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Business Intelligence and Data Warehousing Study of tools for transformation of raw data into business results

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Abstract: 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. This paper focuses on the concept of business intelligence and data warehousing (BIDW) systems and its usefulness in transformation of raw data into appropriate information. In the present paper we also focus on the recent major trends driving businesses' need for BIDW systems and the technology and infrastructure Sun, IBM, Microsoft, Oracle, SAP and other major vendors offer that empower organizations to build cost-effective BIDW solutions. This can be easily seen when we see that the big companies like Sun, IBM, Microsoft, Oracle, SAP and other major vendors offer cost-effective BIDW solutions. In addition, the paper highlights comparison between the tools available for data mining and BI approaches in helping organizations design and deploy BIDW solutions—by providing necessary information, proven designs, testing facilities, and the training, and services.

Keywords: Business Intelligence, heterogeneous information, data warehouse, BIDW solutions.

I. INTRODUCTION

The dynamism in business environment has made Business Intelligence (BI) systems almost necessary to an organization's success. BI systems turn a company's raw data into meaningful and usable information that helps management in identifying important trends, analyze the consumer's or customer's behavior, and make intelligent business decisions quickly. In the past, business intelligence systems have been used to address and understand management needs such as productivity and efficiency but now organizations are increasingly using BI to understand market trends, analyze customer behavior, and search for new opportunities. BI relies on Data Warehousing (a large data repository that enables a company to do decision making) and making cost-effective storing and managing of warehouse data. An effective data warehouse is always required for organizations to explore and extract the data required for information analysis in time to facilitate quick and effective decision-making.

Real-time availability of data has become increasingly critical in recent years because of reduction in decision-making cycle times. Hybrid competition, market pressures require businesses to make intelligent decisions based on their incoming business data quickly. Business Intelligence through data warehouse enables two major activities- the first is analysis of existing processes so as to improve current performance, reduce costs and increase output and the second activity is to track external market activities, competitors, dynamism in consumer preferences etc.

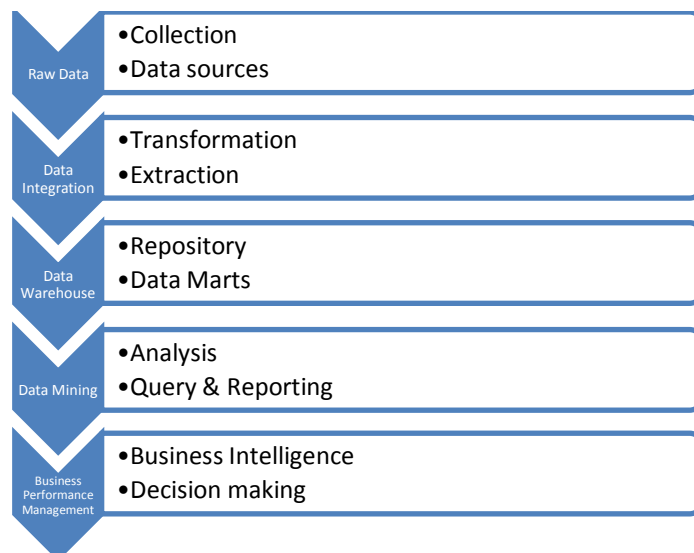


Fig 1: Overview of BIDW (Business Intelligence Data Warehouse)

II. STEPS IN BIDW

1. Use of On-line Transaction Processing (OLTP) System in an organization in order to provide storage, retrieval and updations of raw data into data marts or data warehouse that also includes data from external and legacy sources required for analysis.
2. Cleansing and Optimization of information i.e., removal of duplicate items so as to provide good and structured information for analysis and queries.
3. Usage of data mining and analytical tools so as to help businesses understand and devise new trends, hidden patterns and behavior of customers.
4. Application of new knowledge to knowledge management in order to enhance business performance, competitive advantage and relationships by making new and better strategies and decisions.

True BI, however, is the whole, integrated reporting + analysis + planning leading to Corporate Performance Management.

