COMPARATIVE ANALYSIS OF RELATIONAL AND OBJECT ORIENTED APPROACHES FOR GIS DATABASE

Yi Mon Win*

Abstract

Objects can be many things varying from an actual feature which can be extracted from a scene to more abstract entities which are associated with those features. There are a variety of database structures which can be used to store data about spatial features. These include RDBMS (Relational Database Management Systems), OODBMS (Object Oriented Database Management Systems) and ORDBMS (Object Relational Database Management Systems). All of these have retrieval systems based on SQL (Structured Query Language) and OQL (Object Query Language). The aim of this research is to compare the storage structure, retrieving data of RDBMS, ORDBMS and OODBMS storing the GIS (Geographic Information System) data of some Yangon Region's townships. This research presents a study that investigates the current scope deployment of an effective and efficient geographical information system (GIS) based approach to the representation, organization and access of these databases by Yangon Region information.

Keywords: spatial analysis, RDBMS, OODBMS, ORDBMS, SQL, GIS

Introduction

RDBMS (Relational Database Management System) and OODBMS (Object Oriented Database Management System) are both DBMSs (Database Management Systems) they differ in the model and use to represent data. OODBMSs use object-oriented model while the RDBMSs use the relational model. Both of them have their own advantages and drawbacks. OODBMS can store/ access complex data more efficiently than RDBMS. But learning OODBMS can be complex due to the object-oriented technology, compared to learning RDBMS. Therefore, choosing one over the other is dependent on the type and complexity of data that needs to be stored/ managed.

An Object-Oriented Database Management System (OODBMS), sometimes referred as Object Database Management System (ODMS) is a

*. Dr, Associate Professor and Head of Department, Department of Computer Studies, Dagon University

Database Management System (DBMS) that supports modeling and creation of data as objects. OODBMS provides support for object classes, class property and method inheritance by sub classes and their objects. A Relational Database Management System is also a DBMS but, that is based on the relational model. Most popular DBMSs currently in use are RDMSs.

Databases are traditionally used in business and administrative applications. In this research, it is discussed how these new relational databases and object oriented database can be used to solve the problems posed by spatial data management and compare database design methodologies for developing efficient schema with a spatial dimension using the GIS data as a basis. GIS considers spatial objects which can be defined in space as points, lines or areas. GIS can serve users well in its areas.

Relational Data Model for GIS data of Yangon Region

In the relational data model, information is organized in relations (two-dimensional tables). Each relation contains a set of tuples (records). Each tuple contain a number of fields. A field may contain a simple value (fixed or variable size) from some domain (e.g. integer, real, text, etc.). All of this is accomplished in the Relational DBMS through well defined terms like relation, tuple, domain, and database in Figure (1).

Township Table

Township ID	**Township Name**	**Township Map Url**
1	Ahlone	C:\Yangon Ward Area\Ahlone.shp
2	Bahan	C:\Yangon Ward Area\Bahan.shp

Township Ward Coordinate Table

TownshipDetailID	XCoordinate	Ycoordinate
1	194380.172	1857102.75
2	193364.219	1857881.75

Township Detail Table

Township DetailID	**Township**	**Population**	**Density**	**Area (Acre)**	**…**
1	Ahlone	55482	83.42	665.10	
2	Bahan	96732	53.62	1804.00	

Figure 1. Example of a Relational Data Model

ORDB (Object Relational Database) Enhanced Table Structures

An OR database consists of group of tables made up of rows. All rows in a table are structurally identical in that they all consist of a fixed number of values of specific *data types* stored in columns that are named as part of the table's definition. The most important distinction between relational tables and object-relational database tables is the way that ORDBMS columns are not limited to a standardized set of data types. Figure (2) illustrates what an object-relational table looks like.

The first thing to note about this table is the way in which its column headings consist of both a name and a data type. Second, note how several columns have internal structure. In a SQL Server DBMS, such structure would be broken up into several separate columns, and operations over a data value such as Township Name would need to list other component column in figure(3). Third, this table contains several instances of unconventional data types. X, Y Coordinate is a geographic point, which is a latitude/longitude pair that describes a position on the globe, which is a kind of Binary Large Object (BLOB) in Table (1).

