, and management studies vol 1, no.6,2013

Nastaran G. K and Masoome H. S (2013) made a research on Decision Support Systems (DSS). In this research publication, it is noted that today's importance of decision-making process can be clear as management decisions couldn't rely on ingenuity, intuition and personal judgments but should be on the basis of scientific and statistics studies. It points out that managers are decision making responsible in all issues and one of the most important management challenges is different decisions that should make every day by managers. These decisions have different levels such as short-term decisions that should make every day or guiding long-term decisions that make for several years. Regarding to suitable decision-making necessity on suitable time it is useful a system to provide consultation and help manager in decision making. In this context, decision making activities are a major responsibility of the directors, head teachers, top management committees, and director of studies. For accuracy and better decisions, these have to base on the performance statistical information rather than personal judgments and their ingenuity. According to theses researchers, one decision support system protects three decisions making as follow: (1) **Independent decision making**: Such decision making is when decision maker has general authority and complete executive ability for made decisions. Decision support system that could do such decision making is known personal support. (2) **Sequential dependence decision making**: Such decision making is when decision maker only conducts a part of decision making and provide his decision-making results another person for future decision makings. Decision support system that could protects such decision making is known organizational support. (3) **Convergent dependence decision making**: Such decision making is when a group as a council is decision making responsible. Decision support system that could protects this decision making is known group support. Regarding to three types of decisions making observes that second decision making is the most important and usual one and therefore a decision support system should support such decision making. Like the previous researcher discussed above, in this research, it is noted that there is no common view about what is DSS. Not only expert managers but also users provide different opinions about a decision support system organization. Decision support systems are computer information systems that during decision making supply information active support for managers and workers. In the same way, Smart School System is to supply information to the top school management in order to help in accurate decision making. This research more explains DSS as a sub-collection of information management systems that help planners, analysers and managers in decision making process. It outlines that as compared to other information process systems, DSS to support organizational decisions process combine in other information systems such as management information systems and provide middle managers possibility to examine problems solving by provided information and make necessary decision. (Segal, 2020)

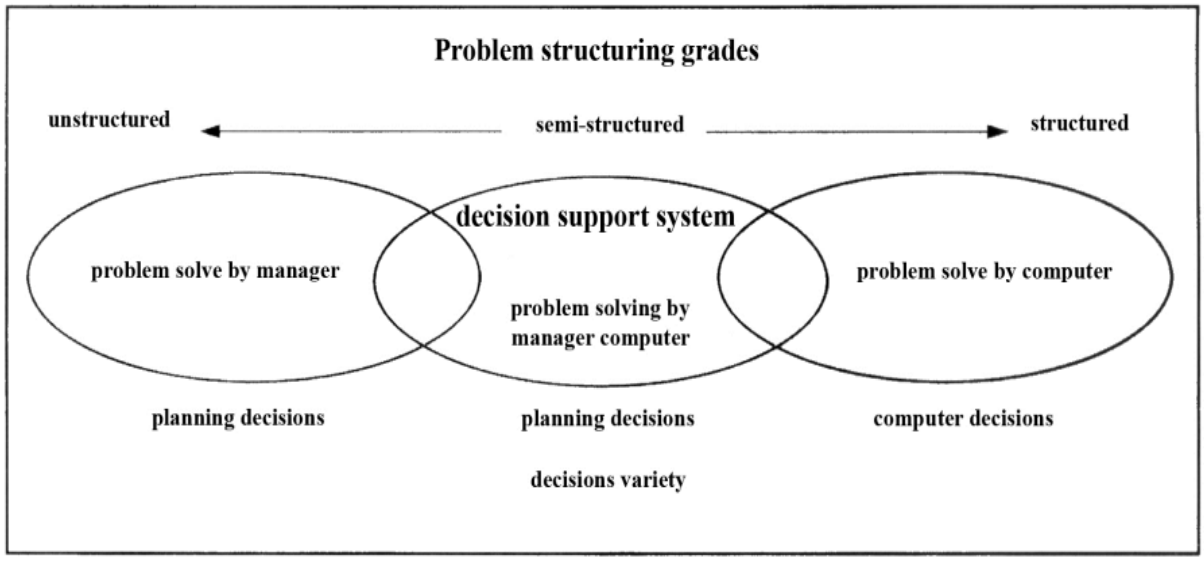


Figure 2 Problem structuring grades and using decision support systems

Following findings of this research, there were three methods of obtaining information from a decision support system. These include; (1) **Reports:** The oldest method of obtaining information. Reports could make as regular daily, weekly, monthly or yearly information and provide it to managers. Also, could make them especially for certain subjects and issues as summary or expand. Expanding reports use in low levels and summary reports use in high management levels. (2) **Data base search**: it's possible through question plan and transfer. Questions could post by terminal and their response that is similar to a report could receive terminal. (3) **Simulation:** it uses to provide real behaviour and using models. Through simulated model could know and evaluate model type, how and behavioural or practical processes during different assumptions determine and effects. Simulation plan could enter through terminal and receive its results in same terminal or print by printer and provide manager. Among the duties of DSS given in this paper, preparing of results quickly to provide suitable model on the base of aims relationships to provide variable directly meets with the aims of Smart School System.