III. REQUIREMENT AND BIDW STEPS

Due to dynamism in business and customers needs, there is huge demand of accurate and timely evaluation of business intelligence. Some important factors are-

- Businesses have pressure to make rapid and accurate decisions in shorter span of time.
- New compliance and legislative regulations regarding data capture, storage, use and management.
- More stringent security and privacy of stored data to protect unauthorized access due to data access availability to multiple users simultaneously.
- Shift to information democracy as multiple people get diverse information in great detail on more devices.
- Mass scale customization of data so as to present news feeds, portals, recommendations etc. to different people in different ways
- Organizations need to store diverse data from multiple sources such as CRM & ERP systems in variety of formats like text, image, audio, video etc.

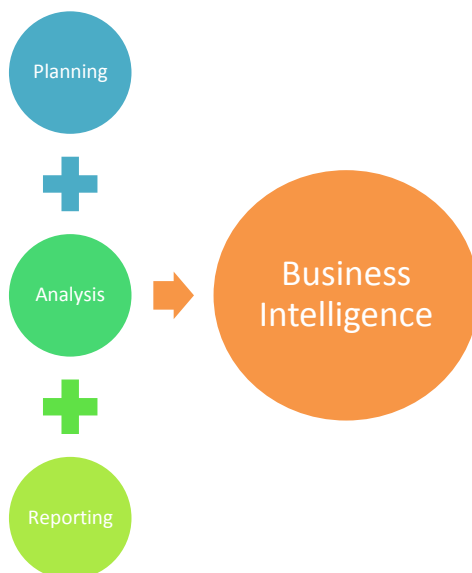


Fig 2: Functions of Business Intelligence

IV. CHALLENGES WITH IMPLEMENTATION OF BUSINESS INTELLIGENCE IN AN ENTERPRISE

- **Complexity-** Big companies have a very complex model for business intelligence as their underlying business systems and processes such as Enterprise Resource Planning (ERP) systems, Customer Relationship Management (CRM) systems, payroll, accounting systems etc. are also complex. This problem is however, not so prevalent in medium or small sized companies as they do not have multiple business lines, mergers and acquisitions and international business. Such companies use off-the-shelf software for their activities and hence have simple business intelligence tools and models.
- **Highly Expensive-** Since the business intelligence systems are that complicated, they incur a lot of expense in purchase. Big companies require massive and custom-built tools for business intelligence which incurs high cost in comparison to small companies which make use of software and packages already available in the market at much cheaper and fixed price. Since these prepackaged software and applications are sold in the market at fixed price, medium and small sized companies can evaluate its impact on their budget and then can go for their purchase and implementation.
- **Disorderly-** Managing a BI system in big companies is too problematic and generates disorders and disruptions in regular day to day working as a lot of time is wasted in designing and customizing the software and preparing infrastructure for complex BI software but for a mid size company, its not that disruptive. Since mid or small size companies rely on pre packaged BI software, no problem is encountered related to business requirements, dashboards, reports, data warehouse design, redesign etc. as the only work is to purchase and install.

Therefore, Core BI capabilities in any organization are analysis or OLAP, advanced data visualization, exploration and discovery, integration with Microsoft and other Office applications, dashboards, performance management, predictive analytics, reporting and querying, report and dashboard distribution capabilities, embedded BI, portal integration and thick and thin clients.

TABLE I
Industry specific drivers for BIDW (source- <http://www.sun.com>)

FINANCIAL SERVICES	TELECOMMUNICATION	RETAIL	GOVERNMENT
Customer Statements	Traffic Analysis	Loss Prevention	e- Government
Compliance Reporting	Churn Analysis	Customer Loyalty Programs	Homeland Security
Branch office Scorecards	Fraud Analysis	Store Operation Analysis	Information Distribution
Customer Profitability	Improving Response Times	Supply Chain Optimization	Citizen service
Portfolio Analysis	Product Affinity & Bundling	Collaborative Planning and Customization	Human capital Management
Customer acquisition			Enforcement & regulation

V. BUSINESS INTELLIGENCE SOFTWARE

Business intelligence software is designed with the primary goal of extracting important data from an organization's raw data so as to help a business make faster and more accurate decisions. The software typically integrates data from across the enterprise and provides end-users with self-service reporting and analysis. BI software uses a number of analytics features including statistics, data and text mining and predictive analytics to reveal patterns and turn information into insights.

