DEVELOPMENT OF KEY PERFORMANCE INDICATOR (KPI) REPORTS FOR WATER BILLING SYSTEM IN BUSINESS INTELLIGENCE APPLICATION

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ABSTRACT

In today's world, in order to achieve strategic objectives and to track enterprise performance, large amount of data gets analyzed thus becoming an essential business activity to improve decision-making. Key Performance Indicators (KPIs) are associated with specific purpose, so that work progress towards organization's objectives or mission can be measured. However, huge and small business requires such indicators to be carried out in the form of data warehousing (DW)/business intelligence (BI) applications. To develop KPI Reports for Utility Billing Information System (UBIS), which further facilitates activities for Water Billing Department, becomes the main objective of this research. A list of requirements that is needed to develop this kind of reports was identified in order to achieve the stated objective. Furthermore, in order to design and develop DW for UBIS, DW/BI developing process was used, the dimensional model (DM) of the UBIS-KPI was defined and its DW model was designed. Moreover, the prototype of a BI application was developed based on the proposed DW model. To ensure that UBIS user's requirements are satisfactorily met, Computer System Usability Questionnaires (CSUQ) was used to evaluate the prototype. Finally, providing guidance to BI developers and supporting decision making of Water Billing department serves as the key contribution of this study.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBEREVIATIONS

KPI	Key Performance Indicator
BI	Business Intelligence
CSUQ	Computer System Usability Questionnaires
DW	Data Warehouse
DM	Dimensional Model
ERD	Entity Relational Diagram
ETL	Extract- Transfer-Load
LDM	Logical Data Map
MDX	Multi-Dimensional Expressions
OLAP	On-Line Analytical Processing
OLTP	On-Line Transaction Processing
PWD	Public Work Department
RAD	Rapid Application Development
UBIS	Utility Billing Information System
UBIS-KPI	Utility Billing Information System-Key Performance Indicator
WB	Water Billing
WBS	Water Billing System
WSB	Water Supply Branch
XML	Extensible Markup Language

CHAPTER ONE

INTRODUCTION

1.1 Introduction

One of the main reasons that led to the selection of this study is its concentration towards the subject of developing KPI-reports for WBS using BI applications. In this chapter, we identify the objectives, significance and the scope of this study based on the illustration and study background of the selected field.

1.2 Study Background and Motivation

In order to satisfy the strategic plan and exacting performance goals, performance management is used to trace the organizational progress as well as to monitor the progress of their organization's performance by managers and decision-makers (Kennerley & Neely, 2002). Gorbach et al. (2006), noted that using Key Performance Indicators (KPIs) was one of the recent ways by which, business estimated the health of an activity by measuring its progress against predefined goals. Managers and decision-makers are measuring the success against some pre-defined goals using KPI as the common application in business intelligence (BI) whereby, each KPI has an actual value against a target value that represents the goal. In addition, the goal should be well thought-out to the success of any business or organization. In order to determine the health of an organization, the actual value is compared to the target value. Each KPI can give one aspect of business growth when KPIs are grouped to give the overall health of

business. Eckerson (2002), mentioned that the organizations start to align their KPIs with their goals and targets. After defining business targets, KPIs can be identified to measure the progress against these targets. In addition, only when smart and customized data warehouses (DW) are built for analyzing data, performance measurement of any organization can be enhanced. In short, to add business metrics to a data warehousing solution, KPIs can be used.

Golfarelli, Rizzi, and Cella (2004), defined BI as set of methodologies, tools, applications, processes, technologies, and architectures used to transform data into a meaningful and useful form to support better decision making. According to Eckerson (2006), BI exploits data warehousing concepts for analyzing business data, such as revenue- by product, by department, or by its costs. Furthermore, BI includes DW as a database used for reporting where often BI applications collect the data from this DW. In DW/BI systems, data is collected from one or more data sources to central data location, represented as DW, after which in an easy and simple way, collected data is displayed and reported for decision-making to the concerned people. According to Few (2006), using interactive and intuitive performance management dashboards called BI Dashboards, BI can help decision-makers to monitor and analyze the important KPIs. BI Dashboard is a visualization tool which can display and represent groups of enterprise KPIs- Performance Scorecards- in one screen. The ability to extract and summarize real-time data from multiple data sources is the general attribute of BI dashboards and systems. Sometimes those data sources are relational databases, OLTP (Online

Transaction Processing) systems, or Excel. Most effective operational monitoring systems provide the ability to view information from many sources at the same time.

Chu (2006), observed that water was not used properly by people at the household even though it was provided free and thereby wasting the same and as such households did not make a valuable use of it As there was no price attached to water, households did not obtain a sign to use water for valuable use and consequently, there are no longer enough resources from top levels of government to provide the quantity of water demanded by households at free cost. According to Munisamy (2009); Bing et al. (2009), water supply industries across worldwide regions have completely turned in last few years due to privatization, and implementation of a new regulatory design. That explains why there are lot of researches and technologies to make water supply safe and reliable. Kun, Talib, and Redzwan (2007), mentioned that Water Billing Department in Malaysia, which lies with the Water Supply Branch (WSB) of the Public Work Department (PWD) which has a Water Billing System (WBS). In WBS, to ensure that the water supply is chargeable, an entity sends notice to customer to pay and this includes a receivable due towards specific individual, government or any other agency. This leads to provide a water safety system, which in turn bills individual customers according to their water usage. This kind of systems has large volumes of rapidly changing data resulting in increasing number of customer accounts and data transactions.

In WBS, specific to multidimensional databases, which are designed for analyzing huge data, the KPI reports can take the same path because it's one of the large groups of records within the mentioned database. This study identified three most important KPIs

of the water billing system that are already applied in Water Billing Department of Malaysia. They are non-revenue water consumption, consumer arrears, and payment collection performance and these KPIs will be represented by BI dashboard tool. To the managers and decision-makers who are working on the Water Billing System, these KPIs will further showcase the important activities in an easy and user friendly manner (Chaudhuri & Dayal, 1997).

1.3 Problem Statement

Dinar (2008), observed that in Malaysia being an industrialized country, water industry is a significant field. As such, in order to meet that target of providing water safely and reliably for intake by human after testing, treating and manufacturing it, there is a need for good management in the water supply sector. Water Billing System in Malaysia is one of the huge systems and wide source of data (Kun et al., 2007). Certainly, KPIs are imposed in any organization having such kind of systems and who think well to achieve their goals successfully in relation to their profit and related fiscal measures (Behn, 2003). As such, in order to transform meaningful knowledge in the form of KPI reports that enable better decision making, BI applications will be a good solution to implement, extract and analyze this kind of huge data. However, the existing Water Billing system does not have such reports and the existing KPIs are still extracted based on the operational data which in addition have data quality issues. Furthermore, developing KPIs requires too much complex data and as such this system is needed to extract water billing KPIs based on BI application.

1.4 Research Questions

The project is attempted to answer the following questions:

i. What is the requirement to develop KPI Report in Water Billing System?

ii. How to design and develop KPI Reports for Water Billing System using BI Application?

iii. Are developed KPI reports satisfying the system users?

1.5 Research Objectives

To achieve the main objective of this study which is developing KPI reports for WBS in using BI application, the following specific objectives are formed:

i. To determine the requirement for developing KPI Report in Water Billing System.

ii. To design and develop a prototype system which consists of KPI Reports in BI application.

iii. To evaluate the prototype system in terms of system user satisfaction.

1.6 Scope of the Study

This study when applied will help Water Billing Department to track their goals and target everyday during their work for the main purpose of supplying water in a reliable and efficient manner. The study defines three important KPIs and further describes them in the context of BI applications and performance management disciplines. On the best ways to deploy these solutions, it also evaluates the developed KPIs and provides recommendations and guidance.

i. KPI in Water Billing System is consisted of information about water consumption, bill charged, collected payment and consumer arrears.

ii. The prototype is developed by using existing hardware and software in UUM.

iii. The study is focused on existing water billing data source from the selected table.

1.7 Significance of the Study

To the most important areas related to a water billing, the significance of this research is to define, develop and evaluate relevant KPI-reports and KPI-dashboard. In order to satisfy the goal of supplying water safely and reliably, the developed reports can help managers on BI system to keep track of growth of water supply performance.

1.8 The Structure of the Report

There are six chapters as a part of our project. In relation to problem associated with the study, most important concepts, its objectives, significance and scope are covered as part of chapter one. Chapter two covers the literature review and other work that are related and established in the same field. Methodology that is used to achieve the objective of the study is covered in chapter three. Specific to the phases of identifying the requirements, analyze, design and implementation of the prototype of UBIS-KPI, chapter four illustrate the associated prototype developing process. To ensure that developed prototype satisfy the user requirements using a questionnaire and analyzing the results using SPSS program, chapter five deals with evaluation. Finally, conclusion of this study, limitations, motivation, contribution, and future work associated are covered in Chapter Six.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Literature and related work concerning factors associated with this project is covered in chapter two. In relation to the implementation of KPIs in BI, this project includes BI definition and architecture, DW concept, Extract- Transfer and Loading (ETL), KPI, KPI Dashboard Analytical reports, Water Billing Systems and some of the previous work.

2.2 Business Intelligence (BI)

2.2.1 BI Definition and Architecture

According to Hancock and Toren (2006), "a set of concepts, applications, methodologies and skills that are used to collect a widely separated data in the organization and turning the same into useful information" is how BI is defined. Using BI reporting and its analysis capabilities, this information is displayed by analysts and decision-makers and comes very handy for business planning and decision-making purpose and typically permit the organizations to gather, access, store and analyze its corporate data (Kasper, 1974; Mun, 2007; Ta'a, Shahbani, & Saleh, 2006). Figure 2.1 is described the conceptual architecture related to BI.

i. Transactional databases: Is a DBMS where write operations on the database are able to be rolled back if they are not completed properly, and as such source data are often relational databases and it comes from one or more operational databases.

ii. Extraction, transformation, and loading (ETL): Data sources are transferred and consolidated (copy data) into DW, but it's more complicated than just copy or moving data. Its supports Reporting, Analytics, Scorecards and Dashboard for data integration purpose.

iii. Data warehouse (DW): Transformed data is transferred and merged into a relational database called a "data warehouse." In relational systems such as Microsoft SQL Server, Oracle or IBM's DB2 is where, DW physically resides. A DW contains the read-only data representing the organization's information at regular points of time viz. monthly, daily, or hourly where important considerations becomes data quality and query speed.

iv. BI: BI systems can generate any kind of reports that allow managers and decision-maker to deal effectively with organization's information using a variety of applications and tools such as: OLAP, live reporting, scorecards, or data mining (Nescu, 2007).

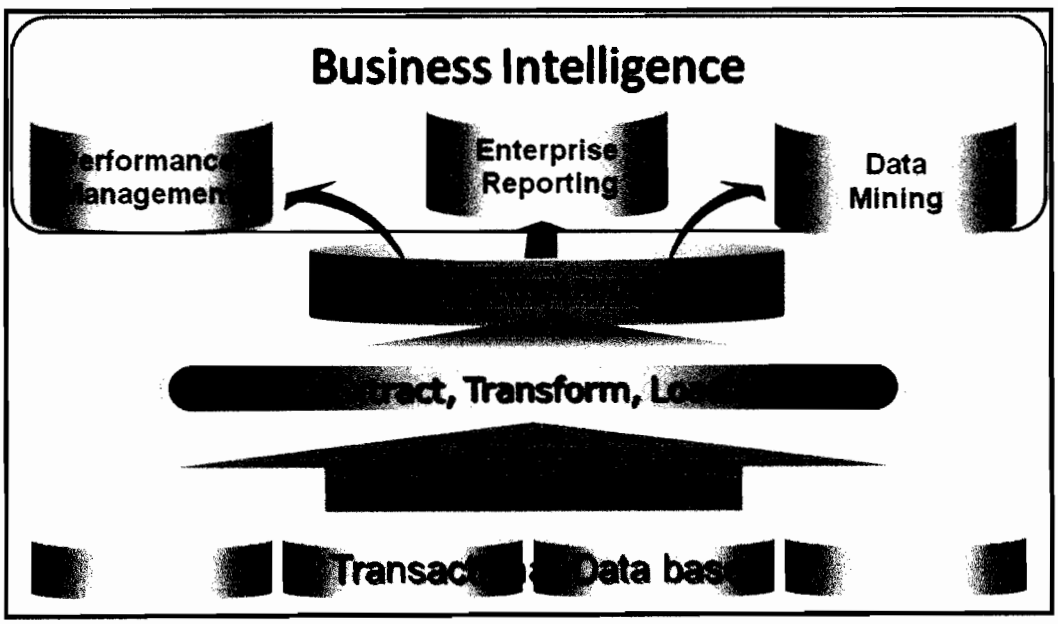


Figure 2.1 Conceptual Architecture to BI (Olszak & Ziemba, 2003)

2.2.2 Extract-Transform-Load

Wicha (2006), defined ETL as a link between the source data and the DW, which is a bridge for data movement in a DW environment. It's consist of three parts: extracting information from data sources that are typically on-line transaction processing (OLTP) systems; transforming, cleansing data and loading data into the DW for analytic reporting purposes. Basically, ETL tools transform the data from the transactional systems to something that can be analyzed in a DW as mentioned in Ericsson and Cline (2005). In the same context, Hancock and Toren (2006), indicated that ETL process loaded data to the multidimensional model through the DW. Despite, it can directly load the data from non relational data source into multidimensional model. The data reaching DW should ensure high quality and that ETL process can satisfy this objective.

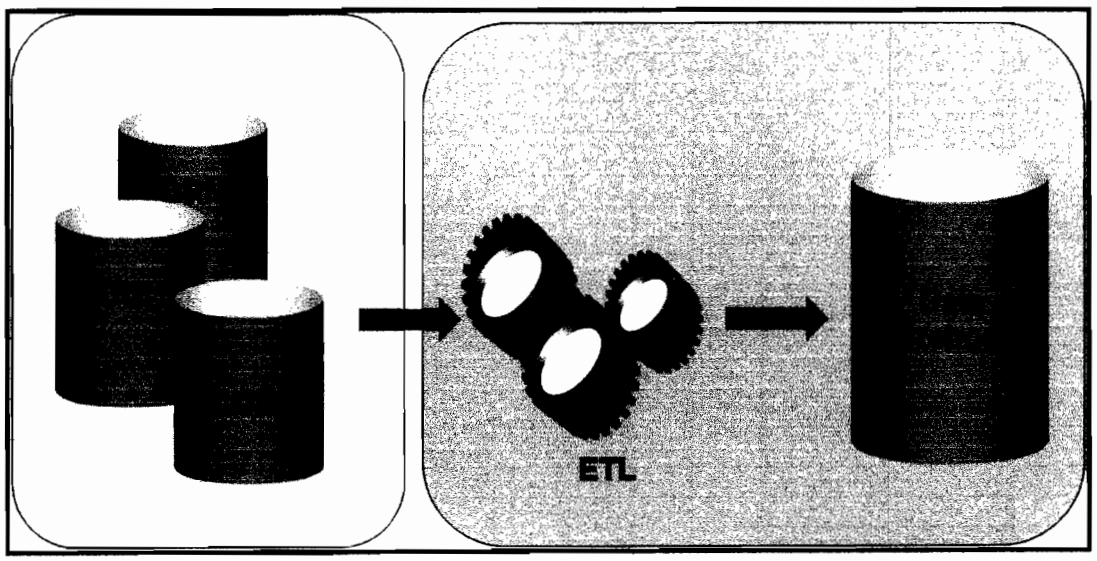


Figure 2.2 DW loaded from source systems (Hancock & Toren, 2006)

2.2.3 Data Warehouse (DW)

Chaudhuri & Dayal (1997), defined the Data warehouse (DW) as a place where the organization's data can be published so that the users can access it easily and quickly.

DW is a collection of decision support technologies, aimed to make better and faster decisions. Data from all the source systems is transferred into DW through a process of ETL as in Figure 2.2 During the ETL process, the information is cleaned and validated to be organized in a way that allow users to formulate their business questions and get their answers faster than using transaction systems. DW in design still uses relational databases, but uses a various approach to design a database schema that is called a dimensional model (DM). At the centre of the DM are the numeric measures such as sales revenue or profit margins. In fact, measures can be viewed in different ways called dimensions where a dimension represented a particular area such as product, customer, or time. Every dimension table has a number of columns called attributes such as product category, color, and size. Related measures are collected into fact tables. The fact table is a multi key table surrounded by dimensions, which are single primary key tables. Each row should contain a different data and to satisfy this we should put a primary key (PK). Typically, the fact table contains an unlimited number of foreign keys that referred to a system generated unique key, which known as a surrogate key on the dimensional table. The resulting database schema known as a star schema consist of one or more central fact tables, joined with number of dimensional tables to give different way of analysis (Hancock & Toren, 2006). According to Gorbach et al. (2006), the star schema is consisting of a fact table and dimension tables connected to the centre which is represented by the fact table. This data model is offered a data flexibility. However, the designers may face problems with one of the dimensions that are too complex to be in one dimension row. In this solution the dimension are extended to be in more than one

table (two or more) connected together to form another image of star schema with more complexity, called as "Snowflake schema".

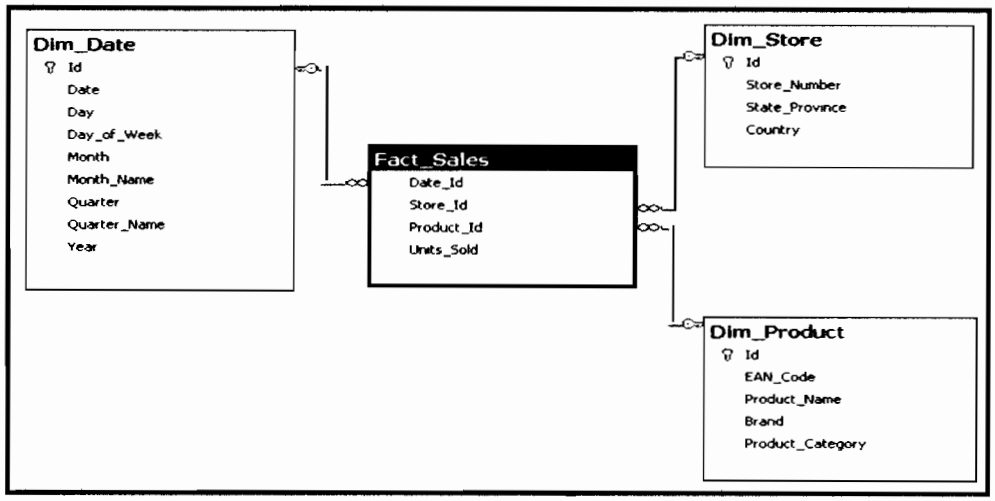


Figure 2.3.Star schema example in SQL server

Gorbach et al. (2006), mentioned that in a Snowflake the dimension table are split into two or more tables as shown in figure 2.4, and the final form will look like the snowflake and thus it is called Snowflake schema. There was a comparison between the two models to determine which one of them is better than the other one. Therefore, the answer to this question was that the two designs have their own strengths and their weaknesses, and it depends on the person to choose which one of them is good for his/her work by avoiding the points attributed under "weakness". The decision whether to employ a star schema or a snowflake schema should consider the relative strengths of the database platform in question and the query tool to be employed. Star schemas should be favored with query tools that largely expose users to the underlying table structures and in environments where most queries are simpler in nature. Snowflake schemas are often better with more sophisticated query tools that isolate users from the raw table structures and for environments having numerous queries with complex criteria.

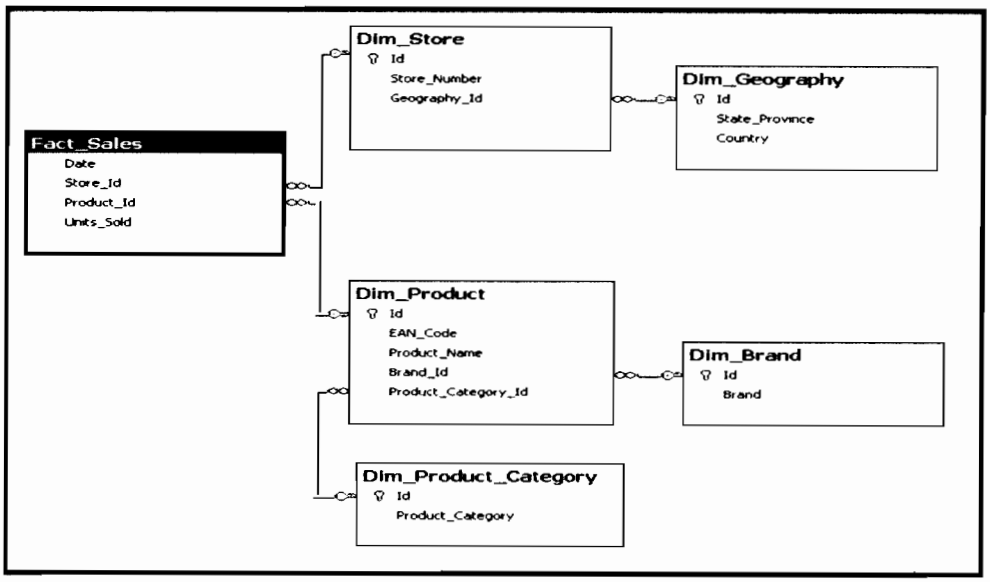


Figure 2.4: Snowflake schema example in SQL server

2.2.4 On-line Analytical Processing (OLAP)

Hope et al. (2003), defined online application processing (OLAP) as a significant technology in BI used to access and analyze organization's information in a better way. OLAP allow organizations to analysis their performance indicators, so that, organizations must get the full benefits of this technology. OLAP considered as the best and strongest technique among the BI tools which can be very useful for decision-makers because it offers them to do multiple kinds of requests such as:

i. Do rapid, dynamic and multiple analyses of the data.

ii. Show the knowledge from different point of view.

iii. Come up with the data in a series time intervals.

iv. Drill-down into multiple levels of data layers in the DW to come up with different kind of details.

A core function of OLAP is the monitoring of important performance measures. OLAP provides a flexible environment for the definition, analysis and sharing of information on performance, including:

i. The interactive analysis and exploration of performance measurement data.
ii. Exception reporting, which provides an automatic check of important performance indicators.
iii. Flexibility in the definition and redefinition of applications to monitor performance measures making it easier to redefine those measures in line with changing business needs.
iv. An environment for the definition and communication of the values to be measured, helping to build agreement and support for the underlying goals.

