"Exploring the Scope of Data Warehouse and Business Intelligence Applications in Indian Higher Education Sector"

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Abstract: *The terms Data warehouse and Business Intelligence have become the part of business jargon dictionary nowadays. Rapidly changing business environment, growing cut-throat competition, dynamically changing business practice and generating data enormously are making business organisation difficult for addressing these issues. Data warehouse, Business Intelligence, Data Mining technologies are dramatically changing the business scenario and helping managers across all levels and domains to support strategic and tactical decision making. Many Indian companies are joining the ranks of data driven companies and exploiting these technologies in order to leverage their decision making process. In Indian Higher Education Sector, these days many universities and institutes are using various functional software or even ERP like integrated information systems. But, its percentage is very low and the use of technologies like data warehousing and business intelligence is almost null. This paper proposes the Data warehouse and Business Intelligence architecture for Higher Education System and explores the advantages by using such technologies.*

I.   Introduction

Data warehouse systems are valuable tools in today's dynamic, competitive and fast-evolving world. In the last several years many organisations have spent millions of dollars across the globe in order to build enterprise-wide data warehouses. Data warehouse is very promising technology and is being accepted rapidly across all domains of the industries. With the marketing perspective, many people think that in this cut-throat competition in every industry, data warehouse is the latest must-have marketing weapon in order to retain customers by learning more about them.

Data warehouse has been defined in various ways with various perspectives therefore there is no one concrete definition on it. But, as a rule, Data warehouse refers to a central repository that is maintained separately from operational database that is standard DBMS.

According to William H. Inmon, Data warehouse is subject-oriented, integrated, time-variant and non-volatile collection of data in support of management's decision making process. This short but comprehensive statement points out four major features of Data warehouse.

Subject-oriented

Data warehouse is organised around major subjects like customers, suppliers, sales, product etc. It doesn't focus on day-to-day transaction processing of organisation. It provides simple yet compact view of a particular subject.

Integrated

Data warehouse is built by using different heterogeneous data sources. These sources may be relational databases, flat files and online transaction records. They all own different format in terms of naming conventions, encoding structure and data format. Integration techniques ensure that all data must be consistent.

Time-variant

Data existing in the warehouse is collected over a period of time, generally past 5-10 years. Data stored in Data warehouse in stored explicitly or implicitly with the time element.

Non-volatile

Data warehouse is always physically separate data store, which is not frequently used for reading/writing data or transactions as used with application database. Since its purpose is just to store data, it does not require any transaction processing.

II. Business Intelligence

BI is a business management term that refers to the applications and technologies used to gather, provide access to, and analyze data and information about a company's operations. A data warehouse is a repository for a company's historical data. One of the foundational structures of business intelligence (BI) solution is the data warehouse(Poolet, 2007).

Business Intelligence technologies provide historical, current and predictive views of business operations such as reporting, performance management, benchmarking predictive analytics and many others. Therefore, it is apparent that Business Intelligence technologies needs data, which is complete, integrated and qualitative, for performing these operations in order to meet modern business decisions demands.

Tools like Online Analytical Processing tools and Data Mining of Business Intelligence rely on Data Warehouse technologies.

III. Related Work

Many educationists and researchers have imparted their contribution in this area. The paper by Manjunath et al (Manjunath T. N., 2012)describes the utility of data warehouse for educational institute along with designing and building the data warehouse for an educational institute by using open source tool freely available. In other study by DELL'AQUILA (DELL'AQUILA, 2007)summarizes the experience in designing and modelling an academic data warehouse.

Applications of Data warehouse are often considered as in large organisations and big business setups. But this technology can equally be useful in academics if rightly explored. Bassil Youssef (Bassil, 2012) proposed a data warehouse model for a typical university information system based on four stages of data warehouse.

Data warehouse systems over normal database systems are able to provide complex information by using historical and current data sources especially to the top management in order to make strategic decisions.

The paper by Shaweta(Shaweta, 2014) proposed a need of data warehouse for an educational institute and discussed various issues related to the development and maintenance of data warehouse for an educational institute. Primary objective of Data warehouse is to support in management decision-making irrespective of domain whether industry or education. An article by Wierschem David et al(Wierschem David, 2003) identified the opportunities associated with development of Data warehouse in academic environment.

The popularity of Data warehouse has grown up rapidly in recent years. Organisations that were using conventional systems like Transaction Processing Systems and Database Management Systems realised the importance of Data warehouse in major decision-making process across all management functions. AlMabhouh et al(AlaaEddin AlMabhouh, 2008)proposed a process model of Data warehouse for Higher Education which would help enhance decision-making capabilities in public universities.

