

ERP Conceptual Model for School Using 4+1 View Model of Architecture

Yohannes Kurniawan and Devyano Luhukay

Abstract—In last couples of year, the usage of Enterprise Resource Planning (ERP) has been applied by the organizations to support an integrated and real time business process. Basically it can be applied not only in a company but also in education institution such as school. This paper will try to provide an ERP's conceptual model to support business process at school. It is pictured using Unified Modeling Language (UML) notation with architecture model "4+1 View" approach. Hopefully this architecture model can help analysis and design for business process at school whole fully. ERP's conceptual model could help ERP School application developer to understand a clearer ERP's system and to develop it easily. Adopt the ERP school model can gain more effective ERP system.

Index Terms—Enterprise resource planning, unified modeling language, school.

I. INTRODUCTION

One way to develop education quality to the higher level is to adopt Information and Communication technology (ICT) into school's management processes. The Emerging of technology provides a tremendous opportunity to develop education management and learning process in school. Current information technology has a high priority in education. At this time, the contribution of information technology to education has been a major subject in the spotlight [1].

Enterprise Resource Planning (ERP) is one of the example of ICT development utilization in various companies. It is already been widespread and advanced, so has become a necessity for big companies in the world. ERP is needed to support the company to run its business process, thus requiring the company to implements ERP to help accelerate the company's growth rate. One study showed that 33% of companies save cost in sales order management, and 34% said that their ERP system greatly reduces the need for the number of employees [2]. The use of ERP system now is not only applied to the company but also can be applied into the school system.

Hopefully the implementation of ERP system in school can create the benefit to establish the center of information that can be accessed by students, teachers and parent/guardians of students to obtain data related to their authorities. Some of the problems often faced by schools in

implementing education management control are: 1) educational services to the student is less that optimal, 2) The lack of synchronization of data and information between the components of school management, 3) lack of collaboration to facilitate coordination, 4) Unsustainable accountability, 5) Ineffective and inefficient provision of information.

And on the ERP System there are 3 aspect to be concern on: 1) Integrated, means that every service on primary element of school is connected each other and interactable on data or information distribution; 2) Customized, this system can be configured according to school's policies and needs of its management and operational activity; 3) Standardized, the system that going to be developed will set.

In the ERP system, there are three aspects to consider: 1) Integrated, in the sense that all elements of the service on a primary school have relevance and can interact in terms of the distribution of data and information; 2) Customized, where the system can be configured according to the needs and school operational and management policies; 3) Standardized, where the system to be built will be adjusted to the standards set by the Department of Education so that the school can provide the information needed (and requested) by the Department of Education. So the benefits to be gained with this ERP system is not only felt by school element alone (including the academic community, alumni, parents and the community), but also by the Department of National Education.

At this paper, the authors propose a conceptual model of ERP for School by using a "4 +1" architectural approach views to modeling notation system based on the Unified Modeling Language (UML). This ERP conceptual model will help requirements analysis for the ERP's system developer, it becomes easier to be realized.

ERP Conceptual model can help to explain the complexity of ERP systems into general form, make it more common and can help project managers who do not have the technical expertise to more easily understand the ERP system [3]. In addition, the modeling framework can also be used to optimize ERP system implementation process, as was done at the time of implementation of ERP systems on Mexican University, Panamerican University of Mexico [4].

II. LITERATURE REVIEW

ERP systems as a computer-based system designed to process organization activities and to integrate facility and planning in a real-time, and specificaly ERP system have several characteristics to assist company's business process [5].

Inclusion of the software application in the ERP concept

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is simply because the technology can provide added value such as [5]: the removal of unnecessary processes (elimination process), simplifying complex processes (process simplification), pooling redundant processes (process integration), and automating manual processes (process automation). ERP system will make business processes better in the dimensions of time, space (Business Scope), and money. In addition to creating time and cost efficiency, this system also have an impact on improving the quality of service. This directly increases the competitiveness of the market [5].

Authors also realize about the lack of an ERP conceptual model that based on object-oriented approach [6]. Technology based on object-oriented can be used for the development of information systems, including ERP systems. Object-oriented models will have implications for the analysis and design with the use of an object [7]. This is an appropriate model of object-oriented techniques for modeling the business processes in the company [8].

Modeling of complex systems consisted of many processes. Ideally, the entire system can be described in a single diagram. Single diagram describes the overall system unambiguously and easily communicated and understood, because the whole system was identified at one time [9]. Basically impossible and very difficult to describe the whole system in a single diagram. Because the majority of the company's business processes is very large and complex. If we only use a single diagram, we can not describe all the information existing in the overall system [9].