2.3 Key Performance Indicator (KPI)

Sinclair and Zairi (1995), mentioned that KPIs are used to measure the progress towards organization's goals or mission. After the organization identifies its goals, KPIs are derived to measure the business progress against these goals. In other words, KPIs reflect the organizational goals. However, each KPI should be based on a criterion, which will make it more suitable for analysis purpose. Shahin and Mahbod (2007) and Doran (1981), inclined towards using the S.M.A.R.T criteria mainly for defining objectives. Because of KPI are derived from organizational goals and by nature and definition of KPI, it should follow the S.M.A.R.T criteria:

i. Specific – it has to be specific to an area as it is linked to a process, functional area or preferably an objective.
ii. Measurable – it should be measurable, otherwise it won't indicate anything

iii. Assignable – it has to be assignable, otherwise it won't be measured

iv. Realistic – setting targets is inherent in the documentation and use of KPIs.

v. Time - it is involved in the measurement process.

Gorbach et al. (2006), mentioned that KPI consist of target value and actual value where by target value represents the success goal. To determine the progress of success, the actual values are compared to the target values. Because KPI can summarize large amount of data to a single value, the managers used it to monitor the business performance. Furthermore, KPIs provided a new advance functionality to help the decision-makers with their job, by integrating business metrics into DW solutions using BI applications.

Ranjan (2005), noted that the KPI is visualized in form of KPI dashboard as a one of the important keys of BI, which represents performance management in a user friendly manner. KPI dashboard is contained some features: Interface, Role Based View, Reports, Charting and Graphing and Pre-defined Performance Metrics. Technically, it is reflected multi managerial reviews by giving the ability to drill-down details. BI Dashboard is similar in function to a car dashboard. It displays and provides access to the powerful analytical systems and key performance metrics in a form enabling business executives to analyze trends and more effectively manage their areas of responsibility. In another word, dashboard converts the complex data into a meaningful display such as charts, graphs, and gauges. Therefore, it's eliminates the needs to several reports by giving a clear picture about the business performance in its critical area. Indeed, its allow the managers to drill-down data to give deeper analyzing.

2.4 Related Research

2.4.1 Web services, Enterprise Digital Dashboards and Shared Data Services: a Framework

Ganesh and Anand (2005) in this study helped in getting a top level view of the perspective enterprise by using digital dashboard. Hence, it is support decision makers by making it easy for them in accessing the data such as total sales per month, inventory status and a number of other KPIs. A solution based on Web services in the context of digital dashboard is discussed here. Furthermore, the managers had easy access to information which would facilitate informed decision making. The technology adoption trend is shifting to a scenario where the decision makers should be able to access KPIs of the enterprise. However, this study did not support BI in their context as a needed tool to analyze huge systems, but it is still required as guide for designing a similar tool that can also support the manager in their work.

2.4.2 Benchmarking the Performance of Malaysia's Construction Industry

Syuhaida and Aminah (2009) in this study, focused on the needs to benchmark the performance of the construction industry in Malaysia especially the stipulation of public infrastructure projects by specifying the standard regular assessment and audition through a KPIs. The researchers in their study provided a literature review of the theoretical, conceptual and functions of KPIs to improvise Malaysia's construction industry performance. However, this literature can guide the development of KPIs for the assessment of public infrastructure project provision in Malaysia which forms the major part of the research undertaken.

2.4.3 Establishments of Performance Indicators for Water Supply Services Industry in Malaysia

According to Kun et al. (2007), the Performance Indicators (PIs) in water supply services is applied as an evaluation tool, although the Malaysian Water Associations and organizations use it as their KPIs. This study succeeds in describing a new set of performance indicators to cover the major aspects of water supply services industry such as the management of water resources, personnel, physical assets, operation, and quality of service and financial. Consequently, the final list of PIs has further enhanced the existing PIs by covering all six key aspects in water supply services besides classifying the PIs into three levels of information grading, i.e., for public assessment, internal assessment and decision-making. However, these suggested indicators are not readily applicable to the Malaysian context that compatible with Malaysian plan that depend on BI in the field of water supply. As such, this study succeeds only in determining and classifying the important KPIs that are required in water supplying. From a management side, the study does not discuss the role of BI in this kind of applications.

2.4.4 Identify KPI in Electricity Marketing

Dun-nan, Xiao-liang, Guang-yu, and Hua-qing (2007), introduced and applied several KPIs to analyze an electricity market in China. This study gave the decision-markers or policy constitutors, a good reference by identifying the harmful behavior of collusion and traced out the strategy of generators. To identify the harmful behavior of this strategy, the study depend on collecting the information and then analyzing it to set the suitable KPIs that can make a quantitative analysis as shown in figures below (Nescu, 2007). However,

this study focused only on the management side and uses the traditional tools to identify KPIs. This has been made suitable to manipulate huge data using BI as unique solution.

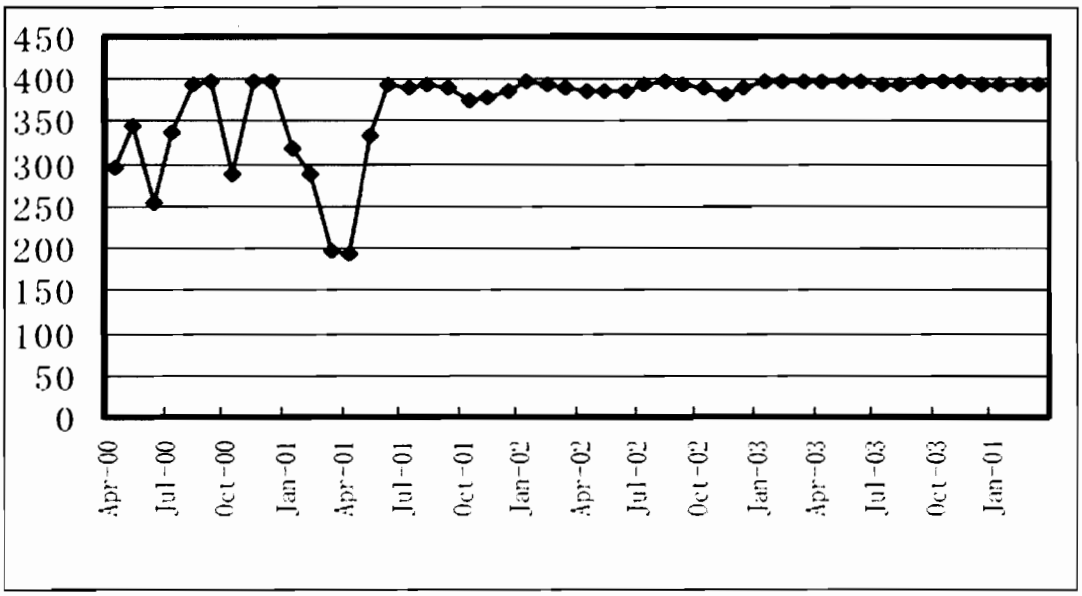


Figure 2.5.Monthly Average MCP of Market, 00-04

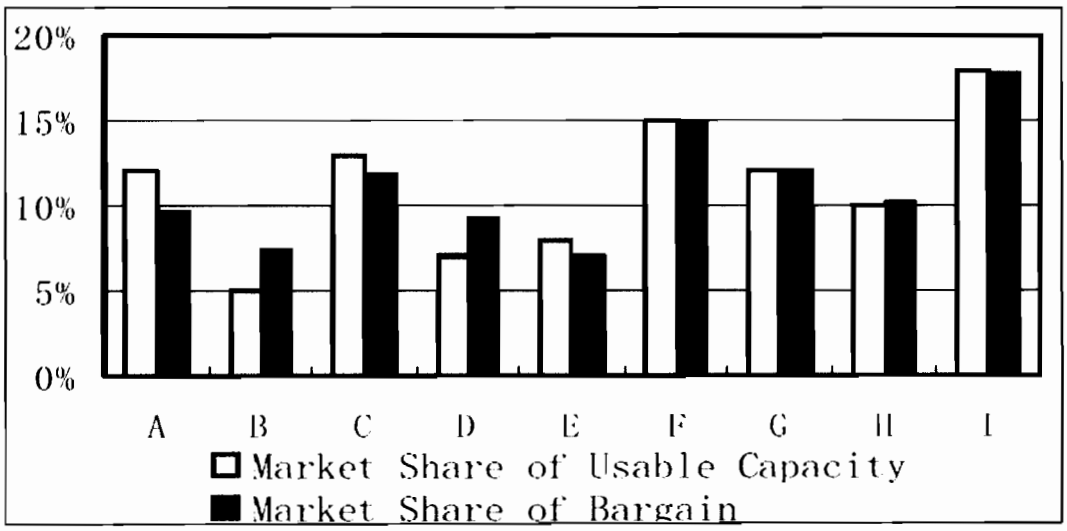


Figure 2.6.Comparison of Plants' Capacity Strategy

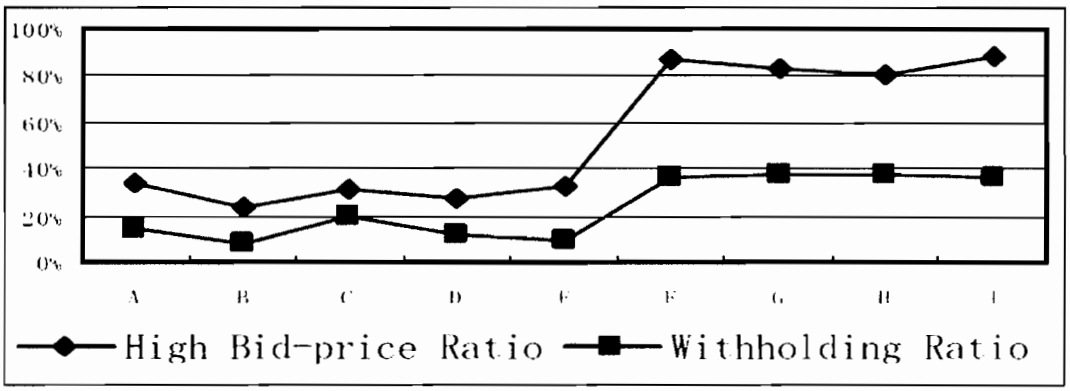


Figure 2.7.Comparison of Plants' Subjective Intentions

2.4.5 Importance of KPI in BI System Case Study in Iranian Industries

Seify (2010), found a good and effective BI system used in monitoring and evaluation of industrial oriented organizations. BI application that applied in this study helped the managers in decision making and indicated a real benefit of using this kind of applications. As such, the managers can get a correct format of information at a real time. Hence, the KPIs are a type of quantitative and measurable significant factors that must be considered in attaining an organization's goals. In addition, this study enabled managers to recognize managerial weakness of Iranian industries depending on diagnosing method. In short, Seify's study is succeeded in defining relevant KPIs and dashboard towards areas of weakness. Based on that, we indicated that we can also use the same path in developing suitable KPIs in form of BI application for Water Billing Department.

2.4.6 Performance Scorecards for Electric Power Distribution

In this study, Petkovic, Petkovic, and Petkovics (2009), are presented a different BI application to measure the performance in order to give a visual presentation to managers using scorecards. This study is identified a business indicators in field of electrical energy

distribution. Whereas, this BI application contains measures called KPIs and stoplight indicators (red, yellow, or green symbols) that provide the managers with needed performance, see figure 2.8. However, we supposed that we can apply this in water billing using more perspective KPIs in form of BI applications.

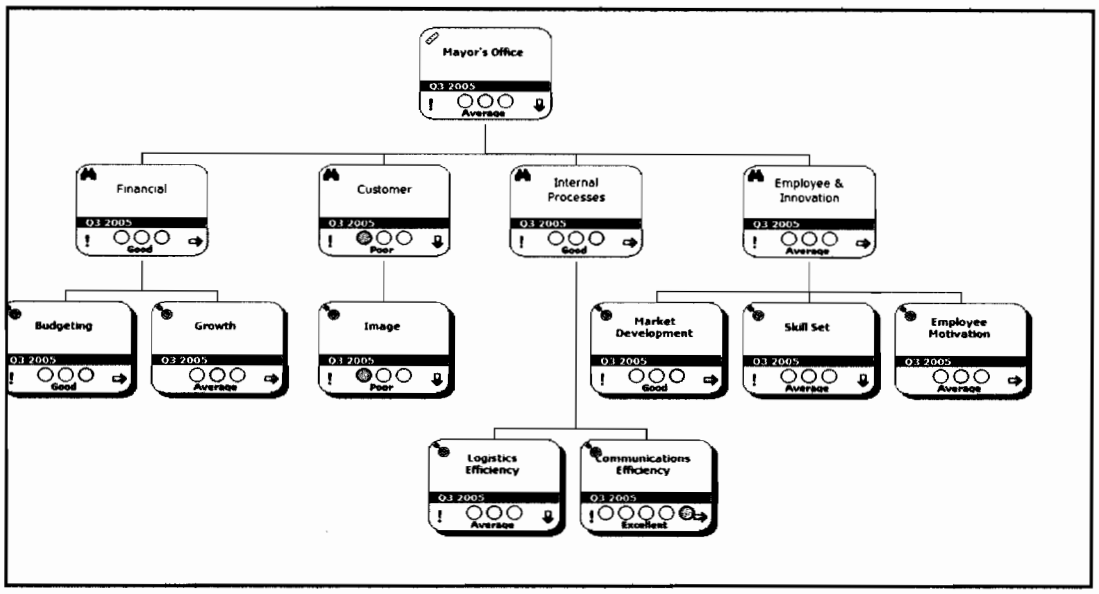


Figure 2.8.Software realization of BI application

2.4.7 Academic Business Intelligence System Development Using SAS® Tools

Ta'a, A., Shahbani, M., and Saleh, A. (2006), described a study that was aimed at defining and developing data warehouse (DW) for academic domain in a public university in Malaysia. A dimensional model (DM) of the DW in Student Affairs subject area was also defined. Then, a prototype of a BI application based on the proposed DW model was developed and linked to the university's information portal. SAS ETL and SAS Enterprise Guide were utilized successfully in developing the prototype. Despite, this study used SAS integration tool to prepare the data for DW then develop a BI system to display a lot of analytical reports and graphs as shown in Figure 2.9:

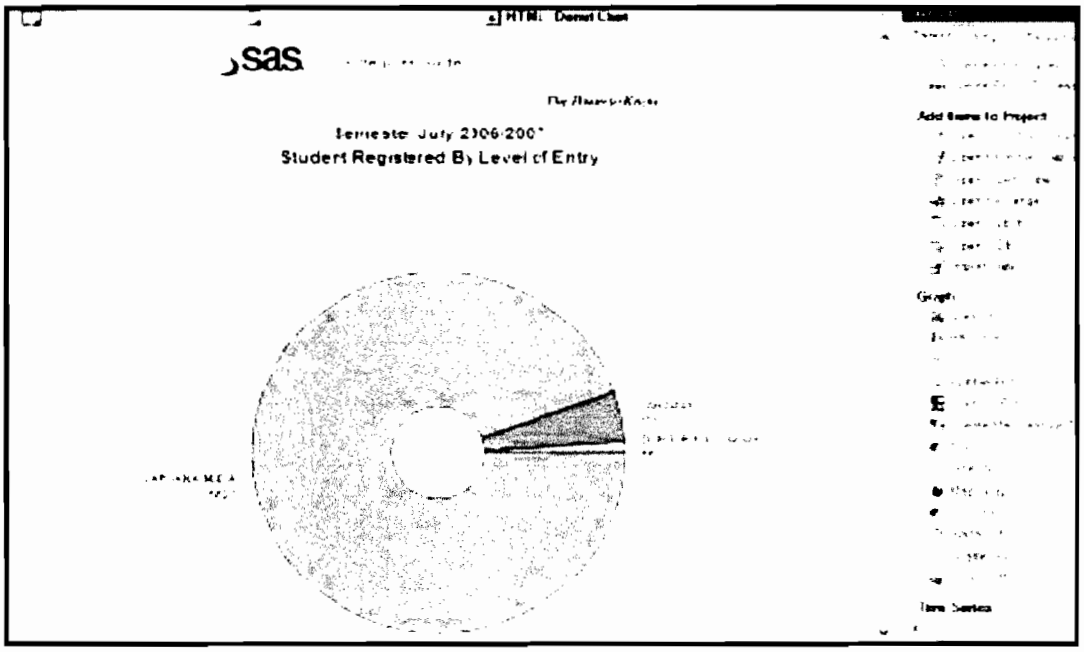


Figure 2.9 Pie chart graph produced from the task list

However, the study did not cover the analysis stage in details. Further, developing a KPI reports is stands on the analysis stage and get its data from the produced cube through this stage.

2.5 Summary

This chapter was covered a wide view about the KPIs, BI systems, DW, and OLAP concepts. In addition, with concept of developing KPIs using BI applications, it displayed the details of the related work. Enough detailed information and through understanding about the subject was covered for the reader as part of this study while next chapter elaborates the methodology that is used to conduct this project.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The methodologies that are used to conduct the objective of this study are discussed as a part of this chapter and at start description to the general methodology is given. Following which methodology in context of process steps starting with awareness of problem, suggestion, development, evaluation, and conclusion are listed. In addition, to develop our prototype, we used Rapid Application Development (RAD) methodology.

3.2 Methodology

There are a lot of methods to carry out a research. The methodologies that are used to conduct the objective of this research are discussed as a part of this chapter. According to Orlikowski and Baroudi (1991), depending on the goal of the study, either descriptive approach, or prescriptive approach are the two common approaches followed by researchers in the research of information technology The researcher is looking for the information about the nature of reality concerned to the study as a part of descriptive approach. As a part of the prescriptive approach, what the researcher looks for is improving the performance of a task. Based on Ardakan and Mohajeri (2009), in order to contribute to the augmentation of the knowledge base through scientific investigation, frameworks are more generally used to establish a research base. The framework that applied in this study proposed by Kuechler and Vaishnavi (2008). According to this

framework, the steps of designing a research in a specific field consists of five steps and each step has a different kind of work. The awareness of problem is covered as the first step of the methodology. This step can be found from the critical reading of the literatures and specially the last updated literatures which presents to the reader, last inventions and discoveries in the specific section. The second step is the suggestion which is called concept design by many researchers and contains data structures, models that define the components. The development stage resembles the artifact that the researcher or the scholar can construct in his/her research and depending on the type of research, the artifact is presented, which gets covered in step three. The fourth step is the evaluation step which can be done by selecting one or more of the evaluation methods (example: interview, survey, and questionnaire).Alternatively, evaluation step can be done using some kind of software whereby, the selection of the evaluation depends on the research and way that fits best with it.

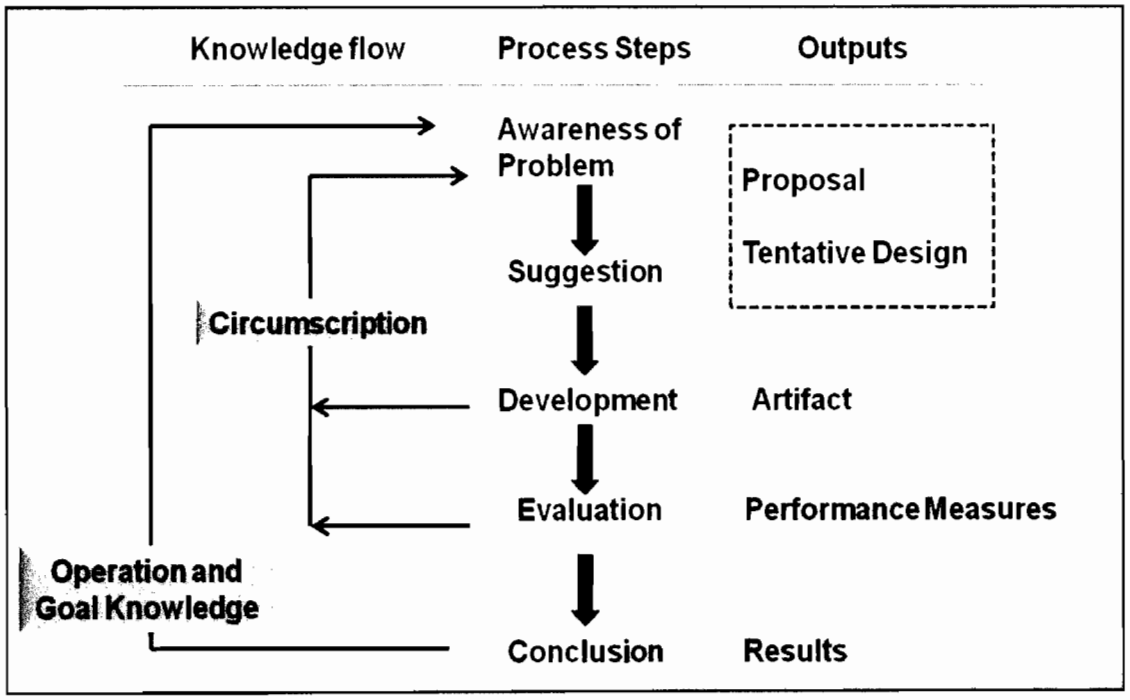


Figure 3.1.The General methodology of design research (Kuechler & Vaishnavi, 2008)

The documentation of the findings, the discussion on the research, future work and the description of the results are covered as part of the fifth and the final step and is part of the conclusion. In the main steps shown in Figure 3.1 and 3.2, the design research methodology or occasionally called "Improvement Research" is included.

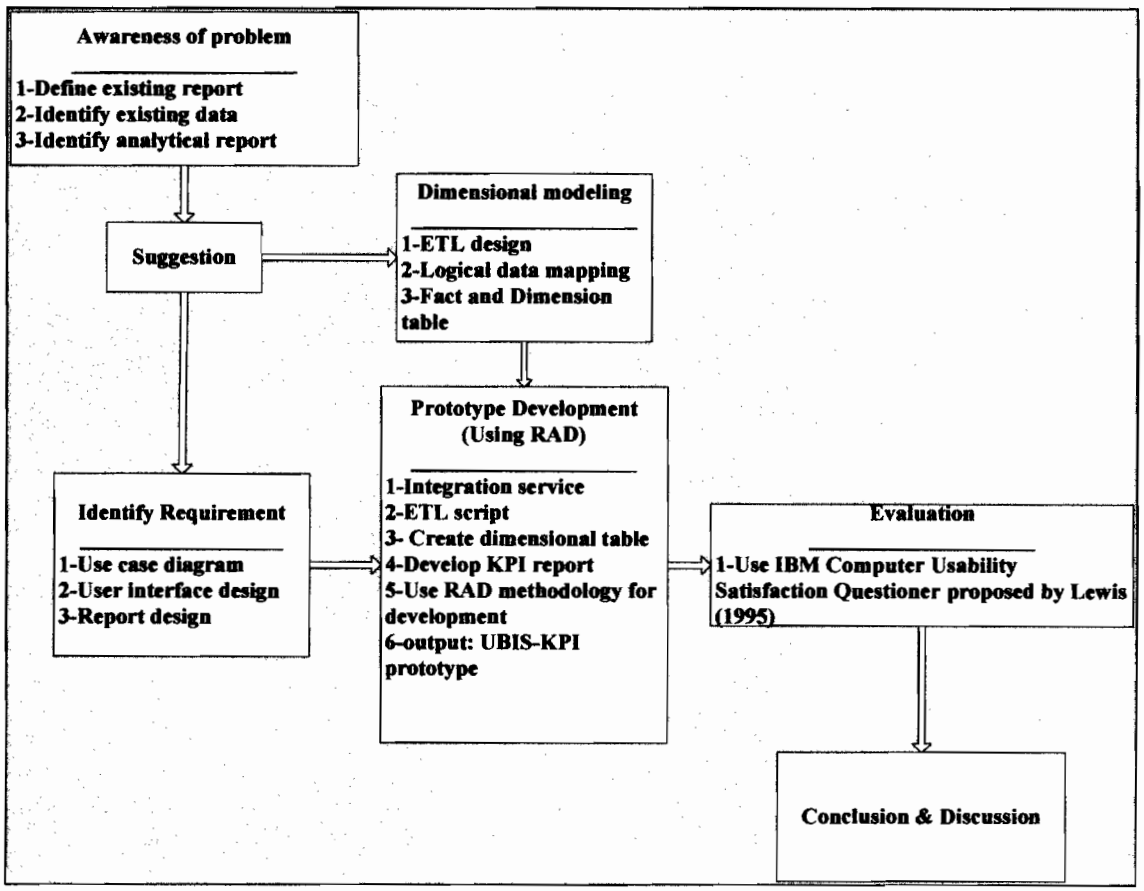


Figure 3.2.Research Method

3.2.1 Awareness of Problem

Offermann et al. (2009), noted that the equivalent phase in the generic design process model includes the analysis. In general, there are four factors that contribute to achieve this phase. Those factors involve identification of problem, literature research, expert interviews, and revaluate relevance. This phase offers a solid and important foundation for the further research process. Thus, we should have enough understanding about the

elements mentioned in the proposal to be able to start with the next phase of methodology, which is the suggestion.

