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## BUSINESS INTELLIGENCE : TECHNIQUES AND INTEGRATION WITH DATA MINING, KNOWLEDGE MANAGEMENT AND CLOUD

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### ABSTRACT

Business intelligence (BI) is an effective way of integrating enterprise applications in real time as it combines operational data with analytical tools to provide competitive intelligence for strategic decisions. To learn from the past and forecast the future, many companies are adopting Business Intelligence tools and systems. Today enterprises are facing the challenges of processing huge amounts of data and turning it into smart and timely decisions to deliver better products and services. In order to have industrial informatics at tips and deliver the useful information for decision-making, business intelligence is the prime solution for users to efficiently extract useful information from big data. It describes the insights on the role and requirement of real time BI by examining the business needs. The capabilities of BI include decision support, online analytical processing, statistical analysis, forecasting, and data mining. This paper focuses on the concepts, technology requirements of BI and its role in data mining, knowledge management and cloud computing.

**Keywords-** data mining, Business intelligence (BI), industrial informatics, competitive intelligence, cloud computing, big data, knowledge management

### I. INTRODUCTION

The exponential growth of unstructured formats, heterogeneous information, and poor data quality pose challenges in information management as they prevent businesses from utilizing information effectively. Business Intelligence (BI) and Data Warehousing (DW) address these issues by retrieving the hidden value from the set of heterogeneous information which finally facilitates in getting the informed (intelligent) decisions (Palak, 2015).

Business intelligence provides an integrated view of data that can be used to monitor, key performance indicators, identify hidden patterns in diagnosis and identify variations in cost factors (Mach, 2010). At one perspective BI relates to the capacity of human intelligence in business domain whereas at other relates to the value of information as it provides expertise, and knowledge in the management of organizational and individual business. . It is the application of human cognitive faculties and artificial intelligence technologies to the management and decision support in different business problems (Jayanthi, 2009). BI systems turn a company's raw data into usable and meaningful information that helps management in identifying important trends, analyze the consumer's or customer's behavior, and make intelligent business decisions quickly. Availability of data warehouse, better technologies for processing big data, data cleansing, and managing web architecture has given a better environment for BI than was available previously (Fatima, 2012). It provides a deeper insight about competitors, economic environment, business partners and day to day business operations for better strategic and tactical management.

Data Warehouse technologies, Extract, Transform, Load (ETL), OLAP reporting tools and BI tools have made possible to deal with huge data repositories in real time mode and convert it into useful information and knowledge upon which actions can be taken.

Business Intelligence provides data extraction, transformation and analysis through mathematical modeling to gain information and knowledge for complex decisions. BI is now integrated with diverse approaches-

- Data mining to provide both knowledge-driven and method-driven business intelligence
- Supply Chain for effective Business Activity Monitoring (BAM).
- Artificial intelligence through neural networks application in analyzing customer heterogeneity.



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- Business Process Management (BPM) through multidimensional models for simulation and data analysis.
- CRM for better customer profiling and measuring customer satisfaction.
- OLAP to enable better decision based interactive support systems.
- Knowledge management through various business intelligent products.
- Strategic Management for managing sustainability in organizations through systematic targeting, tracking, communicating and transforming relevant weak signs into actionable information on which strategic decision-making is based.
- Analytic Network Process (ANP) to assess and evaluate performance of BI systems.
- Decision Support System through web applications and business intelligence enterprise data integration tools.
- Enterprise Resource Planning (ERP)

There are many softwares that are used in Business Intelligence System research like Microsoft SQL Server 2005, SharePoint Server 2007, Microsoft business intelligence stack and BI products, which deliver BI solution with BI stack, and open source Business Intelligence (Fitriana et. al., 2011)

### II. LITREATURE REVIEW

The term “business intelligence” was originally coined by analysts of Gartner, Inc. in 1996. Since then it is defined as the application of a set of methodologies and technologies, such as Web Services, J2EE, XML, DOTNET, data warehouse, Data Mining, OLAP representation technologies, etc, to improve enterprise operation effectiveness and support management/decision to achieve competitive advantages.

Golfarelli et.al, (2004) defined BI that includes effective data warehouse and also a reactive component capable of monitoring the time-critical operational processes to allow tactical and operational decision-makers to tune their actions according to the company strategy.