UML is the standard modeling language adopted by the Object Management Group in 1977. UML as the modeling language describes the system model (real world and software) based on the concept of the object [10]. Since UML is used to describe several types of systems, UML can be used for modeling systems, with a wider coverage [8]. UML contains two vital tools: notation and meta-models [11]. Notation is a set of syntax diagrams, which allows you to analyze and design the system. Meta-models is the definition of the notation. UML provides a rich and complex notation to describe the system [11]. Perspective is the view that is used to see and describe the system from different aspects of user requirement. In this paper, the authors discuss the various views of stakeholders to describe the conceptual model of ERP.

When the author do the modeling for this ERP system, the system is described in several aspects: functional, non-functional, and organizational. However, ERP systems can describe multiple views, such as the view of the projection of a complete picture of the system.

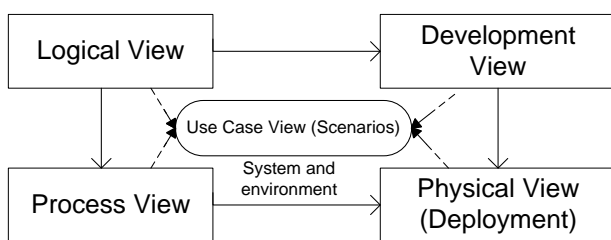


Fig. 1. Model "4+1" views.

System architecture approach to picture a system using

UML diagrams can be represented by a "4 +1" views. This approach allows the system developer to describe the essential characteristics of complex systems (Kruchten, 2012). Here is an explanation of the "4 +1" approach views in Fig. 1 [9], [12]: 1) The Logical View - Representing the structural elements, the level of abstraction, and the frequency of use of object-oriented models; 2) the Process View - Representing the execution aspects of the system: patterns of interaction and relationship; 3) the Implementation View - Representing decomposition in subsystems that are used in the system development environment (View development); 4) the Deployment View - Represents a distribution framework of software components on the physical nodes, computer or processor that been used; 5) + 1 the use Case View - Represents a use case / scenarios involving multiple actors.

III. RESEARCH METHODOLOGY

The method used in this paper is qualitative method. Data collection in ERP conceptual model analysis was conducted to gather input and output documents that flows inside the school, and with regard to all information systems that are running and which will be developed as the primary data source, with direct data collection techniques that consist of: 1) interviews, conducted by a question and answer directly to the interested parties in this study. 2) Observation, in which the authors undertook direct observation of IT-related business processes that took place at school, in this case Binus International School. And for the indirect data collection obtained through a variety of books and journals.

Form of presentation of this paper were presented descriptively. Documentation of the analysis of the conceptual model of ERP using unified modeling language based on the architectural approach "4 +1 views" [9]. ERP conceptual model for schools can be used as a guide design of school ERP system. This conceptual model has been validated with the ERP business processes that are running at Binus International School. This model is also generated from the translation of the running application on Binus International School as a benchmarks of the ERP modeling.

IV. CONCEPTUAL MODEL OF ERP SCHOOL

Basically every school has similar organizational structures and business processes. Based on that, develop an ERP school system can meet the requirements at the school itself. At this paper, the authors introduce a conceptual model of ERP for schools based on school business process functionality, include: new student registration, scheduling and preparatory schools, teaching and learning activities, evaluation, and graduation [13].

Enterprise Resource Planning system (ERP) is a terminology of information systems that support the transaction or the day-to-day operations in the management of company resources. While the application of the ERP concepts in the education industry are substantially the same as its application on a company. When a transactional concept of automation in school thought, some aspects included in the discussion are a learning management,

payment management, libraries, and others. Maybe some educational institutions have had most or some such applications, but its stand-alone, that is not interconnected with each other between the system.

Management education in schools is organized processes for managing components of education in schools, namely: curriculum and teaching programs, staff, student affairs, finance, school and community relations management, and school organization itself. Some of the problems often faced by schools in implementing management control of education in the school management without the use of assistive device management (management tools) are: 1) educational services to the student is less than optimal, 2) The lack of a blend between the data and information between the components of school management, 3) lack of collaboration that facilitate coordination, 4) Accountability is not sustainable; 5) the provision of information is not a quick and effective.

ERP for the schools is a set of integrated web-based information system that consists of 4 main portal, namely: 1) Staff desk as a portal used by teachers and school employees to access relevant information needed for academic activities, 2) Student desk as a portal information for students active in school to access the required information, 3) parent desk as an information portal for parents/guardians to access information related to the development of their children in school, 4) Alumni desk as an information portal to establish community with the alumni of the school.

The purpose of this ERP application development eventually is to provide an integrated solution for the management of activities in the school at the elementary and secondary levels of education, so that the elements can facilitate schools in managing school and concentrated on improving the quality of education and improving the quality of management education so as to result in output a good quality education.

And with ERP Education implemented totally into the school-based management, the effectiveness of the processes that had been done in all the activities of school management can be achieved and will linearly increase the quality of school education.

