Business Intelligence Modeling: A Case Study of Disaster Management Organization in Pakistan

Sohail Asghar
Department of Computer Science
Mohammad Ali Jinnah University,
Islamabad, Pakistan
e-mail:
sohail.asghar@jinnah.edu.pk

Simon Fong
Department of Computer and Information Science
University of Macau
Macau SAR
e-mail:
ccfong@umac.mo

Touqeer Hussain
Shaheed Zulfikar Ali Bhutto Institute of Science and Technology,
Islamabad, Pakistan
e-mail:
touqeer.hussain@yahoo.com

***Abstract*—Acquiring useful Business Intelligence (BI) for high-qualitative decision making is a challenging task in today's dynamic business environment. Powerful tools are available such as ETL, data-warehouse, OLAP, data-mining and visualization. However, companies are lack of standardization of procedures in cultivating BI for improving the performance of the organization at all levels. In this paper, we developed a model that link dimensions of BI and processes together, for providing a good decision support, for disaster management organization in Pakistan as a case study. The model is implemented and validated using Oracle BI tools and techniques. The significance of this research work is the BI model proposed which provides exploratory abilities on the data, and linkages among BI processes from the conceptual BI dimensions.**

Keywords-Business Intelligence dimension, Data Mining, OLAP, Data Warehouse, and Business Functionaity

I. INTRODUCTION

BI is recognized as an increasingly important support for business decision making [1] in today's emerging business environment, where a huge amount of data is growing fast and scattered around. Most organizations nowadays face the challenges of processing and analyzing enormous amount of data [4] for real-time BI. To tackle such problems, data are progressively transformed into useful information and knowledge management techniques are implemented to manage the information and to support decision making [5].

In assimilation to above BI also supports different enterprises by utilizing its tools and techniques [6] in order to support them in carrying out different processes and handle the processes according to different tasks. In regard of this BI is identified as an amalgamation of reporting, data mining and online analytical processing applications. BI supposed to provide access to data that has been cleaned and integrated so that they can be analyzed, manipulated, transformed, and combined to discover correlations, trends, and patterns that offer new insights, aid in decision-making. However, enterprises adopt different practices for BI by using a mix of ETL, data warehouse, OLAP, data mining and decision models [1][4][8]. Data warehouse is the core of BI system which stores aggregated and historical data [1]. It is loaded from many operational data sources i.e. MIS, CRM, ERP and other legacy systems [1][4][6], by some automated procedure called ETL (Extract, Transform and Load) [7]. On top of that, OLAP (Online Analytical Processing) provides analytical views of the stored data in the warehouse in the form of star or snowflake schema [1][3][4]. On the other hand, Data Mining helps to find hidden patterns from the data through different algorithms (association rule mining, decision tree, and clustering etc).

With fast growth of business data in both volume and variety, amalgamation of data from different sources by different autonomous processes into the corresponding BI dimensions is a challenge. To cope with that, we have proposed a model which essentially provides an exploration and linkage among the BI processes and its dimensions for good decision making. In this paper we describe a detailed validation and implementation of the model through a real-life case study. Some key tools and techniques used include Oracle 11g, Oracle analytical work manager (for OLAP) of data warehousing for its multidimensional cube generation. For data representation in cubes as a user interface, some operations have been carried out like slicing, dicing, rollup, drill down and that of pivoting. The proposed model is composed of two main parts: BI dimension and BI process. BI dimension embraces the management concepts of knowledge, functionality, technology, business and organization; whereas BI process includes the technical activities of operational data sources, ETL, data warehouse, OLAPS, data mining and visualization tools.

Consequently, we have linked the BI dimension with the BI process in our model, which is essential during the life cycle of BI system development. As a result of the integration it is possible for us to implement efficient architecture by quick prototyping. The developed prototype architecture is then tested with real life data. The experimental results are validated and we highlight the benefits attained.

The remaining portions of this paper are organized as follows: Section 2 presents a literature review of current research efforts by various researchers in the area of BI models and methodology. We show our proposed architecture of BI system in Section 3. Section 4 discusses the validation and evaluation of experimental results. Finally, Section 5 provides a conclusion and possible future research.

