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A Study on Integrating Business Intelligence into E-Business

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Abstract— **With the high speed of development in the information technology area, many organizations use the Internet in their businesses instead of traditional "brick and mortar" physical stores. With the rapid spread of the Internet, people can access the web easily anywhere and anytime without barriers of time or space. However, a lot of data collected from global and local e-businesses is complex and unstructured and thus of limited use. Business intelligence tools could be used to extract accurate and useful information about future forecasts, business patterns, and business decision making. This paper provides a high level view of business intelligence and its benefits in e-business. Methods of adopting business intelligence are studied and examples of current market business intelligence tools are given in order to give a better idea of business intelligence usage in e-business.**

Keywords— **E-Business; Business Intelligence; Business Analytics; Data Warehouse**

I. INTRODUCTION TO E-BUSINESS AND BUSINESS INTELLIGENCE

Many organizations around the world have adopted e-business in order to increase their revenue and customer base, instead of relying on the traditional brick and mortar business model. Malaysia is one country that has invested significantly in its information communication technology (ICT) and has pooled its resources to deal with the digital world. According to its 8th National Plan, there is 4.7% annual growth in ICT investment spending in Malaysia [1]. With the encouragement of government and infrastructure components such as high speed internet, many organizations have transformed themselves to e-businesses. Based on an International Data Corporation (IDC) survey, overall e-business in Malaysia grew to US$29.3 billion in 2009 [2].

E-business encompasses business processes along the whole value chain, beginning with the supply chain and ending with customers, by using computers, network communication technologies and information technologies (ICT). However, due to the masses of information stored in their huge data pools, companies need high-quality Business Intelligence to enable their top management to efficiently and effectively analyze the enterprise e-business data so they can make accurate decisions.

Business Intelligence combines architectures, databases, analytical tools, applications, and methodologies to enhance business operations [3]. Business Intelligence's major objective is to enable interactive access to and manipulation of data, and to give business managers and business analysts the ability to conduct appropriate data analysis. It involves the transformation of the huge data pools collected from web activity into useful information, which is then used to make good decisions and finally leads to actions that can further business improvement.

Ye, Song, and Li [4] proposed a conceptual model of Business Intelligence in e-business as shown in Fig. 1. In this model, they defined e-business as implementation of any electronic transaction-related activities from Enterprise External Environment, including Customer Relationship Management (CRM), Enterprise Resource Planning (ERP), and Supply Chain Management (SCM). E-enterprises gather quantities of data from different sources such as trade flow, logistic flow, fund flow, workflow and even indirectly from people based on their electronic transactions and other related activities. After the data is gathered, business intelligence converts it into information and knowledge that can be used for enterprise decision-making. Technologies used include Extraction, Transformation and Load (ETL), data warehousing, data mining and data analysis. The results provide an overall view of e-business data flow patterns, while manipulation of the data transforms them into useful information. The technologies used in business intelligence are further described in the next section.

The main goal of this research is to study the integration of business intelligence tools into e-business for improving and enhancing decision making for business purposes. The objectives are:

- To examine the architecture of business intelligence that helps it to improve e-business capabilities
- To identify business intelligence tools currently in use