Township Table

Township ID	Township Name	Township Map Url
1	Ahlone	C:\Yangon Ward Area\Ahlone.shp
2	Bahan	C:\Yangon Ward Area\Bahan.shp

Township Detail Table

Township Detail ID	Township ID	Township	Population	Density	Area (Acre)
1	1	Ahlone	55482	83.42	665.10
2	1	Bahan	96732	53.62	1804.00
. .			. .		
12	2	Kyimyindine	111514	78.38	1422.79
13	2	Mayangon	198113	31.65	6260.48

Figure 2. Inheritance in an Object-Relational Database

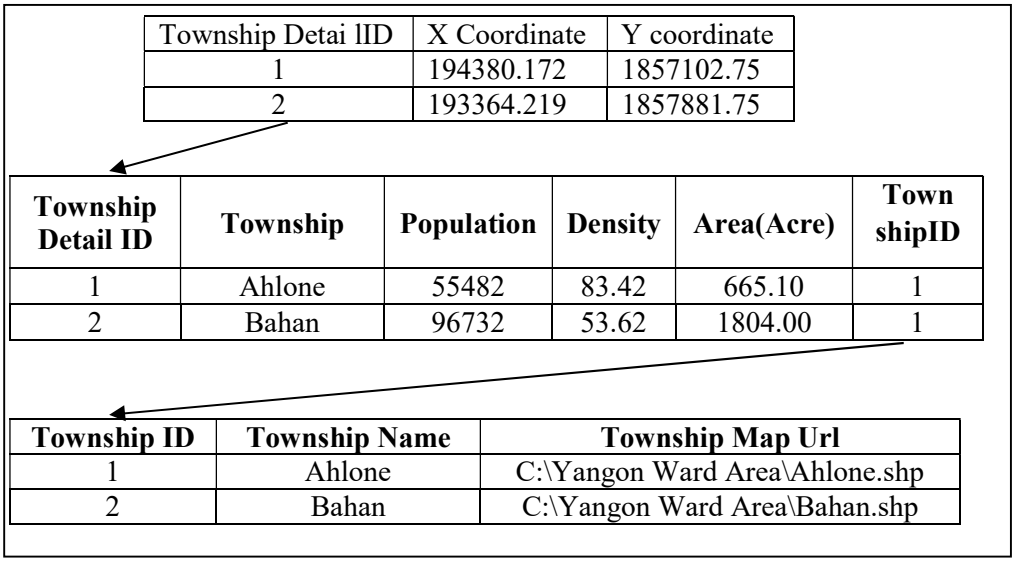

Figure 3. Object Relational Data Model

Table 1. Structure and Data for Object-Relational Table

Township ID::Township ID	**Township Name:: Ward**	**Coordinate::X,Y**
1::1	Ahlone ::Thittaw	194380.172, 1857102.75
2::2	Bahan::NgarHtatGyi(West)	193364.219, 1857881.75

Object-Oriented Data Model for GIS Data of Yangon Region

In the object-oriented data model, information is organized in graphs of objects, where each object has a number of attributes. Attributes can be simple values, complex values (part objects), references to other objects, or methods. Objects are instances of classes, and classes are (possibly) related to each by means of inheritance. The inheritance mechanism supports generalization and specialization and offers many aspects of structured reuse of models. Inheritance also offers the mechanism for qualified polymorphism, since the resulting type system can allow for objects to be recognized as belonging to several different types, namely the types of all the classes in the inheritance hierarchy which lies on the path from the instantiating class to the root of the hierarchy.

Township Table

Township ID	Township Name	Township Map Url
1	Ahlone	C:\Yangon Ward Area\Ahlone.shp
2	Bahan	C:\Yangon Ward Area\Bahan.shp

Township Detail Table

Township DetailID	Township Ward	Population (Person)	Density	Area (Acre)	Township ID
1	Ahlone	55482	83.42	665.10	1
2	Bahan	96732	53.62	1804.00	1
. .		. .			
13	Kyimyindine	111514	78.38	1422.79	2

Township Coordinate Table

Township Detail ID	X Coordinate	Y coordinate
1	194380.172	1857102.75
2	193364.219	1857881.75

Figure 4. Example of Object Oriented Table Structure for Yangon Region GIS Data

A method of an object is a specification (code) of functionality, typically manipulations of the other attributes in the same object, but may also invoke methods, associated with other objects, and thus change the state of these other objects. An important aspect of object-oriented data models is the notion of object identity: Objects has an identity (often called OID) which is totally independent of the state of the object Figure (4). That is, user can have two objects with exactly the same state (same values in all attributes), but they will still in the object system be treated as two distinct objects, with separate identities. Object modeling describes systems as built out of objects: programming abstractions that have identity, behavior, and state. Objects are an abstraction beyond abstract data types (ADTs), where data and variables are merged into a single unifying concept. As such object modeling includes many other concepts: abstraction, similarity, encapsulation, inheritance, modularity, and so on.