In conclusion of this research paper, it was noted that DSS process mass data and provide managers a decision option. DSS does not decide and manager judgments are important. These systems use complex statistical, mathematical models, data analysis and support decisions. Similarly, **Smart School Systems** uses complex students' performance statistical information to provide decision support information to the management of the school.

2.2.3 Decision Support Systems and Web Technologies: A Status Report (2001)

(Bhargava & Power, 2001) made a status report on the decision support systems and web technologies. In this report, it is observed that World Wide Web technologies have rapidly transformed the entire design, development and implementation process for all types of decision support system. It further more explains that web technologies have provided a new media for sharing information about decision support and new means of delivering decision support capabilities. It recommends that DSS developers should us the "Web as computer" which was discussed in the following three categories; **Digital product demonstration**: represents a baseline for the use of the Web's capabilities for remote computation. Online demonstrations can be delivered as animated multimedia documents (e.g., QuickTime movies, or Shockwave animation) that require or allow little user interaction. As a next step, online interactive examples allow users to interact (e.g., by setting parameter values, or choosing which command to execute next, or designing the format of a report)

with the DSS tool in the context of a specific example. Both of these methods allow DSS developers to advertise their features to potential buyers, and can be developed with relatively little expertise in Web-enabled computation. There is substantial exploitation of these capabilities in the category of data-driven DSS. For example, Micro Strategy offers both self-running and interactive demonstrations according to MicroStrategy accessed through "http://store.microstrategy.com" of its OLAP and data warehousing software. Surprisingly, again, very few Model-driven DSS vendors exploit these capabilities. Most company Websites do not go much beyond mentioning DSS products; very few provide online demonstrations or interactive examples. Exceptions include Lumina and TreeAge, both companies offer demonstrations and interactive examples to demonstrate how their products support decision analysis. The next step in the use of the "Web as computer" capabilities is to offer application-specific DSS to users that have decision problems within the supported categories. They gave an earlier example of OptAmaze.com which provides paper trim optimization and transportation optimization services to paper mills. Grazing Systems Limited offers decision support services in the agricultural sector. The value of such deployment of DSS may be appreciated by considering the difficulties that user firms would have in installing, maintaining and applying complex DSS tools on their own; Web-enabled DSS allow such firms to use decision support tools without encountering these difficulties. For DSS developers, the big leap forward in the use the "Web as computer" capabilities were to develop off-the-shelf products that could generate Web-enabled application-specific DSS of the sort described above. Very few vendors have yet developed this expertise. Exceptions include Lumina and TreeAge. Lumina offers Analytical, a desktop DSS generator based on influence diagram techniques. But it also offers the Analytical Decision Engine (http://www.lumina.com/software/ADE.html) that allows developers to produce Web-enabled DSS applications. TreeAge Software sells DATA Interactive, a version of its DSS development products that enables development of Internet-based decision tree applications. In the conclusion of this status report, it states that the practice of building Decision Support Systems can benefit in many ways from the availability of Web technologies. These technologies provide platform-independent, remote, and distributed computation and the exchange of complex multimedia information. The status report continues to conclude that decision support capabilities are of great interest to a broad range of stakeholders and enormous resources have been and will be committed to building systems that promise to improve the quality, speed and effectiveness of specific decisions. From the general view of the issues pointed out by this status report, it clearly seen that building **Smart School System** has improved the quality, speed and effectiveness of the management decisions at a number of institutions that embraced it.

