Efficient Business Intelligence systems utilization
Deliberation of information quality significance on decision-making

Bachelor’s thesis within informatics
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Jönköping June 2012
If you can’t explain it simply, you don’t understand it well enough.

— Albert Einstein
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**Abstract**

Business Intelligence (BI) system facilitates informed and timely decision making in competitive business environment. However, decision making can turn out to be highly challenging if information delivered by BI system does not meet certain level of quality. Organization can benefit from provided information if they are correct, comprehensive, current, and accessible. The organizational members who use BI application to make decision are best informants to verify the quality of delivered information. Additionally, the implementers of BI system are the one who must be aware of delivering high quality of information and can explain the reason of failures if any. It is critical to inquire both implementers and users. Therefore, the factors that can affect the quality of information were studied through comprehensive literature review. Low quality of information may make customers/ suppliers’ relationship worse, shrink the efficiency of the business performance, decrease the level of trust on BI, and eventually cause to lose the competitiveness in market place. This thesis is intended at investigating fundamental dimensions that hinder effective utilization of information in BI system and realizing how these dimensions can affect the quality and outcome of decisions. Study with an exploratory purpose was designed and conducted at a chain retail stores in Iran to gather empirical data from both group of BI users and implementers through focus group interview. The result of investigation shows the main BI system utilized to facilitate customer/ supplier relationship management and store operation management. Business areas and activities influenced by the quality of information include, inventory management, customer loyalty, competitiveness, and supplier management. The information quality issues are encountered mainly due to technical failures, lack of competent system developers, changes in business environment, inappropriate documentation during the system development lifecycle, and logical error in programming and designing algorithms. The time, effort, and resources spent on exploring and resolving problems regarding to the quality of information had a great influence on efficiency and effectiveness. Documentation during system development life cycle is emphasized as a crucial factor that necessitates further study in documentation subject. The preliminary findings signify the importance of study to consider information quality in BI practice.
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1 Introduction

1.1 Background

In earlier times, it was simple to memorize all the necessary information to achieve needs and interests. Soon after, the world established new prospects of knowledge. Mass quantity of information came out since computer innovation and humans experienced storm of information. Consequently, humans tried to gather, save, process, classify, and retrieve data to address their needs (Fang, 1997). Actually, such a large quantity of information is a main characteristic of this age, which is very complex and complicated to control the information flow. Such information flow is outcome of technological development that caused to name this age as the “the information age.” (Kluver, 2000)

Information as a merchandise has turned into an industry with a huge market, which does not vary from other recognized markets. Moreover, invested capital on the information generation and discovery of is in excess of what is funded on many important productions (Fang, 1997).

More notably, the term Information Technology (IT) emerged. IT is concerned with variety of technologies involved in treating information by acquisition, processing, storage, and dissemination of information (Kluver, 2000; Fan & Wu, 2010). The efficient utilization of IT directs to the advanced Information Systems (IS), through implementation of applications and databases to information storage, and processing in organization. Decision Support System (DSS) emerged in 1980s to facilitate business decision-making. DSS can be used at the operational, management, and planning level of an organization and facilitate decision-making (Laudon & Laudon, 1988).

An appropriately developed DSS is intended to assist decision makers to extract and gather valuable information, from available data, personal information and knowledge, business models, or documents, to discover difficulties and make appropriate decisions (Gorry & Scott Morton, 1989). According to Turban et al., (2011) example of information that DSS application typically collects include:

- list of information assets such as relational data sources and data warehouse
- Comparative sales figures
- Expected revenue statistics based on product sales assumptions.

Nowadays modern societies encounter various problems, which are mostly caused by either deficiency of these information or failure in retrieving demanded information in a timely manner. Moreover, increasingly level of competition among businesses makes it complex to sustain an adequate level of profits growth. Gorry & Scott Morton (1989) emphasize that enterprises understand the value of appropriate analysis and manage of information since level of competition increases in marketplace. As a result, according to Fielding (2006) one of the crucial tasks of analyzing information, with the aim of sustaining the successful operation, is to gather information from reliable sources. Furthermore, because of the mass quantity of information that is acquired from various sources, organizations are mandated to utilize various techniques to accomplish their tasks. These techniques are supposed to assist organizational process and analyze the collected information with the aim of extracting the valuable part of it, which, consecu-
tively, will enable the opportunity of taking vital decisions that serve the organizations’ objectives (Turban et al., 2011).

Business Intelligence (BI) is one of the techniques which is used in identifying, analyzing of data comprehensively and converting them into structured information; hence quality of decision making can be improved through simple access and choice of appropriate information (Fielding, 2006). Therefore, BI can be thought as a technology that facilitates right decision making by providing access to the accurate information in a right moment (Bogza & Zaharie, 2008). Principally, Business Intelligence can be expressed as the intelligence in comprehending business (Bogza & Zaharie, 2008).

The subject of BI implementation is a novel method, which is developed from DSS (Watson, 2009). The necessity for BI development was recognized in consequence of the failure in keeping track of markets growth and needs, deficient performance of the management, high expense of IT, and so forth (Turban et al., 2011).

Watson (2009) described BI as a “broad category of applications and technologies for gathering, storing, analyzing, and providing access to data to help enterprise users make better business decisions.” It leads to improved decision-making by utilizing precise and correct information with a satisfactory quality in a timely manner. Besides, Turban et al. (2011) explained BI as an assistant in forecasting likely opportunities, and trends in the marketplace, which will have ability to influence future achievements of a business. Consequently, through applying Business Intelligence, it is possible to take action quickly regarding market potentials by revising processes and turning them to serve the organizational objectives (Fielding, 2006). Hence, the value of BI systems lies in the constructive and practical involvement in classifying and managing information as well as decreasing the expenses and the progressively rising the profits (Turban et al., 2011).

1.1.1 Information quality as a critical success factors of BI

CSFs are the variables that can considerably influence the success of a company competing in specific industry given that the variables are well sustained, or managed (Leidecker & Bruno, 1987). Identifying CSFs aid to explain the character and scope of resources that must be collected to allow the BI project team to focus on precedence problems rather than wasting time thinking about what the existing technologies will permit (Greene & Loughridge, 1996). Identifying CSFs for the implementation of BI practice is varied from the set of interconnected comprehensive tasks, which have to be accompanied to guarantee a project’s completion (Yeoh et al., 2008). Therefore, just ensuring of successful implementation of CSFs may not promise success of a project but certainly, it can offer a prolonged run to the project.

Vodapalli (2009), broadly investigated CSFs relating to implementation of BI, as pointed out by various authors in various articles, journals, etc. He concludes 15 CSFs from twenty authors’ perspectives. The most common factors that most authors are agreed upon respectively include (Vodapalli, 2009):

- Clear vision & planning
- Information quality & management issues
- Map the solutions to the users
- Committed management support and sponsorship
- Performance considerations
However, it must be noticed that this list does not have the aim of highlighting the most important factors, which can be objective of another research and it is beyond the intention of this paper. Since different Authors have a diverse opinion regarding CSFs and their importance, we want to show most common points. As can be seen information quality (IQ) is one of the factors in which almost everyone are agree upon its importance in successful implementation of BI.

The IQ is an essential variable that is believed as the foundation and indispensable in realization of success in BI implementation (Yeoh et al., 2006). The superior excellence of the information, the more valuable decisions can be made, which means success in utilization of BI (Yeoh et al., 2008). As mentioned before the aim is not to prove IQ as the most important factor; rather, we can say that the other factors will not be so imperative when quality of information is low (Yeoh & Koronios, 2010). Moreover, the main concern of this thesis would be appraisal of information quality dimensions and their influence on decision-making.