Experimental Results for Comparison of Databases

Experimental results are based on compare the relational, object-relational and object oriented databases by using GIS data of Yangon Region townships. Its results of comparison are comparing query processing time of these databases. Furthermore map query system compares the land use of Yangon Region. This result can apply for city planning for Yangon Region. Table (2) shows the result of query processing time and area (acre) for RDB and OODB by Yangon Region Townships.

The Comparison of Relational and Object Oriented Database by Townships

According to Table (2), the Figure (5) presents the query processing time of relational database and object oriented database on townships of Yangon Region. The

Table 2. Comparison of Query Processing Time (QPT) for RDB and OODB by Yangon Region Townships

No	Township Name	RDB (Milliseconds)	OODB (Milliseconds)	Area (Acre)	No of Records
1	Ahlone	425	214	665.60	10
2	Bahan	91	76	1804.00	22
3	Botathaung	90	64	588.80	10
4	Dagon	44	47	2880.00	4
5	Dagon Myothit (East)	60	58	6235.00	53
6	Dagon Myothit (North)	50	47	4568	27
7	Dagon Myothit Seikkan	55	45	4985.78	34
8	Dagon Myothit (South)	51	31	5096.00	36
9	Dala	57	28	2138.8	23
10	Dawbon	46	37	910.98	14
11	Hlaing Thar Yar	49	31	5699.00	28
12	Hlaing	46	29	3368	15
13	Insein	45	38	4356.23	20

No	Township Name	RDB (Milliseconds)	OODB (Milliseconds)	Area (Acre)	No of Records
14	Kamaryut	48	34	1363.2	9
15	Kyauktada	44	31	176	8
16	Kyeemyindine lower	45	40	654.23	10
17	Kyeemyindine Upper	45	40	768.56	11
18	Lanmadaw	48	32	248.9	11
19	Lathar	49	30	200.96	9
20	Mayangone	43	29	6260.48	9
21	Mingalar Taungnyut	47	34	377	19
22	Mingalardon	48	39	9875.65	33
23	North Okkalarpa	48	39	4983.35	18
24	Panbedan	44	30	187.53	12
25	Pazundaung	46	31	1056.85	9
26	Sanchaung	44	43	895.65	17
27	Seikkyi Kanaungto	46	36	1508.84	7
28	Shwepyithar	44	32	4465.32	16
29	South Okkalarpa	49	30	1900.58	13
30	Tarmwe	44	39	1184	20
31	Thakada	54	40	3215.47	18
32	Thingangyun	52	34	2841.74	38
33	Yankin	44	41	1242.89	15

system retrieves townships' attributes table from relational database and townships' map from object oriented database. The Figure (5) shows the comparison of the processing time of relational database and object oriented database. According to the result of this figure, Ahlone has more processing time than other townships because Ahlone is the first query of all townships. The Figure (6) shows the area of townships in Yangon Region. Mingalardon is the largest township and its processing time is 48 milliseconds for relational database and 39 milliseconds for object oriented database. Kyauktada Township is the smallest township in Yangon Region. Its query processing

time is 44 milliseconds for relational database and 31 milliseconds for object oriented database.

