Web Based Student Management and Activity Reporting System using Cloud Infrastructure

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Abstract

On the current rapid population growth of schools and the higher education sector, the demand for automated transaction is highly critical for the quality and development of education. One of the several ways that quality of education can be achieved is applying automated student management system in schools and other educational institutions. Even if this technology solution is helpful, there are economic limitations that prohibit education sectors to go forward because the costs of infrastructure, human power and other inputs are increasing from day to day.

The objective of this paper is to find alternatives to the use of information technology, while leading schools try improve agility and obtain savings through the current technology opportunity and practice relating to secondary schools and preparatory schools in Addis Ababa city. This paper discusses the advantages of cloud computing for educational institutions, the limitations of current technology utilization in public schools and alternative solutions to solve the current limitations. More specifically, the research finding shows that applying cloud computing is a better solution for the problems identified and finally presents a prototype of multi-tenant cloud student management system that enables the respective educational bureau to apply for all schools with wise and strategic use of infrastructure which significantly reduces cost.

Keywords: Student Management System; Cloud Computing

1. Introduction

The Ethiopian government recognizes the importance of education for national development. Its policy is mainly aimed at expanding the education sector, improving quality and ensuring that educational content is harmonized with the country's economic needs. In accordance with the federal structure, each of the country's nine regional states and two urban administrations owns educational bureaus (National Regional States Education Bureaus). These bureaus are responsible for the administration and management of general education, technical and vocational education, and teacher-training programs and institutions.

Globally ICT is becoming increasingly used in schools and educational institutions, and established in professional and classroom practice. As a consequence, research activity looking at developing established practices is increasing and becoming more diversified. However, although companies and policy makers continue to take increasing interest in the scope of this field, relatively and according to the reviews undertaken in this research, we can't say that enough research works are undertaken which considers aspects of ICT and school management in the Ethiopian context.

Student Management Systems (often abbreviated as SMS systems) provide capabilities for registering students on courses/subjects, documenting grading transcripts and results of student tests and other assessment scores, building student schedules, tracking student attendance, and managing many other student-related data needs in a school.

A student management system is becoming a critical tool for parent-school relation by supplying up-to-date information to the school community.

The aim of this research is to come up with an effective technology that enables schools to apply and get benefit with effective use of infrastructure at reduced cost.

Cloud computing is one of the most talked about solutions for the education sector. The cloud computing model has already come to represent a solution to IT under-equipment problems, and the trends indicate that this model is set for major development. It is considered by some to be the technological revolution of the twenty-first century [1].

The United States National Institute of Standards describes deployment models. There are different types of cloud models that anyone can subscribe to depending on its business needs. The cloud deployment models stated in [2] are:

- Public Cloud,
- Private Cloud,
- Community Cloud, and
- Hybrid Cloud.

Cloud computing has three service models:

- Software as a Service (SaaS),
- Platform as a Service (PaaS), and
- Infrastructure as a Service (IaaS).

From the listed deployment and service model types, the cloud student management system is designed as community cloud that can be accessed only by the school community. In addition to this, the service model is likely to be SaaS in a way that schools get a student management service from the cloud.

2. Related Work

Ethiopia, as a developing nation, has suffered from limitations in educational budget. Higher educations, primary schools and secondary schools are being expanded at a very high rate. The Ethiopian government invests millions of dollars every year to support education in higher education institutions and schools with technology. However, due to budgetary limitations, it is not able to fulfil ICT infrastructure requirements of all universities and schools. For this reason, different researchers put their own effort to overcome the problem.

Among these works, a cloud computing framework for the Ethiopian education sector is proposed in [3] which consists of a hybrid cloud that combines private and public clouds.

The private cloud is implemented and managed by the Ethiopian Ministry of Education in collaboration with higher education institutions. The framework shows that every resource that can be shared by multiple universities will be placed at EUHC (Ethiopian Universities Hybrid Cloud) and then it will be available to all hosted universities. In this paper we outlined the following scenario as a core reason of significance.