It has been posited that quality of information provided by BI practice has constructive influence on decision-making (Yeoh & Koronios, 2010) and mostly it has positive correlation with organizational performance (Slone, 2006). Furthermore, the more trustworthy the data sources, the more informed and intelligent decisions can be made (Lee et al., 2001; Yeoh et al., 2006).

1.2 Problem discussion

From the previous sections, we can conclude that information and work environment alter extremely fast. Such situations together with a greatly competitive market caused companies encounter challenges in their business. According to Williams & Williams, (2007) These circumstances obligate the organizations to discover different options that can assist them in taking fundamental decisions, to devise organizational objectives and strategies.

Latest technologies, mainly in the field of computerized IS, offer set of suitable tools to study, analyze, and understand information (Williams & Williams, 2007). Since data are certainly, open to interpretation so it is crucial to make use BI to interpret them. This means that, BI facilitates management of business and offers capability for development and perfection of decision-making processes (Turban et al., 2011); also through problems identification, as well as exhaustive and clear data analysis, companies become capable of acquiring the most excellent approach for taking right decisions at a right time (Yeoh et al., 2008).

The value of the Business Intelligence practice resides in its capacity of giving a broad picture of the current situation of the market, which is described as highly competitive and problematical due to rapid change. Besides, BI may perhaps give the possibility to predict the future market trend, - determining opportunities, and/or threats that should be considered – with the ambition of progress in business performance (Williams & Williams, 2007).

Although employing BI has turned into organization’s highly imperative objective, but it is not yet suitably and effectively employed and developed to greatest advantage for assisting decision maker to achieve their objectives (Turban et al., 2011). Moreover, the existing sources of information, which describes actual assets in the organization, are not employed in BI in a correct and inclusive structure (Watson, 2009).
It is essential to consider the main issues that influence the BI competency and effectiveness to assist enterprises in making right decision and cope with such mentioned problems, which in turn leads to development of business execution and gaining competitive advantage (Yeoh et al., 2006).

As it is discussed before, some of the critical aspects that can enhance effectiveness and efficiency of BI comprise clear vision & planning, Information quality & management issues, committed management support and sponsorship. In this paper, the focus will be on Information Quality.

**Why information quality**

The quality of information is important since mass quantities of information are available from various sources and lack of information is not a problem anymore; instead, the problem is capability of gathering, related applicable and consistent information from authentic sources. This means that, information is not significant by itself; instead, the quality and excellence of information as well as its accessibility at right time and quickly for taking a correct decision is an important matter.

Hostmann (2007) argues that even though implementing BI system is becoming increasingly popular investment across organizations, they seem to be failed in utilizing required information as intended. The failure mostly is due to lack of trust on delivered information or availability issues. Redman (1995) also highlights that even a small sign of problem in quality of information may prevent or delay businesses from reaching an appropriate decision. Therefore, organizations are sometimes incapable to employ the BI practice as intended to make informed decision and develop their productivity. Lee et al. (2001) underline information quality as one of the most critical issues that must be addressed carefully in developing data warehouse, which is main component of any BI system. Burns (2005) argue that nearly 50% of data warehouse project were unsuccessful due to overlooking the importance of IQ. Strong et al. (1997) argue that IQ issues are more and more obvious in different organizations. They highlight that certainly 50 to 80 percent of criminal records in IS systems in the U.S. were discovered to be wrong, deficient, or confusing. Such information quality issues impact social/ economic and imposes billions of dollars additional costs. Therefore, it is important to investigate reasons of IQ failures and their consequent influences on business performance. Furthermore, according to the Turban et al. (2011) through access to the excellence information organizations can gain more competitive advantages than organizations, which employ inferior information to make business decisions.

**1.3 Research objectives and questions**

In order to be capable of making right business decisions, organizations constantly struggle to build a competent DSS. Consistency of the DSS process largely depends on the effectiveness of BI practice, and organizational concern about implication of BI in achieving and business objectives (Watson, 2009). To assist enterprise user to make better decision, Organizations should consider the main aspects that play a basic role in developing and employing BI systems competently (Yeoh et al., 2006).

Decision making within a BI field is often viewed complicated, due to information that is hard to utilize. It is not apparent how the information quality influences on the decision-making process. Regarding to the discussed problems and considering information quality as one of the main aspect in implementing BI, the research question is:
1) How does poor Quality of Information delivered by BI system influence the decision-making in business environment?
   a) What issues can affect the quality of information in BI system?
   b) What are consequences of these issues on business performance?

In this thesis, it will be attempted:

- To create a consciousness of core factors that hinder information from being easily utilised and making the exact and precise organizational decisions.
- To study how these factors influence the business decision and performance, especially within a BI environment.
- To stir up interest of companies and encouraging them to realize the great value of the information quality in order to achieve competitive advantage, improve business performance and be far from breakdown.

1.4 Interested stakeholders

Since various units of organization involve in decision-making; so, this thesis is attended to the BI decision makers and users in a variety of organizational units in large chain retail stores, as well as IT unit and BI developers but not only the managerial level. Furthermore, this research can be valuable for researchers who are curious or involved in the subject of BI study.

1.5 Delimitation

The factors that have influence on quality of information in BI systems and how these dimensions can affect practice of decision-making are central concerns. In addition, enhancement of a BI is not going to be focused; rather, deliberation of information quality significance on decision-making and factors that affect the quality of information will be concerned and discussed. In addition, data and information will be distinguished from each other and information will be center of attention but not data.

1.6 Definitions

- **Decision support system (DSS):** Emerged in 1980s to facilitate business decision-making. DSS can be used at the operational, management, and planning level of an organization and facilitate decision-making (Laudon & Laudon, 1988).
  An appropriately developed DSS is intended to assist decision makers to extract and gather valuable information, from available data, personal information and knowledge, business models, or documents, to discover difficulties and make appropriate decisions (Gorry & Scott Morton, 1989).

- **Business intelligence (BI):** Jonathan Wu (2000) says: “The next generation of DSS applications evolved into BI systems”. Business Intelligence (BI) is one of the systems which is used in identifying, analyzing of data comprehensively and converting them into structured information; hence quality of decision making can be improved through simple access and choice of appropriate information (Fielding, 2006). Therefore, BI can be thought as a technology that facilitates right decision making by providing access to the accurate information in a right
moment (Bogza & Zaharie, 2008). Principally, Business Intelligence can be expressed as the intelligence in comprehending business (Bogza & Zaharie, 2008).

- **Extract, transform, Load (ETL):** Used to extract, transform and load data from both operational databases and scattered data sources permitting for the gathering of volumes of data which allows for access to information in real-time, and standardized and consistent data type in which to analyze (Schink, 2009).

- **Data warehouse:** Used as warehouse for all data applicable to an organization to support the decision making in business environment by gathering related and context sensitive data offering multiple dimensions to data (Matei, 2010).

- **Online analytical processing (OLAP):** techniques employed to analyze and report data from vast data sources by giving user access to data warehouse, and building data models (Olszak & Ziemba, 2006).

- **Data mining:** utilized to identify structure, associations, and patterns within a data warehouse and generates comprehensive reports. It facilitates predictions based on past data, as well as graphing and computing to produce formulas to analyze data (Hevner & March, 2005).

