

**DESIGN AND IMPLEMENTATION OF ACADEMIC INFORMATION
SYSTEM USING POSTGRESQL**



By

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ATENEODE DAVAO UNIVERSITY

GRADUATE SCHOOL

DAVAO CITY

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**An Independent Study Presented to the Graduate Faculty of the
Computer Studies Division Ateneo de Davao University**

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TABLE OF CONTENTS

| | |
|---|------|
| Recommendation for Oral Defense | iii |
| Recommendation for Acceptance | iv |
| Acknowledgments..... | v |
| Table of Contents..... | vi |
| List of Figures | viii |
| List of Tables | ix |
| Abstract..... | x |
| | |
| Chapter 1 – Introduction | 1 |
| 1.1 Background of the Study | 1 |
| 1.2 Technology Application Context..... | 3 |
| 1.3 Objectives of the Study..... | 5 |
| 1.4 Significance of the Study..... | 6 |
| 1.5 Scope and Limitations of the Study..... | 7 |
| 1.6 Definition of Terms..... | 8 |
| | |
| Chapter 2 – Review of Related Literature and Works..... | 12 |
| 2.1 Impact of ICT in Academic Institution..... | 12 |
| 2.2 Decision Support System..... | 14 |
| 2.3 IT Methodologies..... | 15 |
| 2.4 ORDBMS..... | 18 |
| 2.5 Academic Database..... | 21 |
| 2.6 PostgreSQL | 22 |
| 2.7 Summary | 24 |
| | |
| Chapter 3 – Project Design and Methodology | 25 |
| 3.1 Operational Framework | 25 |
| 3.2 Methodology | 28 |
| 3.2.1 Analyzing and Designing SCC's AIS | 28 |
| 3.2.2 Developing the SCC's AIS Application..... | 30 |
| | |
| Chapter 4 – Technology Background | 32 |
| 4.1 PostgreSQL | 32 |
| 4.2 Lexical Structures | 32 |
| 4.3 Values Expression..... | 33 |
| 4.4 Calling Functions..... | 33 |
| 4.5 Data Definitions..... | 34 |
| 4.6 Inheritance..... | 34 |
| 4.7 Data Manipulation | 35 |
| 4.8 Queries | 35 |
| 4.9 Data Types | 36 |

| | |
|---|-----|
| 4.10 User Define-Type (UDT)..... | 37 |
| 4.11 Composite Types | 37 |
| Chapter 5 – Results and Discussion..... | 38 |
| 5.1 Implementing the PostgreSQL Type System to Manage Complex Data | 38 |
| 5.2 Implementing Behaviors for AIS Object | 39 |
| 5.3 Designing the AIS Schema | 42 |
| 5.4 Normalization and ORDBMS Tables | 44 |
| 5.5 Loading and Testing | 46 |
| 5.6 Designing the AIS Application..... | 47 |
| 5.7 AIS Application Implementation..... | 50 |
| Chapter 6 – Conclusion and Recommendations | 51 |
| 6.1 Conclusion | 51 |
| 6.2 Recommendations..... | 52 |
| Bibliography | 53 |
| Appendices..... | 59 |
| Appendix A: User Guide | 59 |
| Appendix B: Relevant Source Codes..... | 62 |
| Appendix C: AIS Feedback Form..... | 119 |

ABSTRACT

The study used PostgreSQL for the design and implementation of an academic information system (AIS) of Southern Christian College. This software introduces new approaches to managing complex data in the AIS utilizing the object relational database management system (ORDBMS). Complex data in the AIS are illustrated based on their value and structure. For the design and analysis of the AIS the researcher utilized pgAdmin III, SQL Manager Lite for Postgresql and PostgreSQL 9.0. For the development of the AIS application the researcher utilized the Lazarus and ZeosLib connection component libraries in a Windows platform. The methodology of the study was a combination of aspects of both relational and objects oriented analysis, and design following the ANSI's Three-Tier Database Model. The development of the SCC's AIS application followed the commandments of application design with Zeos and PostgreSQL and that partially focuses on the student financial records. The developer implemented four common PostgreSQL type systems, created four complex types in the AIS, and implemented behaviors such as rules (rule based system), functions, triggers and parameterized view. Designing and implementation of AIS using the ORDBMS features of PostgreSQL provided a holistic approach in creating a functional and smart database.