2.2.4 Decision Support Systems-research on the application of DSS in China's Banks (2011)

(Gao & Zhao, 2011) made a research on the application of the Decision Support System in China's Banks taking a case study of four biggest Banks in that country. In this research, they noted that the world is full of choices for people from study to work, from shopping to entertainment. While there many choices, it had to make a rightful best decision among all the choices presented. This research gives the implication of decision as the end of deliberation and the beginning of action (Buchanan & O'Connell, 2006). One of the major objectives of computerized decision support is to facilitate closing the gap between the current performance of an organization and its desired performance, as expressed in its mission, objectives, and goals, and the strategy to achieve them (Turban, Aronson, Liang & Sharda,2007). In this context, the major goal of high schools is better students' performance, which is directly linked to management decision more especially in the academic areas. Like other researchers, it was also reflected here that the exact meaning and definition of DSS is hard to tell due to it being a content-free expression. It was defined as any computerized system that supports decision making in an organization. DSS are designed, built and used to assist in the activities of supporting the decision-making process. And the potential benefits of DSS can be concluded as that improves personal efficiency; expedites problem solving; facilitates interpersonal communication; promotes learning or training; increases organizational control; generates new evidence in support of a decision; creates a

competitive advantage over competition; encourages exploration and discovery on the part of the decision maker; reveals new approaches to thinking about the problem space (Aronson et al., 2007).

The data that was used in this research was collected using both the primary data sources and the secondary data sources. A number of bank staff members were interviewed and other associated members. With the secondary sources, scientific papers, internal documents of the banks like journals and bank reports, books and internet searching were used to obtain the remaining data that could not be obtained well using the primary sources. The Smart School System too, it used both the primary and secondary sources of data. Primarily, a number of head teachers, director of studies, members on the top management of different schools were interviewed. A number of students' report cards, performance statistical reports from different schools and other related documents were also reviewed and studied to give a wider understanding of the challenge, scope and the real requirements needed from the system.

2.3 Present situation and Smart School System

A number of high schools have embraced the use of computers to manage the students' report card production process and management of other school activities. School report and statistics management system is a system that captures students' information like students' details, students' performance marks and generates report cards for each student at the end of a stipulated period. It also gives the statistical information about the school as regards to comparing of performance over time, general school population among others. In 1980s, this process used to be done manually with no aid of computers. As the work became more tedious mostly for schools that had rapidly increasing number of students, Philip Neal, a teacher at Lea Manor High School developed a computerized system (SIMS) that started offering these services. This system stated offering services like producing students' reports, trucking students' records, sending reports to parents among others. From that, schools have slowly moved ahead to computerize nearly all the activities done from student registration, activity control, time tabling, student reporting among others. Some schools develop their own specialized systems to complete their tasks but since this process is currently too costly, few schools can manage this. A number of schools use general systems that can be bought and customized though customized systems are characterized by having very few features. To enhance this process further, a **smart school system** was developed. In this system, all able high schools are able to use it. This is a general software system that offers a number of offers including; Student registration, student records trucking, staff members' management, general school statistics and report card management.

2.4 Features of Smart School System

This system contains the following features;

i) The system uses termly assessment module marks obtained by the students to produce the bar and line graphs that show the continuous students' assessment of the students to the school management for proper decision-making process.
ii) The system can be fully customized to fit the required appearance (color themes), grading system (O and A level) and many more features needed an institution.
iii) Smart School System almost automates the termly students' report card production, printing students' class lists, management of students' records and also staff management.
iv) The system is able to control the access to specified features and privileges to different users in a most secure and efficient way.
v) The system also includes a special feature for storage of records of printed report cards, students' class list documents, output of graphs and all statistical records generated by users.

3 Method of Study

3.1 Introduction

This chapter presents a detailed description of the methodology which is a composition of the stet-by-step methods of how the objectives of this study were achieved. It comprises of the project design which describes the tools, instruments, approaches, processes and techniques. Major algorithms and data structures which were employed in the research study, data collection, analysis, design, logical flow, implementation, testing, validation of the system and so on.

3.2 Population and sample

This study or research was a quantitative research. This is the type of research that digs deeper the problem and is more of explorative nature. It is used to gain an understanding of underlying reasons, opinions, and motivations. The targeted sample was a minimum of four (4) schools including Mahanga Senior secondary school, St Gonzaga SSS Kijjukizo, Busolwe High School and Lyantonde senior secondary school Kasambya.

PARTICIPANTS	MINIMUM NUMBER
Board of governors	2
Head teachers	1
Direct of studies	2
Head of departments	4
Subject teachers	15
Class teachers	6
Students	30
TOTAL	60

Table 1 Population sample at a given school

3.3 Data collection

Data that was needed for the project was gathered from the various sources including primary and secondary sources. In gathering and collecting necessary data and information for system analysis and requirement elicitation, the following fat-finding techniques were used.

3.3.1 Observation

Observation method refers to the naked eyes to observe what is taking place using the check list without asking from the respondent while noting what is being observed. This was used because is simple to use and it eliminates the biasness of the respondent that they would develop when they are being interacted to physically. Using this method, I was able to use eyes and observe how the director of studies and other concerned teachers produce the results and compile them up to report production.