- **Information Quality (IQ):** information quality is described as information that is fit for purpose and satisfies the objective for which it is intended. In the case of BI, this means that information should have particular characteristics that the data consumer determines as significant in order to be regarded as constructive and valuable for decision making. This explanation also proposes that quality should be considered from a data consumer perspective and that there is more to information quality than just being correct and accurate (Strong et al. 1997).

- **Data Quality (DQ):** Wang et al. (2008), define Data quality as the degree to which data presented by an IS correspond to same data in the actual world. Bertolazzi & Scannapieco, (2001) discuss that the first definition, which is mentioned in IQ definition, stress the nature of quality in the context of information while the latter is more operational view. In addition, it must be mentioned that a conventional method to evaluate quality in context of Data does not exist due to its multi-dimensional nature include correctness, timeliness, comprehensiveness, reliability, and accuracy (Wand & Wang, 1996). For that reason, the actual matter of quality is to ensure that data is sufficiently accurate, timely, and consistent for to make sensible and right decisions. (Wang et al., 2008).
2 Methodology

“A researcher’s methodological approach, underpinned by and reflecting specific ontological and epistemological assumptions, represents a choice of approach and research methods adopted in a given study” (Hay, 2002). Principally, the progression of any research is based on an inclusive plan for the activities necessary to expand the knowledge. Therefore, the research should be started with clear problem discussion, followed by the theoretical reference of it, to construct a proper research design for expanding knowledge. Finally, the last step is data collection followed by data analysis to derive results from the collected data. This is the summary of the procedures used to organize the research process. The following parts will consider different research methodologies, and motivate the reason of selecting particular methods.

2.1 Research approach

While doing a research project, it is crucial to choose between different research approaches that would be best suit to the research. Understanding to these approaches is fundamental to enhance the efficiency of the study. Moreover, the extent to which we are clear about the theory at the start raises an important question concerning the design of research project. This is whether research should use inductive or deductive approach (Saunders et al., 2007).

Inductive research is approach in which theories are emerged from specific observation. In deductive approach, the explicit expectations of a hypothesis are built base on general principle: we commence from existing theory and then find its confirmation. Inductive research is open-ended and exploratory mainly in the beginning. Deductive research is specific in nature and is involved testing or confirming hypothesis (Srivastava et al., 2011). Figure 2-1 illustrates the main points of differences and steps involve in each approach. In fact, all studies that have taken place in different contexts are a continuous cycling of induction and deduction approaches and combination of both (Srivastava et al., 2011; Saunders et al., 2007).

Initially we decided to conduct a deductive approach, so we started with an in-depth literature review to find a proper theoretical framework to describe influences of IQ issues on decision-making and utilize it as guidance to collect data and test hypothesis. Since our theoretical framework is not comprehensive enough to be tested through data collection and yielding a sufficient answer to our research question so we decided to employ it
as guidance for developing interview questions to observe these influences and ending with a conclusion or a theory (inductive rezoning). Also starting a kind of inductive research from a theoretical perspective link our research into the existing body of knowledge in our subject area, help us to get started and provides us with an initial analytical framework (Saunders et al., 2007).

To sum up, this study is neither pure inductive nor pure deductive. It inherited component from both approach, but mostly toward inductive. We started with literature review and we could only figure out 13 dimensions that affect quality of information (figure 3-4) but not influences of these issues on business performance. Therefore, this theory used to investigate and identify information quality issues in our selected case. The theory provided us a prospective during empirical data collection and analyzing quality issues in the company. Moreover, after the empirical data collection and identifying IQ issues in the case, the inductive reasoning used to categorize data and discover influences of identified IQ issues on decision making which has not been considered in the theoretical framework. According to Figure 2-1, we tried to commence with a theory (left side of picture), to deduce the information from the sample. The theory used to observe and investigate IQ issues. Then it became somewhat inductive given that the interviews functioned as the step “observation” of the right side in Figure 2-1, to recognize pattern and identify relationships between collected data to come up with a theory about influences of IQ issues on decision-making and business performance. Such approach enabled us to present subjective analysis with the help of real life example.

However, this developed theoretical position then need to be deductively tested for its applicability through subsequent data collection and analysis, which is going to be addressed in ‘Discussion’ section later as a suggestion for further work. This implies the continuous cycling of induction and deduction approaches highlighted by Srivastava et al., (2011) and Saunders et al., (2007).

2.2 Research design

2.2.1 Research purpose

In order to formulate the research question, we necessarily started to think about the research purpose. The categorization of research purpose most often suggested in literatures is the one of exploratory, descriptive, and explanatory (Saunders et al., 2007).

The purpose of descriptive research is to draw an accurate profile of individuals, events, or circumstances (Robson, 2002). Causal relationship between variables can be established by explanatory research. The stress is on examining a circumstance or a problem for explaining the association between variables (Saunders et al., 2007). An exploratory research, which is adopted for this thesis, is valuable way of understanding what is occurring; to look for new insight; evaluate events with asking questions (Robson, 2002). There are three leading methods of carrying out exploratory study; search of literature, interviewing expert in the context of research, and conducting focus group interviews (Saunders et al., 2007). In addition, exploratory research is generally carried out, if there is no former theory/ model to lead us or if we wish to have, some initial idea to find out the problem to be studied (Srivastava et al., 2011).

The purpose of this research is to design an exploratory study. Since we did not know much enough about the situation, which was influences of different dimensions of Information quality on decision-making and yet we wanted to have some assessment.
However, we could not find Information, theory, or model available as to how same problem was solved in the previous researches. Therefore, through the extensive literature review we tried to create a framework that would lead us in gathering relevant empirical data by conducting focus group interview with expert BI users/implementers. Through the exploratory study, we focused on understanding more about the topic and identifying variables that could be cause of low quality of information and influences of these variables on decision-making.

2.2.2 Research strategy

In this part, we concentrate our attention to the research strategy that is adopted in this thesis. According to the Yin (2003) for exploratory, descriptive, and explanatory study, we can utilize each of the research strategies. Some of these strategies obviously fit to deductive approach, and some of them to the inductive approach. In some cases, allotting strategies to one approach or another is unduly oversimplified. The selection of research strategy is directed by research question and objective, the degree of existent knowledge, available time and resources, in addition to philosophical approaches (Saunders et al., 2007). According to Saunders et al. (2007), different strategies that can be employed include experiment, survey, case study, action research, grounded theory, ethnography, and archival research.

Robson (2002) specifies case study, which is employed in this research, as a strategy for conducting research, which includes an empirical study of a specific existing events within its real world context by means of different source of evidence. The case strategy was of specific interest to us, since we desired to obtain a rich perception of the field of the research and processes being enacted (Morris and Wood, 1991). Additionally, case study has noticeably capability to generate responses to the question ‘Why?’, ‘What?’, and ‘how?’ therefore it is employed in this study (Saunders et al., 2007). However, answers to ‘What?’ and ‘how?’ questions of this study predisposed to be more the concern of survey strategy (Saunders et al., 2007) but due to the lack of time and resources it was somehow impossible to conduct a survey study in industry. Data collection techniques used for this strategy may be different and are possibly to be utilized in combination. They may involve, like interview, observation, and questionnaire (Saunders et al., 2007). Also, according to Yin (2003) case study strategy is suitable for this research since the form of research question is ‘how?’ and the focus was on contemporary events and it did not require control of behavioral events (figure 2-2).