For example, it is true that a Registrar System is required by every university, which means buying the system for all 31 universities. According to the researchers' view, if the Registrar System for one university costs 4 million then anyone can imagine how much it costs the government to deploy the system in all the 31 universities. Finally, the research result proposes a solution to minimize cost by deploying a single copy of the registrar system into the proposed EUHC cloud. The EUHC has an interface from its Ethiopian Universities Private Cloud to Public Cloud Service Providers.

Whenever some resource can't be deployed into EUPC due to different factors, then through the public interface, it is possible to access the resource from other cloud service providers. By deploying a hybrid cloud computing model, privacy and other security related issues can be avoided, since critical and sensitive data could be owned by university members and responsible bodies from the Ethiopian Ministry of Education.

Another work in [4] provides a high performance computing framework for Ethiopian universities that

enables scientists and researchers to solve complex problems that require high computing capabilities.

This framework consists of a private cloud infrastructure and an HPC (high performance computing) infrastructure. The author used Open Stack open source cloud operating system for deploying a cloud infrastructure and Hadoop as computing cluster. When these technologies are jointly used, the benefits a university gets are substantial. This opportunity solves many problems raised in academia and research centers with regard to on demand resource provisioning access and high performance cluster computing infrastructure.

Additional selected websites outline the level of technology utilization which is currently exercised on some schools in Addis Ababa city [5, 6, 7, 8]. Accordingly, most private schools are using web based student management systems to automate the following operations.

- Record management,
- Operational work such as report card generation,
- Human resource management, and
- Collaboration

Even if it is a very slow change, this is a good startup for utilizing ICTs in schools in Ethiopia. But still most schools, especially public schools, have limitations of using this technology due to several factors, mainly economic related issues that need substantial research work on different perspectives to come up with better solutions.

3. The Proposed Solution

The proposed solution of this research is a design and prototype of multi-tenant web based student management system that serves schools to manage and perform activities on a community cloud so that schools are expected only to be registered by the respective educational bureau and start using the system with minimum infrastructural requirement.

Multi-tenancy is an architecture in which a single instance of a software application serves multiple customers. Each customer is called a tenant. Tenants may be given the ability to customize some parts of the application, such as color of the UI or business rules, but they cannot customize the application's code [9].

3.1 Architectural Representation

The system is implemented using a three tiered architecture as shown in Figure 1.

- *Presentation Layer*: consists of the student management system’s pages. This layer contains all of the visible web pages, as well as some of the logic to deal with parsing and verifying user input.
- *Business Layer*: consists of the application business logic of the system and it acts as an intermediary between the data layer and the presentation layer. In addition, it holds logic of tenant configuration and queries to communicate with the data layer.
- *Data Layer*: consists of the MySQL database and provides persistence for the system as well as the logic directly related to the manipulation of that data through the means of queries.