Zeng et al. (2006) define BI as “The process of collection, treatment and diffusion of information that has an objective, the reduction of uncertainty in the making of all strategic decisions.” They categorized BI technology based on the method of information delivery; reporting, statistical analysis, ad-hoc analysis and predicative analysis. Stackowiak et al. (2007) define Business intelligence as the process of taking large amounts of data, analyzing that data, and presenting a high-level set of reports that condense the essence of that data into the basis of business actions, enabling management to make fundamental daily business decisions. (Tvrđiková, 2007) describes the basic characteristic for BI tool is that it is ability to collect data from heterogeneous source, to possess advance analytical methods, and the ability to support multi users demands.

BI includes several softwares for Extraction, Transformation and Loading (ETL), data warehousing, database query and reporting, (Berson et.al, 2002; Curt Hall, 1999) multidimensional/on-line analytical processing (OLAP) data analysis, data mining and visualization.

### III. BUSINESS INTELLIGENECE COMPONENTS / TECHNIQUES

**OLAP-** it provides summarized and multi-dimensional views of business data and is used for analysis, modeling, reporting, and planning for optimizing the business. It discovers trends and analyze critical factors through reporting software, data mining and data warehouses, information visualization and dash boarding, knowledge management mapping, decision support systems and forecasting, management information systems, document warehouses and document management, Software as a Service (SaaS), geographic information systems and Trend Analysis.

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**Data Marts and Data Warehouse-** A data mart as described by (Inmon, 1999) is a collection of subject areas organized for decision support based on the needs of a given department. The data warehouse supports the physical propagation of data by handling the numerous enterprise records for integration, cleansing, aggregation and query tasks. Similar to data warehouses, data marts contain operational data that helps business experts to strategize based on analyses of past trends and experiences. Very few organizations have a full-fledged enterprise data warehouse. This is due to the vast scope of effort towards consolidating the entire enterprise data. (Berson et.al, 2002)

**Corporate Performance Management (Portals, Scorecards, Dashboards-** capability to leverage information about an enterprise market place, customers, and operations to capitalize on the business opportunities.

**Model Visualization-** Making discovered knowledge easily understood using plots, charts, histograms, and other visual means.

**Data Visualization-** Enables multidimensional view of data stored as a matrix of numbers or as a set

**Time Series Analysis-** Reveals changes in user behaviour in-time, changes in sale patterns based on marketing promotions or historical data

**Statistical Analysis-** Provides distribution analysis, confidence intervals and other mathematical formulas for analyzing results of data mining.

**Advanced Analytics-** it is referred to as forecasting, data mining, or predictive analytics, which takes advantage of statistical analysis techniques to provide or predict certainty measures on facts. It is to be noted that despite major investments in enterprise resource planning (ERP) and customer relationship management (CRM), the firms need to support the analysis and application of information in order to make operational decisions.

**Classification, Clustering and outlier analysis-** determines to which class a data item belongs and partition it into classes, whereby items with similar characteristics are grouped together

**Predictive modeling, Association, correlation, causality analysis (Link Analysis)** – used for predicting value for a specific data item and identify relationships between attributes.

**Exploratory Data Analysis (EDA)-** Its goal is to identify patterns in an exploratory manner and then explore a data set without a strong dependence on assumptions or models.

### IV. APPLICATIONS OF BUSINESS INTELLIGENCE

- Analyze click-stream data to improve e-commerce strategies.
- Determine what combinations of service lines and products customers are likely to purchase and when.
- Detect and deter fraudulent behavior, such as data or act of credit or phone cards stolen.
- Determine with churn analysis and attrition and why customers leave for competitors and/or become the customers.
- Companies can identify their most profitable customers and the underlying reasons for those customers' loyalty, as well as identify future customers.



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- Analyze potential growth customer profitability and reduce risk exposure through more accurate financial credit scoring of their customers.
- Employees can also easily convert their business knowledge via the analytical intelligence to solve many business issues.