![Figure 2-2: Associated situation for different research method (Yin, 2003)](image-url)
The selected data collection technique according to the research strategy is focus group interview, which is going to be explained in more detail in ‘data collection and analysis’ section. Multiple sources of evidence, instead of relying only on interview, and using triangulations logic could improve the validity of this research. However, due to privacy issues in the company we could not achieve this. This matter is further explained in ‘Validity’ and ‘Discussion’ section.

Yin (2003) differentiates between four case strategies based on two dimensions: single case vs. multiple cases; Holistic case vs. embedded case (Figure 2-3). Our strategy in this study is to perform a single-embedded case study. We were aware that single case study needs a strong justification for a critical, unique, or representative case in testing a well-formulated theory (Yin, 2003). Therefore, we desired to conduct multiple-cases to study more than one company. In this way, we could institute if the findings of the first case happen in other cases and, consequently, the requirement to generalize from these findings through replication logic (Saunders et al., 2007; Yin, 2003). Although, multiple-case study could not be achieved, since companies either refused to have an interview or did not implement BI system. Therefore, we decided to investigate the only company that agreed to have an interview with us, and consequently following single-case strategy.

In addition, embedded dimension is adopted since this research is interested in examining more than a unit in the organization (Saunders et al., 2007). In view of the fact that various units of organization involve in decision-making; so, this thesis was attended to the business team who use BI technology for assessing business environment, so we could investigate influences of IQ on business environment. In addition, we considered the BI unit of the organization to investigate information quality issues and possible causes of failure in delivering high quality information. Furthermore, it must be notice that, even though the interviewed business analyzers are part of BI unit as a liaison between business and IT and their main responsibility is to work with business team, so we consider them as another sub unit. This justifies our embedded view.

The last concern in this section is to answer why retail industry. Tapscott (2008) claims that the retail industry was one of the first to implement BI system to facilitate collecting and integrating suppliers and consumers’ data. Data driven decision-making is critical for retail industry to appropriate decision about price, assortment, replenishment etc. Competition in this industrial category is becoming ever rougher as the quick product cycles, and changing consumers’ preferences continue to change many segments (Tapscott, 2008). Therefore, mass quantity of data regarding suppliers and customers need to be well organized and met acceptable level of quality to be able to make appropriate decision in timely manner and maintain competitiveness in the market place. Since they have to deal with large amount of data, regarding different product categories/brands, suppliers, and customers, the management of information would be a complex and sensitive task. This complexity can also increase probability of encountering information quality issues and thereby failure to meet market demand (Tapscott, 2008). Therefore, it is necessary to investigate the reasons of IQ failures in BI system and their corresponding impact on their performance to increase awareness about importance of IQ and have an initial idea about the problem to be further studied in future. This implies an exploratory case study.
2.2.3 Method

Ordinarily, one of the primary goals of a research is attempting to search out new information and knowledge that assist us to realize and elucidate different phenomena. To facilitate collection of such information Either Qualitative or Quantitative techniques or combination of both can be employed (Creswell, J. W., 2009).

Qualitative Methodology, which is adopted in this study, intend to collect an in-depth understanding of thoughts, activities, value systems, concern, incentives, and society as well as the grounds that govern such things (Denzin & Lincoln, 2005). The qualitative method considers the why and how of decision-making, as well as what, where, when. For this reason, more often smaller but focused samples are considered necessary than large samples (Denzin & Lincoln, 2005). Typically, qualitative methods generate information merely on the specific cases studied, and any more generalization is only propositions (informed assertions). After that Quantitative, methods can be adopted to look for empirical evidences for such research hypotheses (Denzin & Lincoln, 2005). However, Yin (2003) believes that qualitative study can also be generalized through replication logic and analytic generalization instead of statistical generalization.

As shown in Figure 2-4 in choosing the research methods the researchers have more than one choice. It is possible to either use single data collection technique and corresponding analysis procedure, known as mono method or use more than one data collection technique and analysis procedure to answer research questions that is referred as multiple methods (Saunders et al., 2007).
This research adopted qualitative mono method, which is compatible with the purpose, strategy, and available time for this research as they are discussed in previous sections. By following the qualitative approach, we seek a wide understanding of Business Intelligence experts’ interpretation and perceptions about dimensions of information quality that must be considered, causes of information quality issues and influences of those dimension on making intelligent and informed decision. This achieved by means of selecting a small sample of BI experts (both expert users and technical people). The aim was to interview professionals who are able to provide us with more in-depth and comprehensive information.

### 2.2.4 Time horizon

Two sorts of time horizon that must be concerned for designing a research project include cross-sectional studies and longitudinal studies. The former is often referenced as a “snapshot” since the research is conducted at a specific time. This technique is usually employed for research projects that have a time limitation. The latter is so called also as the “diary” dimension, which studies individuals or events over time. The main question in longitudinal studies is “Has there been any change over a period of time?” (Saunders et al., 2007). Since the objectives and research question aim to study issues related to IQ in past and current time and do not require to observe behaviour of individual or event over a period of time, so the time horizon adopted in this study is the cross-sectional horizon. It means that, the attitudes of the employees and changes over time are not concern of this study, and the research is “snapshot”.

### 2.3 Literature sources

Literature reviewing is considered as a fundamental ingredient of any research, which can provide related information regarding others works in a certain topic of interest. Literature sources can be divided into three groups: primary, secondary, and tertiary (Figure 2-5) (Saunders et al., 2007). The first occurrence of a work is called Primary literature sources such as reports, and thesis. Later publication of primary literature such as books and journals are Secondary literature sources. These are easier to find than primary literature since they are better covered by the tertiary literature. Tertiary literature sources also called search tools, such as indexes and abstracts as well as encyclopedias and bibliographies are intended either to assist to find primary and secondary literature or to introduce a topic (Saunders et al., 2007).
To review the related literature in our topic, we used both primary and secondary sources include the books, articles, journals, thesis, and other materials, which were located through the tertiary sources especially indexes and bibliographies. At first, centre of attention was to have a comprehensive understanding of the terms include, Business Intelligence (BI) and Information Quality (IQ). Through seeking out the main references connected to these terms, we could formulate our research questions and the way of conducting the research.

The process of searching out literature sources that were followed to acquire relevant information regarding to the concerned terms and topic can be summarized as following steps:

1. identifying the keywords;
2. seeking out for books, articles, and other sources via the Google and database of the university’s library to get primary understanding about the subject under study;
3. refining and limiting the keywords and search criteria to concentrate only on the references that could be more useful and relevant to the research questions;
4. Reading, assessing, and sorting the references according to their relevance and input value to our thesis;

Reviewing the previous studies related to our topic gave us:

- A comprehensive knowledge from different perspectives to address the research problem
- Connect our work to the work that was done by others
- Develop theoretical framework and adequate knowledge to guide the empirical data collection
- Raise new research question and direction for further work in future.
In addition, considering various viewpoint and concerns to address the problem can produce different results.

2.4 Data collection

Indeed, to achieve the purpose of any research, and finding the answer of the research questions, it is necessary to gather relevant data. Thereafter, it would be possible to confirm the hypotheses, or provide answer to the research question(s). This can be achieved by considering the collected data, to provide credibility to the result.