II. LITERATURE REVIEW

In 2003, Olszak and Ziemba [1] suggested an integrated approach to build and implement business intelligence solution. This integrated approach composes of four basic dimensions i.e. business, function, technology and organization. According to the authors an adequate approach is required to design, implement and use the BI system, keeping in mind the four dimensions where BI systems are being initiated. The same approach has been suggested by the [2] and [7]. Our approach is similar with respect to their proposed BI dimension. But we are considering also the knowledge as an additional dimension. We explored these dimensions and linked them with BI creation, implementation and using the process as shown in Fig. 1. We implemented this approach in practical domain and developed a BI application whereas [1] only suggested the implementation approach.

Later in 2004, Simmer [2] proposed a stakeholder model of business intelligence which was closely related to the model presented in [1]. According to the author for the purpose of expansion in the organization performance, this model is potentially useful for design, diagnosis, and enhancement of BI because it integrates stakeholder system with technical and human knowledge systems. The stakeholder model of BI is mainly divided into two parts: external environment and internal environment. Whereas the external environment covers the institutional, extra-institutional and industry environment and internal consists of business practices, knowledge base, knowledge source, value creation, and strategic attributes. However, the connection of stakeholder model with respect to our proposed model is similar based upon the BI dimension. The external factors of stakeholder model which we have covered into our organizational dimension and other dimension are covers into internal factors. An important feature of our model is that it is quite generic because we have also focused on the BI process and extensively explored it which is the limitation of the model presented in [1] and [2].

Xu et al [3] presented BI applications infrastructure for the life insurance industry. They have demonstrated that how an innovative BI infrastructure and application could effectively address major business challenges. Here arises a question of how this will help us to achieve operation excellence and business impact. The major parts of the infrastructure are meta-DBs, which are operational data sources. The second part is a BI application that includes data mining, OLAP, data queries and data warehouses. The last part is BI users including end-users of the application, based on their roles/responsibilities. The presented work is limited in relation to our proposed model that it cannot identify the transformation of data from operational data sources to data warehouse, which is an essential part of the BI system. Our proposed model however highlights on the transformation procedure from operation data sources to data warehouse, which is illustrated in Fig. 1.

In 2006 Zeng et al. [4] claimed that successful application of BI in an enterprise should be measured through two reasons. The first is correct, valid, integrated and in-time data, and the other is the means which transforms the data into decisions. Both tasks have certain difficulties. Therefore the authors presented a BI technical framework which consists of an operational application tier (legacy data sources), a data acquisition tier (ETL), a data warehouse tier, BI suite tiers and corporate performance management tiers. The model is quite similar to our proposed model except that our model has details in relationship of BI dimensions and BI processes which mutually facilitate decision making.

In the fall of 2006, Ou and Peng [5] introduced the concepts of business process management to the current business intelligence with the ability of process-driven decision making. These processes are stored in process model base and are flexible and reusable. By using case based reasoning technology, matching processes can be retrieved and delivered to the decision makers when they encounter a new problem. The authors tried to address the situation when the existing data sources could not fulfill the problem statement of new problem. In this situation the assistance of knowledge implementation and business process reuse can attain the decision making efficiency of BI system. To deal with these issues the author proposed a knowledge base business intelligence system (KBBIS). With respect to our proposed model the knowledge dimension also deals with such types of issues when the existing data sources are insufficient to fulfill the problem statement.

Delibasic in 2007 [6] presented an abstract level model of business intelligence system. It proposes to reach for decision making through knowledge in two ways i.e. with experts and computational supports. At experts side a decision maker has support from the GDSS (group decision supports system) with experts' collaboration. The main parts of the model are databases for the computation support, various knowledge discovery tools (case based reasoning system, data mining etc.) and visualization techniques. Our model is supporting these features which are closely related to the model presented in [6]. It also covers other aspects of BI system which are not discussed by the author. Our model covers a comprehensive range of dimensions such as business, technology, functionality and organization, which are very important in designing the BI systems.

Olszak and Ziemba in 2007 [7] introduced a methodology of BI system creation and implementation for organizations. This approach is focused on objectives and functional areas of BI in organizations. According to the authors, the BI has two major stages that are of interactive nature, (1) BI creation and (2) BI consumption. The creation stage involves a series of tools and technologies, which include ETL, data warehouse, OLAP, data mining and different presentation tools. Consumption stage involves the fundamental changes in a particular enterprise. The authors focused on the issue that organizations require some cultural background to go along with information system and information technology, when building and implementing a BI system. This suggested methodology of building and implementing BI system also need sound business practices set by the enterprise. Our proposed model does not only focus on the above listed issue, it actually provides a real

time application in the disaster management domain and provides a better decision-making environment.

