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Research paper

Design and Implementation a Typical University Business Intelligence System Using Data Warehouse Technique (UBIS)

Ayad Hameed Mousa*[1], Nibras Talib Mohammed[2], Heba Adnan Raheem[3]

[1, 2, 3]University of Kerbala, Karbala, Iraq
**Corresponding Author E-mail: Ayad.h@uokerbala.edu.my*

Abstract

In organizations management, a Business Intelligence systems (BI) provides a flexible and computerized approach to help and support their top management (decision makers) to make better decisions. The education institutes tend to develop a Business Intelligence (BI) system to manage, integrate and control the academic information systems in terms of both data.However, until today, information does not integrate and presented in an appropriate manner for the university-decision-maker in helping them to make better decisions. The main issue is how to extract and process a massive amount of the information to speed up the intended data analysis and processing in supporting the university decision-making process. To manage and facilitate the data management process, in this paper, a university business intelligence system based on data warehouse model was designedand implemented into a case study from local education institute are carried out to explore the influences mentioned above. Finally, to find out the applicability of the proposed model the usability tested was conducted. The findings showed the applicability of the proposed system in practice.

Keywords: *Business Intelligence, Data Warehouse, Decision Making Process.*

1. Introduction

1.1. Business Intelligence Overview

Business Intelligence (BI) is the mechanism to provide insight for most of the operations and performance of organizations in addition to identifying strategic business opportunities. In different ways been defined BI, and there is no comprehensive definition of acceptable by all researchers in this area. BI from a technical point is a "set of techniques and tools and methodologies that work together to transform the information and data belonging to the organizations into meaningful and actionable information and make this information available"[1-5].
There are a significant goals of BI goals as a according to [6-12], he has listed the key goals of BI are:

1. Help the enterprisesin avoiding surprises.
2. Provide the ability to identify their challenges and how to overcome them.
3. Help the enterprises to get full understanding a powerless.
4. Speed up the reaction process.

As can be indicated from the BI definition, BI is how to improve the future by analysing the past, and therefore, the data is one of the most important BI components, it's considered as a backbone of BI and the current tend to data management process by use data warehouse as a data integration technique in BI environment.

1.2. Data Warehouse Overview

DW is a new technique used by database management system to gather and store and process data from multiple and heterogeneous data sources to deliver a meaningful information to enterprises top management[13].Typically, DW used for gathering wide businesses information to deliver a multidimensional view to describe the enterprises' performance[14-19]. As I discuss in the next sections, DW is a subject-oriented, integrated, time-variant, non-updatable separately stored from the
operational databases, it is considered an architectural construct of the organization's information system, target to provides the decision makers the live and historical data in a way that is difficult to access using the operational database[13, 20-22].
There are many users are in needed to use DW such as top management decision-makers who depend on the huge amount of information, users who use customized, complicated transactions to obtain a meaningful information from various and heterogeneous data sources, also it is used by developers or stakeholders who in need a simple technique to used and access the sourcing data, it also considered as fundamental for the stakeholders or users who looking for a systematic approach in supporting decision-making process, it is also important for the enterprises how looking for speed up the performance in delivering the reports or/and charts. finally, DW is the step number one in process of discovering the hidden patterns of data-flows[13, 14, 20-26]. Figure 1 illustrate the process to create data warehouse.

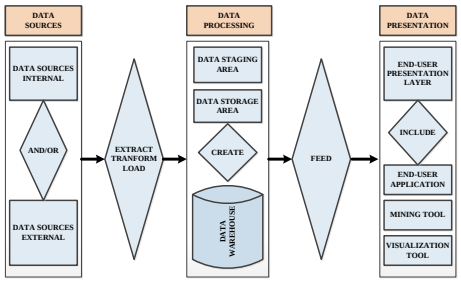

Fig. 1: Data Warehouse Building Process

1.3. Using Business Intelligence System (BI) in Education Management

In the education sector, the current BI systems which are updated continually, are usually employed to run the day-to-day business of the education enterprises. Educational BI systems are extremely complex managerial procedure based on comprehensive analysis of massive amount of information regarding the educational framework, such as academic staff, management staff, students, finance management, teaching resources, offered degrees, study structure, etc.
In higher education climates, data warehouse and other supported and well-suited technologies to guide and help decision makers in generating and delivering the relevant information to support the success of education process[27].