ERP system aims for build a community and school management based on technology of information, which is the first step for realize the study and qualified school foundation. With the existence of ERP school, the activities of the teacher will increasingly helped, with ease to access class schedule, students' data and marking, as well as ease of monitoring the students' development of learning. It is also; create awakening active role of parents to determine the child's educational progress and school administration through the ease information access for student's data via the Internet.

The awakening of students activity to access learning schedule, daily test result/mid semester/final semester and school activities drift student to be quickly responded and responsible to plan his/her learning activity. Not just that, the existence of ERP school also raise The establishment of a good school information archiving activity because it can be done quickly, easy and securely.

If you want to see the system as a whole, it would be very complex and one way to see if we use the diagram 4 +1

views approach to solve the system into 5 sections / view. These models consider the 5 level and document important aspects of the system. This approach solved in modeling the system with the following view (including use case view). This view displays the components (objects) systems that interact / relate each other. UML diagram may help to illustrate the use case, logical, process, development (implementation), and the physical view of the system to help the development of information systems.

At this paper, the authors represent the conceptual model of ERP with UML (object-oriented modeling techniques). By using this conceptual model, the developer of ERP for schools will gain some benefit. Conceptual model of ERP implementations that follow the design and can be used throughout the development of the system, because there are boundaries between analysis, design, and implementation. ERP's conceptual model will simplify the ERP system [14].

A. Use Case View

Use Case View (Scenario View) modeled using UML Use Case diagram. Use case diagrams are used to model the functionality of the system that describes the interaction between the systems with the actors. The purpose of the depiction of the use case diagram is used to portray the context of ERP systems. In this study the authors describe two systems use case diagrams that define high-level processes in the School ERP system as a whole (Fig. 2) and the low-level use case diagram (Fig. 3). In Fig. 2, the conceptual model of ERP split into four use case that represents the portal of the ERP system: *staff desk, parent desk, student desk, and alumni desk*.

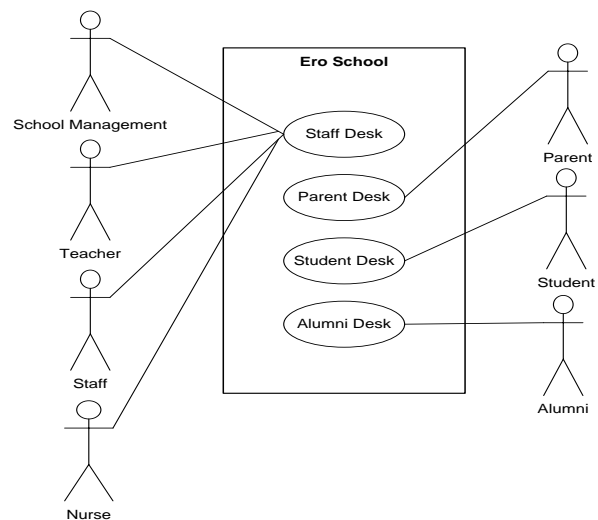


Fig. 2. High level use case diagram.

On low-level use case diagram describes the system use cases that define the details of each sub-system business processes in school activities that interact with the users of the system (school stakeholders). Information System Model designed for the use of Multiuser purpose; information system as the school management software can be accessed by interested parties at school with different privilege.

Basically information system is integrated school administration software that includes a few basic modules that are reflected from each use case that is required to help an educational institution in the provision of timely and accurate information.

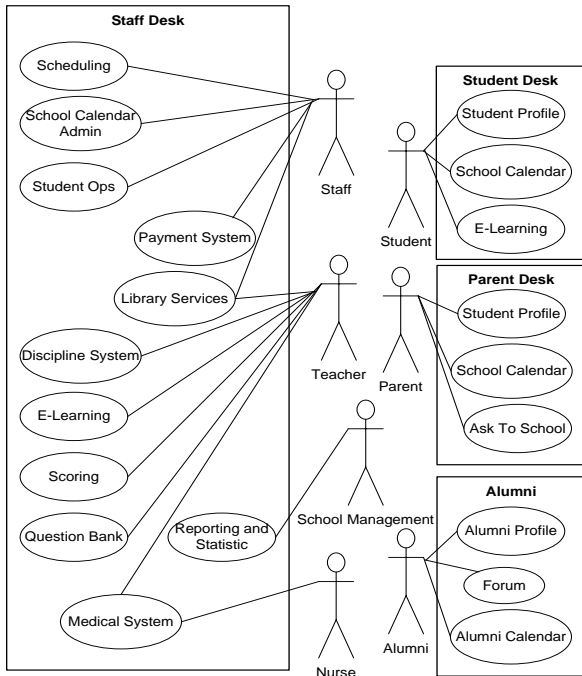


Fig. 3. Low level use case diagram.