The success of any organisation lies in the quality of decisions it holds. This is equally applied in education systems as well. In the wake of this, many universities and educational institutes are adopting newer trends in technology to improve in their decision-making skill in order to deliver a quality service and product. Data warehouse with Online Analytical Processing Tools (OLAP) is one of the best answers. A paper by Mirabedini et al(Shirin Mirabedini, 2014)summarises the scope of analytical databases, business intelligence and data warehouse in the educational environment.

IV. Data Warehouse Architecture

Data warehouse often adopts three-tier architecture. **Figure 1** depicts the data warehouse architecture.**Bottom tier** is a Data warehouse server. Back-end tools and utilities are used to feed data into the Data warehouse from operational databases and other data sources such as flat files, web data, and survey data from external agencies. This tier also contains metadata which defines the overall status of data being stored in the warehouse. A metadata contains *description of data warehouse structure, History of migrated data, status of data to be archived and data to be active, algorithms used for data summarization, system performance related data, data ownershipinformation* and many more.

Middle tier is the OLAP server which is based on multidimensional data model. This model helps data view in the form of *data cube*. Data cube allows data to be modelled and viewed in multiple dimensions known as *dimensions* and facts.OLAP server uses *Star, Snowflakes* and *Fact Constellations Schemas* for multidimensional data modelling. OLAP servers are implemented either by using Relational OLAP (ROLAP) or Multidimensional OLAP (MOLAP) or Hybrid model (Features of MOLAP and OLAP both).

Top tier consists of front-end tools (Client Layer). This layer contains *query* and *analysis tools, reporting tools* and/or *data mining tools*.

Major Application Areas

Data warehouse and business intelligence has become a keyword to success in the business world. Most of the businessand services industries are exploring the potential of using Data warehouse and Business

intelligence in their respective domain. Some of the major areas, where Data warehouse and Business Intelligence are being successfully adopted are as follows:

Threat Assessment:
Data warehouse and Business Intelligence are highly used in searching terror profile and threat assessment by the Government.

Retail:
Data are captured from POS (Point of Sale) system and warehouse the same for further uses in Market-Basket Analysis, decisions about In-Store placement, product pricing and Product movement and supply chain.

Financial Services:
In Financial Services sector, Data warehouse is used in Profitability Analysis, Risk Management, Fraud Detection and propensity analysis.

Telecommunication:
Tasks like Churn Analysis, Fraud Detection, Product packaging and Custom pricing, Network Feature Management, Call Detail Analysis, Customer Satisfaction are frequently conducted under Telecommunication sector.

Medical:
In Medical sector, these technologies are used for drug quality control, drug analysis, diagnosis, and epidemiology studies.

Marketing:
Data warehouse and Business Intelligence technologies are used for segmenting or clustering the market on customers' common attribute, identifying the prospects for direct marketing through mailing lists, advertisement and promotions on web and finding personalisation opportunities.

V.   Data Warehouse and Business Intelligence in Education: Why?

Making informed decision is no-doubt a "Demand of the Time". Besides other area, this statement is equally applied in education sector especially in Indian Higher Education. India's higher education sector is the third largest in the world. By 2014, the sector has 677 universities out of which 45 central universities, 318 state universities, 185 state private universities and 129 deemed universities.

The size of Indian education sector is observing a remarkable growth with the objectives to provide more customised courses, better reach to every bit and corner, better quality and performance.

In the modern world, where fast growth, accurate and informed decision-making, new and innovative products and services offering become the "Mool-Mantra" of being sustained and successful, many Indian universities across the country are rapidly adopting information technology tools   like Enterprise resource Planning (Singh, 2013), Social networking media like Facebook, twitter, youtube and others(Baruah, 2012)(CA Pallavi Gupta, 2013). These tools have created a deep impact on Indian Education System.

Information Technology in the form of internet, intranet, Enterprise Resource Planning, Management Information System, Social Networking systems and other administrative software is nowadays becoming inevitable part in the Indian Education sector. Due to this, data are increasing with a phenomenal speed. Managing such data, extracting information from the data and accurate and informed decision-making is becoming a challenging task. This requires more complex information technology tools to extract more sophisticated information. Tools like Data warehousing and Business Intelligence are the answers for such challenges. These tools are rapidly being accepted in the corporate world being aware of its importance. Companies like Aditya Birla, Reliance, CEAT, Pidilite, Ranbaxy, HDFC, Maruti Suzuki, Hero are the few examples who are using business Intelligence solutions to optimize operations, get informed decisions to make strategic plans.

However, Education sector in other countries, today is gradually adopting the integrated data warehousing and business intelligence tools in order to gain enterprise-wide overviews and management dashboards (Joseph V. L., 2014). But, unfortunately the pace of adopting such promising tools in Indian Education sector is a slow.