A. Features of Sun's BIDW Infrastructure

- Compliance solutions and content management provide cost-effective information management
- High availability systems ensure business continuity
- Enhanced and sophisticated storage software and storage subsystems provide production data to be copied and moved for mining, analysis and query
- Industry-leading scalable servers, storage, and software help reduce complexity and cost through consolidation
- allows organizations to choose from a wide range of best-in-class platforms, applications and middleware making it easier to find the package that's right for their environment
- 24x7 availability of data
- enables BI solutions to be developed and deployed with minimal risk and cost.
- information is provided to multiple users from different locations using a variety of access methods--regardless of the demands and workloads on the system.
- ensure high performance and scalability.
- scalable 64-bit architecture for end-to-end compatibility and support servers from 1 to 100+ CPUs
- enables tiered storage architecture for tape optimization that scales to multi-petabyte sizes enabling effective data throughout
- Ultra SPARC IV processors provide nearly two times the scalability of single core chips, generating nearly double the compute density and thereby lowering total cost of ownership
- unique crossbar center plane technology provides high bandwidth for high performance, throughput and computing power
- Security tools that enables to meet business needs and protect data assets
- Consulting services for regular and proper security assessment and security management
- High-level security through multiple layers that helps in reducing the costs, complexity, and risks of deploying new technology.
- On-line maintenance, live system upgrades, remote monitoring of server and storage systems, auto-diagnosis and recovery
- redundant swappable components, data replication capability, cluster technology, physical and logical partitioning of storage resources and server and Solaris Resource Manager help in continuous and fast data access and better resource utilization.

Examples of tools provided by Sun for BIDW-

- ❖ **Sun StorEdge™ 9990 System-** provides the ultimate storage platform, scalability, capacity and connectivity allowing enterprises to consolidate massive amounts of data - up to 330 terabytes onto one single system.

- ❖ **Sun StorEdge™ 6920 System**- helps improve service levels and reduce costs through segmented distribution of storage resources and consolidated management of applications.
- ❖ **Sun StorEdge™ SAM-FS and QFS Software**- Sun's Storage Archive Manager software and QFS shared file system software enable enterprises to protect, manage and share data and to meet the access and performance requirements of its users.
- ❖ **Sun StorEdge™ 5000 NAS Family**- provides check pointing, file system journaling, clustering, fault-tolerant backend, remote mirroring (file replication), remote monitoring, and RAID arrays to deliver very high levels of performance and data in any open, file-based environment.
- ❖ **Sun StorEdge™ Tape Automation**- provides reliable, cost effective and efficient way for organizations to back up and protect enterprise data.
- ❖ **Sun StorEdge™ Enterprise Storage Manager Advanced Applications Software**- enables storage provisioning, SAN management, storage resource management.

B. Tools provided by IBM for BIDW

IBM Cognos and PureData System for analytics N200X is a scalable Business Intelligence solution that can be deployed either on web or on-premise. It provides companies the ability to mine from large amounts of raw data. The cost/benefit case for PureData System for Analytics N200X is that the distinctive capabilities of this platform map more closely to the long-term requirements of high-performance data warehousing than any competitor.