- To propose a method for integrating business intelligence into e-business

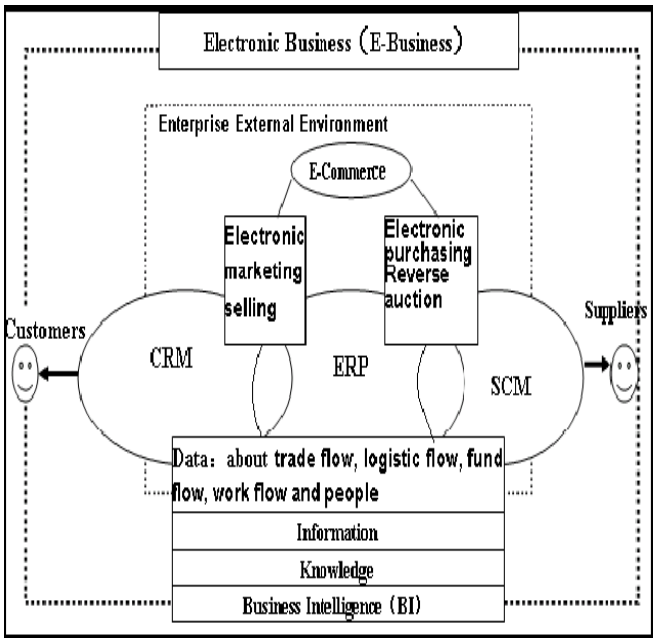

Fig.1 Conceptual Model of Business Intelligence in E-business [4]

II. Architecture of Business Intelligence

Business Intelligence has four components: a data warehouse and its source data; business analytics, a collection of tools for manipulating, mining, and analyzing the data; business performance management (BPM) tools for monitoring and analyzing performance; and a user interface [5]. Fig. 2 shows the high level architecture of business intelligence.

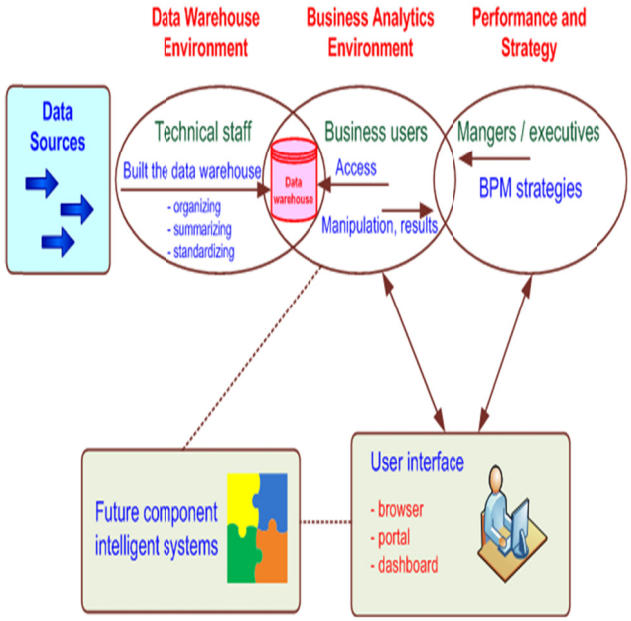

Fig. 2 High Level Architecture of Business Intelligence [5]

A. Data Warehouse

A data warehouse is a collection of data produced to support decision making. From an e-business point of view, data such as customer details are collected and stored inside a database or data warehouse. It serves as a repository of current and historical data comprising all the critical information from different departments of an organization [5]. Different techniques are used to produce structured information for analytical processing activities; these include online analytical processing (OLAP), data mining, querying, reporting, and other decision support applications.

A data warehouse must be subject-oriented; able to integrate different sources of data into a consistent format; time-variant, in that it contains historical data needed for detection of business trends, forecast, and deviations; scalable, so it can expand along with the business; and nonvolatile, so that the user cannot change or update the data stored there [5]. An e-business must have a data warehouse to keep all of its data together, thereby making it easy to find patterns of useful information that emerge from the pool. Fig. 3 shows a typical data warehouse framework and views.