VI.   Data Warehouse And Business Intelligence In Education Sector: Architecture

Major feed for the educational data warehouse as shown in **Figure 2**exists in various documents such as students records, number of courses institute/university offers, industrial visits and events held record, faculty

records, Institute/university ranking, accreditation, affiliation records, records of facility such as buildings, computer labs and other various assets, staff records, students' performance records, placement records and accounts related records. These all records exist either in the form of some local database or in excel sheet or in the physical form(hard copy).Apart from these regular standard sources of data, these days education sector is also witnessing a great influence of Social Media and internet. Facebook, LinkedIn, Naukri.com,Shiksha.com and other education network websites are few examples that are generating loads of data in terms of awareness, new job profiles, institute/university ranking, new courses, sentiments of people towards a particular course/institute/university and many more. These websites are impacting the current education system to a great extent.Integration of data from these heterogeneous sources in the data warehouse is a real challenge. Like businessdata warehouse, educational data warehouse is also designed and developed according to the requirements of users of a university/institute.

Data warehouse for education can be developed either as an enterprise wide physical warehouse or data mart or virtual warehouse. Data warehouse is created by locating resources and exploring the requirements of users across the university/institute. The next step is to use back end tool (ETL) to extract data from these heterogeneous sources as depicted in the *diagram 1*, clean it and load into warehouse after transforming into common format. Now this one format fully integrated data are ready for the further use.

VII. Business Intelligence Tools: An Important And Must Have Component

Just like corporate sector, education sector have a great need for "Business Intelligence" these days especially in India, where minimizing the Industry–Academia gap and meeting the industry demand is a biggest challenge in order to produce industry-ready students' brigade. Beside this, the tool can be used to enhance the universities/institutes' competitive advantage and help achieve the goals on the basis of factual data from all across the data resources.

Business Intelligence tools in the form of OLAP servers and Data Mining (Top three layers in **Figure 2**) will access data from the data warehouse and convert it into meaningful reports. The data will be presented in either reports format or graphs as analysis or as dashboards according to the need of academic users across the hierarchy.

Apart from regular standard queries and reports, Business Intelligence tools can also provide answers for many complicated and difficult questions of strategic value based on the facts collected in data warehouse.

Business Intelligence can help management determining which students should get admitted, what special training required students of a particular course, How to improve admission rate, what special skillsets corporates require, how to improve curriculum to meet industry demand, what can be the other location to expand, what new courses to start, what courses can be started as e-education, which area of the country has more demand for e-courses (Joseph L. V., 2014). Many other such critical queries can be addressed by Data warehouse ad Business Intelligence tools and can help education management of universities/institutes to take more informed decisions.

VIII. Conclusion

Data warehouse and Business Intelligence create a platform for analysing data and present it in the form of information in various waysviz interactive reports, graphs and dashboards. The information provided is actionable and can help education sector particularly universities and institutes to have more informed decisions. This technology, especially for Indian Higher Education Sector, can be proven as "Magic Stick". This will completely change the face of contemporary education system and be able to gain competitive advantage.

References

[1].   AlaaEddin AlMabhouh, A. R. (2008). A DATA WAREHOUSING MODEL FOR MALAYSIAN PUBLIC UNIVERSITIES' OPERATIONAL SYSTEMS. *International Conference on Science & Technology: Applications in Industry & Education.*

[2].   Baruah, D. T. (2012). Effectiveness of Social Media as a tool of communication and its potential for technology enabled connections: A micro-level study. *International Journal of Scientific and Research Publications, 2*(5).

[3].   Bassil, Y. (2012, December). A Data Warehouse Design for A Typical University Information System. *Journal of Computer Science & Research (JCSCR):*12-17.

[4].   CA Pallavi Gupta, B. S. (2013). Relationship between Social Media and Academic Performance in Distance Education. *Universal Journal of Educational Research*(3):185-190.

[5].   DELL'AQUILA, C. (2007). An Academic Data Warehouse. *World Scientific and Engineering Academy and Society (WSEAS) Stevens Point.*

[6].   Joseph, L. V. (2014). *Business intelligence has significant potential in Education*. Retrieved 1 12, 2016, from http://educationinsider.net: http://educationinsider.net/detail_news.php?id=1291

[7].   Joseph, V. L. (2014). *Business Intelligence has significant potential in Education*. Retrieved 02 05, 2015, from www.educationinsider.net: www.educationinsider.net/detail_news.php?id=1291

[8].   Manjunath T. N., R. S. (2012, August). Realistic Analysis of Data Warehousing and Data Mining. *International Journal of Machine Learning and Computing:*419-422.