3.2.2 Suggestion

This phase includes the suggestion to produce a prototype of a KPI reports for Water Billing System in BI application. Suggested KPI reports help to track the progress of Water Billing Department KPIs. The KPI report displays the progress by year or by month.

Suggested report reply the following complex queries in the following particular subjects:

i. Payment collecting: how are the consumer payment trends?

ii. Consumer arrears: how to minimize consumer arrears?

iii. Revenue &Non-Revenue: which are our lowest/highest revenue consumers?

3.2.3 Development

In this phase of project, we used Rapid Application Development (RAD) methodology which is proposed by Beynon-Davies et al. (1999). Based on this methodology, the analysis, design, build and test phases are compressed into a series of short, iterative development cycles shown as in Figure 3.3. RAD methodology has a number of distinct advantages over the other development models. One of the principles of RAD is to start developing as early as possible in the project, so that we can review a working prototype and offer additional direction in order to build our prototype in an iterative software engineering process.

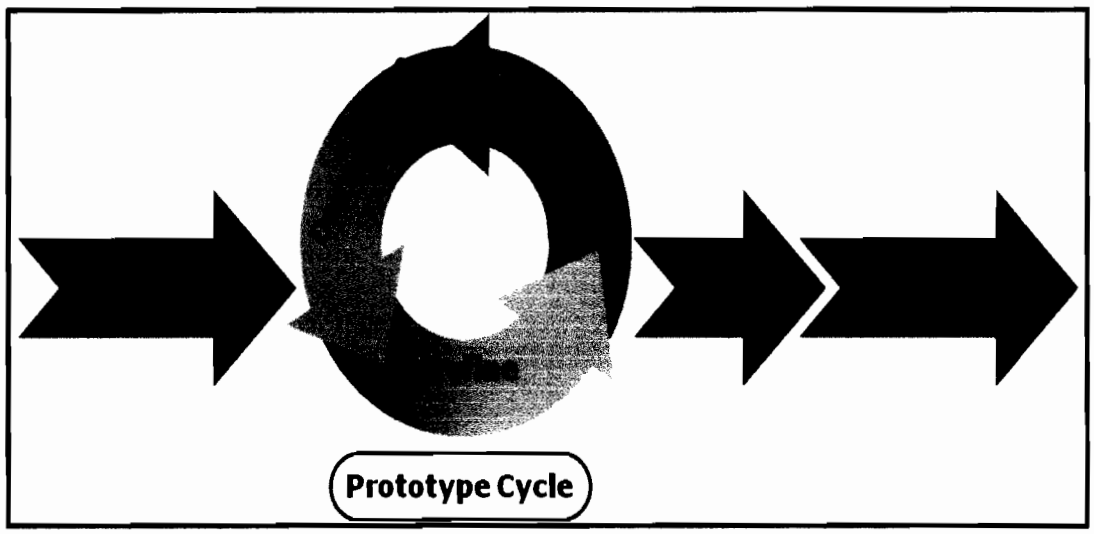


Figure 3.3 Rapid Application Development Methodologies (RAD)

3.2.4 Evaluation

In this phase of methodology, we evaluate our results by distribute a computer system usability questioner which helped us to see if our prototype meets with the expectations; the result system that is done does not need to have a feedback to the first step, or did not require any system modifications.

3.2.5 Conclusion

It includes the findings of the research and the future work of this study. All the results are described in this step with a discussion on it from the sides of BI and DW that are evolved in this study.

3.3 Summary

As we mentioned in this chapter, this project was conducted using two methodologies. Kuechler and Vaishnavi methodology which contains five phases is part of the first methodology. Firstly, the awareness of problem is identified by the data and

needed reports. Secondly, the suggestion which is introduced to the next phase which is the dimensional model whereas, ETL, process, data designs is an output used for third phase. At the next phase, the second methodology is applied which is the development phase. In design and implementation of prototype, the Rapid Application Development methodology is used as the software engineering process and the resulted prototype is evaluated using a questionnaire and these overall forms part of the fourth phase. Finally, we arrive at the recommendation which contains the contribution, limitation, and future work. Our methodology which is walked through the analyzing of the requirement, design and implementation of prototype are covered in next chapter and also part of fifth phase.

CHAPTER FOUR

REQUIREMENTS, DESIGN

AND PROTOTYPE DEVELOPEMENT

4.1 Introduction

By specifying the requirements of designing the logical model of the KPI reports is how we began this chapter which was also suggested in last chapter. As a part of process design and in order to be evolved as the final system, we described the important UML diagrams which are used to translate the system requirements into a group of interacts. With the objective to support BI, we covered the design and implementation of a DW. We discussed the implementation of relational tables using SQL server 2005 features and further took a detailed look at the data modeling process. For the next phase, dimension and fact tables in DW of WBS were populated to be ready. The phase of transforming data to be compliant with the designed DM is known as integration data source and explained as a part of this chapter. We show how the analysis services and cubes are built in order to enable WB managers to access the information in DW. How data models were adjusted to support cubes in analysis services were further described. Following which, how we design and develop our KPI reports that were suggested in the previous chapter were covered in details. The design of the data is provided in this chapter represented by ERD, DM, OLAP-KPI and LDM and further we described interface design and report design which includes the suggested KPI report's formula. During the implementation part, important sample codes were provided for the hardware and software requirements.

4.2 Requirement Specification

The requirement specification represents the heart of DW/BI systems (Mundy et al., 2006). Through this phase we know how to present KPIs on the users' screens. In this section we covered the requirements gathering using the interview with Water Billing System experts. In the interview we asked them three questions. The first one was "What are the most frequently KPIs that suggested and helped them to track and analysis the progress of Water Billing process?" the second question was "what is the progress period of these suggested KPIs is it yearly, monthly or weekly?" third question is "Who are the actors of these KPIs?" The answers come as the following:

No.	Suggested KPI	Actor	Period
1	Payment collection must be more than 70% from total bill amount.	- Manager - Admin	Yearly
2	All collection centers must collect more than 10,000 RM.	- Manager - Admin	Yearly
3	Percentage of Non revenue water consumptions must be less than 34%.	- Manager - Admin	Monthly

Each KPI will be included in a form of the report to perform the target that has been set for each particular indicator. We defined both minimum and maximum levels for a target. The suggested KPI reports objectives are:

i. Collecting payment report: Track payments that were collected (paid) on time expressed during the reporting period.

ii. Water consumption report: To reduce overall water consumption.

iii. Collection agent performance report: To track the performance of these agents and determine whether they meet the collection target or not.

Accounting to what we have already mentioned, the functional and non functional requirements will be as the following:

i. M: mandatory requirements (the system must do it)

ii. D: desirable requirements (the system preferably do it)

iii. O: optional requirements (the system may do it)

4.2.1 Functional Requirements

No.	Requirement	Priority
1	The manager/actor will be able to analyze "collecting payment" and tracking the payments expressed as amounts that were defined by summation of payments year by year.	M
2	The manager/actor will be able to track the "collection payment performance" per each collection agent year by year to see which centre meets the collection target.	M
3	The manager/actor will be able to analyze "non-revenue water consumption" which is defined by minus the revenue water	M

	consumption from the total water consumption expressed as a cube meter. This is analyzed monthly and/or by consumption group.	
4	The system will be able to display the figures and charts and will be able to print. Actors can display charts and graphs, but if this feature is not available, they can export to Excel and do the graphs there. They will need an export to Excel (or to CSV) feature.	D
5	The report and OLAP will have an easy-to-use user interface. The users/managers do not really care about the details of the user interface. The numbers are much more important to the users than the layout. The DW users understand that their job is to deliver business performance, and these numbers are the enabler.	O

4.2.2 Non-Functional Requirements

No.	Requirement description	Priority
	Reliability issues	
1	If the system is crashing, it must be no more than once per 24 hours.	M
2	If the system has reached the point of crash, it should not be more than 10 Minutes.	M
3	If the system has reached the point of crash, it must behave perfectly normal when reloaded again.	M
	Usability issues	

4	The system must be available twenty four hours a day and seven days a week.	M
	Security issues	
5	Only the managers will be able to login to a system to do the available activities.	M
6	Only the Manager can log in to the database and make the maintenance.	
7	Unauthorized person should not use the system, just view the main page.	M
8	The system cannot enter unauthorized pages of the program database.	M
9	No one can change the password without login to the system.	M
	Understandability	
10	The system is easy to understand.	M
	Performance	
11	The system must have a reasonable speed according to the technology used to access many of officers at the same time.	M
	Availability	
12	The system must be available to the managers only not all kinds of users.	M

4.3 Process Requirements

After we finished the requirements and got an idea for them, requirement processing can be start by documenting these requirements in use cases form and series of iterations that

evolve into the final system. To control this process we used the Rational Rose program (Quatrani, 2003).

4.3.1 Use Case Diagram

According to Quatrani (2003), the behavior of the system under development (i.e., what functionality must be provided by the system) is documented in a use case model that illustrates the system's intended functions (use cases), its surroundings (actors), and relationships between the use cases and actors (use case diagrams).

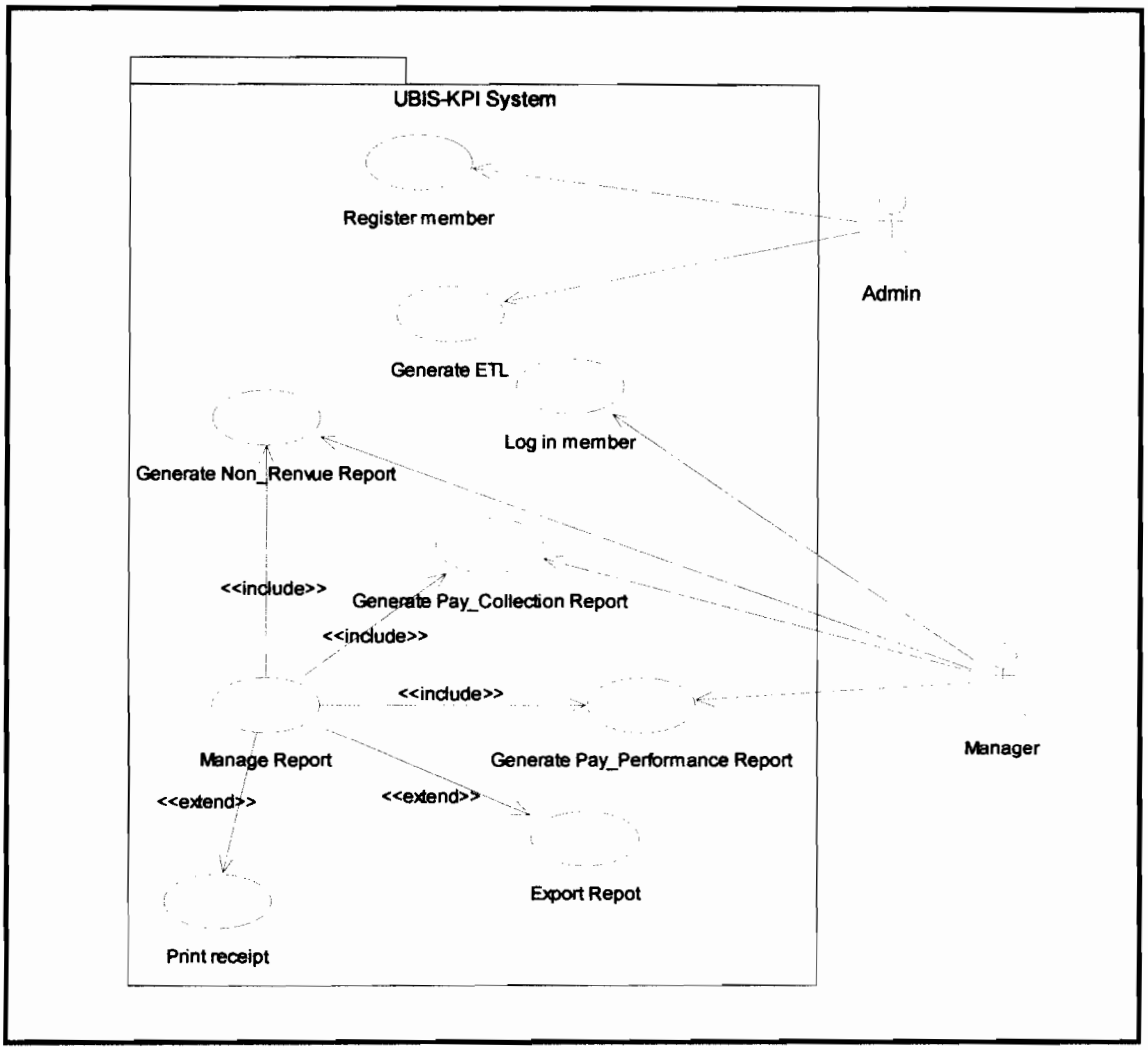


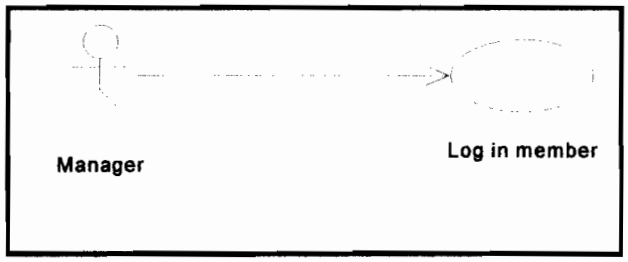
Figure 4.1 Use Case Diagram

The use case diagram is the perfect way to describe the activities of the system by using figures to define the cases whom the users of the system have to deal with to do the activities of the system also the users here are defined as actors. This use case diagram is one of the analysis steps defined by the UML. Figure 4.1 describes the main functionality of the UBIS-KPI system's users as the actors in the developed reporting system and their interaction with the system.

4.3.2 Use Case Specification

This section illustrates the tasks for each use case in use case diagram and how the user interact with the system and does his / her activities.

I. Use case: Log in Member:



a. Brief description

This use case is initiated by the Manager so that he can login to the system.

b. Pre-conditions

The manager should enter the user name and password, and then enter button.

c. Characteristic of activation

Manager demand execution

d. Flow Of Events

i. Basic Flow

The manager views main page.

ii. Alternative Flow

Not applicable

iii. Exceptional Flow

E1. The system show error message if the manager entered the wrong username and/or password.

e. Post-Conditions

View the system main page.

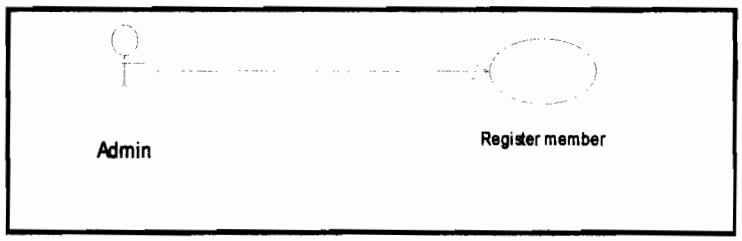
f. Rule(S)

Not applicable.

g. Constraint(S)

Not applicable.

II. Use Case: Register Member:



a. Brief description

This use case is initiated by the Admin to register a new member to the system, this use case will enable the manager to create a new member, delete the member, and edit the member.

b. Pre-conditions

Not Applicable

c. Characteristic of activation

Manager demand execution

d. Flow Of Events

i. Basic flow

a) This use case begin when the manager press "Register Member" button.

b) The system will retrieve all available member information.

c) The system will display all the Members in Register Member page.

d) The manager will press "Add" button [A-1: Delete] [A-2: Update].

e) The system will display Add form.

f) The manager will fill all the information.

g) The manager will press "Save" button. [A-3: Cancel].

h) The system will retrieve the member information.

i) The system will verify duplicate member information

j) The system will update the data base.

k) The system will save the new member information.

l) The system will display a message" The data has been saved ".

ii. Alternative flow

[A-1: Delete]

a) The manager will select a specific member from the list.

b) The manager will press "delete" button.

c) The system will display a message "Are you sure?".

d) The manager will press "OK "button. [A3: Cancel].

e) The system will delete the specific member.

f) The system will update the data base.

g) The system will display a message "Delete has been successful".

[A-2: Update]

a) The manager will select a specific member from the list.

b) The manager will press "Update" button.

c) The system will display Update form.

d) The manager will edit the member information.

e) The manager will press "Update "button. [A3: Cancel].

f) The system will edit and update the database.

g) The system will show a massage "Update has been successful".

[A-3: Cancel]

a) The manager will press "Cancel" button.

b) The system will stop the process.

c) The system will return back to Register Member page.

iii. Exceptional flow

Not applicable

e. Post-conditions

The system will update the database.

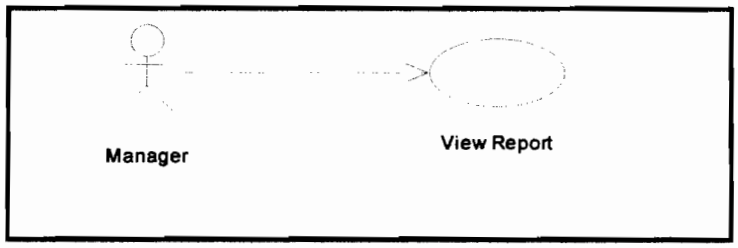
f. Rule(S)

Not applicable.

g. Constraint(S)

Not applicable.

III. Use case: View Report



a. Brief description

This use case is initiated by the manager that can be able to view the particular report.

b. Pre-conditions

Not applicable.

c. Characteristic of activation

Manager demand

d. Flow of events

i. Basic Flow

The user views main page.

ii. Alternative Flow

Not applicable

iii. Exceptional Flow

Not applicable.

e. Post-Conditions

Not applicable.

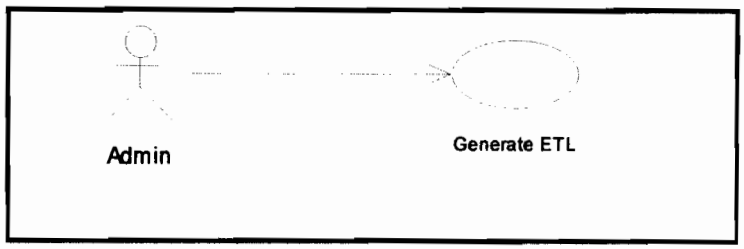
f. Rule(S)

Not applicable.

g. Constraint(S)

Not applicable.

IV.Use case: Generate ETL



a. Brief description

This use case is initiated by the DBMS system to enable the Extract, Transfer and load data to KPI report.

b. Pre-conditions

Data sources is available

c. Characteristic of activation

System demand

d. Flow of events

i. Basic Flow

The system extract, transform and load data from data source to data target.

ii. Alternative Flow

Not applicable

iii. Exceptional Flow

Fail ignored

e. Post-conditions

First generate and yearly/monthly update the data in DW tables.

f. Rule(S)

Not applicable.

g. Constraint(S)

Not applicable.

4.4 Data Design

Hancock and Toren (2006), mentioned that the objective of this step is to build a dimensional model for the DW from the available database to support the business activities and to implement the DW. The process of design dimensional model depends on four ordered steps that many developers utilized it. The key inputs of the dimensional design process are illustrated as follows:

i. Business Process: Chose the business accomplished activities in the organization to model

ii. Grain: State the bit of business process, which means identifying what the distinct fact table row points are to. This step is more in describing what does the single row in fact tabling means

iii. Dimensions: Select the dimensions that support each fact's row, if users clear in identifying there grain then creating dimensions will be an easy task.

iv. Facts: Identifying the measures that will calculated in fact table.

According to our requirements that collected from the Water Billing experts: we had three KPI reports: pay_collection report, pay_performance report and Non_renevue report as illustrated in use case diagram in Figure 4.1.

In this section we display the data design of these three water billing processes.

In Water Billing transaction database we have 49 kinds of payments as shown in Figure 4.2, we focused on the first kind of bill payments (events) depending on its type (*EVNTYP*) and Group (*EVNGRP*) attributes, which is (Bil Air) represented by combined two attributes *EVNTYP* =0 & *EVNGRP* =01.