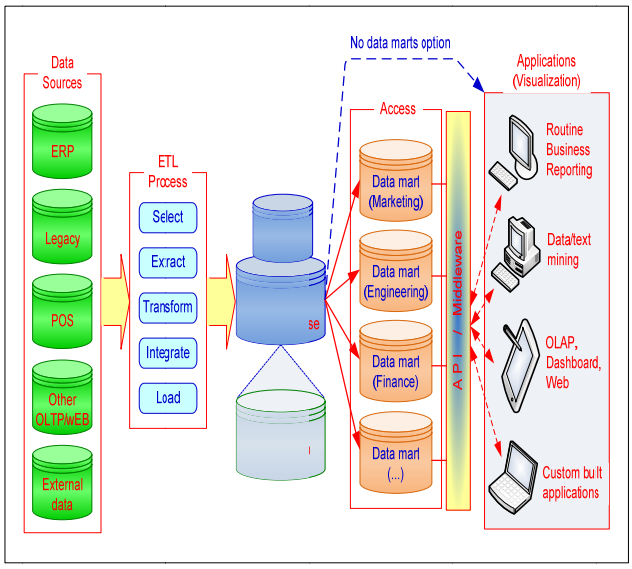

Fig. 3 Data Warehouse Framework and Views [5]

At the first stage, data are imported from web sources or other external/internal resources. Data are organized in a manner that is consistent with the organization's needs, then populated into the data warehouse. Next, data marts can be created and integrated into the enterprise data warehouse (EDW). After that, useful information can be visually represented through a web interface or other applications. One example of EDW is Teradata, the world's largest company solely focused on creating enterprise agility through database software, enterprise data warehousing, data warehouse appliances, and analytics, as shown in Fig. 4.

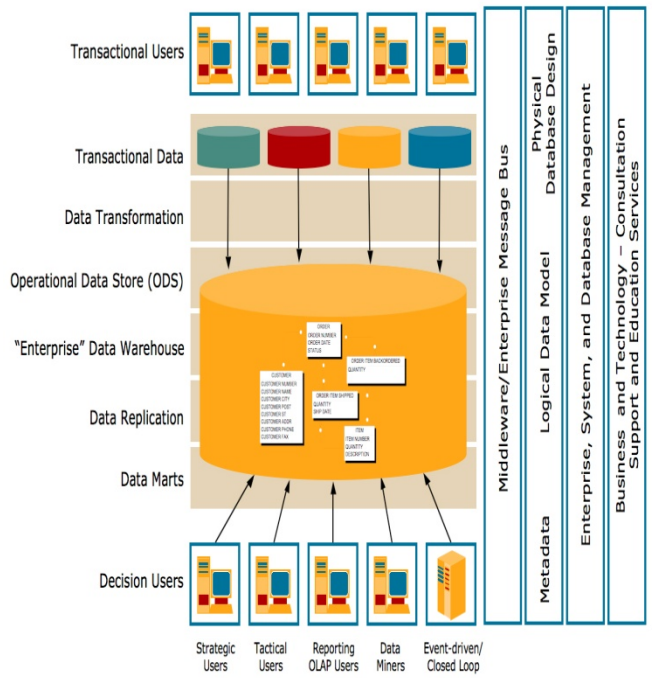

Fig. 4 Teradata's Enterprise Data Warehouse[6].

B. *Business Analytics*

Business Analytics, also known as analytical processing, is a broad category of applications and techniques for gathering, storing, analyzing, and providing access to data to help enterprise users make better business and strategic decisions [7]. Business Analytics can be grouped into three categories: information and knowledge discovery; decision support and intelligent systems; and visualization [7].

The information and knowledge discovery group includes Online Analytical Processing (OLAP), ad hoc queries and reports, data mining, text mining, web mining, and search engines. Many types of OLAP can be used in business intelligence, such as Multidimensional OLAP (MOLAP) which summarizes transactions into multidimensional views ahead of time; Relational OLAP (ROLAP), used on data that has a large number of attributes; Web OLAP (WOLAP), accessible through a web browser; and Desktop OLAP, which provides local multidimensional analysis and presentation of data downloaded to client machines from relational or multi-dimensional databases [7]. One common method of creating ad hoc queries is through the use of Structured Query Language (SQL). It is the query that allows a user to request information that is not available in periodic reports.