[9].   Poolet, M. A. (2007, June). *Data Warehousing: The Foundation of BI*. Retrieved 01 11, 2016, from http://sqlmag.com: http://sqlmag.com/database-administration/data-warehousing-foundation-bi

[10]. Shaweta. (2014). Critical Need of the Data Warehouse for an Educational Institution and Its Challenges. *International Journal of Computer Science and Information Technologies (IJCSIT):*4556-4559.
[11]. Shirin Mirabedini, S. F. (2014). The Research on OLAP for Educational Data Analysis. *International Research Journal of Applied and Basic Sciences:*224-230.
[12]. Singh, P. (2013). *Impact of ERP in Indian Education System with Special reference to M.P. University.* Retrieved 02 05, 2015, from www.caal-inteduorg.com/ibsm2/proceeding/FP40-Preeti_Singh&Rajendra_Singh&Gaurav_S--Imapact_of_ERP_in_Indian.pdf
[13]. Wierschem David, M. J. (2003, November). What Academia can gain from building a Data Wareouse. *EDUCAUSE QUARTERLY*: 41-46.

Figures

Figure 1
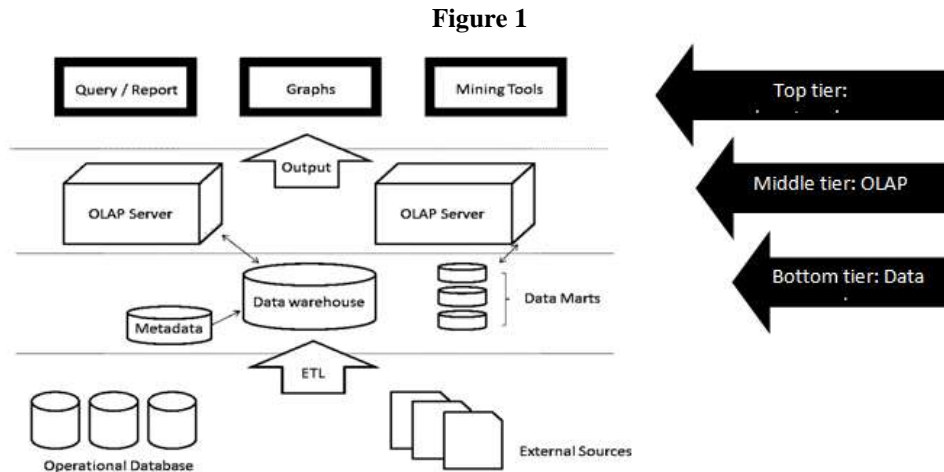
Source: Data Mining (Concepts and Techniques) by J. Han| M. Kamber| J. Pei

Figure 2
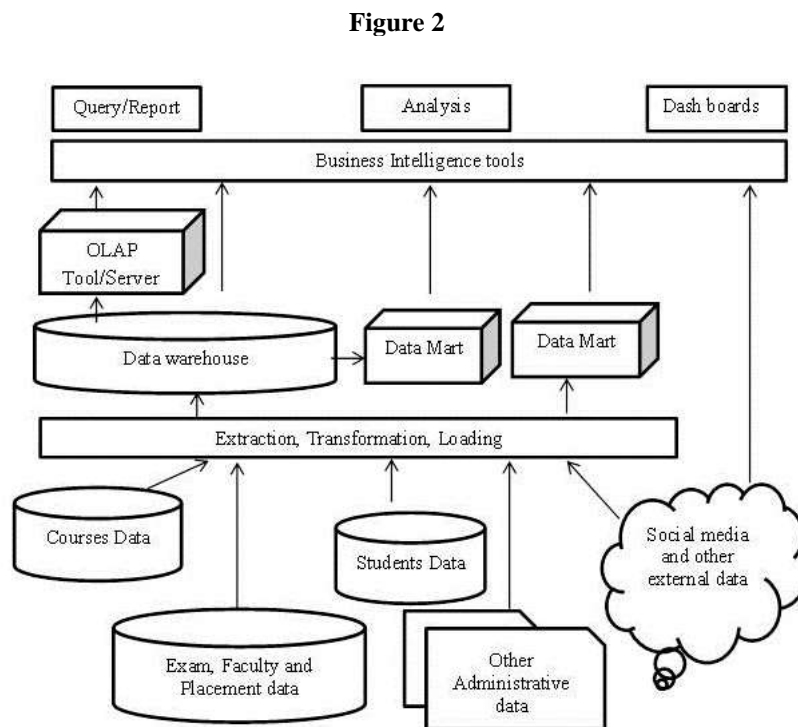
Data warehouse and Business Intelligence model for Indian Higher Education Sector