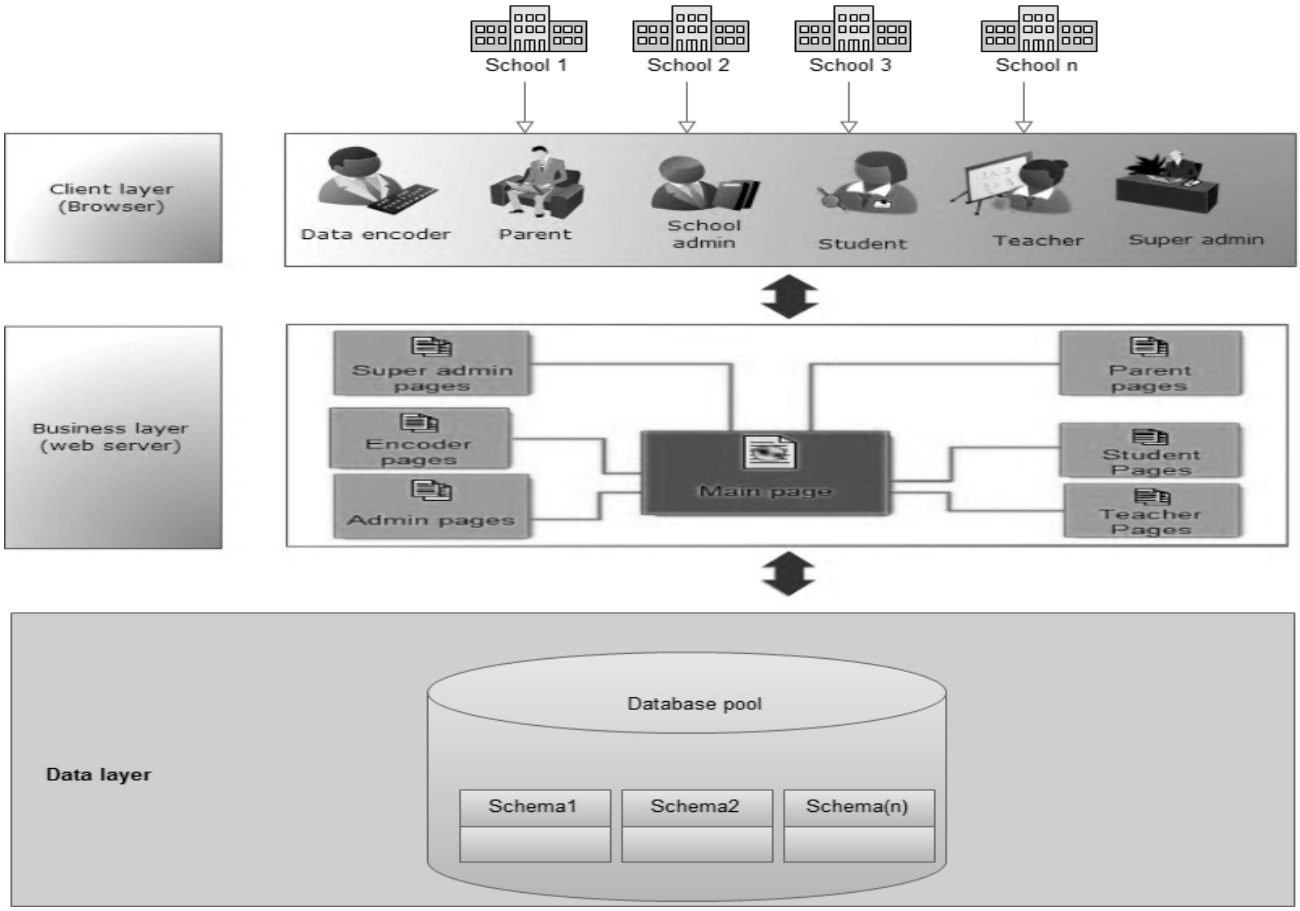

Figure 1: System Logical View

3.2 Deployment View

The student management system is expected to have more than 150000 concurrent users at a time. For this reason the system scalability and performance depend on the architectural design. The deployment structure follows the configuration design on Figure 2. It has an active hardware load balancer connected to application servers installed, when database connection is requested by an application and MySQL connection load balancer selects connection that belongs to the best instance from the connection cache provided by MySQL database.