2. Literature Review

The author in [28] clearly explains that the DW project considers one of IT family project. Therefore, what causes fail of IT project will cause the fall of DW project. It can be concluded, it is necessary for all software engineering process which starts with planning toward implementation passing through design and prototyping. , DW is a subject-oriented, integrated, time-variant, non-updatable separately stored from the operational databases, it is considered an architectural construct of the organization's information system, target to provides the decision makers the live and historical data in a way that is difficult to access using the operational database [13, 20-22].
Two main authors who are popular in the era of DW design, their approaches to some area of the DW are dissimilar; William Inmon and Ralph Kimball.[29] presents a design model for building a DW for an ideal to manage the university information system. While, [30]proposed a design model for building a DW for a university decision support system using a dimensional modelling diagram and techniques.

2.1. Design and Implementing the Proposed System (UBIS)

In line with the above situation, to create a productive business intelligence system using DW technique, a systematic approach consists of three main phases should be followed, started with 1) gathering requirements phase; 2) development phase; and 3) evaluation phase. As clearly shown in Figure 2. In the next paragraphs, a comprehensive explanation for each phase were conducted.

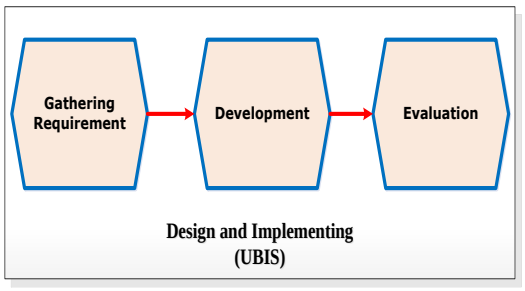

Fig. 2: UBIS Design and Implementing Process

The proposed university BI system UBIS as about a windows-based application which consists of a friendly and usable user interface, this applicationhas ability to connect to data warehouse and achieve many required functions such as login, registration, DDL data sources, ask for new report, create report, delete report, show report, create DW, and feedback. Besides, two types of users can use the proposed system, Admin who has responsibility as a IT manager and the UBIS user which the proposed system create for them, as shown in Figure 3. The aim of these functions to produce the required reports based on the organization requirement in supporting a university decision making process.

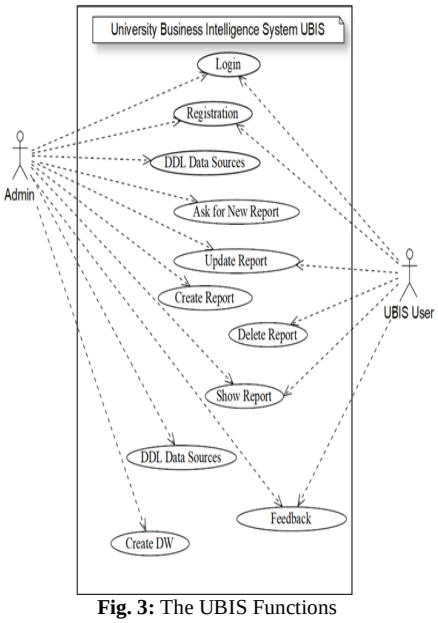

Fig. 3: The UBIS Functions

2.2. Gathering Requirements

It is hereby argued that to better understand the organization mission, the organization requirement should gather and analysis. As discussed in the previous paragraph, the first step in developing (UBIS) is gathering requirement. Hence, to conduct the successful requirement gathering, it is important to understand the users need (the users being may be clients, decision-makers as well as anyone who influences the intended BI system). Working with requirements should use an interview technique as a tool to gather and analysis the requirementsto gain a deeper insight into top management (decision makers) concerns and using these insights, therefore, to support designing and a well-suited BI system. Data (requirements) gathered from the interview with the actual users are tabulated in Table 1. The data were documented as in frequency of responses of the actual users to the questions asked in the instrument.