3.3.2 Interview

An interview method of data collection refers to the presentation of oral-verbal stimuli in terms of oral-verbal responses. This was adopted because it is simple to use and cheap in terms of resources. Both open and close ended questions were used to collect data from mainly the director of studies and other concerned teachers that take part in reports production. The interviews were oral where the interviewer asks questions orally while he is taking the notes as the interviewee gives oral answers.

3.3.3 Review of the existing documents

During this, the existing documents like mark sheets, report cards, mark entry sheets, students list and class lists were reviewed. This enabled me to gather and obtain necessary information needed to design and develop a smart school system to solve the most common challenges faced by a number of schools during the report production process and school progress analysis.

3.3.4 Prototyping

This was a very great technique that was used to collect numerous data that was used in the analysis and the design of the system. In this data collection technique, a demo working system is developed and put into use by users as feedback is collected which is later used to develop a more fitting demo until a full version is completely developed.

3.4 Analysis and presentation

The data collected using the appropriate tools was then recorded by the researcher, analysed and interpreted to give solution to the researchers needs. Descriptive approach was used during data analysis.

3.4.1 Analysis of the Existing System and design

During the analysis of the existing systems, the designing of the smart school system, the techniques applied to achieve this were the use of case diagrams and the data flow diagram

3.4.2 Data analysis out come

The data collected was carefully observed and the decision-making was formulated following consensuses of the participants in the research.

3.5 Method of design

The development of Smart School System followed the five stages of SDLC which include; Gathering of the information, system design, system implementation, testing and system maintenance. Descriptive approach was used during data analysis to come up with the requirements of the proposed system. The data and information collected was then compiled and using the information requirements obtained, a prototype of Smart School System through SSDM was then developed. The system was developed using Rapid Application Development (RAD). RAD is a methodology for compressing the analysis, design, build, and test phases into a series of short, iterative development cycles. In this mode of development, any iteration produces a working version of the full system.

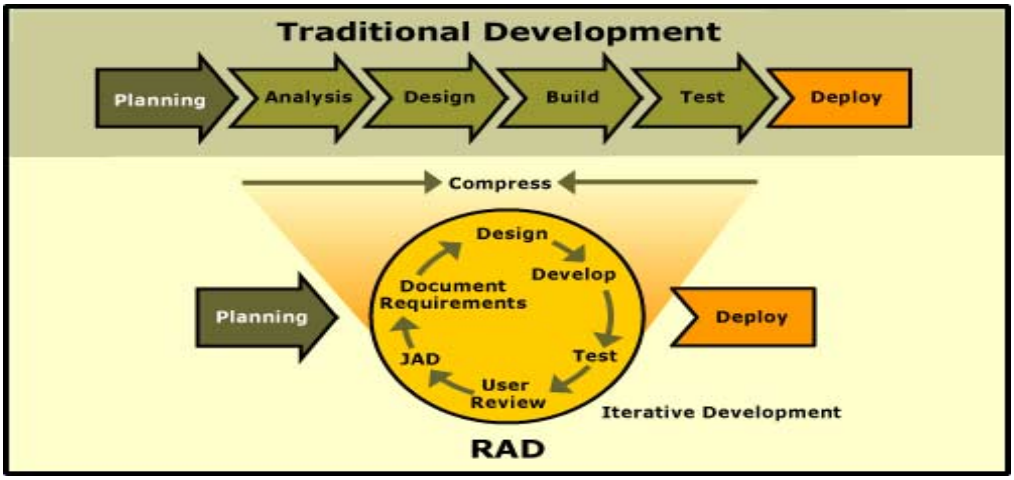


Figure 3 Rapid Application Development

RAD was used due to the following advantages:

i) The iterative nature of the development helps the developer to be effective and self-correctness.
ii) Iterations results into many small refinements and improvements.