Zhong et al. in 2008 [8] applied BI into a social security system. It provides business analysis to the decision makers. Authors proposed a three-dimensional framework of BI which is based on a three-level screening funnel. It refers to the dimension of the user roles, the dimension of instruments and the dimension of contents. In terms of three-level screening funnel it advocates that it is necessary to screen by industry positioning, positioning of value chains and positioning of the stage for expanding users. This idea leads to the best match of BI applied, namely carrying out concrete operations. The role dimension is made up of three kind of personnel namely, business personnel, technical personnel, and business technical personnel. The content dimension reflects application, inclusive of deductive application, inductive application and the application for controlling and developing the instrument dimension.

III. PROPOSED BUSINESS INTELLIGENCE MODEL

The proposed architecture is divided into two main parts i.e. BI dimension and BI process. BI dimension includes the concept of knowledge, functionality, technology, business and organization whereas the BI process includes the activities of operational data sources, ETL, data warehouse, OLAPS, data mining and visualization tools. As a holistic approach, we linked the BI dimension with the BI process as a whole model which is essential during the complete life cycle of BI system development.

A. BI Knowledge aspect

According to [1] knowledge is asserted for enterprise which is applied in all key business processes. It also constitutes a prerequisite for the development of new products and technologies, volume of scales, reaching new customers and maintaining relations with existing customers. The originating source of knowledge in an enterprise includes: their information systems, internal documentation, media press, reports, domestic and foreign statistics, internet, corporate databases, customers, suppliers, business partners, and their employees [1][2]. However, knowledge can be classified into following categories i.e. procedural, descriptive, semantic, episodic, explicit and tacit knowledge [2][6]. As a result, it is very important for an enterprise to analyze the source of knowledge, data sources, knowledge type and solution for the problem when existing data sources are unable fulfill the requirement for the BI system.

B. BI Functional aspect

The second important dimension which is linked with the BI process is the functional aspect. According to [1] BI standard should be analyzed taking into consideration of all the benefits which are likely to be generated in an enterprise. Following are the functional aspect that is considered during BI process [1]:

- Strategic planning included:
  - Different variants in the development of an organization
  - Relation of an enterprise strategy, mission, goals and tasks
  - Identification of bottlenecks to be tackled
  - Providing information on the enterprise environment & market trends
- Improving relation with customers
- Analyzing profitability of products
- Analyzing the internal processes and operational efficacy
- Controlling and managing accounting

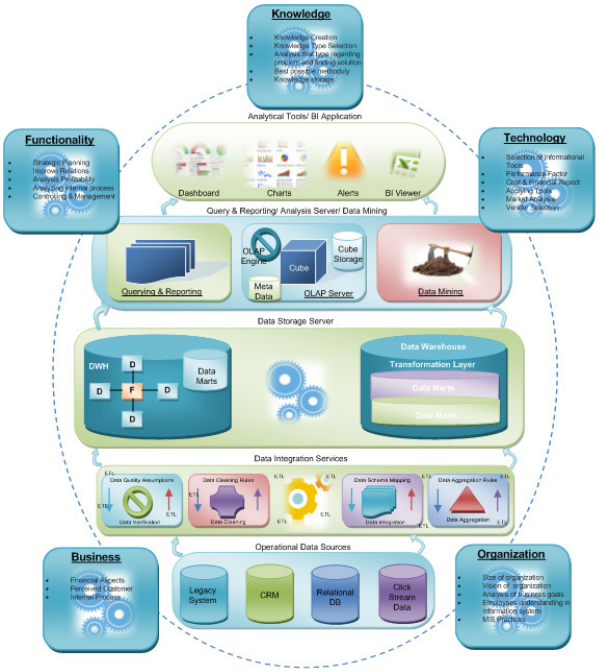

Figure 1. Business Intelligence model.