	EVNGR	EVNTYP	DESCR
1	01	0	BIL AIR
2	01	1	NOTA KREDIT
3	01	2	BAYARAN
4	01	3	PELARASAN ANGGARAN
5	01	4	NOTA DEBIT
6	02	0	BIL PEMASUKAN
7	02	1	KREDIT BIL PEMASUKAN
8	02	2	BAYARAN BIL PEMASUKAN
9	02	4	DEBIT BIL PEMASUKAN
10	03	0	BIL TUKARGANTI METER
11	03	1	KREDIT TUKARGANTI METER
12	03	2	BAYARAN TUKARGANTI MET
13	03	4	DEBIT TUKARGANTI METER
14	04	0	BIL DENDA
15	04	1	KREDIT DENDA
16	04	2	BAYARAN DENDA
17	04	4	DEBIT DENDA
18	05	0	BIL PENYAMBUNGAN SEMULA

Figure 4.2: (Bill payment groups)

The total bill amount (*OPAMT*) will be saved in *tbOpItems* table depending on its event type and event group for the particular consumer (*CONNUM*) with the payment due date (*TimeKey*) as shown in Figure 4.3:

	OPNUM	TimeKey	CONNU...	BILNUM	PAYNUM	EVNGR...	EVNTYP	APPDAT	OPAMT
1	00117760	1	000106	00094712	NULL	01	1	1997-01-01 00:00:00.0	43.00
2	00117770	1	007464	00094706	NULL	01	1	1997-01-01 00:00:00.0	31.00
3	00117771	1	009120	00094707	NULL	01	1	1997-01-01 00:00:00.0	369.20
4	00117772	1	009984	00094708	NULL	01	1	1997-01-01 00:00:00.0	56.50
5	00117773	1	010186	00094709	NULL	01	1	1997-01-01 00:00:00.0	503.22
6	00117794	1	017752	00094716	NULL	01	1	1997-01-01 00:00:00.0	145.10
7	00117795	1	017862	00094717	NULL	01	1	1997-01-01 00:00:00.0	525.10
8	00117796	1	018302	00094713	NULL	01	1	1997-01-01 00:00:00.0	72.00
9	00117797	1	018575	00094715	NULL	01	1	1997-01-01 00:00:00.0	80.10
10	00117798	1	018580	00094714	NULL	01	1	1997-01-01 00:00:00.0	294.10
11	00117842	1	019147	00094744	NULL	01	1	1997-01-01 00:00:00.0	112.60
12	00117857	1	019203	00094752	NULL	01	1	1997-01-01 00:00:00.0	36.10
13	00117881	1	019242	00094743	NULL	01	1	1997-01-01 00:00:00.0	130.20
14	00117923	1	019315	00094751	NULL	01	1	1997-01-01 00:00:00.0	27.00
15	00117930	1	019328	00094746	NULL	01	1	1997-01-01 00:00:00.0	36.10
16	00117946	1	019351	00094745	NULL	01	1	1997-01-01 00:00:00.0	36.80

Figure 4.3: Overall payment table

When the consumer (*CONNUM*) pay his water bill payment (*PAYAMT*) in the particular collection agent (*COLAGT*) particular time that specified by (*TimeKey*) as it saved in *tbPayment* table that shown in Figure 4.4.In Water Billing system we have seven collection agents illustrated in Figure 4.5 represented by *tbCollAgt* table which contains seven payment collection agents.

	PAYNUM	TimeKey	CONNU...	APPDAT	COLAGT	PAYAMT
1	00043685	1	037945	1997-01-01 00:00:00.0	05	24.90
2	00043686	1	033454	1997-01-01 00:00:00.0	05	32.40
3	00043687	1	022895	1997-01-01 00:00:00.0	05	50.00
4	00043688	1	040693	1997-01-01 00:00:00.0	05	8.00
5	00043689	1	031736	1997-01-01 00:00:00.0	05	1526.20
6	00043690	1	032646	1997-01-01 00:00:00.0	05	20.00
7	00043691	1	018675	1997-01-01 00:00:00.0	05	28.80
8	00043692	1	021966	1997-01-01 00:00:00.0	05	71.50
9	00043693	1	036023	1997-01-01 00:00:00.0	05	40.00
10	00043694	1	007609	1997-01-01 00:00:00.0	05	23.90
11	00043695	1	017431	1997-01-01 00:00:00.0	05	37.90
12	00043696	1	018630	1997-01-01 00:00:00.0	05	85.50
13	00043697	1	007909	1997-01-01 00:00:00.0	05	30.00
14	00043698	1	018704	1997-01-01 00:00:00.0	05	10.40

Figure 4.4: Payment table

	COLAGT	DESCR	LSTUPD	LSTUSRID
1	00	JKR	2004-04-04 12:42:22.0...	PCA
2	01	TENAGA NASIONAL	2004-04-04 12:42:22.0...	PCA
3	02	TELEKOM MALAYS...	2004-04-04 12:42:22.0...	PCA
4	03	POS MALAYSIA	2004-04-04 12:42:22.0...	PCA
5	04	MPK	2004-04-04 12:42:22.0...	PCA
6	05	JKR	2004-04-04 12:42:22.0...	PCA
7	06	MALAYAN BANKING	2004-08-05 15:58:24.0...	AZIA

Figure 4.5: Payment collection agents table

The other important table in water billing transaction database is *tbCONSGRP* which is contain 15 types of water consumer group identified by (CONGRP) which is represent group id, (TARCO) which is represented tariff code and (DESCR) which represent the name description of the consumption. Figure 4.6 show this table.

	CONGRP	TARCO...	DESCR	SDESCR	SUSPEN...
1	01	A	KEDIAMAN	NULL	0
2	02	C	RESTORAN KEDAI MAKAN / KANT...	RESTORAN	0
3	03	B	KEDAI RUNCIT & LAIN-LAIN KEDAI	KEDAI	0
4	04	B	KANTIN	KANTIN	0
5	05	A	INSTITUT PENGAJIAN	NULL	0
6	06	A	BANGUNAN SEKOLAH	SEKOLAH	0
7	11	A	KERAJAAN	NULL	0
8	12	A	BADAN BERKANUN	NULL	0
9	21	A	TEMPAT BERIBADAT	NULL	0
10	31	A	PERSATUAN	NULL	0
11	40	A	MISCELLANEOUS	NULL	0
12	51	B	INSTITUT PERGAJIAN	NULL	0
13	61	B	INDUSTRI RINGAN	NULL	0
14	71	C	INDUSTRI BERAT	NULL	0
15	81	D	PANCUR AIR	NULL	0

Figure 4.6: Consumer group table

The other important table is the time table. This table contains time formats, most of them not used in our design like quarter time, fiscal quarter, and fiscal year. In our suggested dimensional data model we don't use any of these forms. Instead we need to create our own time table which contained year and month only depending on our requirements.

	TimeKey	EnglishDayNameOfWe...	EnglishMonthNa	CalendarQuart	CalendarYear
1	1	Wednesday	Jan	1	1997
2	2	Thursday	Jan	1	1997
3	3	Friday	Jan	1	1997
4	4	Saturday	Jan	1	1997
5	5	Sunday	Jan	1	1997
6	6	Monday	Jan	1	1997
7	7	Tuesday	Jan	1	1997
8	8	Wednesday	Jan	1	1997
9	9	Thursday	Jan	1	1997
10	10	Friday	Jan	1	1997
11	11	Saturday	Jan	1	1997
12	12	Sunday	Jan	1	1997
13	13	Monday	Jan	1	1997
14	14	Tuesday	Jan	1	1997
15	15	Wednesday	Jan	1	1997

Figure 4.7: Time table

Water consumption classified to total supplied water measured by cubed meter, non revenue and revenue consumption as in the following tables: *tbSourceCons*, *tbRWCons*

	SICode	Consumpti...	MCCode
1	SI01	26040	2006-01-01 00:00:00.0
2	SI02	0	2006-01-01 00:00:00.0
3	SI01	23520	2006-01-02 00:00:00.0
4	SI02	0	2006-01-02 00:00:00.0
5	SI01	25970	2006-01-03 00:00:00.0
6	SI02	0	2006-01-03 00:00:00.0
7	SI01	25130	2006-01-04 00:00:00.0
8	SI02	0	2006-01-04 00:00:00.0
9	SI01	26040	2006-01-05 00:00:00.0
10	SI02	0	2006-01-05 00:00:00.0
11	SI01	25200	2006-01-06 00:00:00.0
12	SI02	0	2006-01-06 00:00:00.0

Figure 4.8: Source Consumption table

	RWCode	Consumpti...	MCCode
1	RW01	16897	2006-01-01 00:00:00.0
2	RW02	0	2006-01-01 00:00:00.0
3	RW01	15261	2006-01-02 00:00:00.0
4	RW02	0	2006-01-02 00:00:00.0
5	RW01	16982	2006-01-03 00:00:00.0
6	RW02	0	2006-01-03 00:00:00.0
7	RW01	16434	2006-01-04 00:00:00.0
8	RW02	0	2006-01-04 00:00:00.0
9	RW01	17247	2006-01-05 00:00:00.0
10	RW02	0	2006-01-05 00:00:00.0
11	RW01	16690	2006-01-06 00:00:00.0
12	RW02	0	2006-01-06 00:00:00.0

Figure 4.9: Revenue Consumption table

Because of the data source contain just consumption of the year 2006, so that the consumption KPI report contained this data only. Non revenue consumption can be calculated by minus the revenue consumption from the source consumption. This calculation can be accomplished by using Analysis services features and Multidimensional Expressions (MDX) in SQL server 2005. MDX is a query language that is used to interact and perform tasks with multidimensional databases (also called: OLAP Cubes). Before starting with OLAP process it must deal with the source data and do the proper processing on it and specify dimensions and facts, which can benefit from it to support the reports that will propose earlier in this chapter. Figure 4.10 and 4.11 are shown the entity relationship diagram (ERD), which includes 300 tables, that why we selected a particular part of UBIS database that related with our work. In order to transfer the data from the source files, we have to read and understand the data after that take a copy from the needed data to do manipulations on it; in this case, we have to extract the data from UBIS source database system to the our data warehouse.

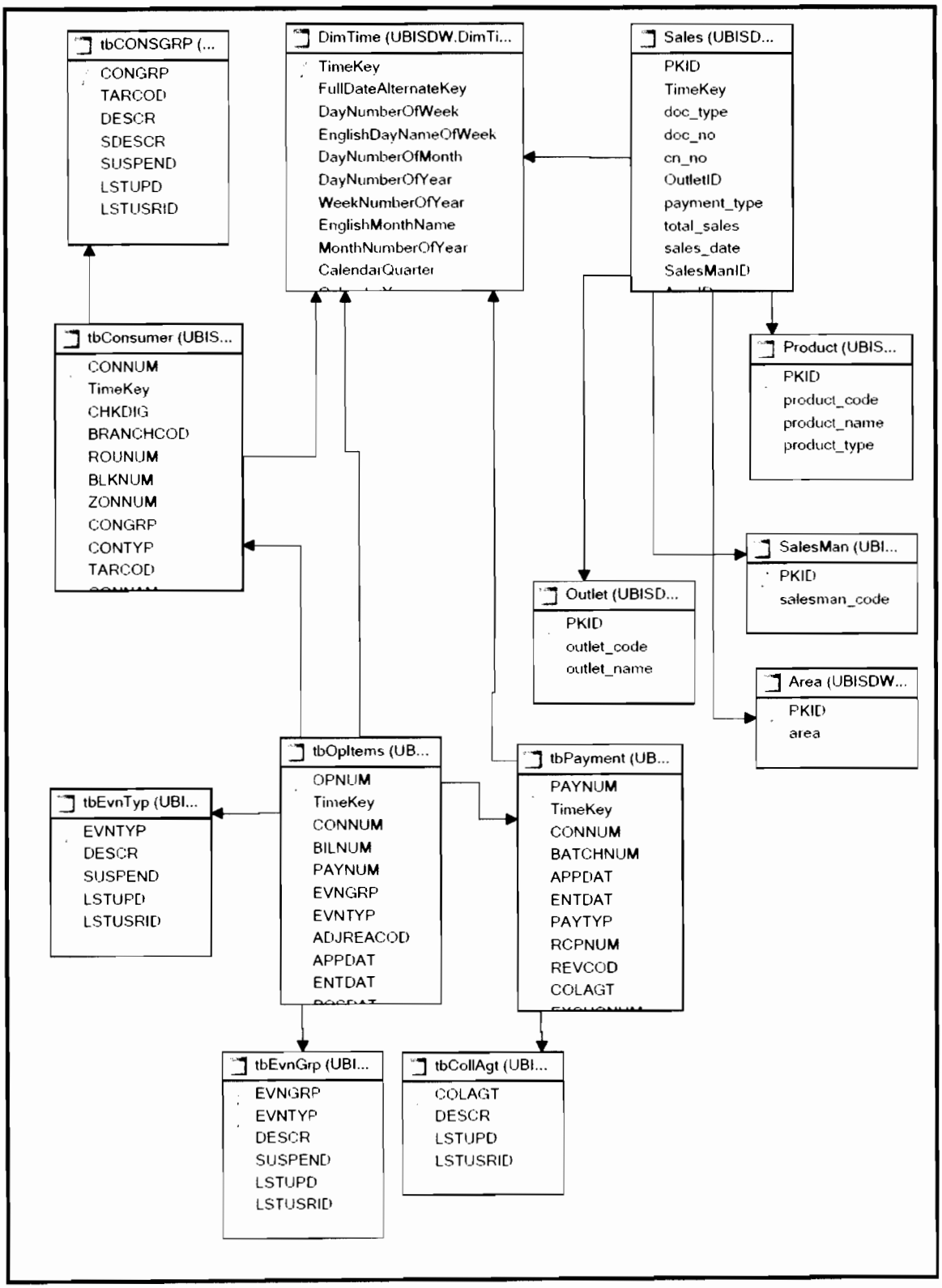


Figure 4.10: ERD diagram

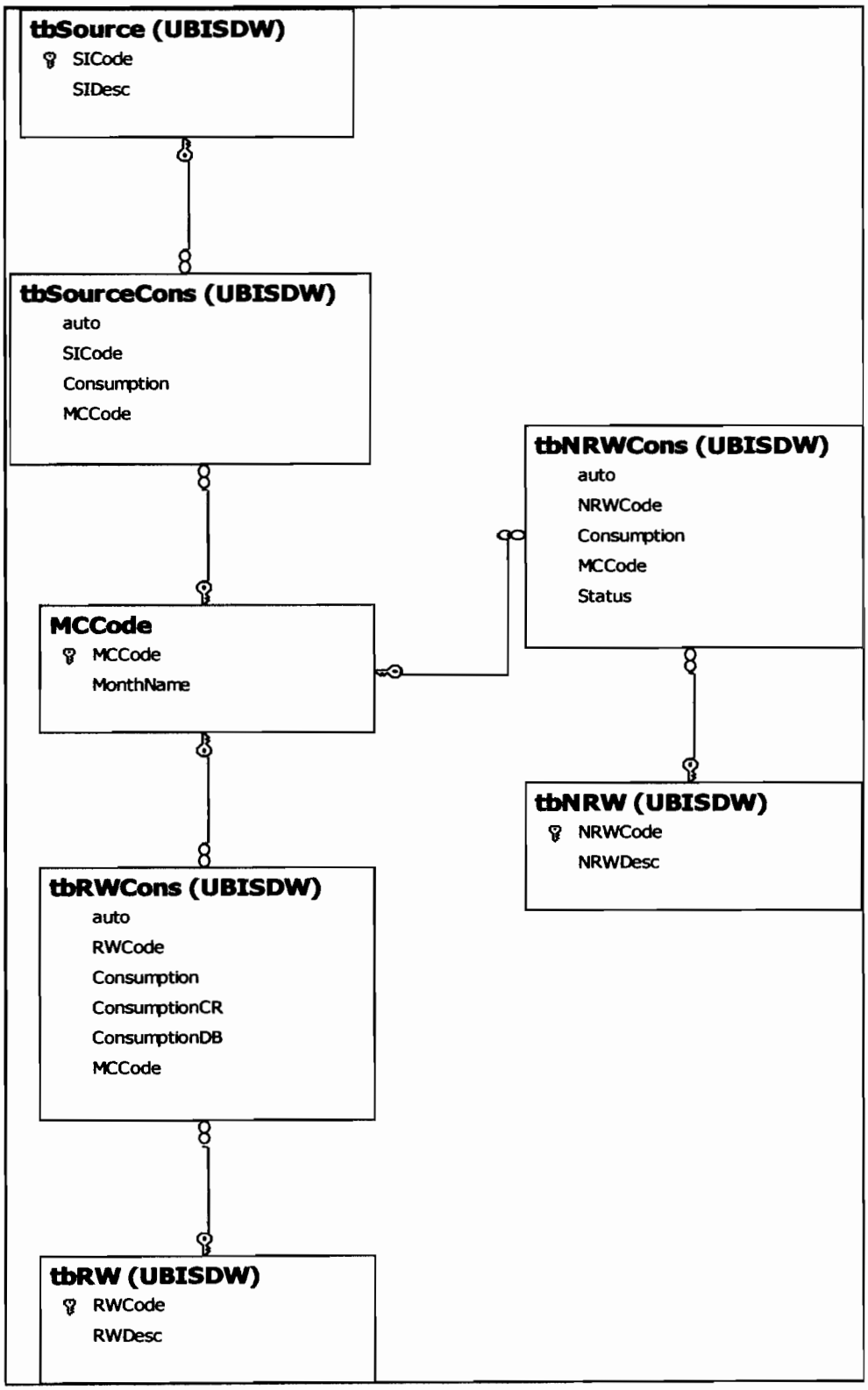


Figure 4.11: ERD diagram

4.4.1 Dimensional Model (DM)

According to Mundy et al. (2006), Dimensional modeling (DM) defined as a logical design of the DWs. It is different than the logical design of the entity- relation modeling (ERD) which used to remove the redundancy in data. The benefit of using DM is to present the data in standard framework to use it then in high performance access. Figure 4.12 showed the roadmap of WB modeling process that we followed in this chapter.

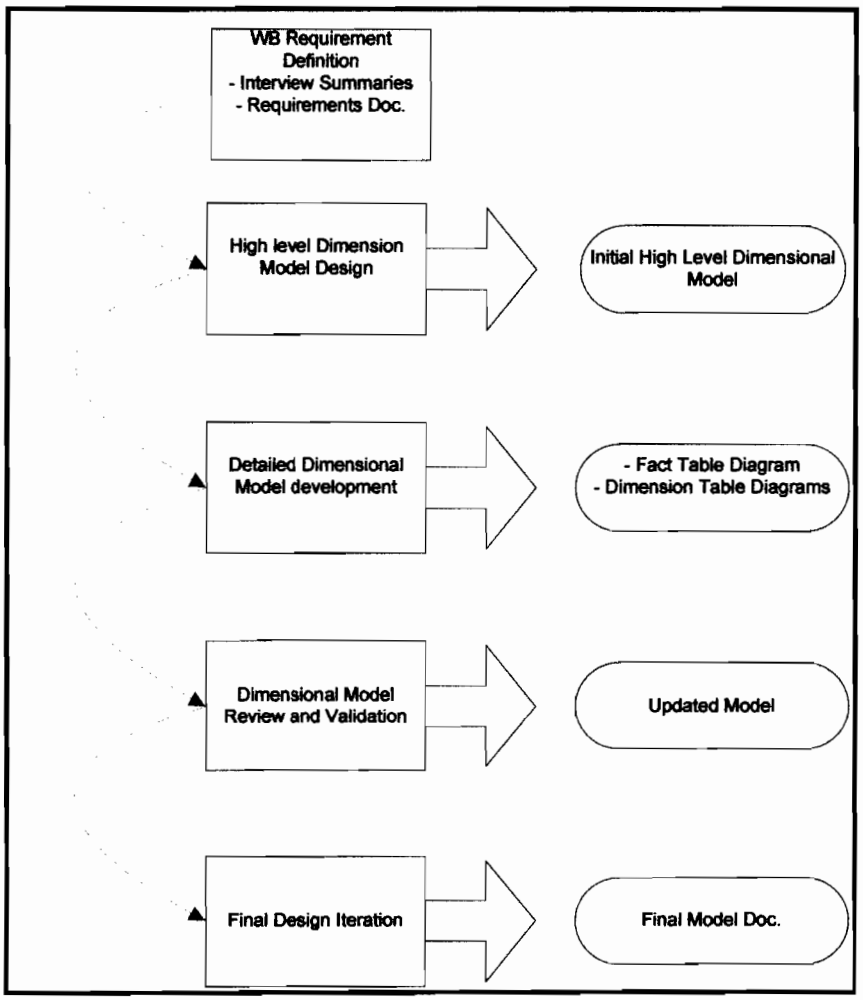


Figure 4.12: The dimensional modeling process flow diagram

4.4.2 Logical Data Map

We often start dimensional modeling using the logical data model, which is a spreadsheet used to make easy changes in our model. Tables 4.1, 4.2, 4.3, 4.4, 4.5, and 4.6 are captured all the elements of or logical DM and all the physical attributes that we need them later. It's also provides a good place to put some ETL information, such as data source and brief description about extracting rules. Indeed, the main purpose of using LDM is to connect the data source with data target. Moreover, and before start building LDM, firstly we have to be sure that what we want to get from the source database exactly and what the target should be looks like (Kimball, 1997).