The purpose of use case diagram in ERP model is to capture the dynamic aspect of a system (features

representation). Use case diagrams are used to gather the requirements of a system including internal and external influences. These requirements are mostly design requirements.

B. Logical View

Logical View displays components (objects) of the system, and describes the interaction / relationship. Currently, the diagrams are commonly used to create a model for the logical view with UML Class Diagram, which is described in 7 clusters (Refer to Fig. 4), i.e. *master, academic services, library, financial, clinic, events, and content*.

The class diagram is a static diagram. It represents the static view of an ERP application for school. Class diagram is not only used for visualizing, describing and documenting different aspects of a ERP system for school but also for constructing executable class code of the software application.

The class diagram describes of a class and also the constraints imposed on the system. The class diagrams are widely used in the modeling of object oriented systems because they are the only UML diagrams which can be mapped directly with object oriented languages.

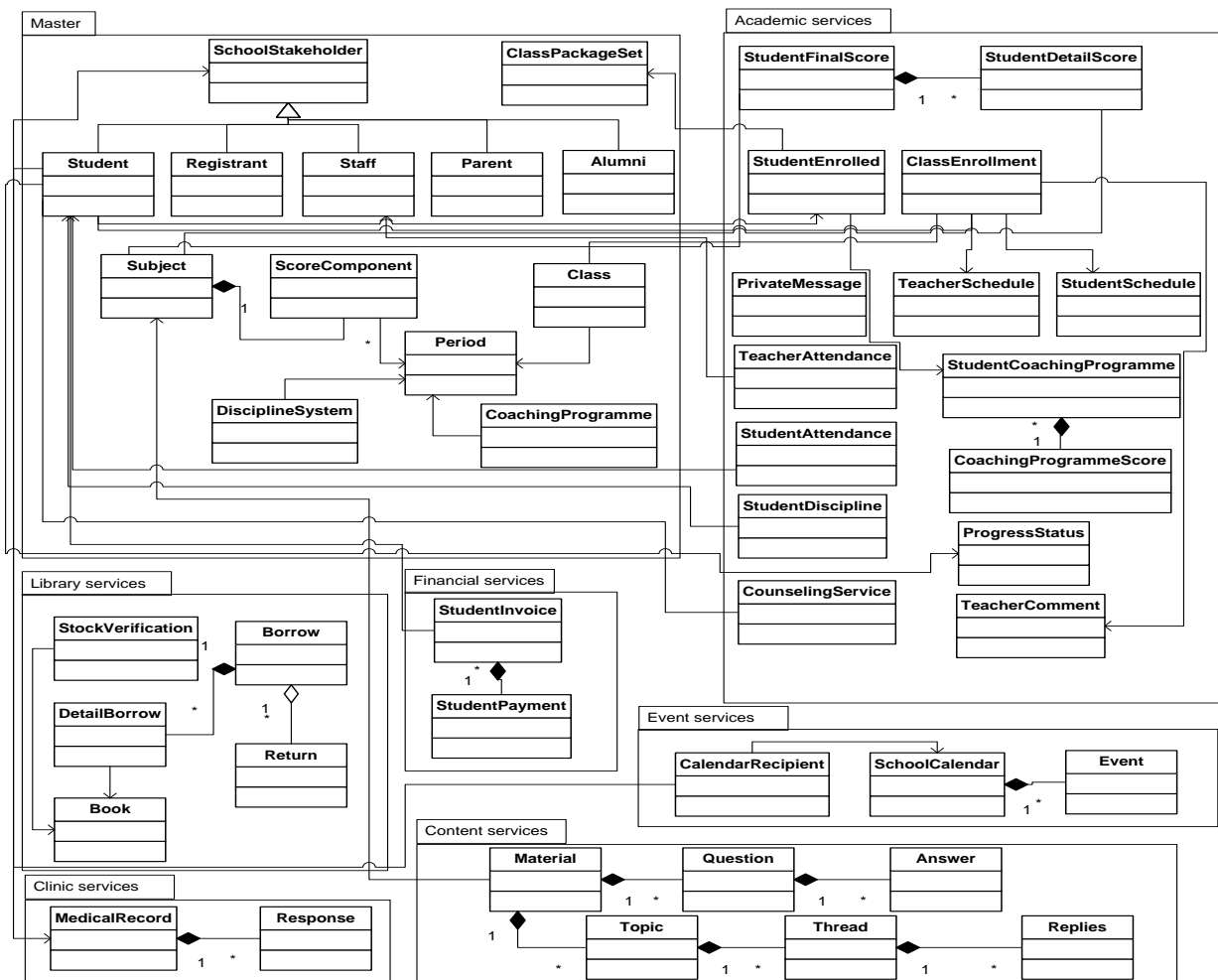


Fig. 4. Class diagram - structural (all cluster).