### Popular Bi Tools

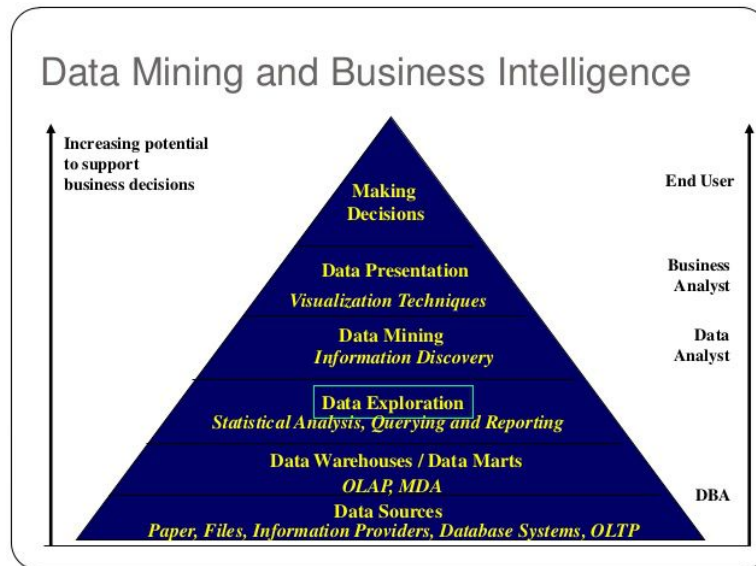
- SAP Business Objects Enterprise
- Oracle Enterprise BI Server
- Microsoft BI Platform
- IBM Cognos Series 8
- QlikView
- Oracle Hyperion System
- SAS Enterprise BI Server
- Actuate

## V. INTEGRATION OF BI WITH DATA MINING

BI methods include information retrieval, data mining, statistical analysis as well as data visualization. Data mining (DM) is used to search for patterns and correlations within a database of information. DM and BI work together to process data and analyze it in a way that eases the workload for the users and aids with the understanding of the materials/findings. BI will combine data analyse to help managers make operational, tactical, or strategic business decisions. Data mining can be used to aid the objectives of a business intelligence system. Patterns extraction and classification from customer data is very important for business support and decision making (Ugale, 2015). Angelina (2013) proposed a data mining methodology called business intelligence driven data mining which combines the method driven data mining and knowledge driven data mining and fills the gap between business intelligence knowledge and existing various data mining methods in e-Business.

Integration of BI and DM systems incorporates use of data mining into business technologies leading to effective decision making process. DM tools have scientific origin and demand heavy work for better results whereas BI has its origin in industry and so BI tools are more user friendly. DM Process involves following steps-

1. Creating a predictive model from a data sample
2. Training the model against the dataset and its known results.
3. Applying the predictive model to a new dataset with an unknown outcome.



*Figure 1 Data Mining Integration with BI (Source- Akannsha, 2012)*

### Applications of BI and DM Integration

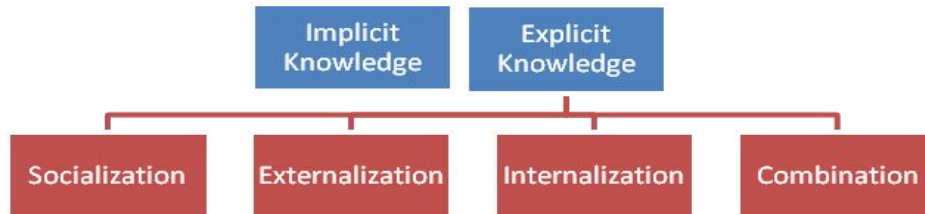
- Market basket analysis-using association rules
- Fraud detection in purchases-using sequence association model
- Instant credit scoring-using if-then rules
- Campaign management- using neural network model
- Online sales improvement-using historical sales and user ratings.

### Benefits of BI and DM Integration

- Business managers can view predictive reports in different dimensions and perspectives.
- Predictive reports and personalized messages can be sent to large population instantly.
- Ad-hoc reporting, pivoting and drilling helps in analysis to experts.
- Strict data security and privacy.

### Integration Of Bi With Knowledge Management

Knowledge Management (KM) whether tacit or explicit, plays a vital role in decision making. However, BI solutions are now adapted by almost all organizations to promote business, attract and retain customers, earn more profits, reduce recurring expenditures etc. which are overpowering than KM. Yet KM is a fast and efficient way to manage intellectual property and providing right information at right time from varied resources.