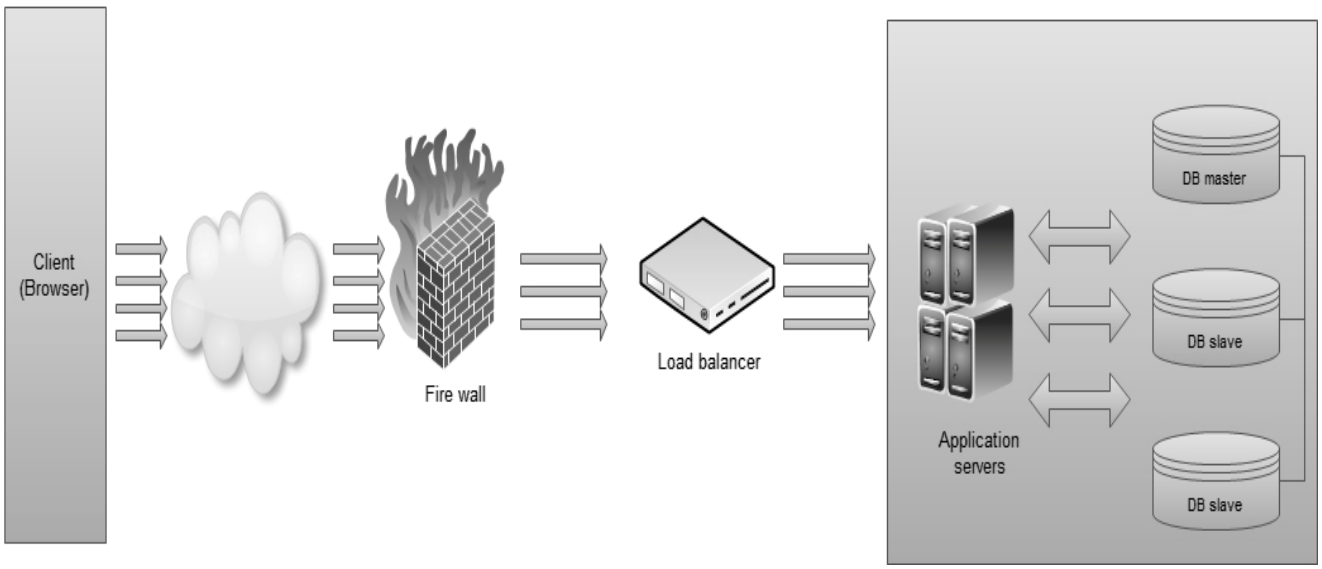

Figure 2: System Deployment Diagram

It also acts as a "traffic controller" sitting in front of the servers and routing client HTTP requests across all servers capable of fulfilling those requests in a manner that maximizes speed and capacity utilization and ensures that no server is overloaded, which could degrade performance.

3.3 Data View

Software as a service (SaaS) application can vary significantly depending on technical and business considerations. Experienced data architectures are used for a broad spectrum of choices when designing architecture to meet a specific set of challenges, and it is certainly no exception. The selected approach is examined on three broad data approaches as shown in Figure 3, each of which lies at a different location in the continuum between isolation and sharing.

Figure 3: Data Approach Spectrum

While choosing the appropriate data architecture for the proposed system, we considered the following as inputs.

- Economic Considerations,
- Security Considerations, and
- Scaling Techniques.

According to the above considerations, the student management system is designed to follow a shared approach with multiple private schemas for every school and one shared schema that schools use for common data access purpose as shown in Figure 4.