The class diagram shows a collection of classes, associations, and navigation visibility. It is also known as

a structural diagram. In Fig. 5 until 11 illustrate the model of class diagram for each cluster. In Fig. 5 will illustrate the

data master cluster is used to draw a master class at a school ERP. Master class is information (attributes) that is a key to the operation of a school. It is the primary focus of the information technology discipline of master data management, and can include reference data for the system. Master data for this ERP system may include data about school stakeholders (student, registrant, non-teaching staff, parent and alumni) class package set, subject in school, score component, period in school, discipline system, class, and coaching program master data.

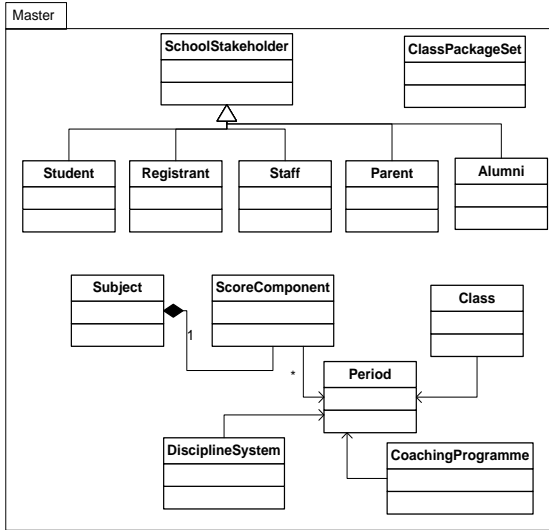


Fig. 5. Class Diagram for master data cluster.

In Fig. 6 below reflects library services cluster, including classes that are in scope of operations on library in schools, such as the process of borrowing, return of book, including verification of stock for the books contained in the library. Whereas in Fig. 7 illustrates the cluster area in the finance of school include school fees and the other invoices, such as school coaching program, study tour or field trip, and payment of fines.

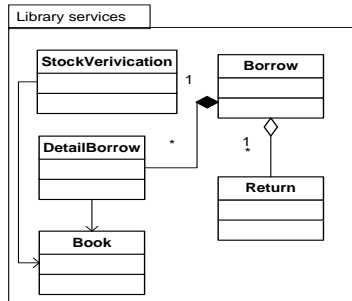


Fig. 6. Class diagram for library services cluster.

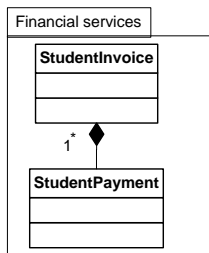


Fig. 7. Class diagram for financial services cluster.

In Fig. 8, displays the model of classes included in the services available through the school clinic include medical record (routine or per event) along with medical acts

performed by the nurse (responses). Whereas in Fig. 9 includes lecture content based on curriculum materials (especially for junior or high school students), question bank (Question Bank contains hundreds of questions created and certified by the teaching staff), and also discussion forums (Learning Management System for school).

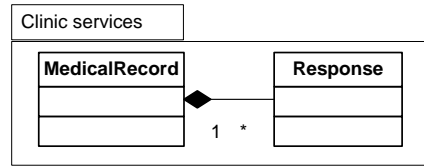


Fig. 8. Class diagram for clinic services cluster.

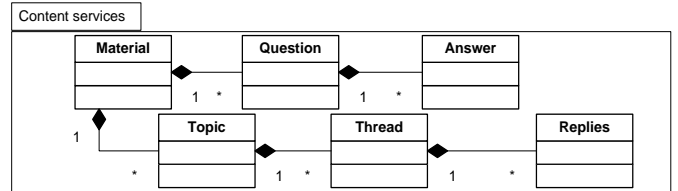


Fig. 9. Class diagram for content services cluster.

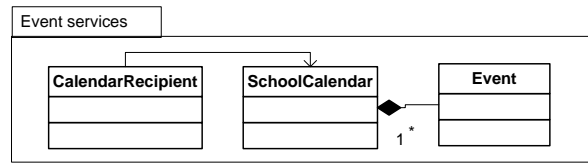


Fig. 10. Class diagram for event services cluster.