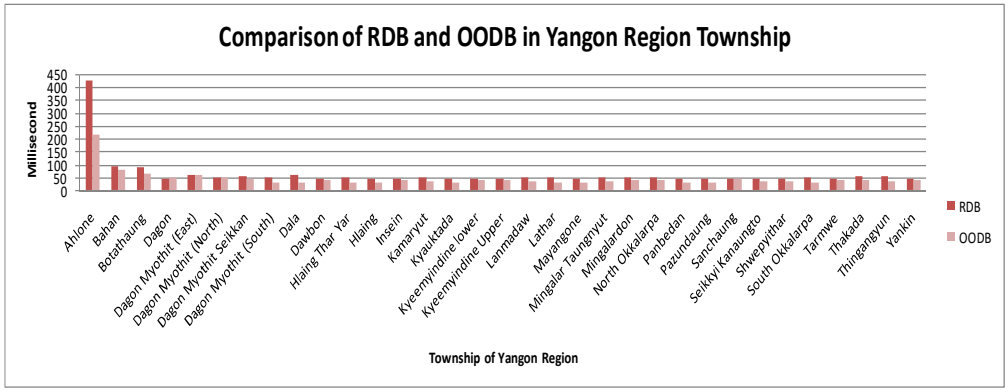

Figure 5. Comparison of Query Processing Time (QPT) for RDB and OODB by Yangon Region Townships Area

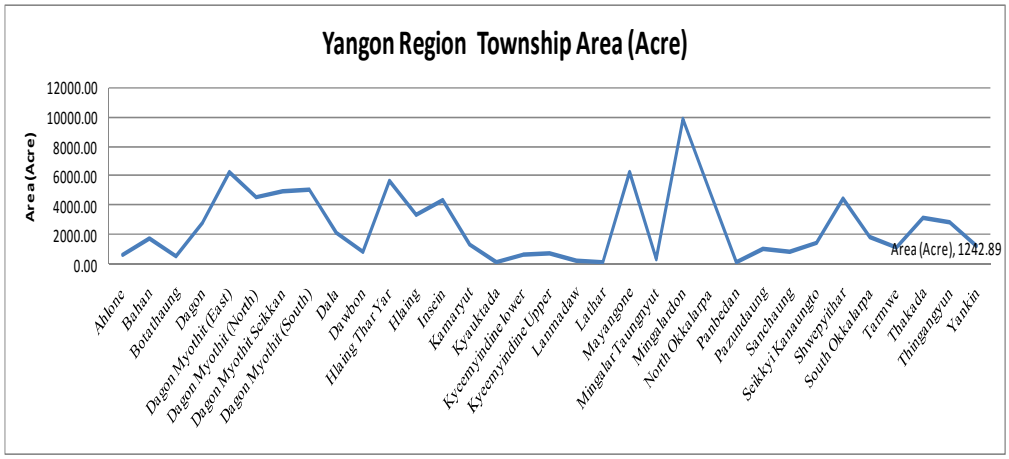

Figure 6. Comparison of Yangon Region Townships' Area

Table 3. Query Processing Time (QPT) for Comparison of ORDB and OODB by Mingalardon Township Regions

No	Region	ORDB (milliseconds)	OODB (milliseconds)	Area Meters	No of Records
1	Airport_Area	54	91.01	1032525.50	1
2	Antenna_mast_Symbol	69	92	1960.63	1
3	Benchmark_Symbol	84	153.01	2009.67	1
4	Builtup_Area	91.01	177.01	32619048.00	30
5	Bush_or_scrub Area	96.01	165.65	940709.60	6
6	Canal(Single).shp	90.01	147.01	283.87	2
7	Cemetery Area	106.01	155.01	350559.78	9
8	Cultivation Area	86	179.01	33381432.01	46
9	Dense_forest Area	87.01	159.01	2778427.75	3
10	Embankment_for_road	83	158.01	35590.91	1
11	Factory_Symbol	53	153.01	3802.18	1
12	Golf_course Area	82	176.01	2216476.75	1
13	Grass Area	61	162.01	5144866.50	13
14	Hotel_Symbol	63	162.01	12271.44	1
15	House_Building	90.01	154.01	443423.60	710
16	Intermediate_contour	73	151.01	4028148.75	63
17	Marsh_or_swamp Area	110.01	149.01	1239681.38	24
18	Monastery_Symbol	78	159.01	43115.71	26
19	Monument_Symbol	81	161.01	14076.13	7
20	Mosque_Symbol	87.01	157.01	1956.97	1
21	Open_or_barren_land_Area	89.01	153.01	17144768.00	46
22	Orchard_plantation Area	115.01	159.01	42347.00	1
23	Pagoda_or_stupa_Symbol	101.01	148.01	140256.84	38
24	Park Area	85	157.01	161752.13	2
25	Plantation Area	82	147.01	1061072.88	5
26	Police_station	89.01	153.01	352.98	2
27	Post_office	86	157.01	178.82	1
28	Public_building	110.01	167.01	1023528.94	677
29	Railway_station	101.01	151.01	15020.04	2
30	Relative_height Point	131.01	171.01	809.71	5
31	River Area	78	153.01	460.47	10
32	Scattered_trees Area	78	177.01	11575209.00	1
33	School Area	86	164.01	44105.99	6
34	Sparse_forest Area	90.01	153.01	9052389.00	22
35	Sport_field Area	86	148.01	62010.20	59
36	Supplementary_contour	113.01	172.01	15449770.11	5
38	Triangulationstat_Symbol	85	166.01	1352580.88	7
39	Vegitation_boundary	91.01	159.01	1352580.88	7
40	Cemetery Area	90.01	151.01	8423.03	1
41	Lake_or_pond	75	156.01	3535622.50	206