Keywords: AIS, ORDBMS, Complex Data, ANSI's Three Tier Database Model, PostgreSQL, SQL Manage Lite for PostgreSQL, Lazarus, ZeosLib

Chapter 1

INTRODUCTION

1.1 Background of the study

Database technology is in a period of intensive change and innovation that is both revolutionary and evolutionary. The revolutionary aspect refers to the innovation of an object oriented database management system (OODBMS) based on object-oriented programming technology. The evolutionary aspect refers to the promotion of a new extended version of relational database technology under the name object relational database management system (ORDBMS) (Wang, ND).

ORDBMS emerged as a way of enhancing object-oriented features in relational database management system (RDBMS) extending traditional RDBMS with object-oriented features (Elmasri & Navathe, 2011). As an evolutionary technology, ORDBMS allows users to take advantage of reuse features in object-oriented technology, to map objects into relations, and to maintain a consistent data structure in the existing RDBMS (Wang, ND). According to Paul Brown (2002), developers who are using ORDBMS get the most benefit from this technology when taking a more "holistic" approach to database analysis and design than is typical with RDBMS technology. He furthermore states that, the principal goal of ORDBMS technology is to enable developers to avoid complications, in turn, create smarter databases.

The success of RDBMS cannot be denied, but developers experienced difficulty when confronted with the kinds of "complex data" found in advanced application areas such as

hardware and software design, science and medicine, mechanical and electrical engineering. To meet the challenges, Oracle, IBM and Microsoft have moved to incorporate object-oriented database features into their RDBMS under the name of ORDBMS. The major database vendors presently support object-relational data model - a data model that combines features of the object-oriented model and relational model (Silberschatz & Sudarshan, 2009).

Complex data creations in most SQL ORDBMSs are based on preliminary schema definition via the user-defined type (UDT). The table remains the clearest form for the representation of complex data in any object of the RDBMS (Savushkin, 2003). This is the most important issue in relational database development. Moreover, Wang (ND) mentioned that normalization problems, speed up query processing, call stored compiled functions defined on the server in programming, and reuse user-defined data objects are some of the problems where ORDBMS is appropriate.

The necessities of a typical academic institution's functional environment are the specific institutional requirements, and the presence of complex data in an academic information system (AIS). However, the current poor and complex implementation of RDBMS to manage complex data in AIS poses a great challenge in the development of the AIS. The emergence of ORDBMS and ongoing support of open-source community in ORDBMS hav provided an opportunity to exploit such technologies in the development of the AIS.

In this study, complex data in the AIS are illustrated based on its value and structure. These are presented in a record with nested columns, record with nested rows, or record with nested columns and rows. The study was conducted and fucosed on the utilization of ORDBMS technology to manage complex data in the AIS. The AIS database design and

development used an open source database designer and tool for PostgreSQL. The researcher used the Lazarus 0.9.30 and ZeosLib, and Windows 7 Ultimate operating system as the environment to host the PostgreSQL 9.0.

1.2 Technology Application Context

The AIS plays a crucial part in an academic institution's information management and retrieval. It will serve as a tool for academic managers to effectively manage the academic institution. AIS provides everyone in the academic community an access to information and better interaction between students, teachers and the management (Sastry, ND).

Managing complex data in an academic institution like Southern Christian College (SCC) is a challenging task. Every school year voluminous and diverse data are added to the academic record's vault from new, transferees, returning and continuing students during the admission and enrollment. In the past seventeen years, an average of 2000 diverse data are individually stored, processed, updated and retrieved from the record's vault.

SCC has been adopting the information system to improve and automate manual processes. As evidenced, the finance, registrar, and library have implemented academic systems to support their day-to-day activities and transactions. However, a disparate system like this has challenges toward its stakeholders. According to Steenkamp and Basal (ND), the concerns of all stakeholders should be addressed in the form of an integrated enterprise architecture, which can result in a cost - effective, adaptable and scalable solution. Accessing information in timely fashion from different offices has always been an issue. Thus developing AIS for SCC that integrate disparate systems and at the same time serve as venue for interaction across students, teachers, and management is necessary. The researcher

found a great need for an easy, efficient and extensive technology that serves as a foundation of SCC's AIS providing academic administration to various academic resources in the institution for its stakeholders while maintaining good interaction between students, teachers, and management.