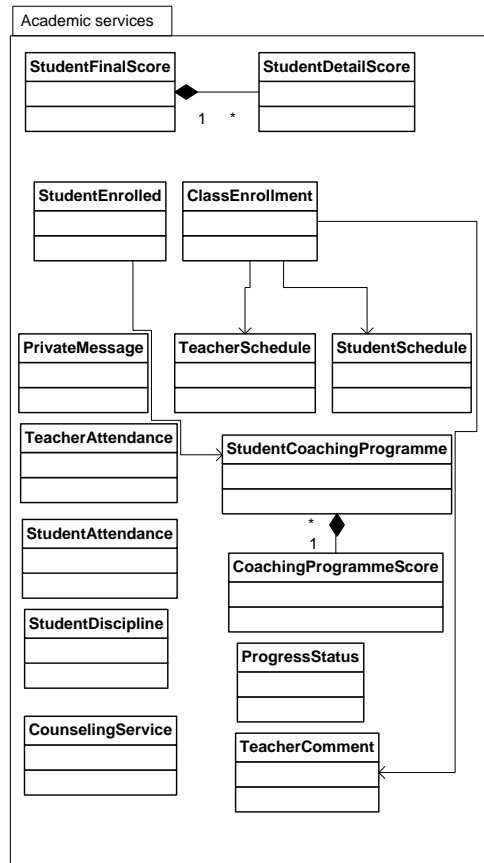


Fig. 11. Class diagram for academic services cluster.

In Fig. 10 illustrates the event cluster that includes documentation of all events contained in the school, such as: exhibition, parent teacher conferences, student holiday, student exchange event, and etc. While cluster in Fig. 11 reflect academic services in the school to support the

structural modeling process of academic school operation, which can cover the following processes: 1) Student attendance; 2) Teacher attendance; 3) Student score transaction; 4) Student registration and scheduling transaction data; 5) School coaching program transaction (attendance or score – if needed); 6) Progress status and teacher comments transaction for progress report; 7) counseling services transaction; and 8) student discipline transaction.

Student services for students and teachers/staff at the school so that they are well informed to advise students. Information could include policies and procedures related to administration in school, academic services, registration, advising and tutoring, request document/legalizing and other services. This school portal could be personalized for individual schools or student groups to customize service offerings.

C. Process View

Process View displays the processes and work flow of the systems and displays also the communication between the business processes that take place at school, starting from the student's registration process until the students become alumni. To display the process view, UML Activity Diagrams is used to illustrate the main processes and flow control system.

In the activity diagram below illustrates the three swim lines school stakeholders in the ERP system, namely: Non-Teaching staff (covering operational staff in school, school management, and nurse), teaching staff (including teachers and assistant teachers), and alumni.

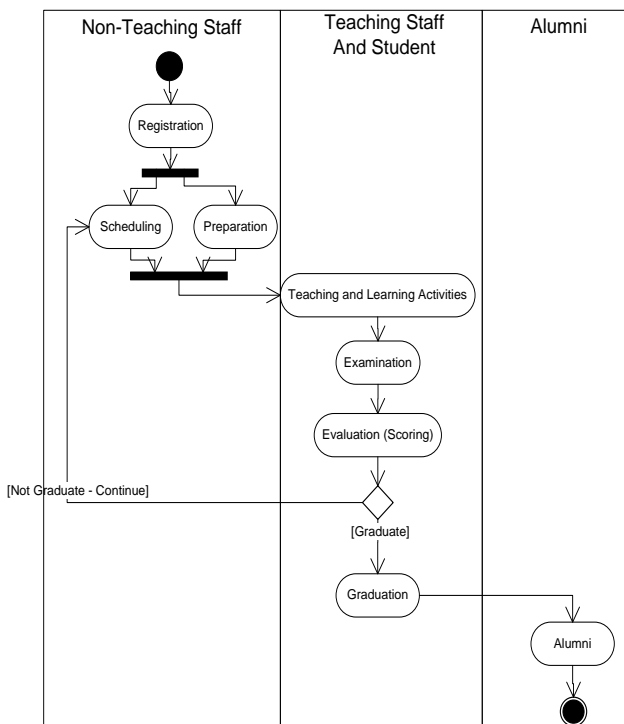


Fig. 12. Activity diagram.

In the era of information technology advancement today, educational institution try to take advantage of ICT to access and deliver educational information about each major activity (Fig. 12). Thus, in order to improve the quality of education, an educational institution should have

information systems that can assist schools in managing the teaching and learning activities effectively and efficiently. By having the School of Information Systems, then educational institutions can serve a variety of information as needed.

D. Implementation View (Development)

In the Implementation View component diagrams are used to display the system components used at the time of operation (operating layer). Architectural structures selected component is a client-server with presentation local pattern.

Client is user of the system, there is only a user interface that will make the request and system interface which will provide access to function on a server that will process and provide the requested response. It aims to maintain the consistency of transaction data because the system can be accessed via the web by some clients who are at different locations. Data is only found in the center because of the need for integration by parts, therefore the model will only be available in the server to maintain data consistency, can be seen in Fig. 13.