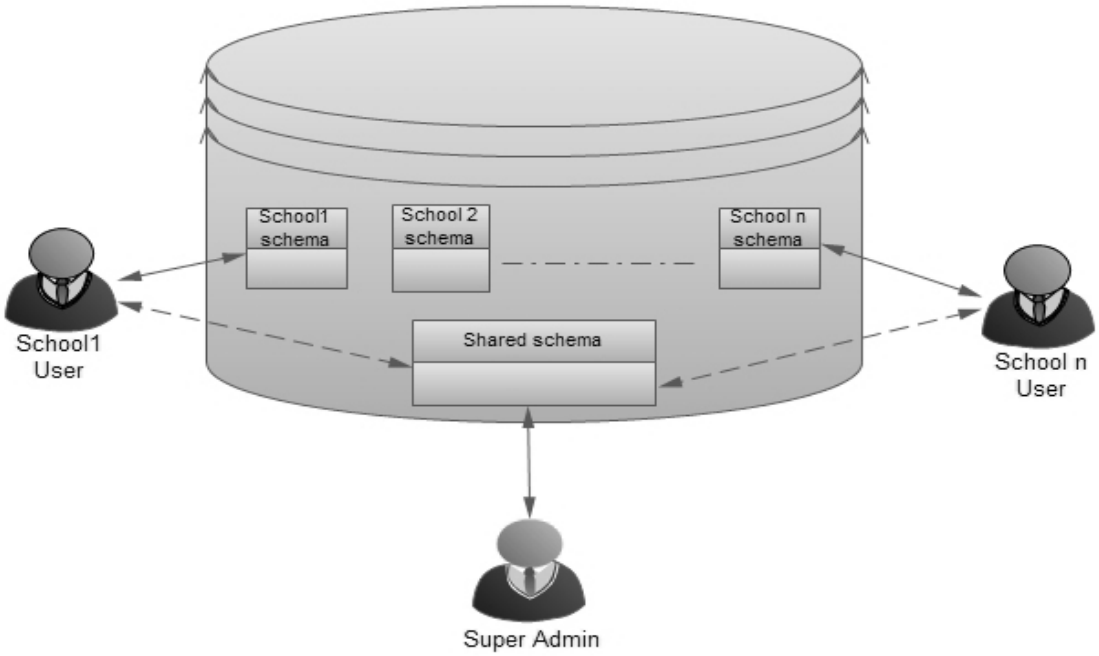

Figure 4: Data View

In addition, using multiple private schemas is an effective way of separating database users from one another when sensitive information is involved. Typically, a user is granted access to only one schema and its contents, thus providing database security at the schema level. Database users can run different applications, multiple copies of the same application, or even multiple instances of the same application. This enables to consolidate applications on one database to reduce management overhead and use resources more efficiently.

In short, the design of the system provides the following major advantages.

- *Resource sharing*: The main advantage of this research solution is its benefit for schools to have shared hardware and software infrastructure so that the cost of installation

and maintenance that is invested by the government can be minimized.

- *Transformation*: Since public schools are currently working all the school transaction manually the existing tradition can change their transaction into automated way through the deployment of this research solution.
- *Interoperability*: One of the methods for quality of education enhancement is the close interaction between the schools and the community. For this reason this research solution can be an option that let students, teachers, school administrators and parents to work and communicate together through the community cloud.

4. Prototype

To realize the feasibility and validity of the proposed solution, attributes and methods of the identified solutions are converted to a source code and integrated in such a way that they work together for common purpose. This process fills the gap between the analysis model and the awaited application. Technologies used include HTML, PHP, CSS, Java Script, and MySQL.

The main objective of this research was to develop a cloud student management system solution in order to solve the research questions associated to the government's financial limitation that is needed to automate school transaction in a collaborative and minimized cost manner. As a result, this research output presents a multi-tenant SaaS school management application prototype which is a single application that can give a service for multiple schools simultaneously as shown on Figure 5.