However, for SCC's AIS to be capable of providing timely information that is fresh, certain, reliable, relevant and manipulative of all levels of decision-making, there is a need for an intensive system analysis and design task. In order to integrate disparate systems it is necessary to build a centralized repository of data using use a sophisticated DBMS that effectively manages information management retrieval. However it requires a higher cost in its development and software. The need of SCC to develop the AIS could be answered by developing it and following the ANSI's three tier model and using an open source ORDBMS. Open source technologies provide a platform on which to build custom solutions and they are free to download and use (Garger, 2010).

The study focused on student administration especially on the bill assessment and cashiering that is also one of the areas suggested by Krishnaveni and Meenakumari (2010). The selection of these areas was motivated by the researcher's actual observation of students when paying their accountabilities during enrollment and examinations.

The design and analysis of SCC's AIS utilized the PostgreSQL 9.0, Druid III Database Manager, and SQL Manager Lite for Postgresql, and its application development utilized the Lazarus 0.9.30 and ZeosLib. The AIS implemented the ORDBMS features of PostgreSQL to effectively manage complex data.

Generally, SCC's AIS application users would gain access to the AIS by connecting to the database server via data access layer. Once connected, the application could access the

information through the ZeosLib to retrieve information using the views, and could also issue, create, read, update and delete (CRUD) operation. The view is enabled to accept CRUD operation where some of the business logics are implemented. This is done using the PostgreSQL view rule system. Other complex and sophisticated business logics that are not possible in the view rule system are implemented using the PostgreSQL trigger and functions.

1.3 Objective of the Study

Using an ORDBMS, the developer of the study aimed to develop the academic information system (AIS) of Southern Christian College (SCC) applying the object relational features of the PostgreSQL 9.0 to manage complex data. Following the ANSI's Three-Tiered Database Model (Brown, 2002), the developer aimed to analyze and design SCC's AIS by combining the aspects of both the relational and objects oriented analysis and design.

The developer implemented the PostgreSQL type system and used a user defined type and function mechanism, created and normalized the SCC's AIS schema and populated it with a production scale data in order to implement a set of workload to measure the performance using a database benchmark.

Specifically, the study aimed to:

1. Identity, review, select and use complex data type of PostgreSQL;
2. Plan, design and implement the rules based system in the AIS to enforce business rules and control access; and
3. Use Lazarus 0.9.30 and ZeosLib in the development of the AIS application.

1.4 Significance of the Study

The use of ORDBMS to develop AIS introduces new approaches such as enforcing the reuse of varying user-defined object types, providing the developer an integrated view of data and allowing multiple database applications to operate efficiently. Ultimately, it can result to improved operational efficiency for the IT department, increased programmers productivity, lower developmental efforts, decreased maintenance cost, reduced defect rate, and raise the applications' reliability. If multiple database applications use the same set of database objects in ORDBMS, a de facto standard for the database objects are created, and these objects can be extended, reused and integrated in the object relational database.

The methodology of the study provides additional working example in helping forerunners to promote the utilization of ORDBMS to traditional database practitioner as he/she remedies to the weaknesses of RDBMS and some normalization problems especially on complex data. The study utilized a collective approach in the development of the application using a hybrid database technology, and provided detailed and summarized information of solutions to problems to effectively manage complex data. This provided the developer a better approach in the design and development of the information system in an academic institution.

The implementation of an AIS provides students, teachers and management details and summarized information that will enable them to make appropriate decisions. It allows a better information management and retrieval for the academic community and enforces responsible interaction across students, teachers and management.

The ORDBMS features help developers to create a better and effective centralized repository of information that is timely, accurate, and relevant. Additionally, these will

enable them to manage complex data easily and efficiently. Using a free and open-source technology provided a better alternative to the management in terms of budgetary concerns and endless user supports. Moreover, using Lazarus 0.9.30 development system increases the productivity and efficiency of the developer in the application development

1.5 Scope and Limitations of the study

Part of the continued efforts of SCC is to seek and develop integrated AIS that automate the core if not all functions of the institution to provide better services to its stakeholders. The focus of the study was on the development student administration specifically on the development of the billing assessment and cashiering. The developer used the open source ORDBMS technology, and database designer and tools. Using the database designer and tools, the researcher designed the AIS specifying the different entities and its attributes and entity relationship diagrams.

For the design and analysis of the AIS the researcher utilized pgAdmin III, SQL Manager Lite for Postgresql and PostgreSQL 9.0 and for the development of the AIS application the researcher utilized the Lazarus 0.9.30 development systems and ZeosLib connection component libraries.