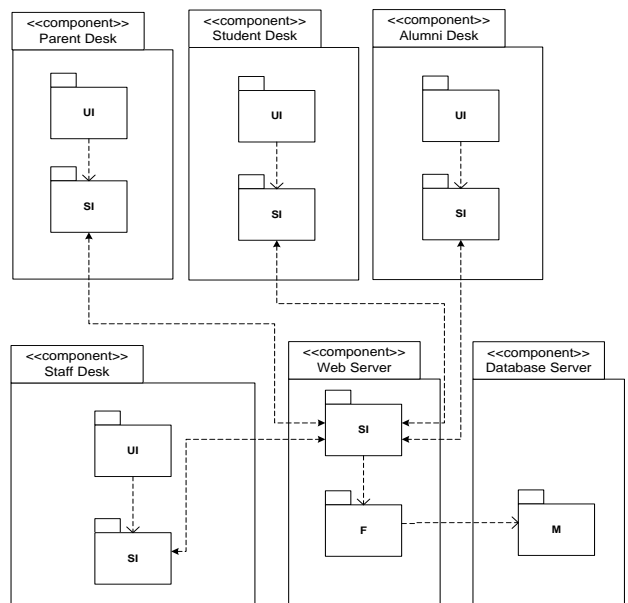


Fig. 13. Component diagram ERP conceptual model for school (Web-based application).

E. Deployment View (Physical)

The Physical View uses UML deployment diagram notation, describe the structural elements of the system in general that are used to represent physical nodes deployment (system environment). Deployment diagrams in the conceptual model for ERP depicted to describe web-based system model that display the system's execution environment (hardware / software platforms), can be seen in Fig. 14. Physical Views in the ERP system for school is a pattern that shows how to encapsulate a physical database so that it can be easily accessed and optimized without affecting upper layers of software.

Encapsulate every table and every view with a physical view. Use these classes to encapsulate overflow tables and other database optimization techniques. To provide a uniform interface derive from physical views.

The Physical View will enable the user to identify non-optimal resources. Use this page to view a physical

representation of your chassis, view each physical components property, and perform hardware maintenance tasks.

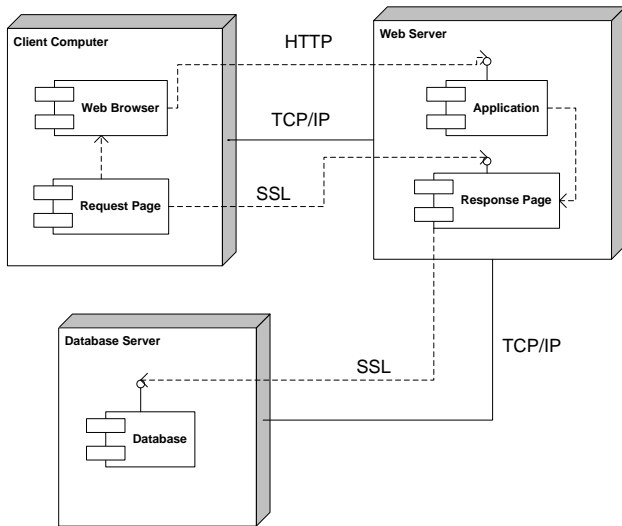


Fig. 14. Deployment diagram (Web-based application).

F. ERP System Design with UML Notation

Web-based information system model will provide an integrated data processing system that can build interconnection input results from existing modules so as to provide ease of presentation of information. Dissemination or delivering this information can be done by using the intranet or internet so the information can be accessed by anyone who has the right, at anytime and anywhere as long as there is internet connection.

Basically School ERP system is complete Student Management integrated software application that spans across all functional requirements of school like student admission system, examinations, fees, attendance, clinic, finance, academic and administration operation, library, e-learning.

The ERP system will provide complete profile of a student in a very systematic way and it will be very easy for an administrator or principal of the school to have an overview of a particular student's profile and generating reports dynamically. Some UML software tools goal to integrate UML and Specification and Description Language to provide a powerful software modeling and development environment, especially for integrated system like ERP. The increasing functionality of various UML tools is a factor in the popularity of UML.

To create model of a system the most important aspect is to capture the dynamic behavior. So only static behavior is not sufficient to model an ERP system rather dynamic behavior is more important than static behavior. In this 4+1 views approach model, we are using UML there are five diagrams available to model an ERP system. Now as we have to discuss that the model is dynamic and static in nature there should be some internal or external factors for making the interaction.

These internal and external agents are known as actors. So the diagram is used to model the system/subsystem of an application. A single use case diagram captures a particular functionality of a system. So the major diagram to modeling ERP system for school is use case as scenario to model the

entire system.

The major benefit of UML notation is it helps to keep a right standard in system development process. Basically UML is a formal language which has a robust defined meaning for each element of it (all components in 4 + 1 view model of architecture). The UML helps to keep a proper understanding of the ERP system in school among the developer system.