Table 1: Frequency of Responses from BI Actual Users (Interview)

	Requirement	Type
1	How many international postgraduates students per college (classified by PhD and MSc)?	M
2	How many local postgraduates students per college (classified by PhD and MSc)?	M
3	How many academic staff (lecturers) per college?	M
4	How much the profit per year for each college?	M
5	How many visitors lecturers per college?	M
6	How many management Staff per college?	M
7	How many Local undergraduate students ( )?	M
8	What's the percentage of students per class (male and female)?	M
9	What's the percentage of students per program (male and female)?	M
10	What's the percentage of lecturers per program (male and female)?	M
11	What's the percentage of lecturers per program (assist Prof, Prof)?	M
12	How many international scientific publications per year?	M
13	How many local scientific publications per year	M

Note: **M** means the requirement is mandatory

Essentially, the operational data sources used as a source to create the data warehouse via extract, transform, and loud (ETL) process.

In this work, the operational data sources consist of ten tables which are connected with each other with suitable relations by means of relationships. The entity relational model (ER) has been implemented using MS SQL Server. These operational data sources demonstrate the comprehensive university databases as illustrated by Figure 4, which includes many tables such as university, college, department, academic staff, management staff, publications, as well as the history tables as needed.

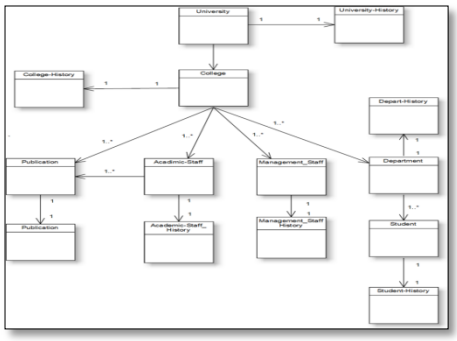

Fig. 4: University Entity Relation Diagram

2.3. UBIS Development

In the following paragraphs, the design and implementing of the proposed system UBIS along with its architecture, building DW are discussed. Therefore, three vital stages are required to be completed, and they are respectively: Extract, Transform, and Load (ETL), consequently, these stages have many sub-stages such as capture, scrub, data cleaning, data cleansing, and finally data indexing.By access and process existed data sources, the ETL process has done to create data warehouse model.
In line with the above statement, the ETL process done based on a study, understand, and analysis the requirement in order to extract the relevant data that can be used as the multidimensional view of data. in line with the above situation, the star schema DW model was created, which is composed of one fact table connected with ten dimensions tables as clearly shown in figure 5.

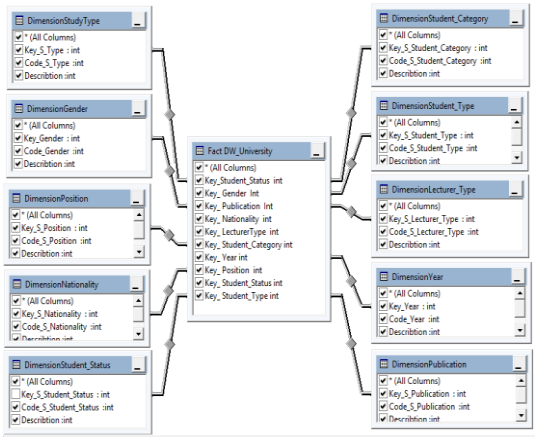

Fig. 5: DW Dimension Model (Star Schema)