Furthermore, to become certain that there is a concrete ground for the research, it is crucial to clarify which type of data is required, ‘primary’, or ‘secondary’. Primary data are, data collected specially for the research project being undertaken; while secondary data are data were originally collected for some other purposes (Saunders et al., 2007). Besides, a variety of data collection techniques can be employed, such as questionnaires, interviews, and observations. Such techniques are utilized to collect essential information to achieve the purpose of the research (Saunders et al., 2007).

In this thesis, we only collected primary data through focus group interviews. Prior to the data collection Literature reviews gave us a foundation for studying and analyzing the other related work in field of IQ and BI and a framework was developed (figure 3-4) to guide the interview with Business Intelligence users and BI implementers.

2.4.1 Selection of respondents

The idea of conducting a qualitative approach is to make it feasible to obtain a deep comprehension about the context. Additionally, it offers as much information as possible to reach this comprehension. Therefore, the chosen respondents should have been met certain condition as follow:

- Adequate familiarity, experience, and understanding in the context of BI practice
- They must be in a position of decision making in organization, to be qualified to answer questions regarding user perspectives about influences of information quality on decision-making.
- In addition, in order to investigate information quality issues and their possible causes from developer perspective chosen interviewees must have adequate experience and knowledge in development and implementation of BI systems.
- Furthermore, BI must have already been applied in the selected company and employed in carrying out jobs and tasks.

Through realizing such situations, the empirically collected data could provide a solid foundation to find out various opinions regarding the importance of information quality, issues affecting quality of information and the impacts of these dimensions on decision making.

2.4.2 Interviews

An interview is a purposeful discussion between two or more people (Kahn and Cannell, 1957). Interview can assist to collect valid and reliable data that are applicable to research question(s) and objectives (Saunders et al., 2007). It is important to consider that the nature of any interview should be consistent with research question, objectives, purpose, and strategy that have been adopted (Saunders et al., 2007). According to Saunders et al. (2007) there is one typology that is usually used is related to the level of
formality and structure, whereby interview may be categorized as one of: standardized (structured interviews) or non-standardized (semi-structured interview, in-depth interview) and it can be also either group or individual interview (figure 2-6).

This study adopted focus group interview. However, according to Boddy (2005) currently there are different terms used interchangeably to explain group interviews and often assumed to have equivalent meaning (such as, focus groups, group interview, group discussion, Delphi group, etc) (cited in Saunders et al., 2007). Morgan (2008), argue that the term group interview is currently equal with focus groups for nearly all type of data collection through interviewing two or more people. He also highlights that there are two distinctive differences between focus group and other forms of group interview. First unlike many other interview groups, the objective of conducting focus group interview is to collect data in which topic is defined clearly and focused plainly upon particular issue or topic. Secondly, focus group includes the need for interactive discussion between participants use to obtain information from the group.

In the conducted focus group interviews, the participants with certain characteristics in common, corresponding to the topic, were selected for each group. Therefore, we had one group from business side to discuss influence of IQ on business performance, and a group of technical experts to discuss IQ issues and reasons of failure of delivering proper information.

Through focus group interview, we believe that we could extract more detailed information and variety of opinion in a shorter time than would be possible by one to one interview. It also allowed us to benefit from the situation in which interviewees’ feed off each other thoughts and spark opinion that may not had been obtained in individual interview (Saunders et al., 2007). This was mostly because of dynamic of the group and interactive discussion among participants about the topic, which in turn facilitated achievement to exploratory purpose of this research (Morgan, 2008). During the interview, we considered to keep the discussion in relation to the introduced topic and pre-
venting unrelated discussion, while allowing group members to discuss freely about the topic, as it was fit. In addition, we encouraged discussion among the group whenever we felt that someone had been quite for a while. This had been done by asking questions such as “what do you think about your colleague’s point of view?” In this way, we could encourage same amount of contribution in the discussion by everyone, prevent domination of discussion by one or two people, and gather all points of view. Moreover, during the interview we had never tried to reach an agreement; instead the purpose was to gather all possible opinions.

Focus group interview used in this research to explore in depth the area of interest. The interviews were carried out on a one-to-many basis through internet-mediated focus group interviews via video chat room. Internet interview-mediated interview was selected due to geographical barrier. The connection established by using the Skype software since they had that software and the voice recorded by using “Skype Call Recorder.”

Furthermore, the Focus group interview is suitable to this study since (Judicial study Board, 2007)

a. We wanted to extract more in depth information even about issues that we had never considered before the interview;

b. The required information was complex, especially in term of technical issues, so it was not appropriate to have more structured interview;

c. Participants were experienced and shared common agenda

This kind of interview enabled us to have an open conversation with few boundaries around a topic (Saunders et al., 2007). We had some question prepared in advance; they were the general questions that needed to be answered carefully and helped us to encourage discussion as much as possible. Moreover, during the interview some qualifying questions were asked to obtain deeper insight about the topic, such as “can you elaborate this issue with an example?” Additionally, the general questions had been different for each group of interview, since technical group of interviewees were asked about information quality issues, and business Analyzers were asked about influences of IQ on business performance.

Given that, interviews were the main source of collecting relevant empirical data for this research, our plan for interview could be summarized as follow:

1. Choosing a company, that utilized BI systems to carry out their tasks extensively (we decided to focus on retail industry as the reason discussed in ‘research strategy’ section 2.2.2);

2. Who could give us required, valuable, and constructive information (since managers, specially CROs and CFOs, and business analyzers are main users of BI and they are involved in decision making activities, so we believe that such organizational members are in the best position to realize IQ issues and its impact on decision making); on the other hand developers and technical people are in a best position to recognize and identify reasons IQ issues;

3. Contact to make appointments;

4. Developing knowledge about how to manage the questions and how to conduct focus group interview;
5. Arranging the general questions that could help us to analyze and explore both users and BI perspectives about IQ issues. Then categorizing questions based on different topics of interest. Such topics later used as titles of ‘empirical findings’ section 4.

An abstract of outline of interview and a list of general questions were included in the manuscript of interview. The questions were sort out into a few different groups based on the character of the questions. These groups include: the areas and benefits of using BI on decision-making process, BI architecture, issues affecting the quality of the information, Influence of poor information quality (BI developer perspective), and Influence of poor information quality (business perspective). Such planning could help to ensure that all the issues were covered up in the interview.

In addition, during interview, we pursued the procedure recommended by Myers & Newman (2007) as follow:

1. **Positioning the researcher as actor:** we provided the information about ourselves to the audiences, so that the audiences could be capable to evaluate the credibility of the research.

2. **Reducing social dissonance:** By providing a comfortable environment for the respondent so, the respondent can reveal the details or describes his or her opinion comfortably without any distraction. Since the interview was internet based, interviewee had opportunity to choose most comfortable place.

3. **Representing different perspectives:** Different roles in the organization should be involved in the interview to avoid bias. Focus of our study is on a specific topic, so we had to attend the opinions of experts on the area of study. However, within this specific area we interviewed different roles as head of BI department, business analyzers, and BI team.

4. **Each person is an interpreter:** A flexible interview makes it possible to adapt opinions raised during the interview.

5. **Use mirroring in interview:** We attempted to get used to the respondent’s talking style. In addition, we asked open questions, rather than closed one, since open questions can encourage interviewees to provide an extensive answer, and may be used to reveal attitudes or obtain facts (Saunders et al., 2007).

6. **Flexibility:** The interviewer should be ready to discover interesting lines of research, and look for surprises. The interviewer should take into consideration respondent’s differing attitudes (deceiving, fatigued, show off, and confessing) and react accordingly.