The UML notation in this conceptual design will helps in quicker system maintenance because it provides transparency and depth visibility of the system which helps to track the errors, mistakes, causes of the problems and even solutions for the ERP system in school.

This UML notation possible to make system maintenance quicker and easier even with developers who are outside the project team because it describes the system structure very clearly. The UML notation in this system is comprehensive to describe all the important aspects of an ERP system in school and it is scalable to handle immense system modeling projects.

By using the UML tools, it will provide exporting facilities to translate data in UML models into the programming language such as Java or C++ code. And to gain the greatest benefit from UML notation design in this paper, it must be used at the beginning of the process when requirements are being collected, reviewed and evaluated. Traditionally, this has been a relatively informal process involving discussion within technical persons. The UML can provide the formalization and visualization which make the requirements clear and unambiguous. The School stakeholders will accomplish this through deployment of ERP conceptual model (customizable web sites that provide targeted information to staff and teachers and allows them to publish to specific communities), support of e-learning technologies, enhanced capture and distribution of lessons learned, support for the development of learning communities, and creation of collaborative environments to enable sharing and managing of the school operation within a stakeholders in school.

V. CONCLUSIONS

Conceptual model of ERP for schools described in this paper with the UML notation (4 +1 view approach) as object-oriented modeling techniques can help the ERP system application developers to understand the ERP for school clear and comprehensively. ERP conceptual model is the result of analysis and design that can be used for development of ERP software at school integrated way. This model can help simplify the existing functionality in the ERP system, so that the process of identifying the needs of the ERP system becomes easier to do.

The model of information system designed for the school in order to utilize the full potential of information technology sophistication. This Model of the information system will provide school management administrative solutions by utilizing computer technology, communication technology and Internet technology.

School information system is expected to be a reference of the school to improve the quality of their schools with the establishment of good communication between teachers,

students and parents because of the availability of service of learning process information that "real time" which can be accessed easily via the Internet.

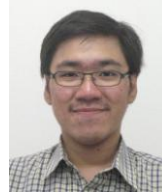
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REFERENCES

- [1] C. F. Webber, "New technologies and educative leadership," *Journal of Educational Administration*, vol. 41, no. 2, pp. 119-123, 2003.
- [2] R. Weber, *Information System Controls and Audit*, New Jersey: Prentice-Hall, 2000.
- [3] M. Carl and L. Lessing, "A conceptual model for enterprise resource planning (ERP)," *Information Management & Computer Security*, vol. 13, no. 2, pp.144 – 155, 2005.
- [4] J. H. Worley, K. A. Chatha, R. Weston, O. Aguirre, and B. Grabot, "Implementation and Optimization of ERP systems: A Better Integration of Processes, Roles, Knowledge and User Competencies," *Journal of Computers in Industry*, vol. 56, no. 6, pp. 620-638, 2005.
- [5] S. F. Wijaya and S. Darudiato, *Enterprise Resource Planning dan Solusi Bisnis*, Yogyakarta: Graha Ilmu, 2009.
- [6] J. Sutherland, "Business Objects in Corporate Information Systems," *ACM Computing Surveys*, vol. 27, no. 2, June 1995.
- [7] C. Casanave, "Business-Object Architectures and Standards," *Business Object Architecture*, May 2012.
- [8] J. Arlow, W. Emmerich, and J. Quinn, "Literate Modeling-Capturing Business Knowledge with the UML," in *Proc. The Unified Modeling Language: first international workshop selected paper/UML '98: Beyond the Notation*, Springer-Verlag, 1999, pp. 189-199.
- [9] P. Kruchten, "Architectural Buleprints - The '4+1'View Model of Software Architecture," *Whitepaper UML Rational*, June 2012.
- [10] M. Hitz and G. Kappel, "Developing with UML Some Pitfalls and Workarounds," in *Proc. The Unified Modeling Language: first international workshop selected paper/UML '98: Beyond the Notation*, Springer-Verlag, 1999, pp. 9-20.
- [11] P. L. Hrubby, "Structuring Specification of Business Systems with UML (with an Emphasis on Workflow Management Systems)," presented at OOPSLA '98 Business Object Workshop, 1998.

- [12] I. Jacobson, G. Booch, and J. Rumbaugh, *The Unified Modeling Language User Guide*, Addison Wesley, 1999.
- [13] J. Ranjan and S. Khalil, "Application of Knowledge Management in Management Education: A Conceptual Framework," *Journal of Theoretical and Applied Information Technology*, vol. 3, no. 3, pp. 15-25, 2007.
- [14] J. Park and N. Lee, "A Conceptual Model of ERP for Small and Medium-Size Companies Based on UML," *International Journal of Computer Science and Network Security*, vol. 6, no. 5A, pp. 42-49, May 2006.



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