C. BI Technology aspect

The third aspect of BI system is technology. According to [1][4] different world-wide leading BI vendors provide end-to-end advanced enterprise platforms; BI solution primarily involves method of knowledge creation, source of knowledge and information technology tools. However, integration between world-class databases management, analysis server, enterprise sources and flexible, easy-to-use front-end applications make the power of BI accessible to users at all levels of the organization and realize benefits in some key access.

More and More enterprise solution and platform for BI have been developed. Some commercial solution include, just to name a few, Oracle databases, IBM DB2, Microsoft SQL Server [1][4][7], with the BI tools Microsoft analysis server, Oracle Analytical Work Manager (AWM), Oracle Warehouse Builder [1], Oracle BIEE (Business Intelligence Enterprise Edition), NCR teradata warehouse, Hyperion, SAS, Cognos, Business Objects [7], Open source project Pentaho, and MS Miner [4].

However, selecting appropriate BI tools from the above list vender is not an easy task. The authors in [7] suggest a

set of criteria that should be taken into consideration during the selection. The criteria are based on the following factors that are being analyzed: functionality, complexity of solution, compatibility, and organizational functional needs. However, it is also important that these tools meet the organization expectations in a foreseeable future.

D. BI Business aspect

The fourth important aspect of BI system is business. According to [2] the increasing use of business practices has given rise to spiraling demands for information. BI is able to codify and share these demands through multiple internal and external environments. In turn technical development within BI has enabled the increased diffusion of these business practices.

E. BI Organization aspect

The last but not the least important aspect of BI system is organization. It is imperative to understand the business, goals of an enterprise before implementing the BI solution [1] because the present and future demands for knowledge in an enterprise are based on these goals. Next tasks are to analyze and design key processes, positions, responsibilities, and stream knowledge flows.

IV. VALIDATION AND EVALUATION

This section is presented in five phases: in the first phase we explain the implementation model details and elaborate the different parts of the model; in the second phase we enlighten the data warehouse schema, its development in Oracle Warehouse Builder (OWB) and also the ETL process; in the third phase we clarify the implementation details of a case study with Oracle BIEE tool; in the fourth phase we explain the ad-hoc queries implementation details with Oracle Discover and Discover Plus (that are embedded in Oracle Application Server 10g); we explain the integration of Oracle BI solution with MS-Office which is very useful for different analysis purposes in the last phase.

The implementation model is depicted in Fig. 2 and it is divided into four main parts: the first part is operational data sources which include the three main data sources physical, financial and training. We had applied ETL process on these data sources and the lode data into data warehouse shown in Fig. 3. We mapped them on a logical schema called data warehouse schema shown in Fig. 4. The schema consists of three main facts tables and two dimensions which are TIME and LOCATION respectively.

On the third step of implementation model we had linked Oracle BIEE, Oracle Discover plus & Desktop, and MS-Office with warehouse for data presentation. This presentation comes with web browser and desktop utilities.

Fig. 5 gives a preview of business model development in BIEE administration tools. This model contains three main layers, i.e. physical, business model & mapping, and presentation. Physical layer consists of actual data sources imported from a data warehouse which is consisting of dimension and facts tables. Based on this physical data source we built a business model & mapping layer where we could logically define a hierarchy of LOCATION and TIME dimensions that are depicted in Fig. 6. When the hierarchy is defined, it can be published in the presentation layer.

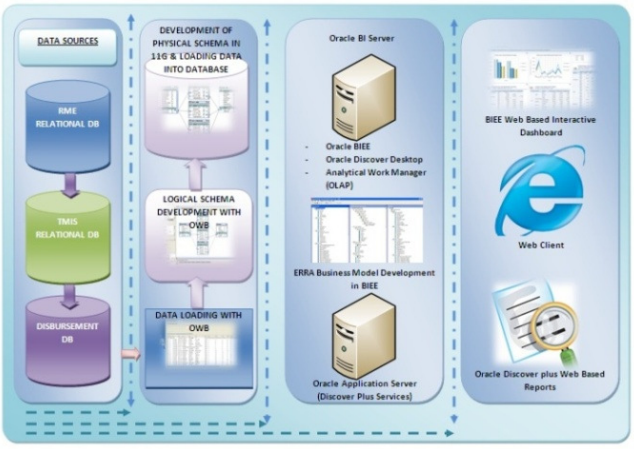

Figure 2. Business Intelligence Implementation Model.