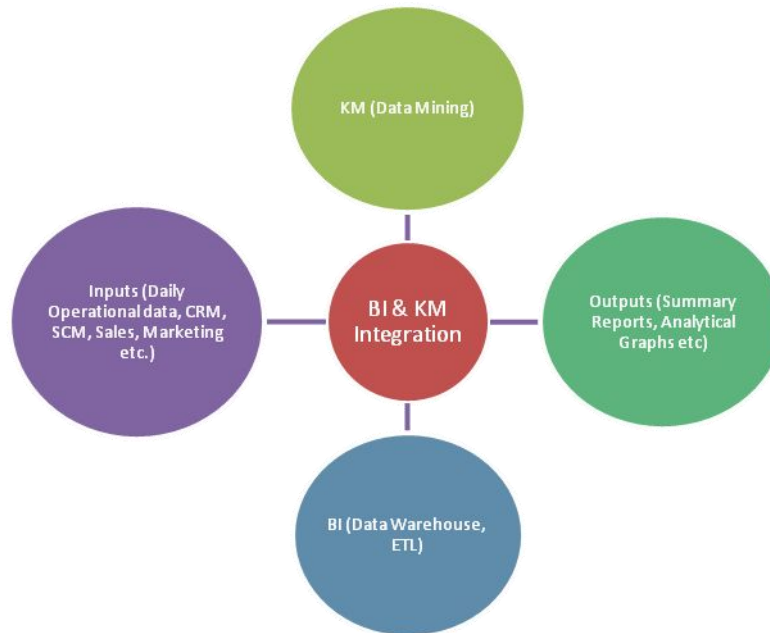


**Figure 2 Classification of Knowledge (Source-Nonaka SECI KM Model)**

BI along with KM helps in better scoping of the profit for achieving predefined organizational goals by adopting latest business technologies. BI and KM together increase efficiency and productivity of the organization (William Yeoh). They help organizations to enhance efficiency, innovate, import monitoring capabilities, increase productivity and competitive edge (Shehzad, 2013).

#### **Critical Success Factors of BI and KM Integration**

- Strategic and extensible technical framework.
- Business-user oriented change management.
- Sustainable data quality and governance framework.
- KM Organizational Leadership.
- Effective Strategy and IT Infrastructure.



*Figure 3 Model of BI and KM Integration*

### Integration Of Bi With Cloud Computing

Cloud computing has transformed a large part of IT industry and when it is integrated with Business Intelligence running in heterogeneous systems, complexity arises which has ultimately led to emergence of Business Intelligence Service Management (BISM) (Horakh et. al., 2008). However, not every service is suited from cloud because of its vague data confidentiality and fear of a vendor lock-in (Armbrust et al., 2010). Cloud is an infinite computing resource available on demand that enables convenient, ubiquitous and on-demand network access to vast pool of computing resources. Cloud enables cost savings through usage based pricing models, improves level of quality and increases agility (Hayes, 2008). But it also has lack of trust and security, legal issues, technological limits and fear of a vendor lock-in.

BI Service Management (BISM) improves manageability and flexibility of IT environment to support customer needs and business goals. It allocates technological and organizational elements of BI solutions to individual services (Van Haren Publishing, 2007). Cloud and BI can be integrated in following scenarios-

- Tool integration
- Add-on Functionality
- Solution Provision

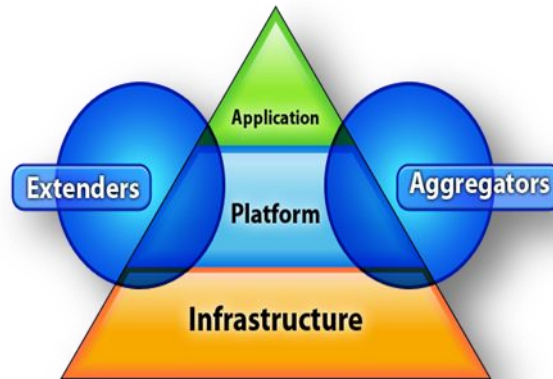


Figure 4 Hybrid Cloud Pyramid (Source <http://milinic.blogspot.in/>)

The complex structure of BI architecture raises the need of a more coherent perspective to evaluate the cloud suitability of a particular BI service (Ereth). Cloud technology is disrupting this digital age as it is rapidly growing and is being used with analytics because of its simple data entry process. BI helps management in timely and consistent business decisions as it minimizes data entry errors, improves customer service efforts, monitor employee performance. So integration of BI and cloud gives better access to more information with highest level of accuracy. Visual reports, dashboards and real time notifications are better representation of a situation to make managers work on spot. Gartner predicts that by 2020 a corporate “no cloud” policy will be the past and hybrid cloud will be the future.

## VI. CONCLUSION

Companies will have to rely more heavily on their business intelligence systems to stay ahead of trends and future events as now is the demand for real time or near real time Business Intelligence particularly in frontline operations. Moreover business information will become more democratized where end users from throughout the organization will be able to view information on their particular segment to see how it's performing. BI is an important tool for analyzing demographic and economic information, market conditions, future trends, changes in customer behavior and spending patterns and competitive intelligence. BI has gone considerable evolution and development over last years to evolve as an area of Decision Support System (DSS) that attracts business managers to grab more summarized and accurate information for effective decisions

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