Table 4.1: Logical Data Mapping for DimTime1 dimension table

Table Name: **DimTime1**
Table Type: **Dimension**
Description:

Target Database (DW)			
Table name	Column name	Data Type	Table Type
DimTime1	TimeSKey	Int	Dimention
DimTime1	MCCode	Datetime	Dimention
DimTime1	MonthName	nvarchar(10)	Dimention

Source Database (OLTP)				
DB Name	Table Name	Column Name	Data Type	**Trans-formation**
ETL process				
UBIS.mdb	UBISDW.MCCode	MCCode	datetime	Extract
UBIS.mdb	UBISDW.MCCode	MonthName	nvarchar(10)	Extract

Table 4.2: Logical Data Mapping for DimTime dimension table

Table Name: **DimTime**

Table Type: **Dimension**

Description:

Target Database (DW)

Table name	Column name	Data Type	Table Type
DimTime	TimeKey	Int	Dimention
DimTime	FullDateAlternateKey	Datetime	Dimention
DimTime	DayNumberOfWeek	Tinyint	Dimention
DimTime	EnglishDayNameOfWeek	nvarchar(10)	Dimention
DimTime	DayNumberOfMonth	Tinyint	Dimention
DimTime	DayNumberOfYear	Smallint	Dimention
DimTime	WeekNumberOfYear	Tinyint	Dimention
DimTime	EnglishMonthName	nvarchar(10)	Dimention
DimTime	MonthNumberOfYear	Tinyint	Dimention
DimTime	CalendarQuarter	Tinyint	Dimention
DimTime	CalendarYear	char(4)	Dimention
DimTime	CalendarSemester	Tinyint	Dimention
DimTime	FiscalQuarter	Tinyint	Dimention
DimTime	FiscalYear	char(4)	Dimention
DimTime	FiscalSemester	Tinyint	Dimention

Source Database (OLTP)

DB Name	Table Name	Column Name	Data Type	**Transf-ormation**
ETL process				
UBIS.mdb	UBISDW.DimTim	FullDateAlternateKey	Datetime	Extract
UBIS.mdb	UBISDW.DimTim	DayNumberOfWeek	Tinyint	Extract
UBIS.mdb	UBISDW.DimTim	EnglishDayNameOfWeek	nvarchar(10)	Extract
UBIS.mdb	UBISDW.DimTim	DayNumberOfMonth	Tinyint	Extract
UBIS.mdb	UBISDW.DimTim	DayNumberOfYear	Smallint	Extract
UBIS.mdb	UBISDW.DimTim	WeekNumberOfYear	Tinyint	Extract
UBIS.mdb	UBISDW.DimTim	EnglishMonthName	nvarchar(10)	Extract
UBIS.mdb	UBISDW.DimTim	MonthNumberOfYear	Tinyint	Extract
UBIS.mdb	UBISDW.DimTim	CalendarQuarter	Tinyint	Extract
UBIS.mdb	UBISDW.DimTim	CalendarYear	char(4)	Extract
UBIS.mdb	UBISDW.DimTim	CalendarSemester	Tinyint	Extract
UBIS.mdb	UBISDW.DimTim	FiscalQuarter	Tinyint	Extract
UBIS.mdb	UBISDW.DimTim	FiscalYear	char(4)	Extract

UBIS.mdb	UBISDW.DimTim	FiscalSemester	Tinyint	Extract

Table 4.3: Logical Data Mapping for DimCollAgt dimension table

Table Name: **DimCollAgt**
Table Type: **Dimension**
Description:

Target Database (DW)			
Table name	Column name	Data Type	Table Type
DimCollAgt	CollAgtKey	int	Dimention
DimCollAgt	COLAGT	nvarchar(2)	Dimention
DimCollAgt	DESCR	nvarchar(60)	Dimention

Source Database (OLTP)				**Trans-formation**
DB Name	Table Name	Column Name	Data Type	
ETL process				
UBIS.mdb	UBISDW.tbCollAgt	COLAGT	nvarchar(2)	Extract
UBIS.mdb	UBISDW.tbCollAgt	DESCR	nvarchar(60)	Extract

Table 4.4: Logical Data Mapping for FactBillPay fact table

Table Name: **FactBillPay**
Table Type: **Fact**
Description:

Target Database (DW)			
Table name	Column name	Data Type	Table Type
FactBillPay	TimeKey	Int	fact
FactBillPay	CalendarYear	varchar(4)	fact
FactBillPay	Bill	numeric(38, 2)	fact
FactBillPay	Pay	numeric(38, 2)	fact

Source Database (OLTP)				**Transformation**
DB Name	Table Name	Column Name	Data Type	
ETL process				
	UBISDW.DimTim	CalendarYear	varchar(4)	Extract
	UBISDW.tbOpItems	OPAMT	numeric(38, 2)	EVNGRP=01,EVNTYP=0
	UBISDW.tbOpItems	OPAMT	numeric(38, 2)	EVNGRP=01,EVNTYP=2

Table 4.5: Logical Data Mapping for DimPay fact table

Table Name: **DimPay**
Table Type: **Fact**
Description:

Target Database (DW)			
Table name	Column name	Data Type	Table Type
DimPay	TimeKey	int	fact
DimPay	CollAgtKey	int	fact
DimPay	PAYAMT	numeric(16, 2)	fact

Source Database (OLTP)				
DB Name	Table Name	Column Name	Data Type	**Transformation**
ETL process				
ETL process				
	UBISDW.tbPayment	PAYAMT	numeric(16, 2)	Extract

Table 4.6: Logical Data Mapping for FactNRConsumption fact table

Table Name: **FactNRConsumption**
Table Type: **Fact**
Description:

Target Database (DW)			
Table name	Column name	Data Type	Table Type
FactNRConsumption	TimeKey	Int	fact
FactNRConsumption	revenue	Int	fact
FactNRConsumption	source	Int	fact
FactNRConsumption	MCCode	Datetime	fact

Source Database (OLTP)				
DB Name	Table Name	Column Name	Data Type	**Trans-formation**
ETL process				
UBIS.mdb	UBISDW.tbRWCons	Consumption	int	RW02<>0
UBIS.mdb	UBISDW.tbSourceCons	Consumption	int	SI02<>0
UBIS.mdb	UBISDW.MCCode	Consumption	datetime	Extract

After we determined the LDM, it was the time for profiling the data, knowing the transaction rules and extracting the important data. The main goals for this phase are:

i. To know which tables need to be populated first and what is the missing data.

ii. To determine the ETL design specification.

iii. To show the dependency of fact tables on dimension tables and sometimes the dependency of dimension on another dimension tables (Mundy et al., 2006).

The high-level map should be associated with the dimensional model, by showing which source tables required to feed which target tables. In figures 4.13, 4.14, and 4.15, at the top, we have the list of source tables that required extracting the fact tables in addition to the conditions of each extract. Just below there are small boxes that contain monthly/ yearly load. The follow boxes described in early time the XML file which is an Integration Services package, and has the file extension .dtsx.

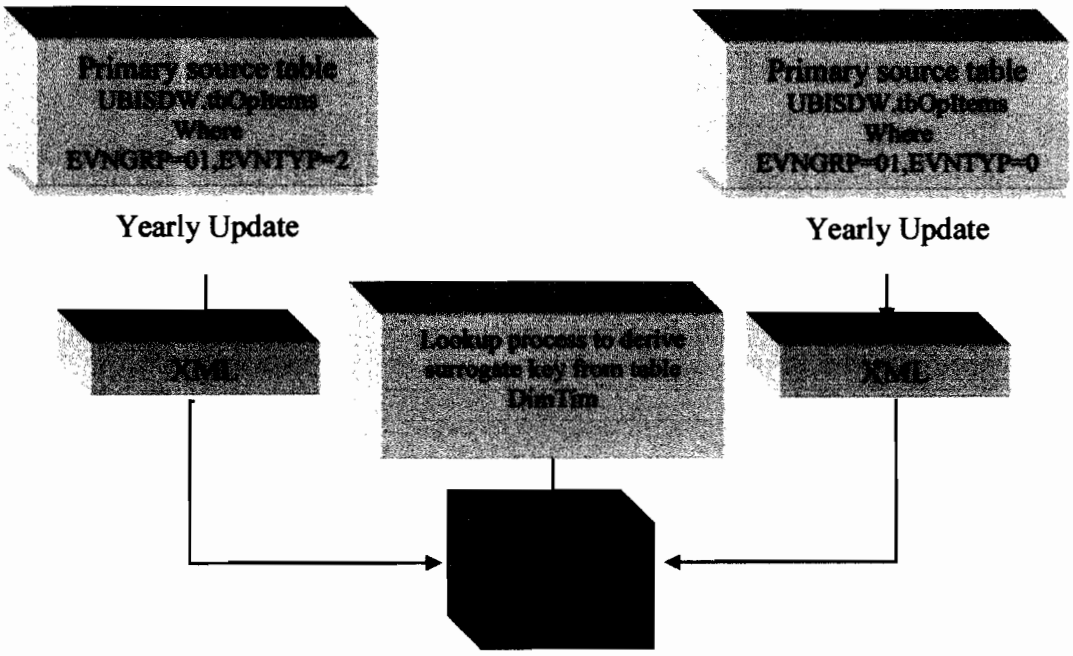


Figure 4.13: High-level mapping for FactBillPay table

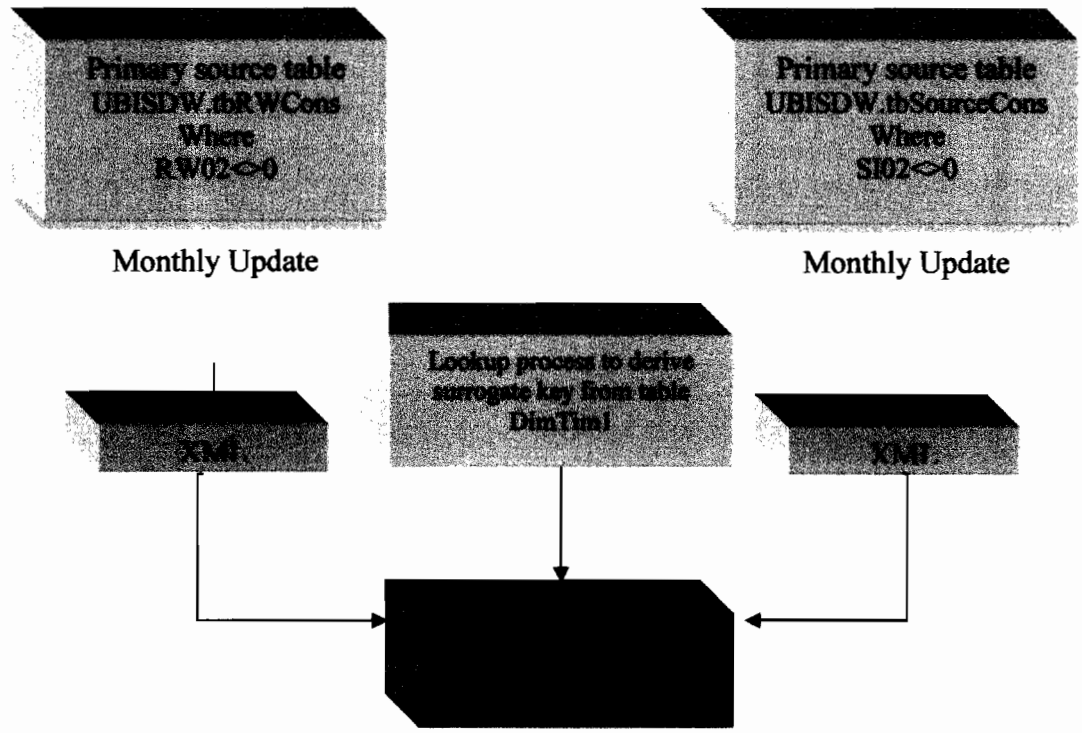


Figure 4.14: High-level mapping for FactNRConsumption table

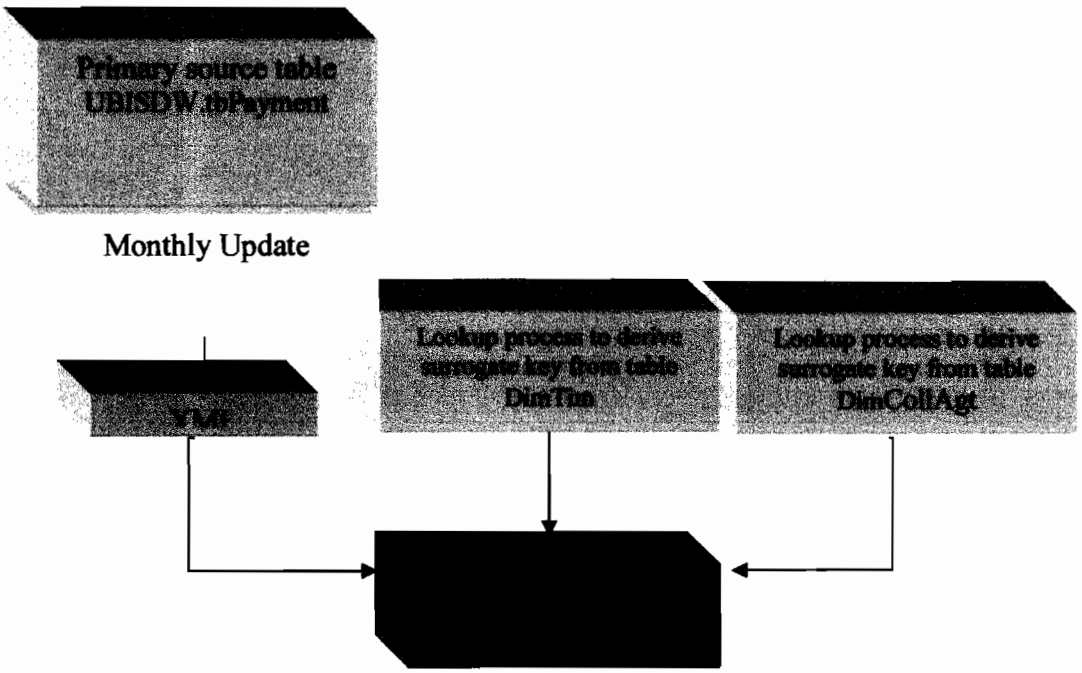


Figure 4.15: High-level mapping for DimPay(Fact) table

4.5 OLAP Structure

In this section, we explained why we should use an Analysis Services OLAP database our BI system. It made the manipulation easier, and increased the query performance and gave a complex analysis instead of using relational database. Figures 4.16, 4.17, and 4.18 illustrated the OLAP structure in our system. OLAP structure contained how to develop the dimensions and measures such as bill amount, paid amount and water consumption size. In addition, we explained how we developed our required calculations such as non revenue consumption and consumer arrears. After preparing measures and calculations, we defined them in form of KPI framework. A KPI consisted of value, goal and status, which are calculated MDX scripts and displayed in a graphic forms like gauges as in Figures 4.19, 4.20, and 4.21