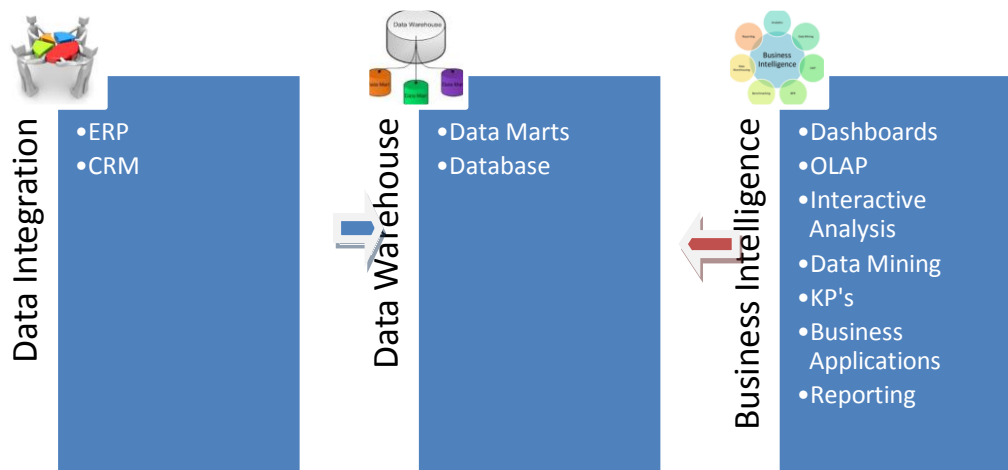


Fig 3: IBM Business Intelligence Structure

IBM provides business analytics solutions in the areas of Corporate performance management, planning and budgeting, Business Intelligence (BI), spreadsheets, data warehousing, reporting and querying software, Online analytical processing- DB2 OLAP. These are tools that extract, sort, summarize, and present selected data for example- **Query Management Facility (QMF)** and **Lotus Approach** which is a desktop relational DBMS. IBM Server implements a three-tier client/server architecture for performing complex multidimensional data analysis that includes Digital dashboards and Data mining tool Intelligent Miner Version 1 which runs on Windows NT, OS/400, UNIX and OS/390, and can process data stored in DB2 family databases or any relational database supported by DataJoiner, and flat files. Except for spreadsheets, these tools are sold as standalone tools, as components of software targeted to a specific industry, as components of ERP systems or packaged into data warehouse appliances.

C. BI Tools provided by Teardata

As more and more organizations depend on analytics for competitive advantage, Teardata helps to mobilize all of business intelligence (BI) to improve decision making at every level by pushing historical and detailed data and advanced analytics to front-line decision makers. Some examples are-

- Teradata Active Data Warehouse Private Cloud – it provides scalability, consistency, virtualized resources, elasticity, performance, and self-service business intelligence.
- Teradata Decision Experts- it rapidly converts ERP data into information that helps in taking critical decisions.
- Teradata Warehouse Miner- it identifies meaningful new data trends and patterns faster without data movement.
- Teradata Demand Chain Management- it helps retailers decrease inventory and increase sales with advanced forecasting.
- Teradata Value Analyzer- it improves profitability analytics with a behavioral-based, enterprise-wide view of value.

D. Oracle Business Intelligence Foundation Suite

It is a trendy and market-leading BI platform which provides the industry's best in class platform for dashboards, ad hoc query and analysis, mobile analytics, enterprise reporting, scorecards, predictive analytics, and multidimensional OLAP on an architecturally integrated business intelligence foundation. This helps organizations drive innovation, and optimize processes while delivering extreme performance. For large Enterprises **Oracle Business Intelligence Foundation Suite** and for Small and Medium Enterprises **Oracle BI Suite Standard Edition One** is used.

Oracle Business Intelligence Foundation Suite provides Enterprise BI Platform to allow business users to easily create their own reports with adequate information, OLAP Analytics to enable business users forecast performance levels and deliver "what-if" analyses for varying conditions, Scorecard and Strategy Management for defining strategic goals and objectives, Mobile BI to provide critical information despite of the location and Enterprise Reporting for a single, Web-based platform for managing, authoring, and delivering interactive dashboards, reports etc.