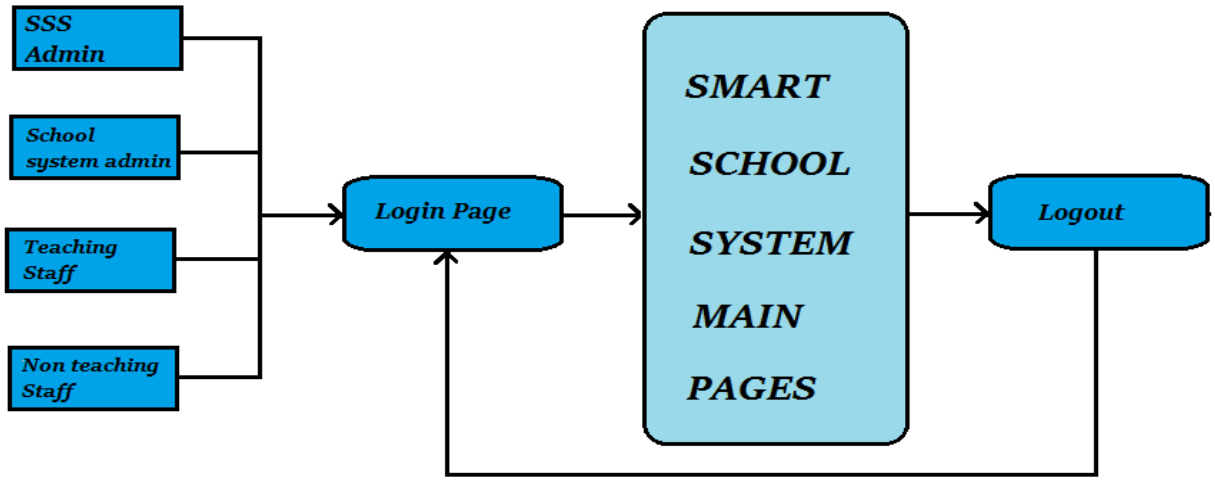


Figure 4 SSS Design

3.6 Implementation

The implementation of this system i.e. developing it into operational environment was done on computers running windows 10 operating systems and additionally running the following support software;

i) Xampp software
ii) Sublime text editor

The back end was implemented using MYSQL as database management system. The front end was implanted using Hypertext pre-processor (PHP) as the main Programming Language, Hypertext Markup Language (HTML) was used to develop user interfaces with cascading style sheet (CSS). There was also the use of bootstrap files to graphically design the interfaces.

3.7 Testing

After the designing of the prototype, testing and validation of the system was done by testing of the individual components after which integration testing was done and then finally system testing was done.

3.7.1 Component testing

Various components of the system were individually tested among which include the following;

Continuous student's performance curve plotting module.

Test or demo marks of a sample student (Kambugu Moris) were entered in the system for a period of four years and the system accurately tabulated and produced a performance graph of this student in a particular subject (Mathematics)

KAMBUGU MORIS AGGREGATED PERFORMANCE FOR LAST FOUR YEARS

S/N	CODE	SUBJECT	2020	2019	2018	2017
1	[234]	Mathematics	84	94	90	70
2	[323]	Physics	88	88	88	85
3	[332]	Commerce	78	78	78	75.33
4	[553]	Agriculture	79	79	79	71.33
5	[443]	Biology	61.5	70	57	71.33
6	[342]	Chemistry	57	57	57	78
7	[254]	Computer	79	79	88.33	67
8	[324]	Geography	57	57	78	76.67
9	[660]	Fine art	78.5	87	87	83.67
10	[269]	English	N/A	N/A	N/A	N/A
11	[280]	Entreprenurship	N/A	N/A	N/A	N/A

Figure 5 System output showing Kambugu's results for the past four years

The system plotted a curve that reflects Kambugu's continuous performance in one of the sample subjects that had been chosen as shown in above picture (Mathematics)