4.5.1 Consumer Arrears OLAP

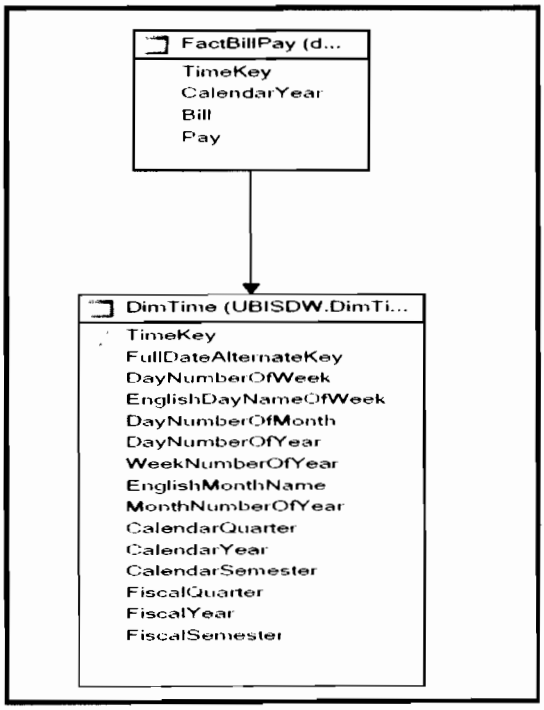


Figure 4.16: Consumer arrears OLAP

4.5.2 Collection Agent Performance OLAP

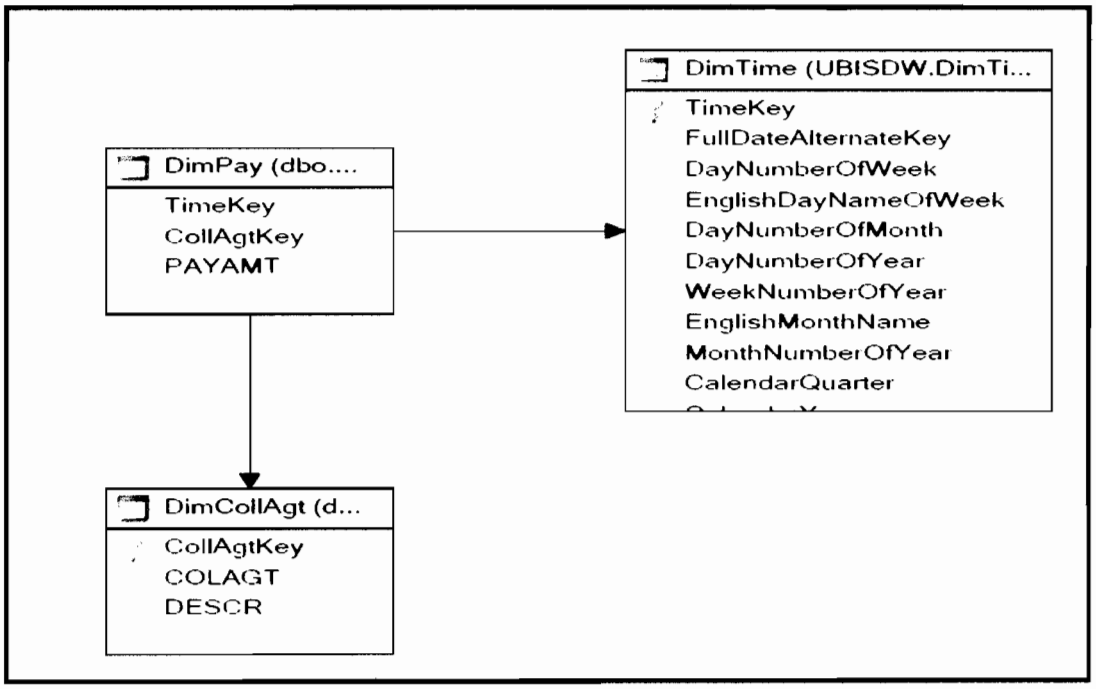


Figure 4.17: Collection Agent Performance OLAP

4.5.3 Water consumption OLAP

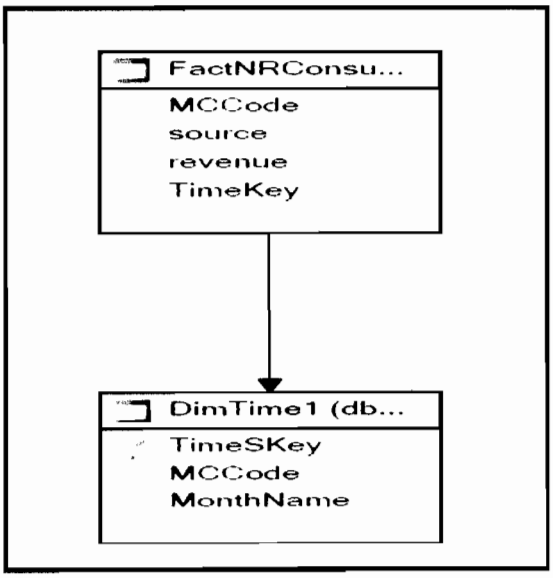


Figure 4.18: Water consumption OLAP

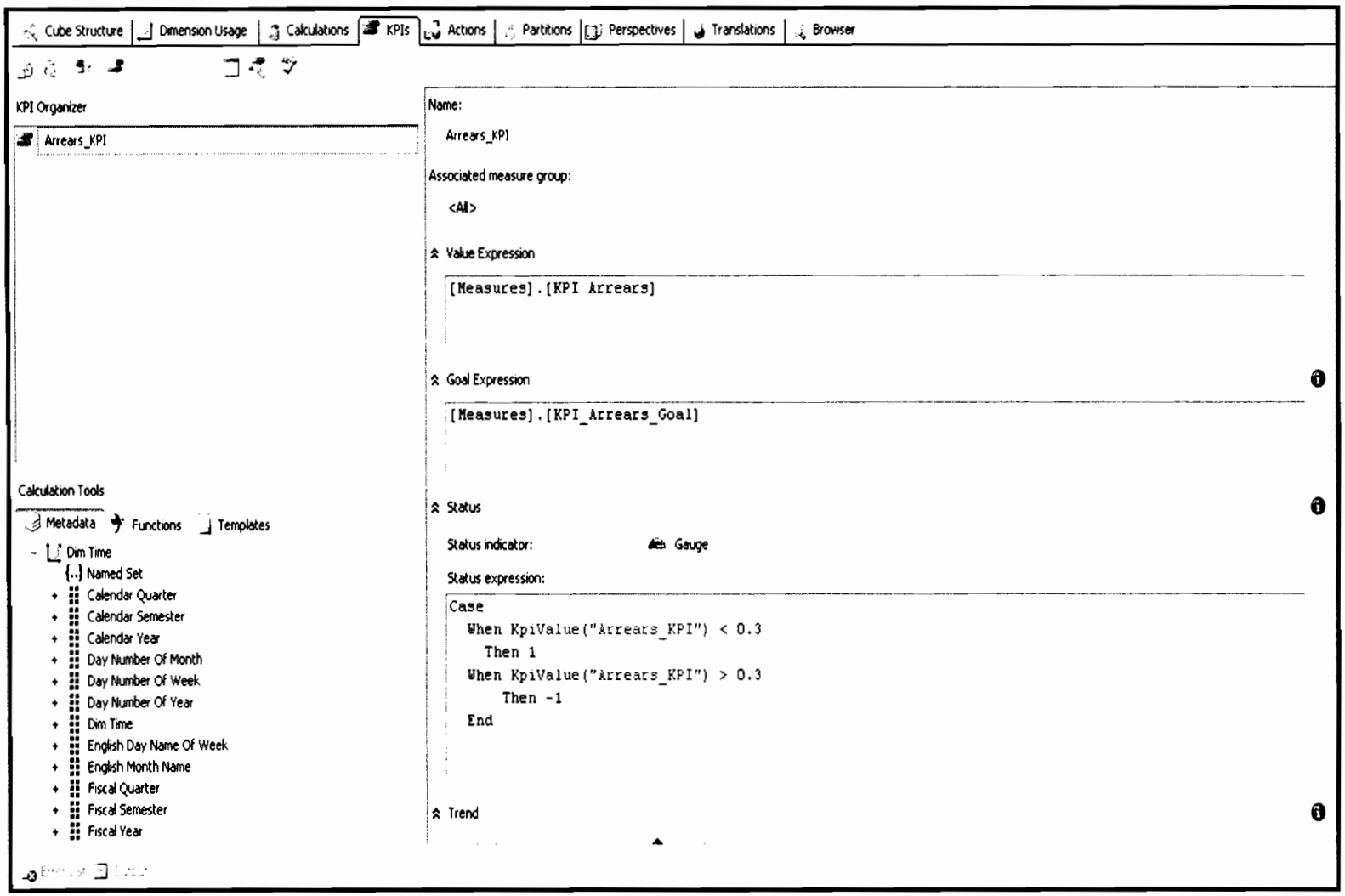


Figure 4.19: Consumer Arrears KPI

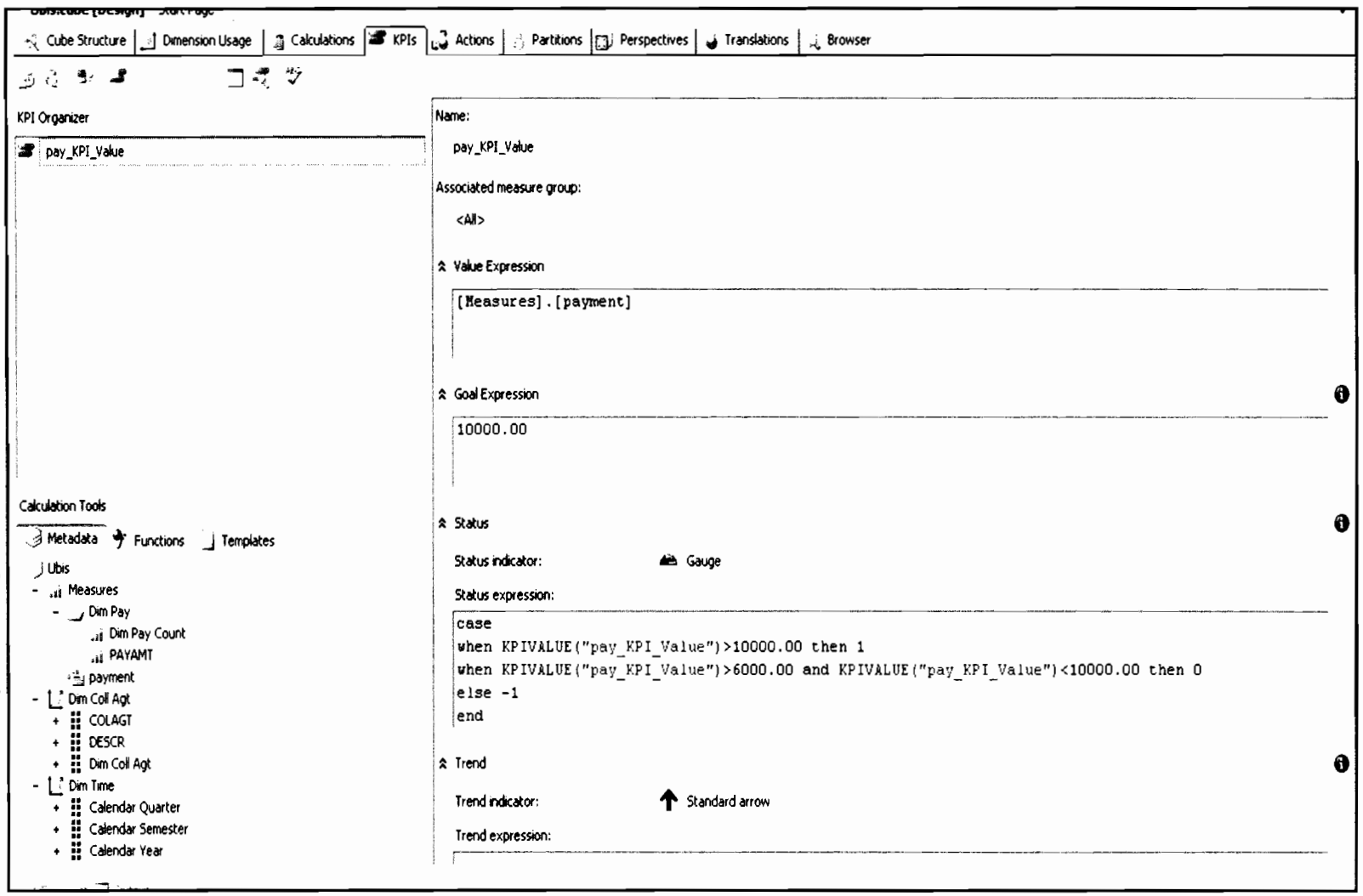


Figure 4.20: Collection Payment performance KPI

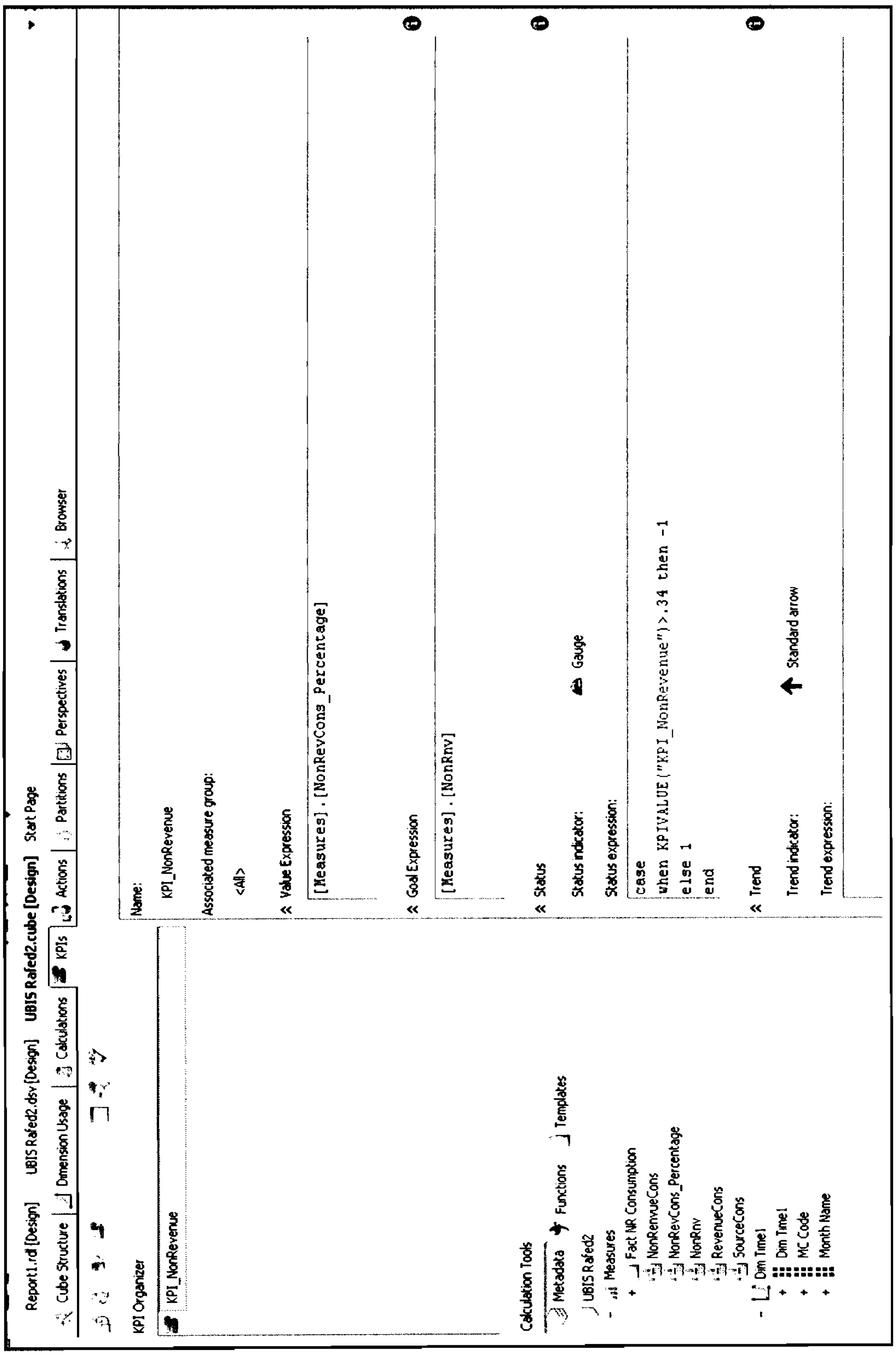


Figure 4.21: Water Consumption KPI

4.6 System Interface

4.6.1 Main Page

This page allows the user (Admin, Manager) have their own username and password to enter the system. Figure 4.22 presents the prototype login page. Users must enter the right username and password to login into the system.

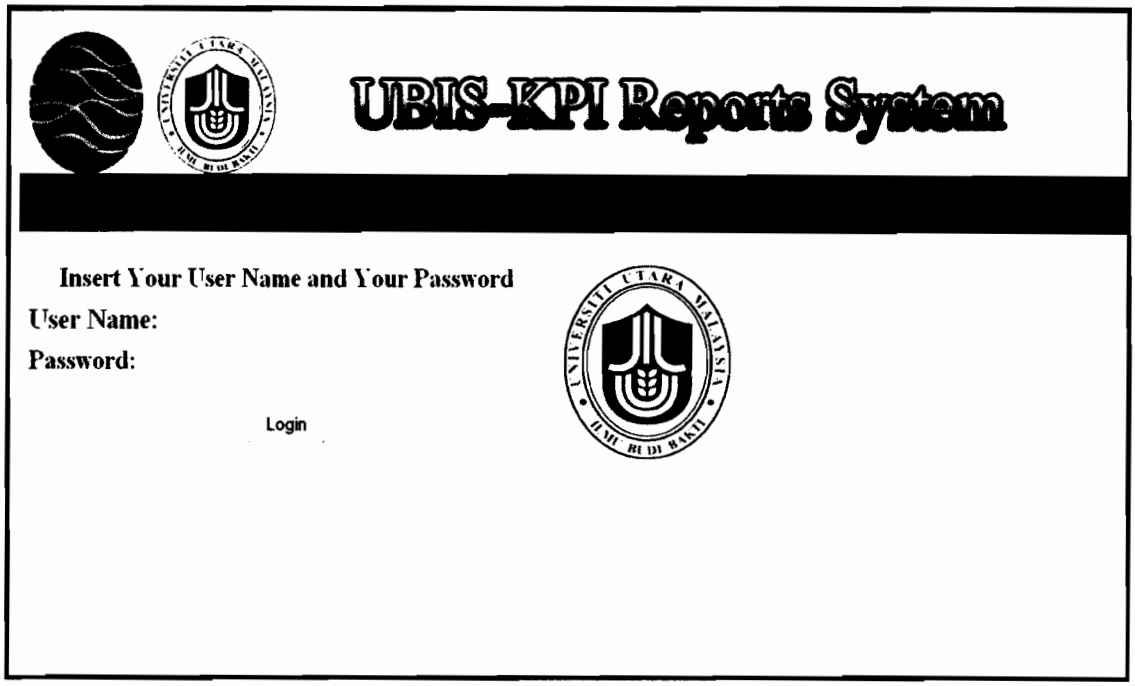
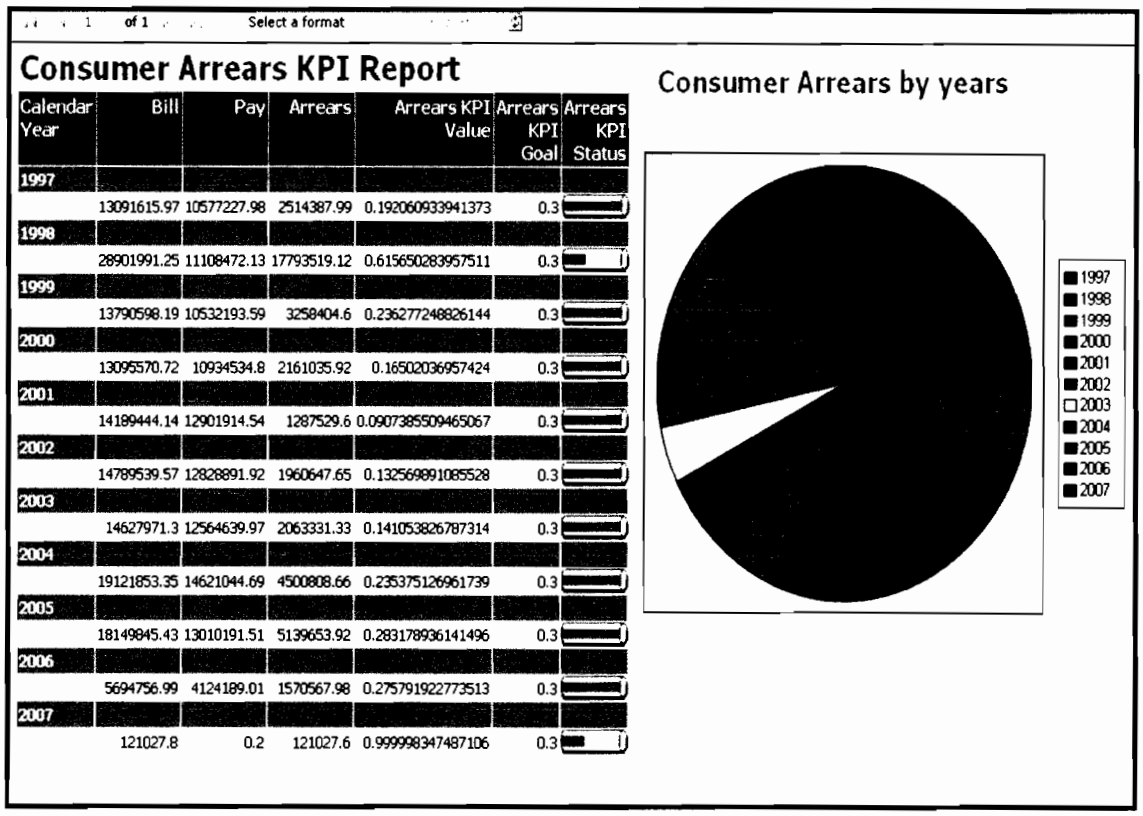


Figure 4.22: Log in page

4.6.2 Consumer Arrears KPI Report

Using Consumer Arrears KPI Report, the manager/report viewer will be able to analyze "Consumer arrears" and tracking the consumer arrears expressed as amounts that were defined by minus the total consumer paid from total bill amount of payments year by year.



Calendar Year	Bill	Pay	Arrears	Arrears KPI Value	Arrears KPI Goal	Arrears KPI Status
1997						
	13091615.97	10577227.98	2514387.99	0.192060933941373	0.3	
1998						
	28901991.25	11108472.13	17793519.12	0.615650283957511	0.3	
1999						
	13790598.19	10532193.59	3258404.6	0.236277248826144	0.3	
2000						
	13095570.72	10934534.8	2161035.92	0.16502036957424	0.3	
2001						
	14189444.14	12901914.54	1287529.6	0.090738550946506	0.3	
2002						
	14789539.57	12828891.92	1960647.65	0.132569891085528	0.3	
2003						
	14627971.3	12564639.97	2063331.33	0.141053826787314	0.3	
2004						
	19121853.35	14621044.69	4500808.66	0.235375126961739	0.3	
2005						
	18149845.43	13010191.51	5139653.92	0.283178936141496	0.3	
2006						
	5694756.99	4124189.01	1570567.98	0.275791922773513	0.3	
2007						
	121027.8	0.2	121027.6	0.999998347487106	0.3	

Figure 4.23: Consumer Arrears KPI Report

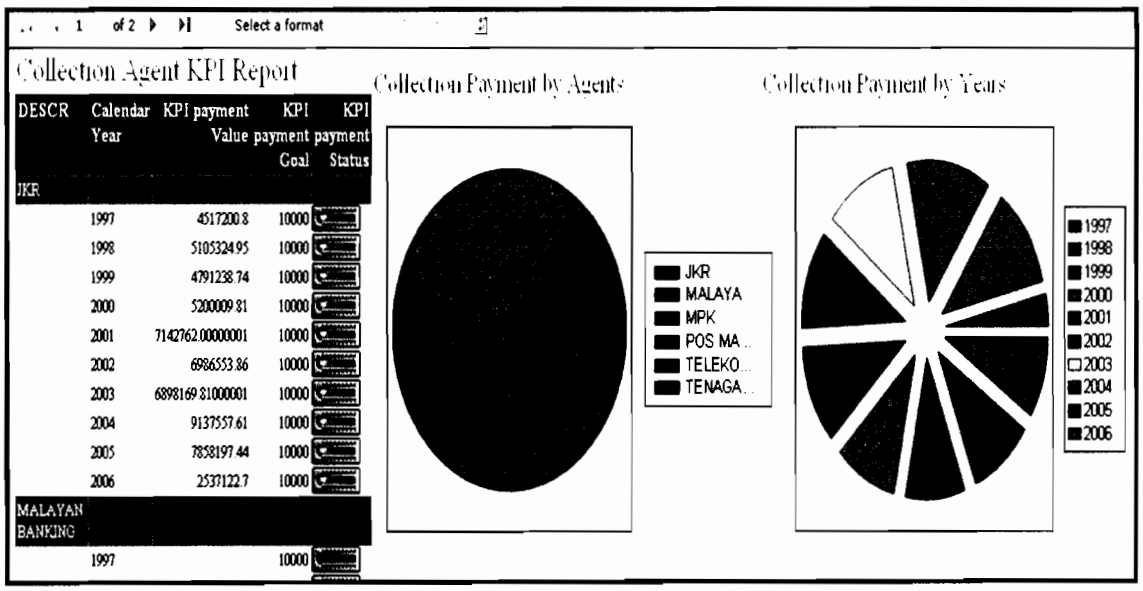
Table 4.7: Extracted Consumer Arrears KPI Report

1997						
	13091615.97	10577227.9	2514387.99	0.19	0.30	
1998						
	28901991.25	11108472.1	17793519.1	0.62	0.30	
1999						
	13790598.19	10532193.5	3258404.6	0.24	0.30	
2000						
	13095570.72	10934534.8	2161035.92	0.17	0.30	
2001						
	14189444.14	12901914.5	1287529.6	0.09	0.30	
2002						

	14789539.57	12828891.9	1960647.65	0.13	0.30	
2003						
	14627971.3	12564639.9	2063331.33	0.14	0.30	
2004						
	19121853.35	14621044.6	4500808.66	0.24	0.30	
2005						
	18149845.43	13010191.5	5139653.92	0.28	0.30	
2006						
	5694756.99	4124189.01	1570567.98	0.28	0.30	

4.6.3 Collection payment performance KPI Report

Using this report, the manager/report viewer will be able to track the "collection payment performance" per each collection agent defined year by year to see which centre meets the collection target.



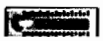
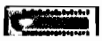
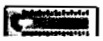
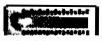
DESCR	Calendar Year	KPI payment Value	KPI payment Goal	KPI payment Status
JKR				
	1997	4517200.8	10000	
	1998	510532495	10000	
	1999	4791238.74	10000	
	2000	5200009.81	10000	
	2001	7142762.00000001	10000	
	2002	6986553.86	10000	
	2003	6898169.81000001	10000	
	2004	9137557.61	10000	
	2005	7858197.44	10000	
	2006	2537122.7	10000	
MALAYAN BANKING				
	1997		10000	

Figure 4.24: Collection payment performance KPI Report

Table 4.8: Extracted Collection payment performance KPI Report

DESCR	Calendar	KPI payment	KPI payment	KPI Status
JKR				

	1997	4517200.80	10000	[redacted]
	1998	5105324.95	10000	[redacted]
	1999	4791238.74	10000	[redacted]
	2000	5200009.81	10000	[redacted]
	2001	7142762.00	10000	[redacted]
	2002	6986553.86	10000	[redacted]
	2003	6898169.81	10000	[redacted]
	2004	9137557.61	10000	[redacted]
	2005	7858197.44	10000	[redacted]
	2006	2537122.70	10000	[redacted]
MALAYAN BANKING				
	1997		10000	[redacted]
	1998		10000	[redacted]
	1999		10000	[redacted]
	2000		10000	[redacted]
	2001		10000	[redacted]
	2002		10000	[redacted]
	2003		10000	[redacted]
	2004	4029.20	10000	[redacted]
	2005	160251.90	10000	[redacted]
	2006	4654.00	10000	[redacted]
MPK				
	1997	13509.11	10000	[redacted]
	1998	11905.30	10000	[redacted]
	1999	4841.00	10000	[redacted]
	2000	6672.70	10000	[redacted]
	2001	1622.10	10000	[redacted]
	2002		10000	[redacted]
	2003		10000	[redacted]
	2004		10000	[redacted]
	2005		10000	[redacted]
	2006		10000	[redacted]
POS MALAYSIA				
	1997	4469498.52	10000	[redacted]
	1998	4320289.26	10000	[redacted]
	1999	3979859.57	10000	[redacted]
	2000	3871420.16	10000	[redacted]
	2001	3901711.52	10000	[redacted]
	2002	4016506.38	10000	[redacted]

	2003	3976826.72	10000	
	2004	4348530.05	10000	
	2005	4125054.45	10000	
	2006	1316020.95	10000	
TELEKOM				
	1997	576471.1	10000	
	1998	612635.93	10000	
	1999	588818.92	10000	
	2000	566374.52	10000	
	2001	573326.4	10000	
	2002	528351.16	10000	
	2003	484359.18	10000	
	2004	533543.49	10000	
	2005	455380.28	10000	
	2006	129397.88	10000	
TENAGA NASIONAL				
	1997	1000623.55	10000	
	1998	1058332.19	10000	
	1999	1167435.36	10000	
	2000	1290057.61	10000	
	2001	1282492.52	10000	

4.6.4 Water consumption KPI Report

Using this report, the manager/report viewer will be able to analyze "non-revenue water consumption" which is defined by minus the revenue water consumption from the total water consumption expressed as a cube meter. This is analyzed monthly and/or by consumption group.

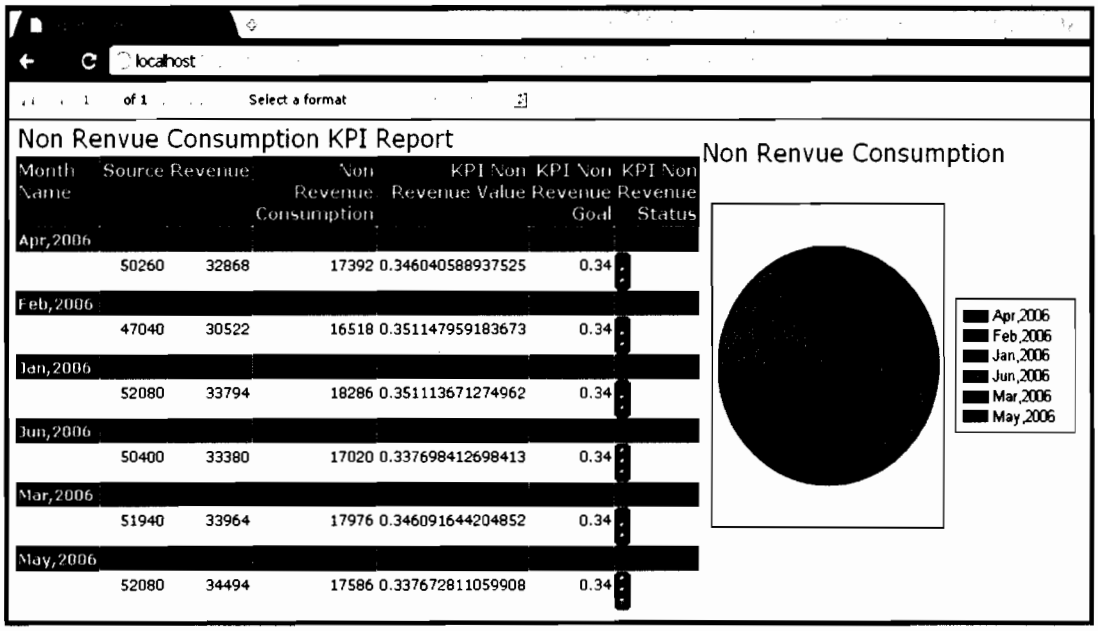


Figure 4.25: Non Revue Consumption KPI Report

Table 4.9: Extracted Non Revue Consumption KPI Report

Non Renvue Consumption KPI Report

Month Name	Source Revenue	Non Revenue Consumption	KPI Non Revenue Value	KPI Non Revenue Goal	KPI Non Revenue Status
Jan,2006					
	52080	33794	18286	0.351113671274962	0.34
Feb,2006					
	47040	30522	16518	0.351147959183673	0.34
Mar,2006					
	51940	33964	17976	0.346091644204852	0.34
Apr,2006					
	50260	32868	17392	0.346040588937525	0.34
May,2006					
	52080	34494	17586	0.337672811059908	0.34
Jan,2006					
	52080	33794	18286	0.351113671274962	0.34

4.7 Conclusion

The process of developing KPI reports was discussed as a part of this chapter and further into many sections, the task of development had been divided. In the first section, how to construct the logical design of the project was our key area of concentration.