E. Microsoft BI Tools & Capabilities

SQL Server predictive analytics along with the simplicity of Excel provides a highly advanced data mining solution. **Power BI is a cloud service** that lets one to share, collaborate and access Excel reports anywhere on any device. It is used in corporate like Mahindra, Satyam as it provides visualizations in the form of an interactive chart or graph which change dynamically with queries creating a truly interactive experience. Its tools for data mining are -

- Excel – it provides new self-service capabilities like data discovery, analysis, and visual exploration. It helps in finding hidden insights and facilitates ease of collaboration and access from anywhere through HTML5 and mobile applications.
- SharePoint Server-it is a web application framework and platform that provides a full set of rich dashboard and scorecard capabilities including interactive analytics, advanced filtering, visualizations and guided navigation.
- SQL Server Reporting Services- it is a highly scalable and comprehensive, solution providing operational reporting for browser-based viewing, exploration, pixel-perfect printing and visualization.
- SQL Server Analysis Services- it empowers building of enterprise-scale and comprehensive analytic solutions that provides interactive exploration of aggregated data.

F. SAP Solutions for Data Warehouse and Business Intelligence

SAP solutions enable advanced analytics, enterprise mobility, in-memory computing, cloud, and helps all employees in an enterprise to streamline and simplify data warehouse by reducing data movement and data preparation with improved speed and

scale. SAP provides tabular structure for data warehouse from memory to disk that delivers optimized data federation, the best analytic performance in the market, and enable customers to analyze data across enterprise-wide data silos on different technologies without sacrificing on latency and performance and offers the power of both Customized and Pre-Packaged Data Warehousing options like On-premise, Cloud or Hybrid. Connected or Wireless.

SAP provides 24/7, user-friendly access to the Big Data mining tools and business intelligence (BI) including self-service data visualization and dashboards, mobile apps, ad hoc reporting, predictive analytics, and more that improves business performance. Applications of SAP in Enterprises include real time analytics and reduced latency, flexible and simple architecture with fewer data movements and enterprise-wide analytics.

SAP Data Warehousing Portfolio

- SAP IQ: Logical Big Data warehousing (OLAP)
- SAP Business Warehouse: Real-time complex event processing
- SAP HANA Dynamic Tiering
- SAP Data Services
- SAP HANA Smart Data Streaming: Real-time complex event processing
- SAP IQ Near-Line Storage

G. QlikView BI Tool

QlikView is a wonderful tool for business intelligence used extensively in corporate like Canon, Panasonic, Fila. It helps in easy access to database and provide complex business data in easy to understand format. It helps in easy model building at initial stage leading to identification of entities and relationship at core level that helps to satisfy user requirements in a much better way. It serves as BI KPI tool and also advanced reporting tool. It is ideal for business owners who wish to improve overall output by creating the most productive system possible. So the main value supplied by Qlikview is to reduce uncertainty, make the users question, discover, interact with each other, and eventually improve the process.

H. Tableau

It is core BI-enabled software that produces a wide range of interactive visualization tools that help businesses analyze large quantities of data in intuitive, quick, and user-friendly way. Tableau features five major products-

- a. Tableau Desktop- : - A drag-and-drop desktop program that allows users to quickly analyze, sort, and visualize big data in record time.
- b. Tableau Server: - Browser-based analytics with sharable, usable BI, an interactive dashboard available for desktop and mobile use.
- c. Tableau Online: - enables users to share live, interactive dashboards within the company as well as with partners and customers.
- d. Tableau Reader: - A free PC app that enables sharing of data visualization created with Tableau Desktop.
- e. Tableau Public: - Website enhancement with interactive data storytelling. No programming necessary to create, publish, or share visualizations.

I. SAS

SAS Business Intelligence package is an all-in-one tool for data analysis that can handle all of the statistical analysis that a company requires. It performs functions like fetching relevant information from multiple sources, mining, managing and adapting. The SAS Business Intelligence software allows users to handle, understand, and analyze their data in both past and present fields, as well as influence vital factors for future changes. Users can also create and publish reports based on their findings so that others in their field can share the information and input suggestions. The graphic presentation is another benefit that many businesses find useful when presenting their findings to others.