7. **Confidentiality of disclosures:** It is important to keep transcripts and records confidential and protected. It is better to send copy of transcript to respondents to check with them about factual matters if required.
2.5 Analysis

Qualitative data analysis processes help to build up a theory from data. They involve both deductive and inductive approaches and sort from the simple divisions of answers to processes for recognizing the association between categories (Saunders et al., 2007). Qualitative data analysis is based on meaning derived from words; collection results in non-standardized data needs arrangement into categories; analysis carried out via utilization of conceptualization (Day, 1993; Healey & Rawlinson 1994; Saunders et al., 2007).

2.5.1 Transcribing qualitative data

First of all, in order to make interviews as effective as possible, we planned to inform each participant in advance with list of the most important topics that would be argued in the interview session. This could be an opportunity for the participants to prepare themselves, and to use time effectively as there was time limitation for conducting the interview. After giving approval from the respondents, we recorded the entire interview. Since we decided to carry out the focus group interview, two of us made notes of significant issues during the interview to ask further questions.

For purpose of analyzing the responses, we listened to the record and extracted answers in details. Subsequently, there was fine-tuning of these responses by reformulating them to become more obvious and easy to comprehend. As we were interested in interviewees’ pronouncement as well as the way that they say it, therefore we attempted to give an indicant of the tone in which it is stated and the interviewee non verbal communications.

In order to not being distracted by irrelevant information, we eliminated information that did not belong to the field of this research (as we mentioned before during the interview we intervened if participants discussed irrelevant issues). The interviews are not demonstrated in this study by means of mentioning the questions and answers; relatively, the interviews are demonstrated by means of citing the perspective of respondents concerning the debated subject. We think this method is more appropriate for those who will read this research, and facilitate to concentrate on the major themes that were argued in the interview. In addition, to ensure that the collected data was interpreted accurately and without any misunderstanding a copy of transcription was sent for respondents to be checked and confirmed as well as added extra information if needed.

2.5.2 Qualitative analysis

According to Saunders et al. (2007) qualitative data analysis is carried out in non-standard way, there are various approaches to qualitative study, which cause various ways to analyse qualitative data. Although, according to Tesch (1990) different strategies can be categorised into four classes, (cited in Saunders et al., 2007):

- Understanding the characteristic of language
- Discovering regularity
- Comprehending the meaning of text or action
- Reflection

The first two classes are related to analytic strategies that need greater structure and arrange processes to pursue, compared to the second two. Moreover, the first two classes are related to analytical strategies that begin deductively, where data divisions and
codes to study data are come from theory and existing framework. On the contrary, the second two classes are related to analytical strategies that start inductively, with no existing or determined divisions and codes to analysis (Saunders et al., 2007).

As it discussed in section 2.2, there are two approaches to data collection and analysis namely deductive or inductive. Since we started our research by following deductive approach after the literature review we came up with different dimensions of information quality (figure 3-4), but we noticed the theoretical frame of reference did not supplied an adequately convincing answer to our research question and objectives, which is impact of these factors on decision making. Therefore, we settled on to analyze collected data both deductively and inductively. The combination of the two approaches could produce more solid answer to our question and objectives.

Through the deductive analysis of empirical data, we coded and divided our data according to theoretical framework (figure 3-4) and identify data quality issues in the studied company, so theoretical framework organized and guided this part of data analysis in order to be tested in that company. Afterwards we focused on “discovering regularities” to realize what different interviewees had and not had in common. On the other hand, through the inductive analysis focus was on “Comprehending the meaning of text or action” to discover influences of these quality dimensions on decision-making in order to reveal a theory and discover the themes and issues that could be a complementary.

Qualitative data analysis includes set of activities, which is argued bellow (Saunders et al., 2007):

- Categorization
- Unitizing data
- Recognising relationships and developing categories
- Developing and testing theories to reach conclusion

**Categorization:** This involves categorization of data into meaningful categories, which could be extracted from empirical findings for the theoretical framework. Actually, codes or labels were categories that were used to classify data. They gave us an emerging structure that was associated with research to arrange and analyze data, which was guided by the purpose of our research (Saunders et al., 2007). According to Saunders et al. (2007), we identified categories from three resources include, terms that came out from data, real terms used by respondents, or terms employed in current theory and literature. Each category then highlighted with different color and the same color was used to highlight any sentences related to a certain category. Categories were identified in a way that to be meaningful in relation to the data and the other categories. Therefore, we could develop hierarchical approach to the categorization of the data. This in turn enabled us to interpret and indicate linkages between the data to create tables and figure.

**Unitizing data:** this activity of analytical procedure involve attachment of related data ‘bits’ or ‘chunk’ that will reference to as units of data, to the proper category that have been made (Saunders et al., 2007). As it is mentioned in ‘categorization’ part, as we read the transcription of interview, chunk of data that was related to a certain category highlighted with the same color as the category. These chunks of data were either number of words, a sentence, or number of sentences. Afterward, all highlighted parts were moved to other ‘MS Word’ and labeled with appropriate category or even categories.
This approach helped us to rearrange and reduce data into more manageable and comprehensible form, according to the research purpose. After unitizing the data, the patterns in data became more clear and we close to developing tables, figure, and recognizing the importance of documentation in BI system development (section 5.5).

**Recognising relationships and developing categories:** creating categories and rearranging data in accord with them, or formulating a proper matrix and putting the data collected in its cell, indicates that we are joining in the procedures of data analysis (Yin, 2003). After unitizing data, the data was read several times to find key themes and relationships in rearranged data. This led to changing some categories by sub-dividing or combining them. The tables and figure in section 5 are result of identified relationships and patterns.

**Developing and testing theories to reach conclusion:** since we look for exposing patterns in collected data and identifying association between categories, the hypothesis can be developed for testing. Testing the hypotheses, which inductively come out of the findings, by exploring alternative interpretation and negative instances is important (Saunders et al., 2007). However, the testing part is skipped since the goal of exploratory study is not to conclude a study but to develop ideas for further study (Yin, 2003), and enough number case is required to test the findings in other cases. This further explained in ‘Discussion’ section 7.

### 2.6 Research credibility

When designing and conducting a research it is important to address credibility of the research findings. This will help auditors and readers to ensure the quality and correctness of findings. Considering credibility of the research, also reduce the possibility of getting wrong answers. Reducing the likelihood of getting the incorrect answer means that attention has to be paid to ‘reliability’ and ‘validity’ on research design (Saunders et al., 2007).

#### 2.6.1 Reliability

“The purpose of reliability is to make sure, if another researcher follows the same procedures as described in methodology part and conduct the same case study all over again, the other researcher should arrive at the same findings and conclusions” (Yin, 2003. p 45). It must be concern that reliability is about the quality of the research method and procedures. Here the emphasize is to enable other researchers to do the same case with same method and procedures over again, not on "replicating" the results of one case by doing another case study and other informants. The aim of reliability is to reduce the errors and bias in the study.