Furthermore, in order to successfully accomplish the task, the researcher explained the most important steps required for same process of integrating these reports was the key focus area in second section. Represented by OLAP cubes, third section explains the specific analysis service. Finally suitable for WB business, we identified KPIs and reporting services including these identified KPIs which is our final step towards developing our prototype. In following chapter, IBM Computer System Usability Questionnaires (CSUQ), will be applied to evaluate the system prototype, which were designed and implemented in line with the present chapter's recommendation.

CHAPTER FIVE

EVALUATION AND RESULTS

5.1 Introduction

According to (Gutwin & Greenberg, 2000), the researcher can use the feedback based on the questionnaire received to make the system more efficient once the UBIS users are given new system for use and access. To evaluate the system prototype that was designed and implemented in line with chapter four, chapter five illustrates the final phase of this research. Proposed by Lewis (1995), usability testing is evaluated by using IBM Computer System Usability Questionnaires (CSUQ). Nineteen questions and likert scale ranging from one to seven degrees is part of this questionnaire. To obtain the feedback of respondents in easy and fast way by means of mailed survey or by doing that online becomes the main purpose of using CSUQ. UBIS-KPI reports are attached and uploaded with copy of the CSUQ along with a covering letter, once the responses based out of the returned questionnaires have arrived within seven days. For evaluation and in order to assess UBIS-KPI efficiency and effectiveness, fifteen of UBIS users from the management staff were selected. Some of the respondents of this questionnaire are managers and decision makers who play an important role in strategic analysis, in alignment of the organization strategy. Using nineteen questions and distributed within three main categories as gender, work experience and manager level, the reliability of our system is evaluated by the actual users which also becomes the goal of this work is to meet the objectives of developing this system. In short, to get the benefit of using this system by the actual UBIS users, the researcher used CSUQ.

5.2 Descriptive Statistics

The researcher used SPSS program to analysis the gathered data. General number of respondents is (15) as showed in figure 5.1 and table 5.1, which is include the number of respondents for the questionnaire, and the minimum and maximum value for each question depends on user's answers and feedback. In addition, this table illustrates the number of respondents classified by each category.

The researcher displayed using SPSS program the results of each type of each user's feedback in the questionnaire. These feedbacks showed user satisfaction on the prototype system. The following figures and tables show that in more details:

Table 5. 1: Descriptive statistics

Questions	N	Minimum	Maximum	Mean	Std. Deviation
The system is ease of use	15	5	6	5.53	.516
The system is simple of use	15	5	6	5.40	.507
The system is effectively complete the work	15	5	6	5.33	.488
The system is quickly complete the work	15	5	6	5.47	.516
The system is efficiently complete the work	15	5	6	5.27	.458
The system is Comfortable	15	5	7	6.07	.594
The system is easy to learn	15	6	7	6.27	.458
I become productive quickly using the system	15	5	6	5.27	.458
The system Gives clear error messages	15	5	6	5.47	.516
The system recover easily and quickly	15	5	6	5.27	.458
System has clear online help & documentation	15	5	6	5.40	.507
The system is easy to find the information	15	6	7	6.20	.414
The system Info. Is easy to understand	15	5	6	5.40	.507
The system Info. help to complete tasks	15	5	6	5.33	.488
The system Info. Organization is clear	15	5	6	5.40	.507

The system interface of this system is pleasant	15	4	6	5.33	.617
I like use the system interface	15	5	6	5.60	.507
The system has all the functions that we need	15	5	6	5.20	.414
I am satisfied with this system	15	5	6	5.40	.507
Valid N (listwise) Missing	15 0				

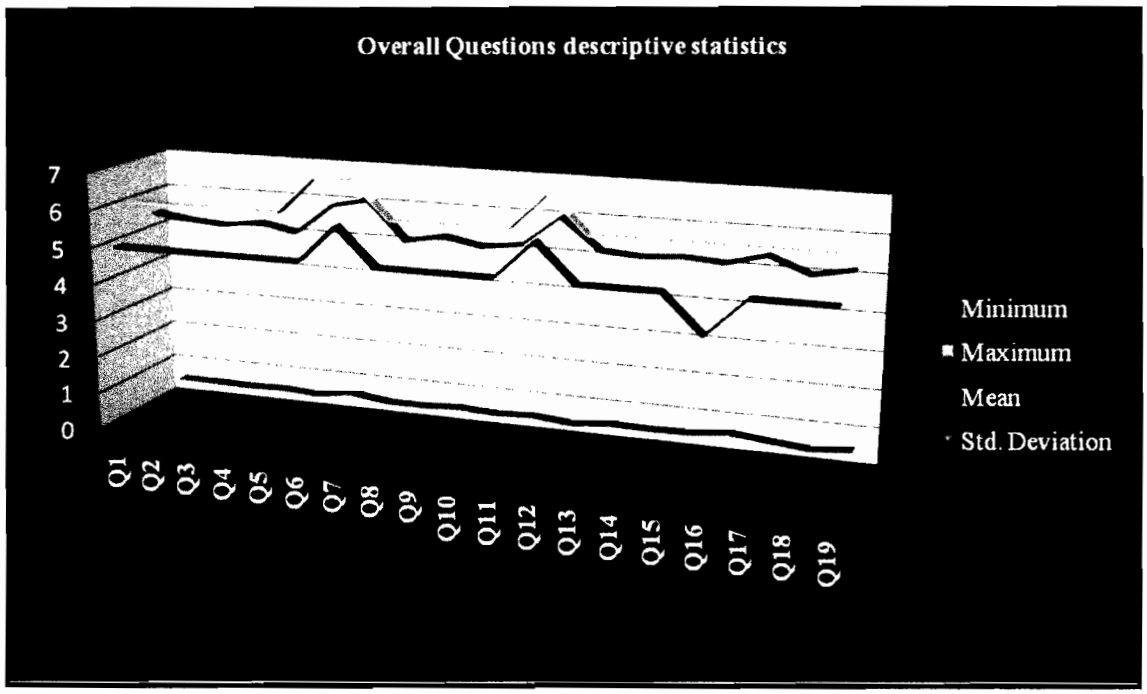


Figure 5.1: Statistics chart for all questions

As in figure 5.2 and table 5.2, the number of respondents is (15) users and the rate of females: (46.7%) it means (7) users and the rate of males: (53.3%) it means (8) users.

Table 5.2: Descriptive statistics for respondent's gender

Gender		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	7	46.7	46.7	46.7
	M	8	53.3	53.3	100.0
	Total	15	100.0	100.0	

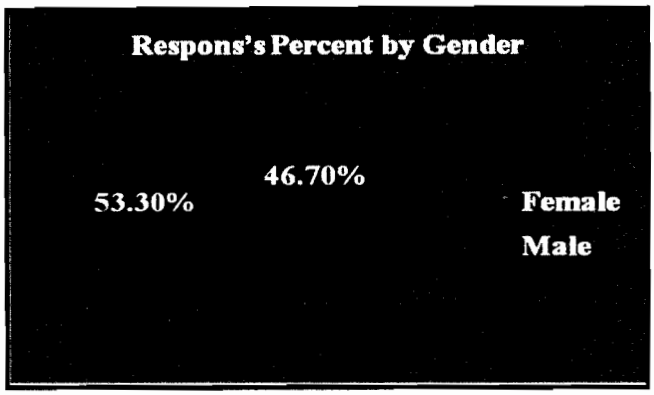


Figure 5.2: Statistics chart for respondents' gender

This questionnaire includes experienced users to evaluate the prototype system as shown in figure 5.3 and table 5.3 it explained and illustrated all the number of experience years: one year with rate (60%) it meant (9) users, two years with rate (26.7%) it meant (4) users, and four years with rate (13.3%) and it's meant (2) users.

Table 5.3:Describtive statistics for respondent's work experience

Work Experience		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	9	60.0	60.0	60.0
	2	4	26.7	26.7	86.7
	4	2	13.3	13.3	100.0
	Total	15	100.0	100.0	

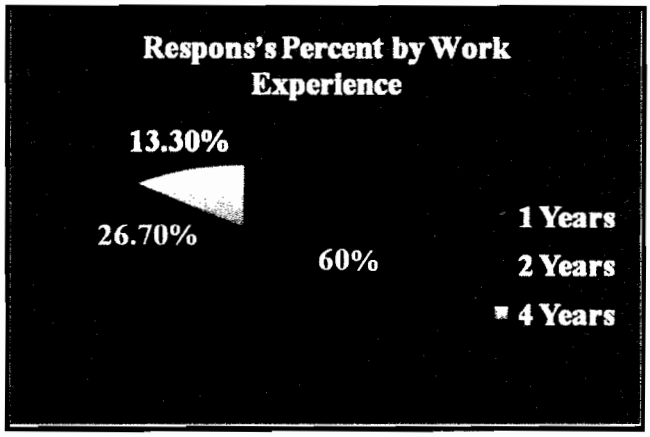


Figure 5.3: Statistics chart for respondents' work experience

As shown in figure 5.4 and table 5.4, the percentages for manager levels are (13.3%) it means 2 users and (86.67%) it means 13 users.

Table 5.4:Describtive statistics for respondent's manager level					
Manger level		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	13.3	13.3	13.3
	2	13	86.7	86.7	100.0
	Total	15	100.0	100.0	

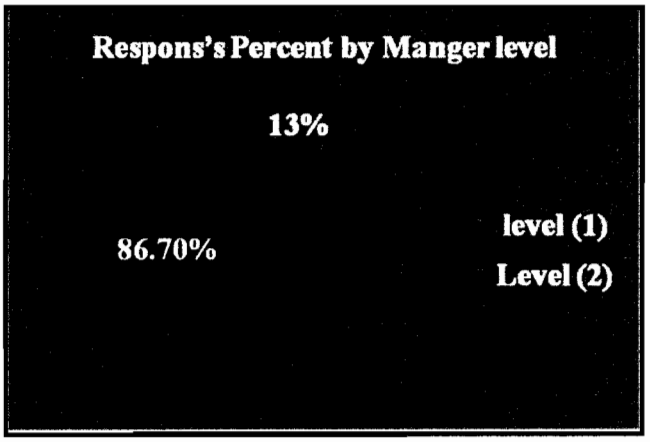


Figure 5.4: statistics for respondent's manager level

The analysis for question one as shown in table 5.5 and figure 5.4 illustrates two kinds of response the first is 56.7% for "strongly agree" and the second is 43.3% for "agree".

Table 5.5:Q1:overall , I am satisfied with how easy it is to use this system					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	7	46.7	46.7	46.7
	6	8	53.3	53.3	100.0
	Total	15	100.0	100.0	

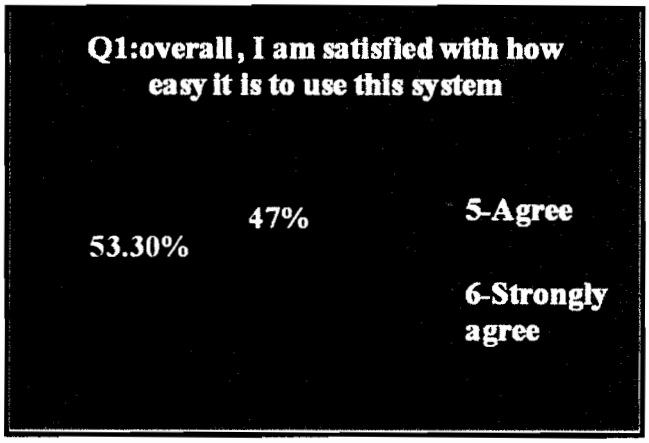


Figure 5.5: Statistics for question one

The analysis for question two as in figure 5.6 and table 5.6 shows three types of respondents, first is (60%) meant (9) users gave (5) from (7) , the second is (40%) meant (6) users gave (6) from (7), both of them near to "strongly agree" that the system is simple to use.

Table 5.6 Q2:It was simple to use this system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	9	60.0	60.0	60.0
	6	6	40.0	40.0	100.0
	Total	15	100.0	100.0	

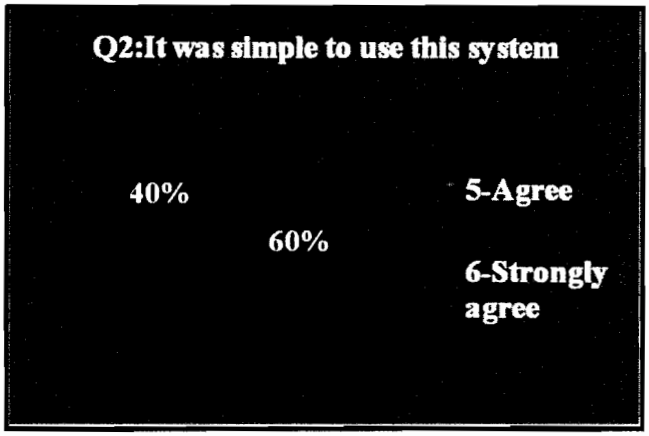


Figure 5.6: Statistics for question two

The analysis for question three as shown in table 5.7 and figure 5.7 shows two types of responses the first is (66.7%) meant (10) users gave (5) for "agree" , the second is (33.3%) meant (5) users gave (6) for "strongly agree". In short, the (15) users agreed that the system can help them to complete their work effectively.

Table 5.7 Q3:I can effectively complete my work using this system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	10	66.7	66.7	66.7
	6	5	33.3	33.3	100.0
	Total	15	100.0	100.0	

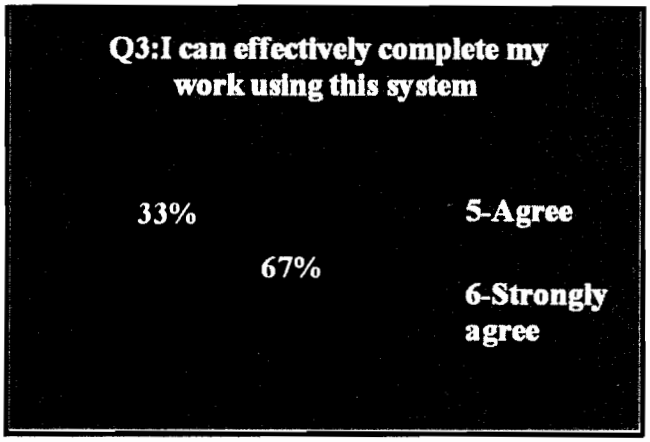


Figure 5.7: Statistics for question three

The analysis for question four as shown in table 5.8 and figure 5.7 shows two types of responses the first is (53.3%) meant (8) users gave (5) for "agree" , the second is (46.7%) meant (7) users gave (6) for "strongly agree". In short, the (15) users agreed that the system can help them to complete their work quickly.

Table 5.8 Q4:I am able to complete my work quickly using this system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	8	53.3	53.3	53.3
	6	7	46.7	46.7	100.0
	Total	15	100.0	100.0	

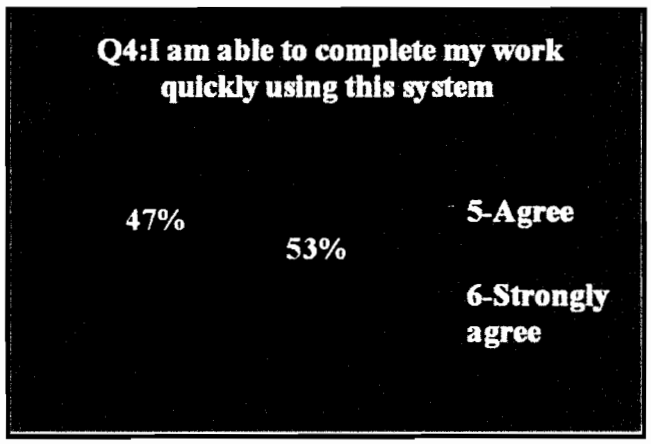


Figure 5.8: Statistics for question four

The analysis for question five as shown in table 5.9 and figure 5.9 shows two types of responses the first is (73.3%) meant (11) users gave (5) for "agree" , the second is (26.7%) meant (4) users gave (6) for "strongly agree". In short, the (15) users agreed that the system can help them to complete their work efficiently.

Table 5.9 Q5:I am able to efficiently complete my work using this system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	11	73.3	73.3	73.3
	6	4	26.7	26.7	100.0
	Total	15	100.0	100.0	

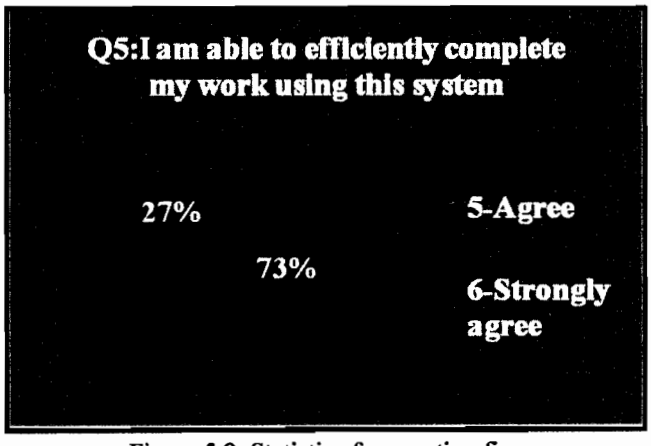


Figure 5.9: Statistics for question five

The analysis for question six as shown in table 5.10 and figure 5.10 shows three types of responses the first is (13.3%) meant (2) users gave (5) for "agree" , the second is (66.7%) meant (10) users gave (6) for "strongly agree" , and thirdly is (20.0%) meant (3) users gave (7) for "strongly agree". In short, the (15) users strongly comfort using the system.

Table 5.10: Q6:I feel comfortable using this system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	2	13.3	13.3	13.3
	6	10	66.7	66.7	80.0
	7	3	20.0	20.0	100.0
	Total	15	100.0	100.0	

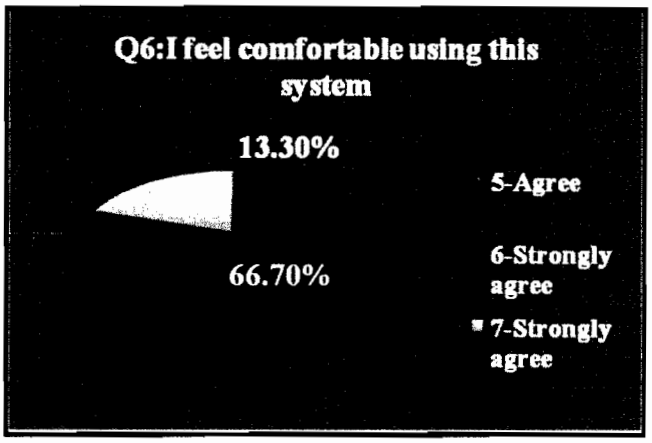


Figure 5.10: Statistics for question six

The analysis for question seven as shown in table 5.11 and figure 5.11 shows two types of responses the first is (73.3%) meant (11) users gave (6) for "strongly agree" , the second is (26.7%) meant (4) users gave (7) for "strongly agree". In short, the (15) users strongly agree that the system easy to learn to use this system.

Table 5.11:Q7:It was easy to learn to use this system					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	6	11	73.3	73.3	73.3
	7	4	26.7	26.7	100.0
	Total	15	100.0	100.0	

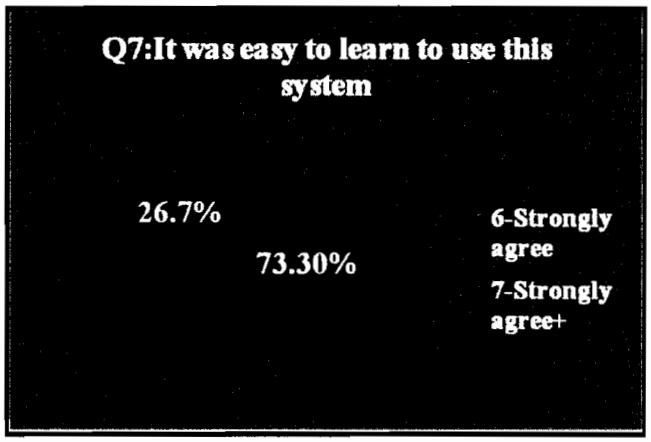


Figure 5.11: Statistics for question seven

The analysis for question eight as shown in table 5.12 and figure 5.12 shows two types of responses the first is (73.3%) meant (11) users gave (5) for "agree" , the second is (26.7%) meant (4) users gave (6) for "strongly agree". In short, the (15) users agree that they can be quick productive using this system.

Table 5.12:Q8:I believe I became productive quickly using this system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	11	73.3	73.3	73.3
	6	4	26.7	26.7	100.0
	Total	15	100.0	100.0	

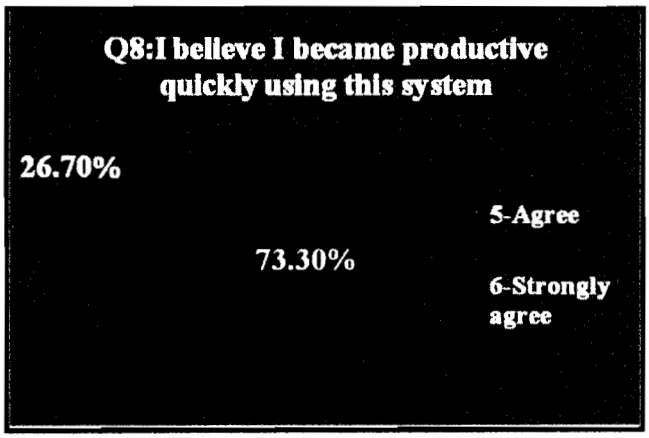


Figure 5.12: Statistics for question eight

The analysis for question nine as shown in table 5.13 and figure 5.13 shows two types of responses the first is (53.3%) meant (8) users gave (5) for "agree" , the second is (46.7%) meant (7) users gave (6) for "strongly agree". In short, the (15) users agree that the error messages clearly tell them how to fix the problems.

Table 5.13:Q9:The system gives error messages that clearly tell me how to fix problems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	8	53.3	53.3	53.3
	6	7	46.7	46.7	100.0
	Total	15	100.0	100.0	

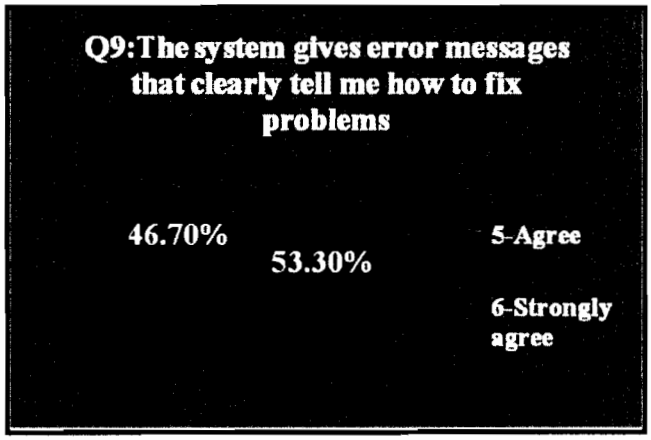


Figure 5.13: Statistics for question nine

The analysis for question ten as shown in table 5.14 and figure 5.14 shows two types of responses the first is (73.3%) meant (11) users gave (5) for "agree" , the second is (46.7%) meant (7) users gave (6) for "strongly agree". In short, the (15) users agree that the system recover quickly.