Data mining tools are used in business analytics to extract hidden, predictive information from databases by searching for patterns in large datasets. The most common type of mining used in e-business is web mining. Web mining is the discovery and analysis of interesting and useful information from the Web, through Web-based tools [7]. Web mining can be further subdivided into three categories: web content mining, for mining web page contents and search results; web structure mining, for finding link relationships and Web organization structures; and web usage mining, for general access pattern tracking and customized usage tracking. Shen and Wang [8] described how Business Intelligence uses web mining through five processes: user access paths, association rule discovery, sequential patterns of data, classification rule patterns and clustering rule patterns from the data pool [8].

The second category of Business Analytics is decision support and intelligent systems. This group includes group decision support (GDS), executive-end enterprise support, automated decision support, web analytics, management science and statistical analysis, data mining and predictive analysis, applied artificial intelligence, and business performance management (BPM) [7]. GSS is a combination of hardware and software that strengthens group work for decision making [6]. It supports parallel processing of information and idea generation from multiple participants to speed up the process of decision making.

The third category is visualization. This involves techniques such as visual analysis, scorecards, dashboards, and 3D virtual reality. Visualization can be used for interpretation of data and information that includes digital images, graphical user interfaces, graphs, and videos.

All three categories of Business Analytics share the same goal: to help top management make better decisions. To do this, top management needs to be able to comprehend vast quantities of data, such as total number of visitors or customer preferences and buying patterns, to perform accurate business prediction and forecasting.

C. *Business Performance Management*

A Business Performance Management (BPM) system is a real time system that alerts managers to potential opportunities, impending problems, and threats, and then empowers them to react through models and collaboration [5]. It is used to plan and forecast the business future, identify opportunities and problems, determine priorities and allocate resources accordingly, align top level strategic objectives and bottom level initiatives, and so on.

D. *User Interface*

One example of a user interface is a dashboard. A dashboard provides a visual view of corporate performance measures, trends, and exceptions. It presents graphs, charts and other visualization tools in a single screen to give management a better view of crucial information about the business.

III. Current Business Intelligence Tools

In this section, we will review one particular business intelligence tool currently used in e-businesses and study its application to the development of e-business. That tool is Microsoft IT Business Intelligence. Based on Dragoljub, Drahica, and Biljana [9], Microsoft Business Intelligence contains two components: Microsoft SQL Server and the Microsoft Office suite. Some of the business intelligence tools contained in SQL Server 2008 are SQL Server Database Engine, SQL Server Integration Services, SQL Server Analysis Services and SQL Server Reporting Services. Table 1 shows the functions of each of these SQL Server technologies.

TABLE I
FUNCTION OF EACH TECHNOLOGY INSIDE SQL SERVER [10].

Component	Description
SQL Database Server	A scalable, high-performance data storage engine for extremely large volumes of data. It is an ideal choice for consolidating business data from across the enterprise into a central data warehouse for analysis and reporting.
SQL Server Integration Services	Comprehensive platform for extract, transform, and load (ETL) operations, which enables the population and synchronization of a data warehouse with data from the disparate data sources that are used by business applications throughout the organization.
SQL Server Analysis Services	An analytical engine for Online Analytical Processing (OLAP) solutions, including business measure aggregation over multiple dimensions and key performance indicators (KPIs). Its data mining solutions use specialized algorithms to identify patterns, trends, and associations in business data.
SQL Server Reporting Services	An extensive reporting solution used to create, publish, and distribute detailed business reports both within and outside the enterprise.

An e-business website can be developed through Microsoft's Web Platform which includes Visual Web Developer, SQL Server Express, Silverlight Tools, Internet Information Services (IIS), and ASP.NET extensions under the dot net framework [11]. E-businesses can run smoothly via the website and the data is stored in the database via the SQL Server Database Engine. First, it acts as a central data warehouse that gathers all the data from different sources or different web sites together for analysis and reporting purposes. Next, for Extraction, Transformation and Load (ETL) purposes, SQL Server Integration Service (SSIS) is used to transform and load data into different formats and to send alerts to business organizations based on different business needs. SSIS has a graphical user interface which eases the developer's burden by allowing him to do ETL tasks without writing the code. The user just needs to drag the desired tool from the tool box and edit the settings on the interface. This saves time over having to write long SQL Scripts. While SSIS performs ETL functions, SQL Analysis Server (SSAS) performs Online Analytical Processing (OLAP) tasks to identify patterns, trends, and associations hidden in e-business data.