In order to address the reliability of the research, the procedure of data collection and utilized research method are described in detail in methodology section. This enables other researchers to judge the reliability of the procedure and repeat the case study by using the same procedure, to see if they can reach to the same result. To approach the reliability problem we made as many steps as operational as possible and we conduct research as if someone were always looking over our shoulder. Therefore, we described what we really did in detail and avoided to claim following of a procedure (which could increase the credibility of our research) that has never followed. According to the Yin (2003), “a good guideline for doing case studies is therefore to conduct the research so that an auditor could in principle repeat the procedures and arrive at the same results.”
In addition, errors and biases are addressed by considering the threats to reliability. According to the Robson (2002), there are four threats to reliability, namely subject or participant error; subject or participant bias; observer error; observer bias. To address participant error we allowed interviewees to select most appropriate time for interview and during the interview misunderstood questions and loss of concentration was handled by further clarifying the meaning and purpose of questions. In addition, they described their point of views and addressed many of shortcomings and problems without any hesitation, and they allowed us to record their voice and publish name of company and their positions. This increased our assurance of low probability of participant bias in our research. Moreover, the interview was conducted by one of us and we had only one company to interview, so there was not possibility of observer error and asking questions in different way in different interviews to obtain answers. Finally, to avoid observer bias, during the interview, any attempt to impose personal view and frame of reference was avoided and after interview, answers analyzed and interpreted by all of us, then it was sent to interviewees for confirmation.

2.6.2 Validity
According to the Yin (2003), validity of the case study can be achieved through considering construct validity, internal validity, and external validity. However, “internal validity is mainly a concern for explanatory case studies, when a researcher is trying to explain how and why event x led to event y” (e.g. by addressing rival explanation, performing pattern matching, etc) (Yin, 2003), so it is not applicable to exploratory purpose of this research.

Yin (2003), explained three tactics to enhance construct validity when doing case studies, include, use of multiple sources of evidence, establish a chain of evidence, and to have the draft case study report reviewed by respondents.

- Construct validity
  - Multiple source of evidence:

To achieve higher level of validity it is recommended to use multiple source of evidence, instead of individual source of data. However, in this research we collected data only through use of focus group interview. Utilizing triangulation rational by means of using different method of data collection could be a great help to reach result that is more valid. We were interested in investigating archival records to obtain more valuable and accurate information about the logged information quality issues and associated problem in business environment as well as administrative documents and logged users’ feedback. However, they denied access to such information. In addition, we could conduct questionnaire across all branches. Although, conducting a quantitative study is the next step after identifying issues through interview. The result of interview would inform the content of questionnaire.

To sum up, this thesis has an exploratory purpose, and it is viewed as an early stage of research to gain basic ideas, insight, and understanding about the problem area, identifying variables, and hypothesis generating through a focus group interview. The goal of exploratory study is not to conclude a study but to develop ideas for further study (Yin, 2003). The theory can be tested in a larger scale thorough, for example, survey at the next stage of research. This is also discussed in section 7 “Discussion.”
Chain of evidence

To improve the *construct validity* of the information in this research, we preserved a chain of evidence. We allowed readers of the thesis to pursue the source of any evidence from initial research questions to conclusions. The process was tight enough that evidences and findings presented in report is confidently the same evidence that was gathered during the data collection process. On the other hand, no original evidence had been missing, through inattention or bias, and therefore failed to be given appropriate attention. The section 4 ‘empirical findings’ provided the detail of interview exactly as discussed by respondents. Therefore, when audit read the conclusions and desire to know more about the basis, she/he can map out the evidentiary process backward. Tracing evidences are facilitated as follow:

- The list of interview question is available in the appendix
- Answers can be found in empirical finding section, and the same headings that are used to categorize questions are used in empirical finding and analysis sections.
- The circumstances under which the evidence was collected (i.e. time and place), data collection procedure and research method, and position of respondents (to prove their competency of providing valid answer) are all described in detail.
- Data collection procedure and questions are followed as described in methodology part.
- Lastly, relation between the content of the interview protocol and the research questions are clear.

Taken together, Audit/ readers are enabled to move from one part of the research process to another, with apparent connection to methodological procedures and to the resulting evidence.

Report reviewed by respondents

The third procedure that followed to increase the overall quality of the study was to have the draft report reviewed by the participants in the case. By doing this, we wanted to establish that the results of research are convincing and believable from the participants’ viewpoint. Since the intention of this thesis is to explain and realize the information quality issues in BI system from the participant's eyes, the interviewees can reasonably critic the trustworthine ss of the results. Therefore, we sent a draft of analysis and empirical findings for the interviewees to review and inform us if any differences in facts had been settled. Moreover, they confirmed the result of our analysis.

According to the Yin (2003), only the informants or participants will know the correct identities. Confirmation and corrections made through this can increase the correctness of our study, hence improving the construct validity of the study.

External validity (generalization)

This test concerns whether the findings in this study are generalizable beyond the immediate case study. Yin (2003) highlights that; survey research relies on statistical generalization, while case studies rely on analytic generalization. In analytical generalization, the researcher is attempting to generalize a particular set of results to some broader
theory. Yin (2003), also suggests use of theory in single-case studies and replication logic in multiple-case studies to achieve generalization.

We created a theory about IQ issues in BI environment and their corresponding influences on business performance of a retail chain store (figure 5-2). This is our attempt to generalize findings to a broader theory. Therefore, the generalization of findings is limited to the case itself and the theory will also help to identify the other cases to which the results are generalizable. This theory then would be the domain to which the results could later be generalized. However, the generalization is not automatic. The theory must be tested in other cases by replicating the findings in a second, third, or even more cases, where the theory has specified that the similar results should occur (‘replication logic’) (Yin, 2003). Once such replications have been established, the results might be accepted as presenting strong support for the theory. Therefore, new empirical studies should be made in other retail stores, to examine other aspects of our idea. Our theory, in essence, “became the vehicle for examining other cases, and the theory still stands as a significant contribution” to the field of IQ issues in BI (Yin, 2003. p 44).

Moreover, as it mentioned before the next step in this research can be followed by a survey study. This also enables to test the inductively emerged theory and generalize the result to population statistically. This requires designing a quantitative research.
3 Theoretical frame of reference

3.1 Business intelligence (BI)

3.1.1 History

Socio-economic reality of modern-day organizations has made organizations face some essential to explore instruments that would ease efficient acquiring, processing, and analyzing mass quantity of data that come from different and discrete sources and that would serve as some basis for finding new knowledge. For lengthy period, companies have utilized management information systems (MIS) to achieve their various tasks (Olszak, & Ziemba, 2004). In order to respond rapidly to changes that occur in the market, organizations require MIS that would make it possible to fulfill different causal relationship analyses of the companies themselves and their environments (Power, 2001).

Business intelligence is an area of DSS that which is an information system (figure 3-1) that can be employed to support compound decision making, and figure out composite, semi-structured, or ill-structured issues (Shim, et al., 2002). The first citation to BI was made by Lunh (1985), which has substituted for other terms such as Executive Information Systems and MIS (Turban et al., 2008).

Jonathan Wu (2000) says, “The next generation of DSS applications evolved into business intelligence systems.” Being evolved from the DSS, BI has endured a substantial development over that last years and is, now, domain of DSS that draws much concern from both business and researchers (Clark et al., 2007).

3.1.2 Definition of BI

According to Turban et al. (2007), BI has several meanings for different individuals and is therefore an alleged content-free expression. Turban et al. (2007) also say that the most important purpose of BI is to provide business managers and analyzers the instruments required conducting analysis. This is done through interactive access to existing and historical information, circumstances, and executions, which all supply perception in the organization and makes capable intelligent decisions. BI can be served as architecture, tool, technology, or system that collects, stores, and analyses data by analytical tools, facilities reporting, querying and delivers information that eventually lets organizations to enhance decision-making (Turban, et al., 2008). The BI systems contribute to enhancement and precision of information flows, and knowledge management and they make capable organizations to (Liautaud, & Hammond, 2002; Moss, & Alert, 2003):
• pursue profitability of their goods sold;
• analyze costs;
• monitor incorporated environments; and
• Detect business anomalies and frauds

Cui et al. (2007) consider BI as way and technique of developing business performance by supplying influential supports for managerial decision maker to let them to have liable information at hand. BI tools are viewed as technology that facilitates the effectiveness of business function by giving an enhanced value to the enterprise information and therefore the way this information is used.