In order to allows user to carry out the intended actions efficiently and effectively, without causing too much of a distraction, UBIS prototype was built with a friendly and usable interface.As discussed above, the usability testing for the prototype was conducted. The measurements were made through an adopted instrument from[23]. Meanwhile, the instrument comprises of six main dimensions, visibility, flexibility, easy to use, usefulness, error control and help, and decision support as usability attributes.
The adopted usability instrument was handed to 25 respondents (actual users); they were required to answer questions after examining the prototype. Consequently, a usability test has been conducted to measure the usability of the prototype based on the evaluation instrument that comprise six attributes and 49 items spread over them. In other aspect, the descriptive statistics was conducted. in order to describe the basic features of the data in this study, to provide simple summaries about the sample and the measures, together with simple graphics analysis, and to form the basis of virtually every quantitative analysis of data.
To obtain the overall finding, the average of findings for each usability attribute was calculated. All finding above were supported with bar chart and statistics in Figure 6 and Table2 have affirmed that the usability of the proposed UBIS system can be adopted.

Table 2: The UBIS Usability Finding

	Usability Dimension	Response
1	Visibility	90 %
2	Flexibility	92 %
3	Easy to use	89 %
4	Usefulness	95 %
5	Error Control & Help	96 %
6	Decision Support	90 %

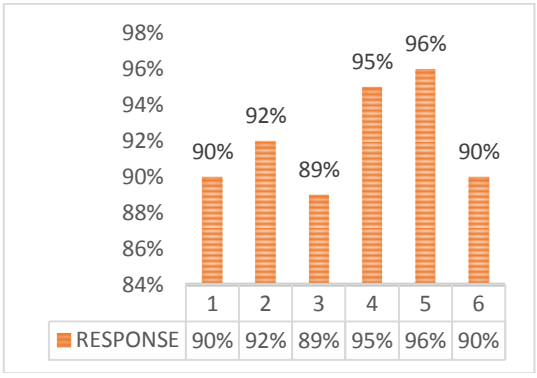

Fig. 6: The UBIS Usability Finding

Note: response means (the participants who agree and strongly agree with UBIS).
It can be seen from Table 2 and Figure 6 that the proposed UBIS is usable and workable in practice. Besides, the mean values for each measurement item are greater than 4 indicating the respondents agreed with the statement for each measurement item. Meanwhile, it was found that the mean scores overall usability attributes of UBIS system fall under “High” or "Fairly High” as clearly visualize in Figure 7. Therefore, the results show sufficient indications that by adopting UBIS works in practice in terms of usability.

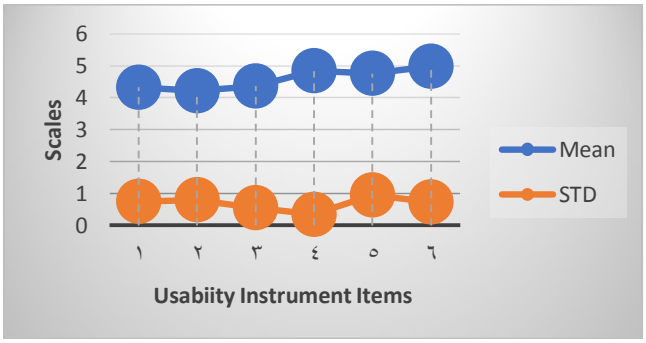

Fig. 7: The Descriptive Statistic for UBIS

3. Conclusion

DW is one of the data integration techniques, besides, DW useful to provide multidimensional and relevant data for business intelligence systems. It's consider as backbone in BI systems. The researchers have focused in designing and implementing a university business intelligence system using data warehouse

technique. The organization requirement was gathered and based on the organization requirement the operational data sources was studies and analysis, the ETL process was done and the DW dimension model (star schema) was built and based on such model the intended reports was created in supporting the stakeholders in the university BI system. Then, the usability test was conducted, and the data collection was analyses and finally, the finding shows that the proposed system is usable in practice.

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