Table 5.14:Q10:Whenever I make a mistake using the system, I recover easily and quickly

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	11	73.3	73.3	73.3
	6	4	26.7	26.7	100.0
	Total	15	100.0	100.0	

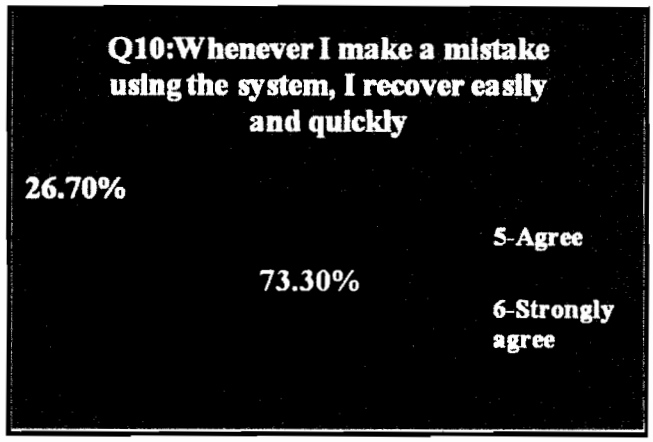


Figure 5.14: Statistics for question ten

The analysis for question eleven as shown in table 5.15 and figure 5.15 shows two types of responses the first is (60%) meant (9) users gave (5) for "agree" , the second is (40%) meant (6) users gave (6) for "strongly agree". In short, the (15) users agree that the system provides a clear documentation and .online help.

Table 5.15:Q11:The information (such as online help, on-screen messages, and other documentation) provided with this system is clear

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	9	60.0	60.0	60.0
	6	6	40.0	40.0	100.0
	Total	15	100.0	100.0	

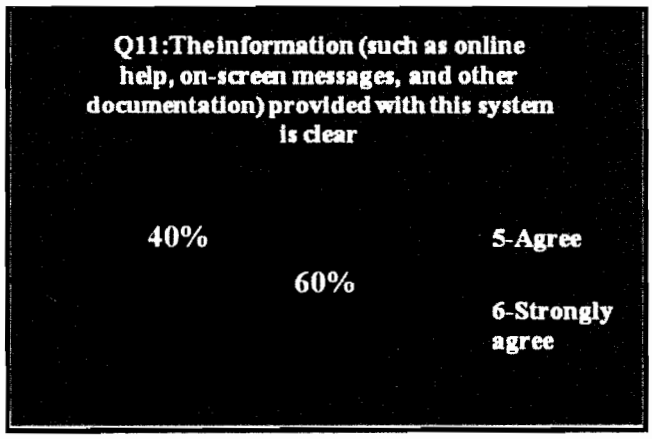


Figure 5.15: Statistics for question eleven

The analysis for question twelve as shown in table 5.16 and figure 5.16 shows two types of responses the first is (80%) meant (12) users gave (6) for "strongly agree" , the second is (20%) meant (3) users gave (7) for "strongly agree". In short, the (15) users agree that the system is easy to find the information that the user need it.

Table 5.16:Q12:It is easy to find the information I needed

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	6	12	80.0	80.0	80.0
	7	3	20.0	20.0	100.0
	Total	15	100.0	100.0	

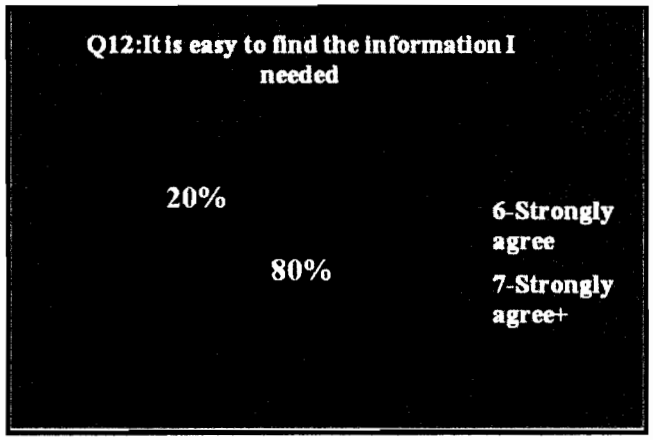


Figure 5.16: Statistics for question twelve

The analysis for question thirteen as shown in table 5.17 and figure 5.17 shows two types of responses the first is (60%) meant (9) users gave (5) for "agree" , the second is (40%) meant (6) users gave (6) for "strongly agree". In short, the (15) users agree that the system is easy to understand.

Table 5.17:Q13:The information provided for the system is easy to understand

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	9	60.0	60.0	60.0
	6	6	40.0	40.0	100.0
	Total	15	100.0	100.0	

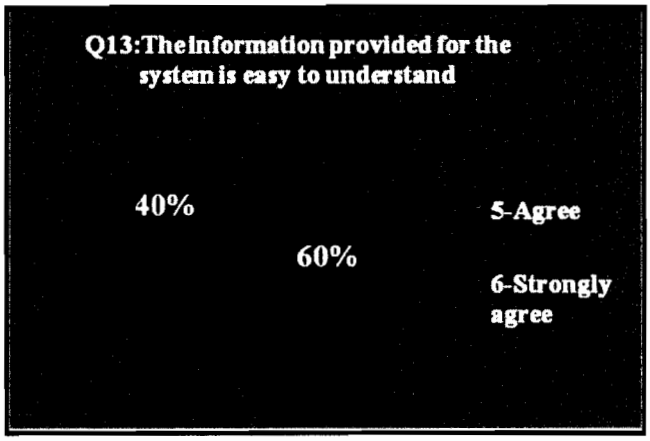


Figure 5.17: Statistics for question thirteen

The analysis for question fourteen as shown in table 5.18 and figure 5.18 shows two types of responses the first is (66.7%) meant (10) users gave (5) for "agree" , the second is (33.3%) meant (5) users gave (6) for "strongly agree". In short, the (15) users agree that the system information helpful effectively.

Table 5.18:Q14:The information is effective in helping me complete the tasks and scenarios

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	10	66.7	66.7	66.7
	6	5	33.3	33.3	100.0
	Total	15	100.0	100.0	

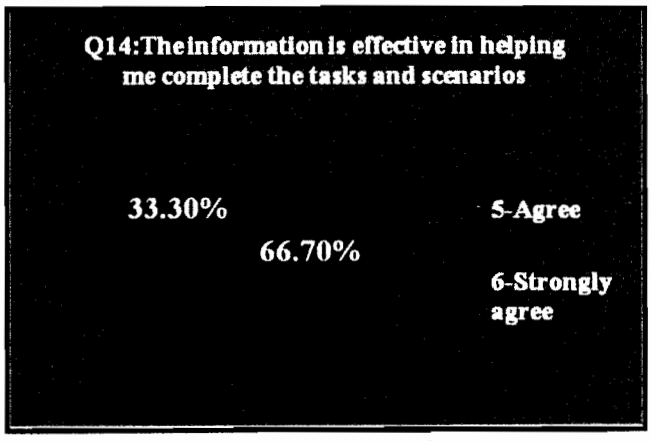


Figure 5.18: Statistics for question fourteen

The analysis for question fifteen as shown in table 5.19 and figure 5.19 shows two types of responses the first is (60%) meant (9) users gave (5) for "agree" , the second is (40%) meant (6) users gave (6) for "strongly agree". In short, the (15) users agree that the information on the system screens is clear.

Table 5.19:Q15:The organization of information on the system screens is clear

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	9	60.0	60.0	60.0
	6	6	40.0	40.0	100.0
	Total	15	100.0	100.0	

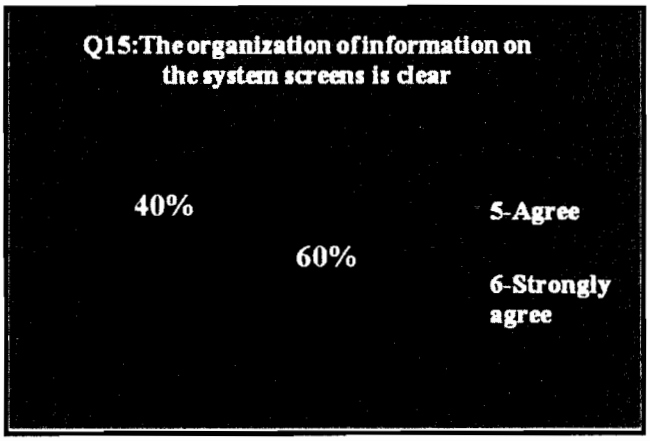


Figure 5.19: Statistics for question fifteen

The analysis for question sixteen as shown in table 5.20 and figure 5.20 shows three types of responses the first is (6.7%) meant (1) users gave (4) for "not sure" , the second is (53.3%) meant (8) users gave (5) for "agree", and the third is (40%) meant (6) users gave (6) for "strongly agree". In short, the (14) users agree that the information on the system interface is pleasant, but one user not sure. According to this feedback the researcher modify the system interface to be more pleasant even though it's not focused depending on the functional requirements described in chapter four.

Table 5.20:Q16:The interface of this system is pleasant					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4	1	6.7	6.7	6.7
	5	8	53.3	53.3	60.0
	6	6	40.0	40.0	100.0
	Total	15	100.0	100.0	

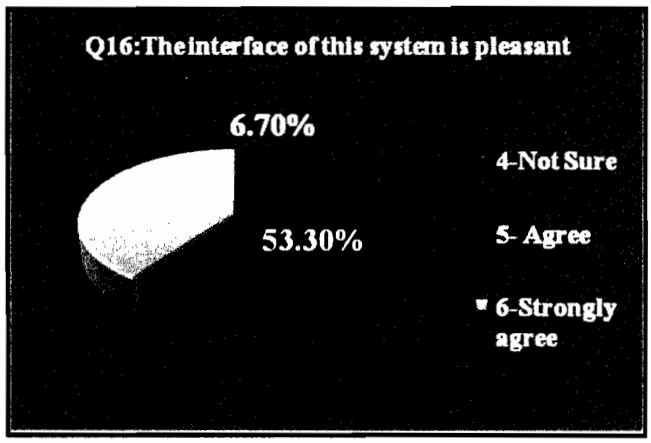


Figure 5.20: Statistics for question sixteen

The analysis for question seventeen as shown in table 5.21 and figure 5.21 shows two types of responses the first is (40%) meant (6) users gave (5) for "agree" , the second is (60%) meant (9) users gave (6) for "strongly agree". In short, the (15) users liked using the interface of this system.

Table 5.21:Q17:I like using the interface of this system					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	6	40.0	40.0	40.0
	6	9	60.0	60.0	100.0
	Total	15	100.0	100.0	

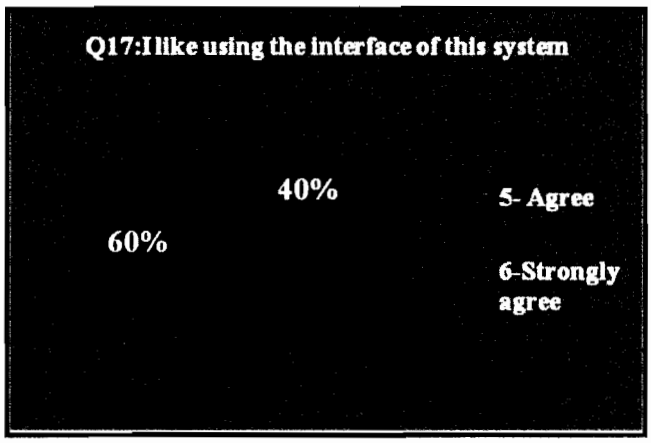


Figure 5.21: Statistics for question seventeen

The analysis for question eighteen as shown in table 5.22 and figure 5.22 shows two types of responses the first is (80%) meant (12) users gave (5) for "agree" , the second is (20%) meant (3) users gave (6) for "strongly agree". In short, the (15) users agreed that this system has all the expected functions and capabilities.

Table 5.22:Q18:This system has all the functions and capabilities I expect it to have

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	12	80.0	80.0	80.0
	6	3	20.0	20.0	100.0
	Total	15	100.0	100.0	

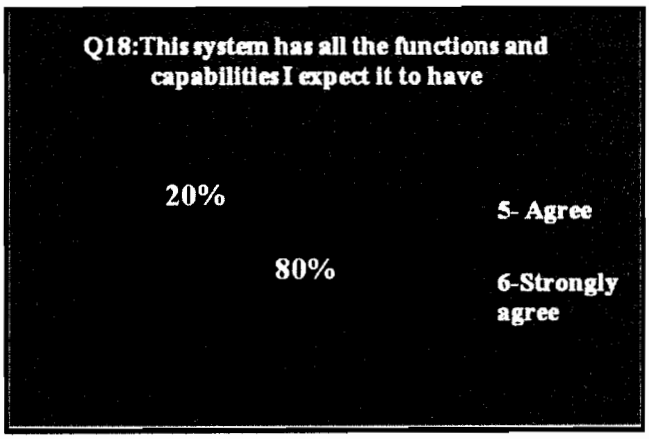


Figure 5.22: Statistics for question eighteen

The analysis for question eighteen as shown in table 5.23 and figure 5.23 shows two types of responses the first is (60%) meant (9) users gave (5) for "agree" , the second is (40%) meant (6) users gave (6) for "strongly agree". Overall, the (15) users satisfied with this system.

Table 5.23:Q19:Overall, I am satisfied with this system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5	9	60.0	60.0	60.0
	6	6	40.0	40.0	100.0
	Total	15	100.0	100.0	

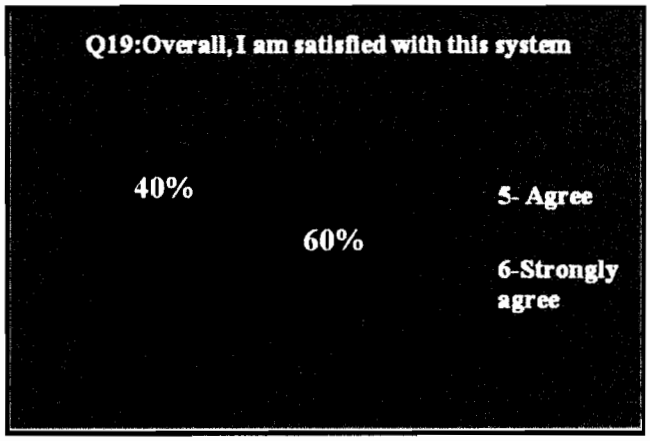


Figure 5.23: Statistics for question nineteen

5.3 Summary

The evaluation and testing results of the system prototype are discussed in this chapter. The system evaluation results analyzed using SPSS by using CSUQ questionnaire. The main objective of the evaluation is to measure the acceptance of users for using the UBIS-KPI system, investigate the usefulness, usability, and interfaces design of the system. The results confirmed that the users of the system are satisfied by the UBIS users.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter is to summarize and conclude the project's overall steps in order to achieve the objectives based on the area and scope of this study and also presents the contribution made towards this project. In addition, this chapter reviews the overall finding related to this project and also give a lead for possible future work in this area.

6.2 Conclusion of the Study

In accordance to the challenges associated with the use of BI in performance management area, this work was selected to measure the performance of water billing department in the form of KPI reports. Besides, the assessed KPI reports indicate three of the billing processes which are: Consumer Arrears, Collection payment, and Water Consumption. As shown in Chapter one, the objectives of this study are to: develop a prototype of BI system (UBIS-KPI) which can provide KPI reports for an existing Water Billing System (UBIS). The prototype will help the managers to track the monthly and yearly progress of billing, payment, and consumption of the Water Billing Department. In short, the resulted KPI-reports will significantly help the managers in the area to make right decisions based on the given indicators. In this project, we implemented our BI system built upon based on a large BI system of Water Billing, called as "Utility Billing Information System (UBIS)". We called our system as "Utility Billing Information System- Key Performance Indicator (UBIS-KPI)". Despite of the fact that the UBIS was in service many years ago and contained a lot of analytical reports, there

were no KPI reports to help the decision-makers of billing department to give a good recommendation which are based on easy and visual indicators. Thus, the implementation of our UBIS-KPI takes into account the need for this kind of reports to redress the necessity.

Throughout this project, we mentioned in details the most important concepts related to this field. Next, we identified the problem, objectives, scope, and reviewed the literature and related work concerning our problem and its awareness. Since this study applied two methodologies, the first one was Kuechler and Vaishnavi(2008), which was to conduct the general methodology of our research. The second methodology conducted by Beynon-Davies et al. (1999), which was RAD methodology to develop our prototype as mentioned in chapter three. It is worthwhile to mention that software engineering process was applied in design of our prototype. Therefore, we identified the requirements by reviewing it with UBIS experts. Next, we walk through the analysis, quick design and prototype cycle which are defined by the following three steps: refine, build, and demonstrate. The next step of RAD methodology was testing the prototype by using the questionnaire and the results were found pleasantly satisfactory as shown in chapter five.

Finally, the prototype was implemented with some modifications depending on the feedback from actual user (UBIS users).

6.3 Evaluation Process

In the assessment process, the researcher depends on group of rules to lead this process rightly. These rules are as follow:

i. **Number of users:** The number of users was 15. They are actual UBIS users and they clearly know the necessity of KPI reports, importance regarding its existence and application in UBIS.

ii. **Years of Experience:** In fact all the users have experience in working with Water Billing Department, and they already know the right process regarding billing, payment and consumption context of KPI reports.

iii. **Manager level:** The way of selection the users was regular with different types of managers who were working on UBIS.

Actually the outcome of assessment process was, most of users prefer to use a UBIS-KPI prototype as BI tool that can support their work and the users were sopleased and satisfied in dealing with this depository system.

6.4 Contributions of the Study

i. After designing and developing our system, the users of UBIS can easily and rightly deal with real KPI in form of analytical reports.

ii. This work will be a guideline for the BI developer to understand the process so that they can develop their own BI systems.

6.5 Limitation of the Study

i. Large amount of time consumed and its associated process limitations make the development, design, implementation, and operation of BI systems using DW, a difficult task.

ii. Size of data stored in UBIS is very huge and the entity relational diagram (ERD) includes about 300 tables. In addition, the main tables stores hundred million of records and there is a need to spend more time to design the ETL system.

iii. Data quality limitations because of the data came from different data sources and are stored in summarized tables. The resulting table has little descriptive columns with a lot of null's values. This further lead towards trying to internally join several big tables to extract one measurement. This by its role in itself makes the query very complex and need long time to execute or review.

6.6 Recommendations and Future Work

No one can deny the importance of investing in performance management in relation to BI in general, and specifically in Key Performance Indicators. In addition, the researcher widely advices to extend this work in other area. Despite, the extension should be horizontally done by increasing the number and type of reports to cover all the aspects of water billing. However, vertical extension is highly recommended by using data mining as an important field in BI. This helps to give recommendations as well as sets further expectations to the Billing enterprise, based on the historical data. Furthermore, the fact that our ETL system design being very simple irrespective of having time limitation, the researcher advices to give it more attention so that complex and important KPI can be obtained. In addition, ETL design should consider the data update from source to the target to be on-line or on a real time basis. As such, managing the design, development, implementation, and operation of even a single corporate DW can be difficult and time

consuming task. Based on same, walkthrough all steps to ensure that DW development do track the successful and standard approach is highly recommended as a future work.

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Appendix

Universiti Utara Malaysia
College of Arts and Science

**Development of Key Performance Indicator (KPI)
Reports for Water Billing System in
Business Intelligence Application**

COLLEGE OF ATRS AND SCIENCES
UNIVERSITY UTARA MALAYSIA

Development of Key Performance Indicator (KPI)
Reports for Water Billing System in
Business Intelligence Application

I am Master of Science (Information Technology) student at final semester in University Utara Malaysia. Currently, I am performing this questionnaire to help me gain an understanding of the user who used UBIS at Water Billing Depertement, Malaysia. This questionnaire aims to understand general information about system user's and the usability of the system. The results from this questionnaire will help me to understand the system requirements for developing a UBIS-KPI prototype system by using dimensional modeling technique.

All your information will be held in strictest confidence and it will be used for research purpose only. Your insights a feedback in making this study successful is highly appreciated. If you have any queries or if you like to know the result of this study, please do contact me at 014-9300029/ 016-4061503 or through the e-mail: rs13_mm@yahoo.com

This questionnaire consists of two sections:

- Section A - General Information
- Section B - System Usability

This questionnaire is adopted from Lewis, J. R. (1995) IBM Computer Usability Satisfaction Questionnaires: Psychometric Evaluation and Instructions for Use.

Thank you for your valuable time and help in completing this questionnaire.

MSc. IT Candidate

Rafed S. Al Jibowrry

PLEASE RATE THE USABILITY OF THE SYSTEM.

- Please respond to all the items.
- Please tick one only, except question 4- Section A.

A. GENERAL INFORMATION

This section is about your background information. Please fill up the blanks and mark (√) the most appropriate

1. Gender [ ] Male [ ] Female

2. Working Experience [ ] Less Than 5 years [ ] 5 – 10 years
   [ ] 15-years and above [ ] 11- 15 years

3. Management Level [ ] Manager
   [ ] Supervisor
   [ ] Operational

4. What type of report did you used? (You can tick more than one)
   [ ] Analytical
   [ ] Tactical
   [ ] Operational

5. How often you use UBIS-KPI system in a week?
   [ ] Every day (except holiday)
   [ ] 3 – 5 times per week
   [ ] Less than 3 times per week

B. SYSTEM USABILITY
(Refer to UBIS-KPI**)**

No	Items	Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree	N A
1	Overall, I am satisfied with how easy it is to use this system										
2	It was simple to use this system										
3	I can effectively complete my work using this system										

4	I am able to complete my work quickly using this system										
5	I am able to efficiently complete my work using this system										
6	I feel comfortable using this system										
7	It was easy to learn to use this system										
8	I believe I became productive quickly using this system										
9	The system gives error messages that clearly tell me how to fix problems										
10	Whenever I make a mistake using the system, I recover easily and quickly										
11	The information (such as online help, on-screen messages, and other documentation) provided with this system is clear										
12	It is easy to find the information I needed										
13	The information provided for the system is easy to understand										
14	The information is effective in helping me complete the tasks and scenarios										
15	The organization of information on the system screens is clear										
16	The interface of this system is pleasant										
17	I like using the interface of this system										
18	This system has all the functions and capabilities I expect it to have										
19	Overall, I am satisfied with this system										
		Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree	N A

Thank you for your commitment.