TABLE III
Comparison of BI Tools for Data Warehousing and Data Mining

BI Tools for Data Warehousing & Data Mining	Features	Drawback	Clients
Sun JasperSoft for MySQL open source database	<ol style="list-style-type: none"> 1. Its an open source BI software 2. Provides reporting, dashboard driven end user query and reporting, data analysis & integration 3. Suitable for both stand-alone and embedded business intelligence applications 4. Cheaper than other big vendors 	<ol style="list-style-type: none"> 1. Lacks support in comparison of commercial tools 2. Extensive training required 	Ericsson, Alcatel-Lucent, PUMA, Cognizant etc.
IBM Cognos	<ol style="list-style-type: none"> 1. It offers BI, strategy management, financial performance, and data analytics applications. 2. suitable for all levels in organization 3. It is used mainly in Large Financial Services Firm 4. Report Studio is a valuable feature 5. best security and in-memory feature 	<ol style="list-style-type: none"> 1. Poor environment deployment and ability to manage source code 2. not very stable 3. creates issues on scalability and dispatcher performance 4. SQL auditing yet required 	Some examples of Cognos customers include BMW Financial Services, Michigan State University etc.
IBM Intelligent Miner	<ol style="list-style-type: none"> 1. Features advanced visualization tools and data presentation; 2. suitable for value prediction, time-series, classification, clustering, association and sequences 3. Can work with DB2 database management system. 	<ol style="list-style-type: none"> 1. Warehouse need to be relational with conventional data sources and simple transformation requirements 2. Packaging, integration and complexity problem 3. disconnect between managing relational data and managing OLAP data 	BMW Financial Services, Michigan State University etc.
Teradata	<ol style="list-style-type: none"> 1. massive parallel processing system 2. best enterprise data warehouse platform (Forrester Research, 2009), "Magic Quadrant for Data Warehouse Database Management Systems"(Gartner Research, 2012) 3. Automated backup, archive and restore 4. operational intelligence to front-line employees, business partners and customers 	<ol style="list-style-type: none"> 1. Arithmetic functions, aggregate operators, exponential operators etc. are not allowed 2. Concatenation of data files is not allowed 3. Data retrieval from Teradata Database with the SELECT statements not allowed 4. Does not support hash index, join index etc. 	Intel, Capgemini
Oracle BI Foundation & Standard Edition	<ol style="list-style-type: none"> 1. It has a complete set of components, OLAP and data mining capabilities 2. It started with algorithms such as association and Naive Bayes (version 9i) and with the 10g version it includes a great variety of algorithms; 3. Integrates Java Data Mining API, a Java package for including the data mining 	<ol style="list-style-type: none"> 1. Variable attributes functionality need to be incorporated in Planning 2. build and manage capabilities are not consistently implemented for relational and OLAP data 	Lufthansa, Siemens, Audi etc.