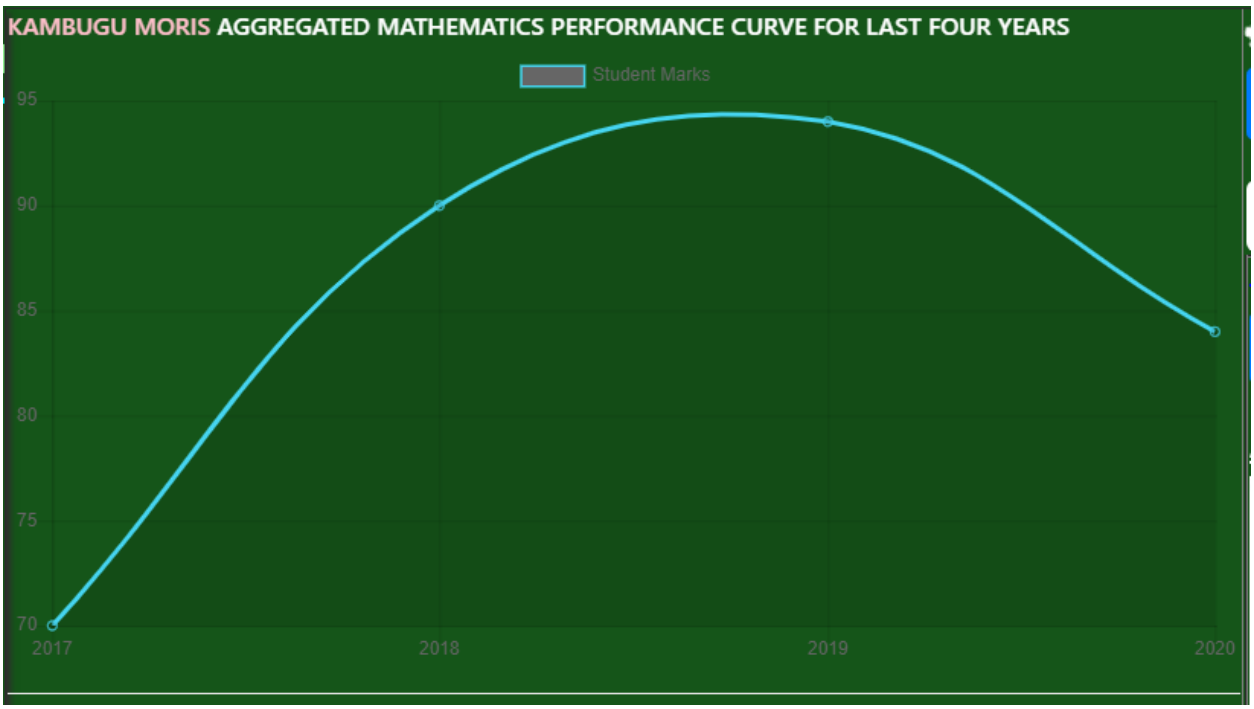


Figure 6 Curve segment showing Kambugu's results in mathematics for the past four years

Various school's registry module

Three schools were made to register on the same system and enter or set their desired parameters as far as grading systems, marks entry criteria's, and registering a relatively large number of students at each school. This process ended successfully where the system managed to independently handle each school's data and produce outputs that match to the given school or institution that owns it.

3.7.2 Integration testing

After completion of individual module tests, integration testing was done where all modules of the systems were integrated together and tested as a whole system. This test ended successfully with results that confirmed users that the system was able to efficiently fulfil its features designed for.

4 Results

4.1 Introduction

Following the above findings, the most needed information towards the development of the required system to solve the above challenges was obtained. All the activities, processes and steps that are done during report processing and statistical analysis on different schools were obtained and thoroughly studied.

4.2 Analysis and design

From the above results, it was practical to use the system development model that would suit the solution to the above challenges faced. Considering the impact of the developed system at institutions, software development limitations, the scope of the challenge at hand, the planned schedule and the resource limitations, looking at requirements of the system, all these helped to output the system inform of context diagrams, data flow diagrams, use case diagrams, ERD among others.

4.3 Current System

Currently, a number of high schools have embraced automatic report card systems and progress evaluation systems where teachers collect student's marks, enter them in the computerized system that compiles them and produces termly report cards for students. The teachers get student data for example student names, age, class, term, year, and marks that entered in the system from which the authorized personnel like the DOS, Head Teacher can automatically generate the report cards for students. The automated systems mostly end at this stage currently. In case where the school progress analysis is required over some years, the records have to be collected from various manual reports that were produced by the system for a number of years and totals aggregated manually in order to give the statistical data and information.

4.4 Challenges of the current system

Right away from the beginning of the student registration process to issuing of the student report cards and obtaining of the school progress statistical with the current systems used has a number of challenges; some of them include;

i. There is no general customizable system. This means that every individual school has to develop its own system from scratch which is costly in terms of finance, manpower and materials.
ii. Obtaining the aggregated statistical students' performance information for a period of time to support decision making is still a challenge with the current systems. This is majorly because a number of systems end at termly student reports evaluation and production.
iii. Re-registration of students every term is also a big challenge in most of these systems. This causes data inconsistence in students' details in case data is miss-captured due human errors.
iv. Group and individual performance trucking over time is not yet possible in a number of these systems.

4.3 Advantages of the current system

i. The special purposes-built systems for report card production at a particular school normally fits easily with in the requirements of the school
ii. Students' re-registration per term makes it easy to truck whether a student has reported in that very term or not

4.4 Description of the smart school system

Smart School System is generalized web-based system that is used by both the management and operational employees like teachers, director of studies, head teachers among others. At the operational level, the teachers enter the students' marks which are used to obtain students' termly report and as well keep truck of the general and individual student's performance. The system is able to produce statistical information about the performance of the students in form of graphs and other view formats which helps the management to make accurate and appropriate decisions quickly. All the users of the system are required to login first before they access their rights on the system.