The study was limited to the complex data characteristics of the ORDBMS. Specifically, the use of PostgreSQL data type: composite type, user define type (UDT) or function (UDF) and trigger. In this study complex data were in the form of multi-valued attributes.

The study implemented the PostgreSQL rule based system. According to the PostgreSQL 9.0.4 Documentation (2010), the rule system (more precisely speaking, the

query rewrite rule system) is totally different from stored procedures and triggers. It modifies queries to take rules into consideration, and then passes the modified query to the query planner for planning and execution. It is very powerful, and can be used for many things such as query language procedures, views, and versions.

The PostgreSQL sever is configured in a Windows based operating system, and the users of the application are using Windows 7 operating system.

1.6 Definition of terms

Academic Information System (AIS) –the database for an academic institution that provides the ability to store and organize a variety of data.

Academic Institution –an educational institution dedicated to education and research which grants academic degrees.

American National Standards Institute (ANSI) – a private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems, and personnel in the United States.

Complex Data –the representation of data in a table. These are usually composed of many data type that represent the higher objects and synonymous to composite type.

CRUD –an acronym for create, read, update and delete, the basic functions of a computer database.

Data Definition Language (DDL) – the formal language for describing the data or information structures in any schema.

Data Manipulation Language (DML) – the family of computer languages used by database users to insert, delete and update data in a database.

Database – the system intended to organize, store, and retrieve large amounts of data easily.

It consists of an organized collection of data for one or more uses, typically in digital form.

Database Management System (DBMS) – the set of computer programs that controls the creation, maintenance, and the use of a database, allowing organizations to place control of database development in the hands of database administrators (DBAs) and other specialists.

Database System – the term that is typically used to encapsulate the constructs of a data model, DBMS and database.

Decision Support System (DSS) – the computer-based information system that supports business or organizational decision activities. DSSs serve the management, operations, and planning levels of an organization and help to make decisions, which may be rapidly changing and not easily specified in advance.

Enhanced/Extended Entity-Relationship (EER) model – a high-level or conceptual data model incorporating extensions to the original entity-relationship (ER) model, used in the design of databases. It was developed to reflect more precisely the properties and constraints that are found in more complex databases, such as in engineering design and manufacturing, telecommunications, complex software systems and geographic information systems.

Higher Education Institution (HEI) – a legal entity authorized by the government to implement degree programs and grant higher education degrees.

Information and Communication Technology (ICT) – a general term for all kinds of technologies which enable users to create, access and manipulate information. This

also refers to the combination of information technology and communications technology.

Information System (IS) – the combination of any information technology and people's activities using that technology to support operations, management, and decision-making. In a very broad sense, the term information system is frequently used to refer to the interaction between people, algorithmic processes, data and technology. In this sense, the term is used to refer not only to the information and communication technology (ICT) an organization uses, but also to the way in which people interact with this technology in support of business processes.

Information Technology (IT) – the acquisition, processing, storage and dissemination of vocal, pictorial, textual and numerical information by a microelectronics-based combination of computing and telecommunications.

Lazarus – is a free and open-source development system based on Free Pascal language which supports both Linux and Windows operating system.

Object Oriented Database Management (OODBMS) – a database model in which information is represented in the form of objects as used in object-oriented programming.

Object-Oriented Analysis and Design (OOAD) – a software engineering approach that models a system as a group of interacting objects.

PostgreSQL – an ORDBMS and was released under an MIT-style license and is thus a free and open source software.

Relational Database Management System (RDBMS) – a DBMS that is based on the relational model as introduced by E. F. Codd.

Relational Database Model – the declarative method for specifying data and queries: users directly state what information the database contains and what information they want from it, and let the database management system software take care of describing data structures for storing the data and retrieval procedures for answering queries.

Technology – the usage and knowledge of tools, techniques, crafts, systems or methods of organization in order to solve a problem or create an artistic perspective.

Unified Modeling Language (UML) – a standardized general-purpose modeling language in the field of object-oriented software engineering.

User-Define Type (UDT) - a way to combine object or data types into more complex one. In database programming, it is a way of defining a column that can represent multi-value attributes or a multi-column. Defining the UDT is usually the results of not being to map certain attribute definitions or the DBMS does not have a native data type that defines the attributes.

Zeos –also referred to as ZeosLib, are sets of connection libraries that provide interactivity between Lazarus database aware components and supported database.