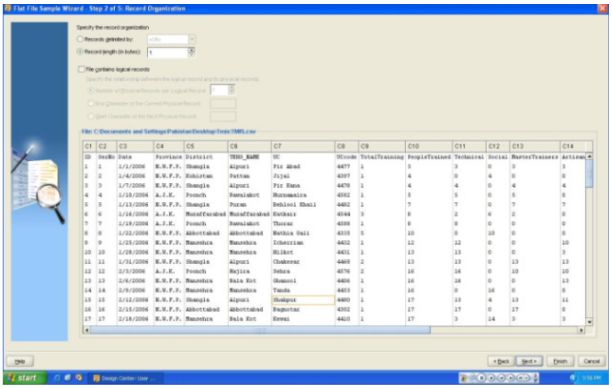

Figure 3. Data Transformation Services (SQL Loader) wizard view.

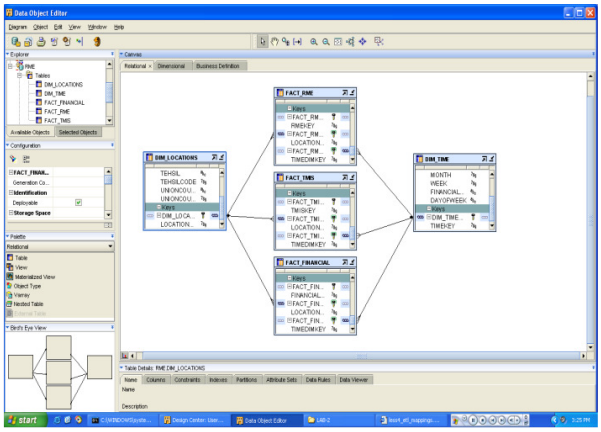

Figure 4. Schema Development in Oracle Data Warehouse 11g (OWB) Screen view.

After completing these steps we established an OC4J server and named it BI Presentation Services which is a web based interface shown in Fig. 6. In this interface we compiled the different answers and save them into appropriate folders, which in turn can be used as useful queries presented on the dashboard as shown in Fig. 7

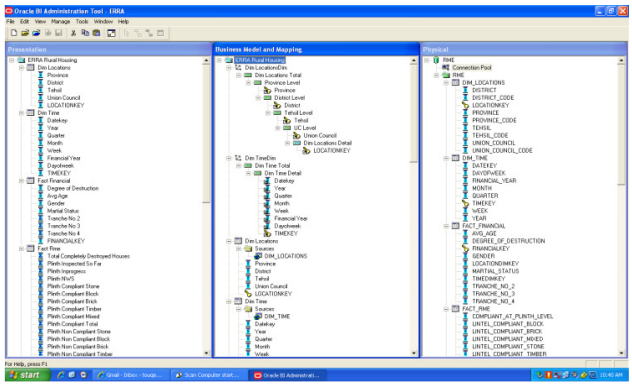

Figure 5. Business Model Developments in BIEE Administration Tool.

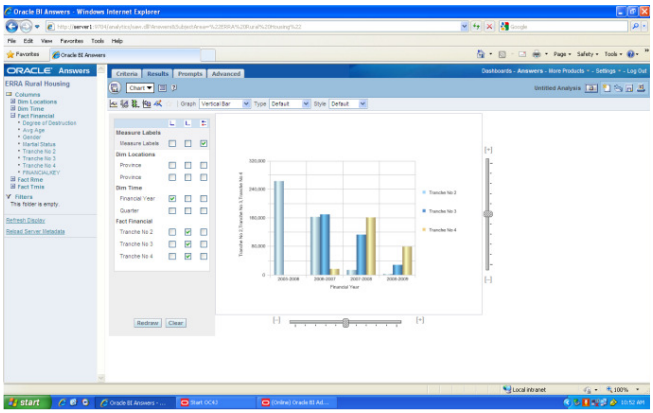

Figure 6. BIEE Answer Development wizard.