4.4.1 Advantages of smart school system

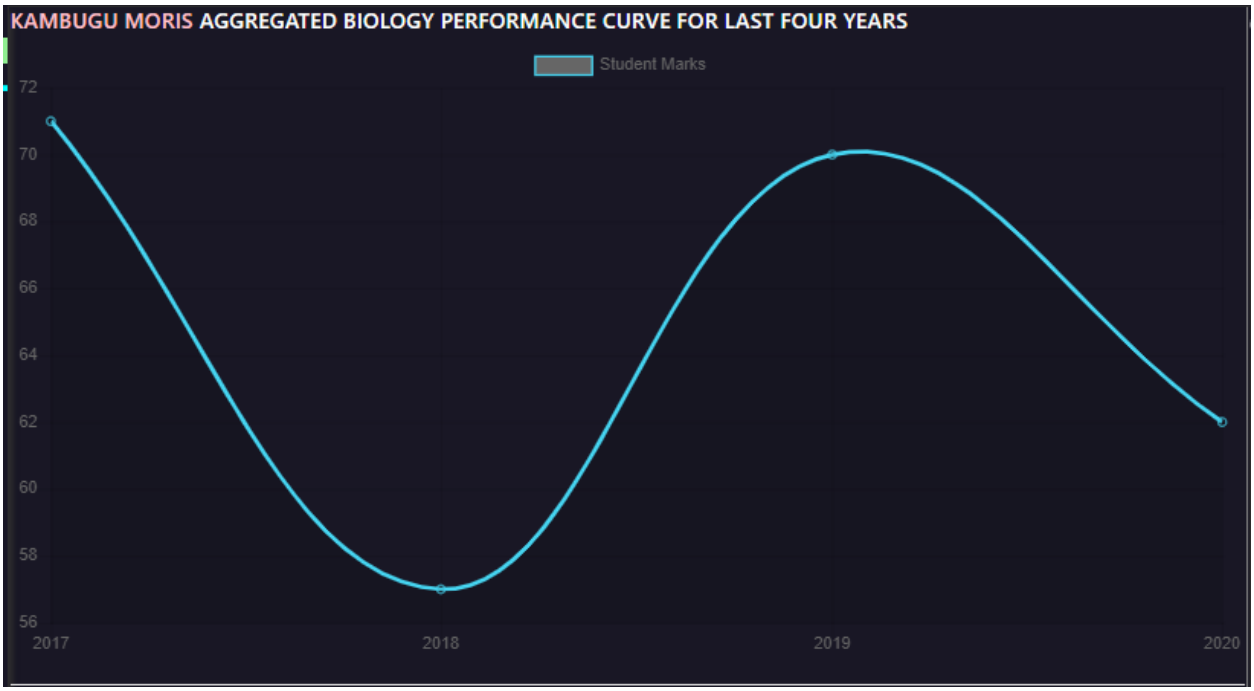
The merits of the smart school system are numerous but a few are listed below;

i) Trucking students' general and individual performance is quick and available in a click
ii) Offers a starting basic framework that can be customized by any school to build a computerized school system hence eliminating the burden of starting from scratch
iii) Provides secure and reliable storage services where the students mark and performance reports can be kept for a long period of time
iv) Students' reports generation is available in a single click
v) Since it is a computerized system, it eliminated biasness from the users by reducing human errors in marks compilation process
vi) Students details, staff details and other stakeholder's details are also available in a single click