	facilities into the user's application 4. Highly stable, scalable, multidimensional and easy to deploy		
Microsoft SQL Server	1.It comes from the database field of activity 2.It offers algorithms for decision trees, clustering and prediction 3.Implements the OLE DB standard for Data Mining, which defines a data mining language similar to SQL 4.Features an easy to use API interface for facilitating the integration of data mining facilities into the user applications.	1. Too expensive and advanced for small companies as Enterprise edition is too costly 2. Its core language is different from other database applications so poses difficulty in programming or analysis services 3. Specialized and advanced hardware requirements.	Mahindra, Satyam etc.
Microsoft PowerBI	1. It is used mainly in Midsize Financial Services Firm. 2. Microsoft licensing scheme is really better, specially when there are large number of users and a lot of SQL licences are deployed making it much cheaper 3. Cleansing, Data Integration and Warehousing is better	1. End-user tools such as Excel is not good enough for all business scenarios 2. Security is a major concern 3.Set up process and deployment of SharePoint is a problem	Mahindra, Satyam etc.
SAP BusinessObjects	1. helps in real-time decisions 2. cost effective, scalable and simple to deploy 3. better formatting and interactive GUI 4. Provides crystal reports, dashboards, explorer and web intelligence 5. security	1. Visualization needs to be improved	FedEx, Hero MotoCorp Ltd, Tata Motors, Indian Oil, Big Bazaar, Pepsi, Samsung etc.
SAS	1. Ensures data credibility and consistency. 2.Easy to use graphical interface 3.Rich set of algorithms including algorithms for data mining, decision trees, neural networks, regression, association, etc. 4.Ability to analyze text. 5. Best platform for managing metadata, security and huge databases.	1. Expensive 2. Complex installation 3.Compatibility issues in integration	Reliance Capital, Reliance Communications, ICICI Bank, Standard Chartered Bank, SEBI,
IBM SPSS	1. Includes decision tree and data mining algorithms (IBM SPSS Modeler) 2.Allows users to perform data transformation, data cleansing, text analytics, survey authoring and deployment(IBM SPSS Data Collection).	1. costly for stand alone license 2. limited model intervention 3.poor graphics and menu outlines	Highmark Blue Cross Blue Shield (Healthcare company), research and survey companies, eBay, Infosys, Accenture, KPMG, TCS, HSBC etc.
QlikView	1. It is used mainly in Midsize Financial Services Firm. 2.Reduce uncertainty, make the participants discover and interact with each other 2.Best in-memory tool 3.Extremely powerful for data analysis and data discovery 4. The SME server edition is a good package for management reporting purposes. 5.Can scale both horizontally and vertically	1.more graphics and dashboard support required (Currently Qliktech is working on this problem with Expressor, a powerful graphic dataflow tool) 2.Needs more support for collaboration. 3.The SME server edition doesn't include a deploy tool 4.licensing scheme is a problem (To solve this and to stop third parties (e.g: Tableau), QlikTech launched Qlik Sense, although the future is unclear)	Canon, Panasonic, Fila etc.

		5.reload process encounters some kind of dead lock while extracting the data from the DB	
Tableau	1. It is used mainly in Midsize/ Large Financial Services Firm. 2.easier to use than any competitor product 3. suited best for data visualization and data discovery as speed of data disc is too good. 4. easy to implement and increment aggregate data sets without having much IT involvement.	1. Expansion of number of visualizations is a problem 2. Advanced statistical functions required on massive data.	Accenture, Adobe, Amazon.com, Bank of America, Coca-Cola, Deloitte, eBay, HP, Intel, PayPal, Pfizer, Skype, and Walmart

VI. CONCLUSION

The decision to choose a particular tool for Data warehousing, data mining and business intelligence depends on a number of factors like ease of querying against relational and multi dimensional data using SQL, managing structured analytic data within platform's engine, optimizing queries structure, self-dependence, integrating with different management systems and optimizing load processes. To choose the best business intelligence tool is quite confusing as there are number of branded vendors in the market offering almost same solutions for data mining and warehousing. Business intelligence solutions provided by Microsoft are quite flexible, popular and easy to deploy. People can retrieve different information from the same report according to their requirements without paying extra license fees. It is much cost effective but yet requires better SharePoint integration. IBM Cognos takes more steps to reach to the same conclusion in comparison to other BI tools and some of which are even tough to understand. SAP is however, positioned as a Leader for BI & Analytics Platform in the 2015 Gartner Magic Quadrant for Business Intelligence and Analytics platform as it provides better formatting and GUI features.

The following is a checklist for comparing data warehouse vendor offerings:

1. Is the DW product a good fit with existing systems and needs?
2. Does the vendor solution have easy to use tools for retrieving data?
3. Are benchmarks satisfactory for anticipated requirements?
4. Is vendor solution easy to administer and have good ETL, security and maintenance tools?
5. What is the estimated total cost of ownership?
6. Does the proposed solution have additional benefits that are valued?
7. What is the reputation of the vendor for service and support?
8. Is it likely the proposed solution will be accepted?

According to the IT Central Station community, the most important buying criteria for BI tools are scalability, mobile/cloud based customization, ease of development, performance, usability and user interface. So, an effective BI solution is that which is able to access any data source and provide capabilities for both internal and external users from the same platform, as well as provide better integration with other systems (e.g. CRM, ERP).

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