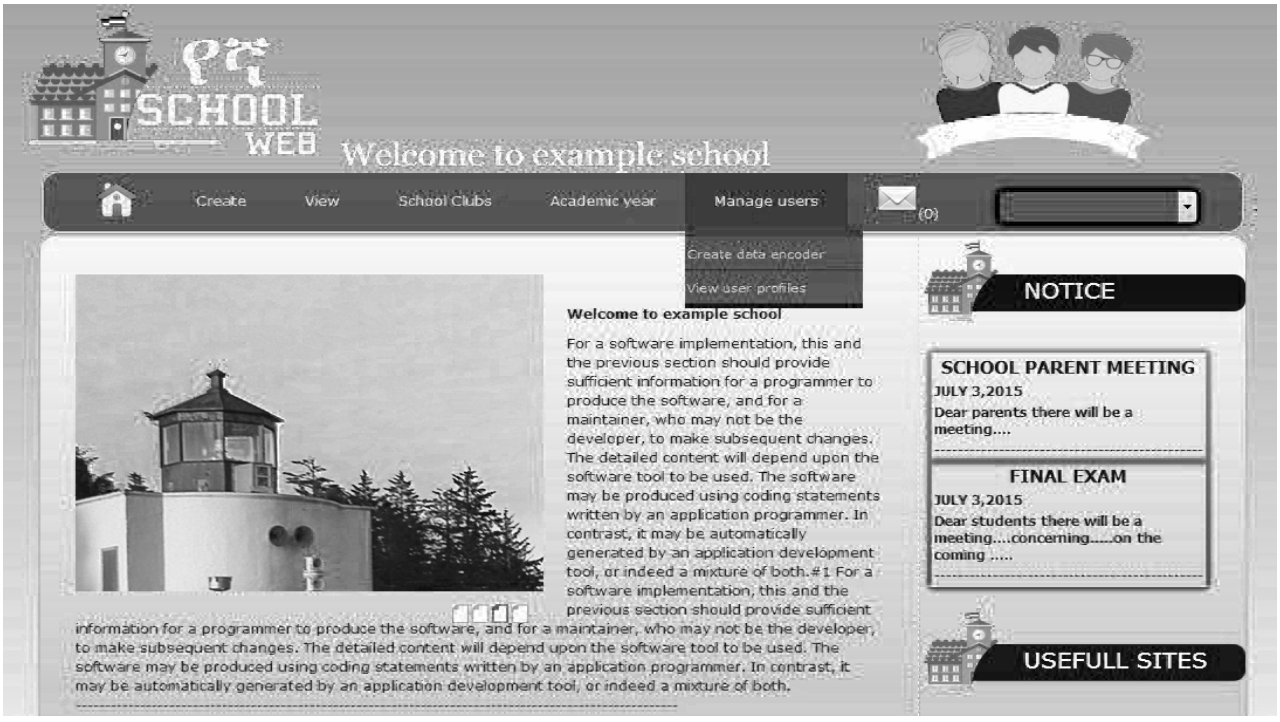

Figure 5: Cloud Student Management System Home Page

Since most of the related works of school web applications are designed to support only one user base or 'school', it is typically installed and maintained by the organization. This traditional software architecture usually requires each school to maintain a unique software code base that results not only in substantially higher technical support costs but makes software implementations and upgrades much more difficult to deploy than multi-tenant

architectures. This approach also limits the frequency of functional upgrades.

Another drawback of the single tenant architecture is that each customer (school) is provided with a dedicated server, which at first may appear to be an advantage. However, since data centers and application installation cost are multiplied by the number of new schools, it will result in an expensive investment (budget).

In contrast, this multi-tenant school management solution allows software updates to be rolled out to all customers simultaneously and it standardizes software versions utilized by customers. Because each school maintains the same application and shared infrastructure ensured through consistently applied upgrades, they are also beneficiaries of more stable software, fewer bug fixes and less disruption to service operations.

In addition, each school is put on the same database rather than individual servers, so the multi-tenant solution will lease far less data center equipment compared to a single-tenant solution supporting a comparable number of customers. Since each customer does not require its own data center equipment in a multi-tenant environment, the cost of adding new schools is very less compared to a single tenant solution.

Moreover, the application architecture of the prototype gives more emphasis on the school community collaboration. Since the functionality of the system includes parent participation, this will have a value on the development of education quality.

5. Conclusion and Future Work

The present economic situation will force more and more organizations to at least consider adopting a cloud solution. Schools have to start to adhere to this initiative and it is obvious that the Ethiopian government could get twofold benefits through significantly decreasing expenses due to the implementation of cloud based solutions and achieve education quality. The proposed solution is just a roadmap for the implementation of a whole virtual cloud based applications for the teaching-learning process. Even if the cloud solution is modern way of ICT utilization as discussed on the literature it comes up also with some uncertainties and drawbacks. In cloud computing we are putting our important and crucial data in one place and it could be exposed for illegal access or hack. Protection of data is a major security issue. Transferring data to a third party for hosting in a remote data center, not under the control of the institution and the location of which may not be known presents a risk. For this reason if more emphasis could be given to the security issues more advantage could be found from this technology opportunity.

This research solution mainly focuses on getting advantage of resource sharing (cost). In addition to this, a better design architecture which specially focuses on security issues, network latency, ease of use and other parameters are research areas for further exploration.

Since the scope of this research is limited to Addis Ababa city, it can be expanded to a national level with different education curricula.

It is also good to explore additional business requirement on the education system for development of better application with rich functionalities.

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