4.4.2 System description

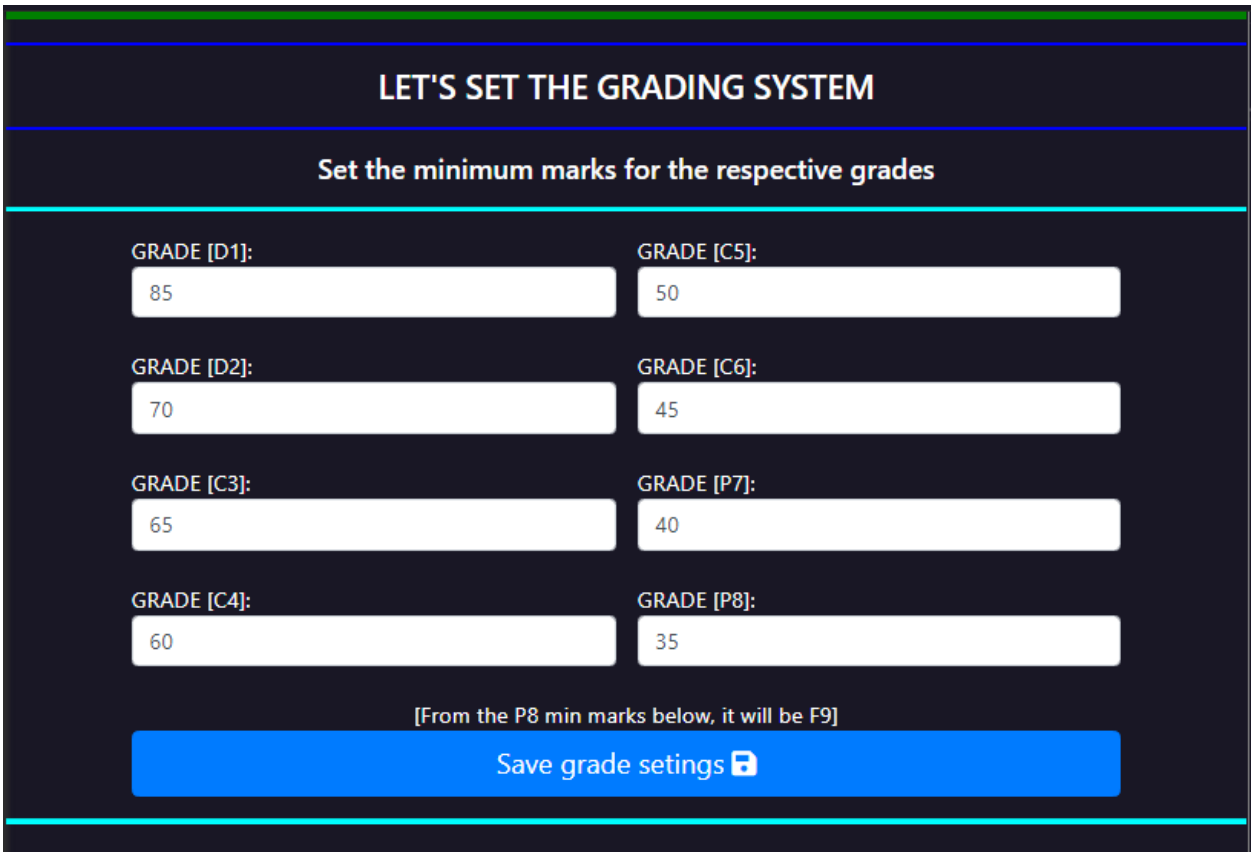
The system contains a number of functionalities major ones being customizable to fit school requirements and determining student's continuous performance over a given period of time, it can also give the performance trend in a minimum time unit possible for example term, year, combined class and at individual level. In the following picture for example, a student in the names of Kambugu Moris is trucked for a period of four years in Computer studies performance and a response curve is drown using this system.

Figure 7 Kambugu Moris Four Years Computer Performance Curve



This system can also be customised to fit a number of institutional parameters. For example, the system allows the school to decide whether to use their own set grading system or UNEB standard grading system. The institution is allowed to set the grading system to use differently at O and A level.

Figure 8 Setting the minimum and maximum marks for different grades



5 Discussion

The overall progress, development and success of any institution say a high school is majorly influenced by the top management decision making. Positive results are mostly realized with the accuracy and appropriate managements' decision making. In a high school for example, the board of governors, director and head teacher are the key participants in decision making. Areas that need their attention include; employing teachers, grading systems, subjects taught, employing non-teaching staff, terminating employee's contracts among other areas.

Accurate and appropriate decision making is driven by access to accurate and aggregated information for a reasonable period more especially in academic area. The major purpose of this project was to develop a computerized system with a customizable framework to fit a wider range of high schools and producing the needed accurate and aggregated information in form of graphs and numerical representations of students' marks to the management which were all archived after the development of the system. Furthermore, this system has other achievements like, students' termly report card production, storage services and staff management. Development of this system has been achieved through studying well the existing systems and the available report management systems used by a number of high schools. This system continues to have a greater number of user positive feedback from users such as reduction in operating costs by reducing specialized system development costs due to customization, highly protected record keeping and staff management. However, this system faces a challenge of internet connectivity that is not readily available in a number of schools and remote area. Therefore, it is recommended that if a stand-alone version of this system is developed, more efficient and effective service could be noted.

6 Conclusion

In conclusion, successful implementation of this new system developed in a number of schools will enhance the successful development of schools in both performance and structural growth. This is because it can be seen that since this system can be customized, a number of schools can use it at a low cost, efficiently and reliable. The developed system can as well be used by the management to obtain clearly continuous students' assessment information which aids in decision making. Therefore, in short, this system is majorly important to both the management and operational employees, customizable to a number of schools, less costly and efficiently operational.

Finally, this system enhances steady academic progress of the school by directing and causing accurate and appropriate decision making by the management of the school.

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