Comparison of Object Relational and Object Oriented Database by Townships

According to Table (3), the Figure (7) shows the query processing time of the maps of Mingalardon township's regions from both databases. Mingalardon is the largest township and has multiple regions in Yangon Region among 33 townships. The Figure (8) shows the regions of Mingalardon Township. Cultivation region is the largest region and its area is 33381432.01 square meters. The Figure (7) shows query processing time where object relation database is 86 milliseconds and object oriented database is 179 milliseconds. The smallest region is the post office region (178.82 square meters) and its query processing time of object relational database is 81 milliseconds and object oriented database is 157.01milliseconds.

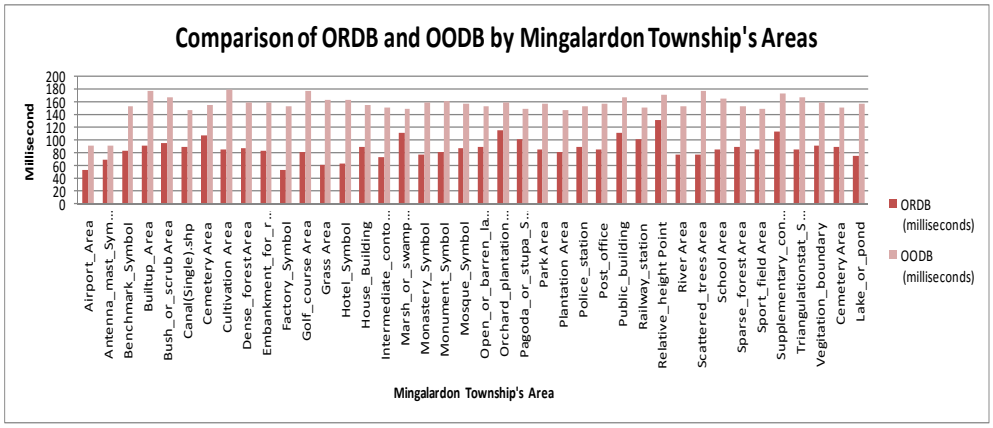

Figure 7. Comparison of QPT for ORDB and OODB by Mingalardon Township's Regions

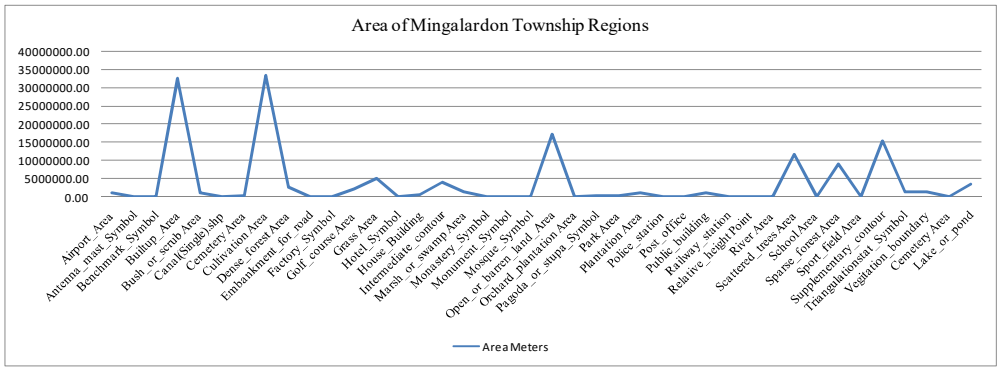

Figure 8. Area of Mingalardon Township's Regions

Conclusion

This research is comparing relational database, object relational database and object oriented database for GIS data of 33 townships in Yangon Region by using map query system. This map query system has been implemented by using Microsoft C#.Net 2010, MapWin GIS, MS SQL server 2010 for object relational database, db4o database for object oriented database on Intel® Dual Core CPU P6100 @ 2.00 GB main memory and Microsoft Window7 Ultimate. The experimental results are taken out from these computer specifications. It can vary depending on the enhancement of computer specifications. According to the result and discussion, it is generally concluded that the effective use of structured query language (SQL) on sql server 2010 for ORDB and query by example method on db4o database for OODB. It analyses the performance of the different query languages and same sizes of different databases.

This system is compared to the query processing time performance of RDB, ORDB and OODB. It is noticed that the experimental results in the figure and tables are counted from the outcome of the first time running on the query processing. All results are taken from the results of the first time query processing not from the result of the next times because same query processing are faster than the first time. This is because the database optimizer optimizes execution by using least recently use (LRU) algorithm for frequents the same query.

As a result of comparison of relational and object oriented database, the system retrieves the township attribute data tables from relational database that is more processing time than OODB and retrieves GIS township map from object oriented database that is less processing time than RDB because the traditional RDBMSs are not suitable for applications with complex data structures or new data types for large, unstructured objects, such as CAD/ CAM, Geographic information systems, multimedia databases, imaging and graphics.

According to comparison of object relation and object oriented database by townships, the Mingalardon township and Kyauktada township are compared by object relational and object oriented database. In the result of this comparion, Mingalardon is the biggest township and Kyauktada township