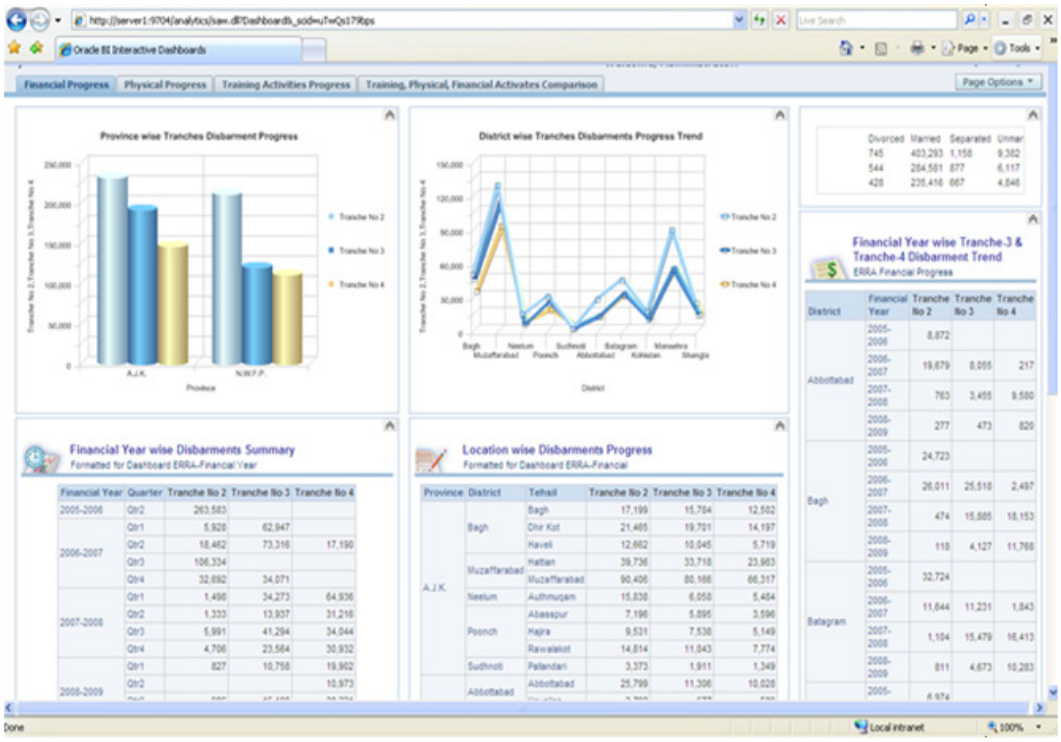

Figure 7. Real Time Activities Monitoring Dashboard.

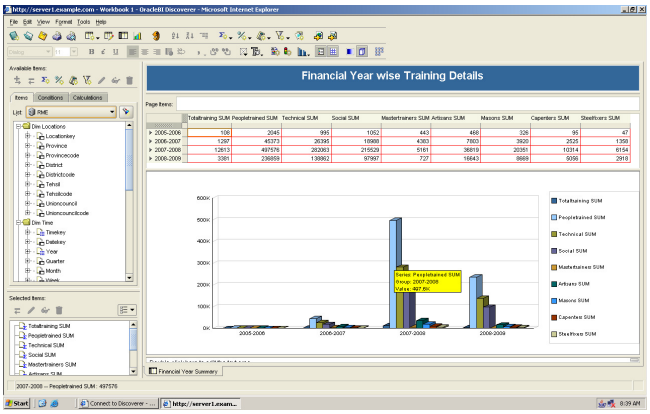

Figure 8. Business Model Developments in BIEE Administration Tool.

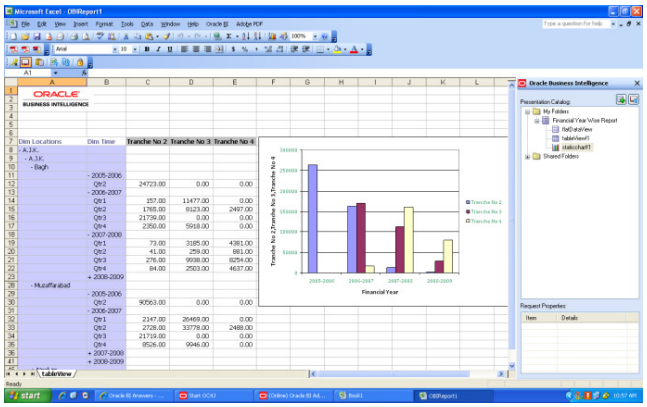

Figure 9. Integration with MS-Excel 2003 as BI viewer.