SQL Server Reporting Service (SSRS) provides all the functionalities necessary for business intelligence inside a full SQL Server package. It helps e-businesses gain access to near real-time, streaming reports which support effective decision-making.

The Microsoft Office suite of applications also supports e-business. Office includes Word (word processing), Access (database), and Excel (spreadsheets), all of which can be integrated with SQL Server. Office Web Components (OWC), on the other hand, can be implemented as ActiveX controls which can be plugged into web pages or any Windows Forms to allow access to spreadsheets, charts, pivot tables and other data source components that can make the business analytic process much more powerful [12].

In addition to Microsoft Office and Microsoft Business Intelligence, scheduling jobs and batching are also important in business processing. Accurate and near-real-time information can be pulled from a database or data warehouse by scheduling jobs and batching as "window services". In window services, when a specific date and/or time is reached, a window will open to run the scheduled batches. It then checks for and pulls the data within the specific duration, refreshing the data and creating the latest information for business organizations.

IV. INTEGRATING BUSINESS INTELLIGENCE TOOLS INTO E-BUSINESS

Before integrating Business Intelligence tools into e-business, the first step is to identify all the software and hardware used in the e-business. Software -- whether Microsoft Web Platform or PHP with MySQL database -- needs to be identified so that the integration of business intelligence tools will be time-effective. The web server architecture also needs to be determined, whether it is two tier, three tier or multi-tier. The operating system used in the computers must be compatible with the chosen Business Intelligence tools. Next, the scope of the e-business needs to be defined. Based on the scope and size of its e-business, an organization can select the business intelligence tools that are most cost-friendly and easiest to maintain. There are several business intelligence tools available depending on the size of the e-business, including Software as a Service (SaaS), Teradata, Sybase, Oracle, and Microsoft SQL Server. For small and medium size e-businesses, SaaS Business Intelligence tools would be a good choice because of its high-quality services, low cost, and minimal maintenance required. Different data warehousing vendors provide different packages to meet the Business Intelligence needs of different organizations.

For business analytics purposes, e-business organizations can choose from several business analytics tools. For example, the MicroStrategy software package includes unlimited data analysis, reports and dashboards, mobile BI, data mining, forecasting, and executive decision making and delivers actionable information to business users via e-mail, web, and mobile devices, including the iPhone, iPad, and BlackBerry [13]. MicroStrategy divides its products into five categories: enterprise reporting, cube analysis, ad hoc querying and analysis, statistical analysis and data mining, and report delivery and alerting. It is based on Relational OLAP and so provides both high scalability as well as high interactivity via its new MicroStrategy 9 [13].

From our study, it can be concluded that the benefits of integrating business intelligence tools into e-business are as below:

- Time and cost savings
- Access to real time information
- Help in decision making
- Improved strategies planning
- Satisfaction from users of business organization.

V. CONCLUSIONS

In this paper, we first introduced the concepts of e-business and business intelligence. Then, we discussed the function of business intelligence in e-business and laid out the four components of a Business Intelligence architecture: data warehouse, business analytics, business performance management (BPM), and user interface.

We further discussed these components in order to give a better view of the important role played by business intelligence enhancing business process and decision making. We outlined the functionalities of Microsoft Business Intelligence tools to enhance our understanding of what this suite of tools can do to improve e-business performance. Finally, based on the architecture of business intelligence tools, we proposed a method of integrating business intelligence into e-business based on the identification of software, hardware, operating system, scope and type of e-business operation. Given these parameters, top management can choose from multiple business intelligence software packages the one that best suits their organization's size and business patterns.

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