is the smallest township of Yangon Region. Mingalardon township owns 41 regions and Kyauktada owns 13 regions. Query processing time of ORDB is faster than OODB because of ORDB employs object-oriented concepts and capabilities on top of a conventional relational database management system (RDBMS). ORDBMSs are extensions of RDBMSs. The ORDBMS standard SQL: 1999 is a superset of the purely relational SQL-92 standard. Hence, all relational features are still available in ORDBMSs.

According to comparison of object relational and object oriented database by each region of townships, query processing time of object oriented database has more processing time than object relational database. First compared region is built up region; every townships of Yangon Region has built up region. Mingalardon has the largest built up area and Lathar owns smallest built up area. Second largest built up area is Shwe Pyi Thar and the second smallest is Panbedan township.

This research work performs well on the comparing relational database, object relational database and object oriented database for GIS data of 33 townships in Yangon Region. It also supports well for understanding how to build the databases and to retrieve from these database by using query languages. This research analyses on various types of databases and their query languages about structured query language in SQL server 2010 and object query language in db4o. In this research, Object Relational database is the more effective than other databases. Therefore one of the future works is to extend this research will build the data center for three dimensional urban planning of Yangon Region GIS data, and will retrieve these data by using oracle spatial query language. So, the query performance will view different urban land use pattern with three dimensions. Furthermore, the system can apply city planning of Yangon Region land use.

Acknowledgement

I wish to thank Dr Win Naing, Rector of Dagon University and Dr Aye Aye Tun and Dr Nu Nu Yee, Pro Rector of Dagon University for permitting the opportunity to present this paper. The author wishes to express her gratitude to professor (Retired) Dr Nwe Nwe Win, Head of Department of Computer Studies for her encouragement to carry out this presentation.

References

1. Agathoniki, T., Semantic optimization of OQL queries, University of Cambridge. 2002
2. Bergholt, L DTI et al, Database Management Systems: Relational, Object-Relational, and Object-Oriented Data Models, COT/4-02-V1.1.C. Feb 25,1998
3. Date, C.J, Foundation for Future Database Systems: The Third Manifesto,

   2nd edition, Addison-Wesley Professional, 2000
4. Department of Population, Ministry of Immigration and Population, May-2015, The 2014 Myanmar Population and Housing Census, The Union Report
5. Kiran Kumar, B.V.S.S.D et al., DO-GIS - a distributed and object oriented GIS, 2012
6. Worboys & Hearnshaw etal, Object-oriented Data Modelling for Spatial Databases, International Journal of Geographical Information Systems, Volume 4, Number 4. 1990