The interactive dashboard is very useful for analysis purposes. Users can roll-up and drill-down any answer presented on the dashboard and move into the next level of information which is in deeper details by a given domain. In our case study, our users can navigate information up to four levels: *Province* ⇨ *District* ⇨ *Tehsil* ⇨ *Union Council*.

The ad-hoc query presented in Fig. 8 is built in Oracle Discover Plus. User can build different cross-tabs and multiple graphs from which BI reports can be printed.

Fig. 9 and Fig. 10 demostrate the integration service of Oracle BI tools with MS-Excel and MS-Power Point respectively. It is effective for the users that they can easily call a query from the Oracle dashboard and display them in BI viewers with the data in the MS-Excel formats.

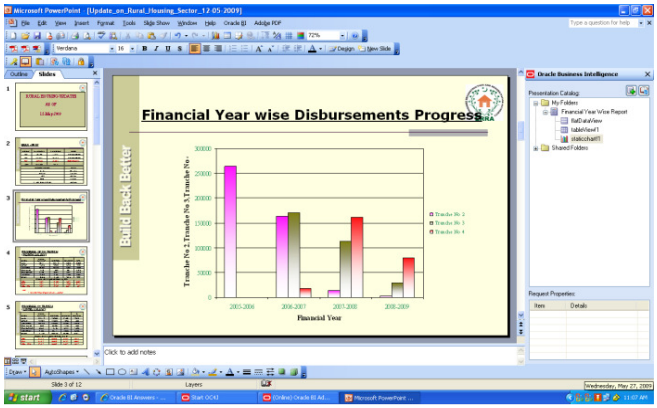

Figure 10. Integration with MS-Power Point 2003 as BI.

V. CONCLUSION AND FUTURE WORK

In this project we linked BI dimension with BI process which is a primary source of BI solution creation in any organization. We have devised a architecture for the BI system and made it more useful with this mapping of BI process and dimension. Furthermore, the proposed architecture along with its components is discussed, highlighting their limitation and advantage. A prototype has been developed and experiments are performed on a case study of disaster management organization in Pakistan.

It is observed that our architecture is possible to implement and manage. We experimented with several sets of data, the results show that they are quick and efficient decision-making can performed over the BI system.

Currently we are trying to explore the relation of enhanced OLAP, different data mining techniques, real time data warehousing and DSS. We are now in exploratory phase of how these technologies contribute the BI system for increasing its performance and visualization. The ultimate goal is to develop a better business decision-making environment.

REFERENCES

[1] C. M. Olszak and E. Ziemba, "Business Intelligence as a key to Management of an Enterprise," Proceedings of Information Science and IT Education Conference, pp. 855-863, June 2003

[2] Claire A. Simmers,"A Stakeholder Model of Business Intelligence," Proceedings of the 37th Hawaii International Conference on System Sciences, pp. 1-9, 2004

[3] Z. Xu, M. Zhang and X. Jiang, "Business Intelligence - A Case Study in Life Insurance Industry," Proceeding of the International Conference on e-Business Engineering (ICEBE), pp. 129, 2005

[4] Li Zeng, et al, "Techniques, Process and Enterprise Solutions of Business Intelligence," IEEE Conference on System, Man, and Cybernetics, pp. 4722-4726, Taipei, Taiwan: October 8-11, 2006

[5] Luan Ou and Hong Peng, "Knowledge and Process Based Decision Support in Business Intelligence System," Proceedings of the First International Multi-Symposiums on Computer and Computational Sciences (IMSCCS), 2003

[6] B. Delibasic, et al., "Towards Knowledge in Business Intelligence," 8th Balkan Conference on Operational Research, pp. 97-10, Belgrade, Zlatibor, September 14-17, 2007.

[7] C. M. Olszak and E. Ziemba, "Approach to Building and Implementing Business Intelligence Systems," Interdisciplinary Journal of Information, Knowledge and Management, Vol. 2, pp. 135-148, 2007

[8] W. Zhong, et al., "A Framework of Applying BI to Social Security Systems," Proceeding of the International Conference on Intelligent Computation Technology and Automation, pp. 189-193, 2008