One of most complete definitions of the business intelligence can be found on the IBM web site (IBM, 2003):

"Business intelligence is the gathering, managing, analyzing, and sharing of information in order to gain insights that can be used to make better decisions. Business intelligence turns information into knowledge, and knowledge into business wisdom. Combining advanced techniques such as data warehousing, data mining, and decision support, business intelligence systems offer the ability to transform information into powerful customer relationship management systems that can help create stronger, more profitable relationships, identify new business opportunities – even anticipate customer demands."

3.1.3 Components of BI

Despite the fact that definitions alters, and business requires dictate the obligation for various components and intricacy for a BI system, every BI system needs, at least, four particular components to produce BI (Olszak & Ziemba, 2006). These components are explained all over the larger literature to the extent that they are now nearly clear and they consist of (Olszak & Ziemba, 2006)

• Data warehouse,
• ETL (Extract, Transform, Load) tools
• OLAP (On-Line Analytical Processing) techniques
• Data mining

Figure 3-2 shows the interaction between these components to organize, give context, and transform data into information that can be utilized and analyzed by a data consumer to convert into knowledge, which in turn can contribute in making informed/intelligent decision.
Executive decision making actions can be supported by the utilization of these components (Cella, Golfarelli & Rizzi, 2004). Actions are explained as (Olszak & Ziemba, 2007):

- Acquire (e.g. supported by the data warehousing)
- Gather (e.g. supported by the ETL)
- Analyze (e.g., supported by the use of OLAP)
- Report (e.g., supported by the data-mining) data that come from various and discrete sources

Table 3-1 lists the BI system components and summarizes how they enable and support decision making in business.
### BI system component | How used in decision-making
--- | ---
**ETL Tools** | Used to extract, transform and load data from both operational databases and scattered data sources permitting for the gathering of volumes of data (Schink, 2009) which allows for:
- Access to information in real-time
- Standardized and consistent data type in which to analyze

**Data Warehouse** | Used as warehouse for all data applicable to an organization to facilitate the decision making (Matei, 2010) by:
- gathering related and context sensitive data
- offering multiple dimensions to data

**OLAP Techniques** | employed to analyze and report data from vast data sources (Olszak & Ziemb, 2006) by:
- giving user access to data warehouse
- building data models

**Data Mining** | Utilized to identify structure, associations, and patterns within a data warehouse and generates comprehensive reports (Hevner & March, 2005). It facilitates:
- predictions based on past data
- graphing and computing to produce formulas to analyze data

| **Table 3-1:** BI component employed for decision-making |
| --- | --- |

### 3.2 BI support for decision-making

BI systems are believed to be solutions in charge for converting of data into information and knowledge. Beside they provide some environment for effective decision making, strategic assessment, and taking steps in organisations (Figure 3-2). importance of BI for organization is mainly articulated in the fact that BI systems cast some light on information that may serve as the base for accomplishing radical changes in a specific enterprise, i.e. creating new cooperation, attracting new clients, developing new markets, offering products (Chaudhary, 2004; Olszak, & Ziemb, 2004; Reinschmidt, & Francoise, 2002).

It is claimed that BI may uphold decision making on all managerial levels. Figure 3-3 point out the varieties of decisions range from ad hoc (strategic) to automated (tactical) (Olszak, & Ziemb, 2003; Karen, 2010).
On the **strategic level**, BI makes potential to set goals accurately and to pursue realization of the goals. BI facilitate carrying out a variety of comparative reports, such as on chronological results, profitability of a certain offers, effectiveness of distribution channels together with doing modeling of development or anticipating future trend on the base of some hypothesizes (Olszak, & Ziemba, 2003). Strategic decisions are made or modified rarely, but the scope of decisions is extensive and has influence on other decisions (Karen, 2010).

On the **operational level**, BI Systems are utilized to carry out ad hoc analyses and respond matters linked to departments’ current operations, the latest financial status, collaboration with contractors and clients, sales etc (Olszak, & Ziemba, 2003). Operational decisions represent a policy hub, as the policies are applied to different decision points where actions are taken (Karen, 2010).

On the **tactical level**, BI Systems can facilitate decision making in sales, marketing, capital management, etc. BI is capable of optimizing future achievements and changing organizational, financial or technological aspect of business performance properly to support organizations in achieving strategic goals successfully (Olszak, & Ziemba, 2003). Decisions in this level can happen in high volume and repeat regularly. Such decisions can also be made automatically such as, approval of loans and assignment of credit lines. These decisions are made by extremely programmed algorithmic decision support processes (Karen, 2010).

### 3.3 Definition of Data and Information quality

For the purposes of this thesis, the terms ‘data quality’ and 'information quality' are used alternately, since in some of the references the word ‘data quality’ is used while some others employ ‘Information quality’ to express the same thing and some apply them alternately for the similar context. This alternate usage is in line with Wand & Wang (1996) who argue that the concept of quality of data or information conditional upon the actual use of data. On the other hand, an understandable definition to distinguish data from Information is drawn by Strong et al. (1997). They define data as to be raw and unstructured facts, which are then structured, given context and converted into information. Information can be exploited and analyzed to become knowledge. The conver-
sion of data into information and then knowledge is referred as the *data manufacturing system*.

### 3.3.1 Information quality

Three rules are identified within *data manufacturing system* by Strong et al (1997) as follow:

- **Data consumer**: Individuals who use data
- **Data producer**: Individuals/sources who produce data
- **Data custodian**: Individuals who are generally in charge of the data and supply required resources to manage (process and store) the data

*Data consumer* in the context of this thesis can be perceived as a decision maker.

The authors then describe information quality as information that is *fit for purpose* and satisfies the objective for which it is intended. In the case of BI, this means that information should have particular characteristics that the data consumer determines as significant in order to be regarded as constructive and valuable for decision-making in business environment.

This explanation also proposes that quality should be considered from a *data consumer* perspective and that there is more to information quality than just being correct and accurate (Strong et al. 1997).

### 3.3.2 Data quality

Wang et al. (2008), define Data quality as the degree to which data presented by an IS correspond to same data in the actual world. Bertolazzi & Scannapieco, (2001) discuss that the first definition, which is mentioned in previous section, stress the nature of quality in the context of information while the latter is more operational view.

In addition, it must be mentioned that a conventional method to evaluate quality in context of Data does not exist due to its multi-dimensional nature include correctness, timeliness, comprehensiveness, reliability, and accuracy (Wand & Wang, 1996). For that reason, the actual matter of quality is to ensure that data is sufficiently accurate, timely, and consistent for to make sensible and right decisions. (Wang et al., 2008)

### 3.3.3 Relationship between data and information quality

As it is discussed before information can be seen as structured data so IQ certainly depend on quality of data. Therefore, enhancing data collection, standardization, cleansing and aggregation can increase directly or indirectly the quality of information (Chen et al., 2009). Although, some authors argue that there are no explicit principles to make a distinction between these two. Wang (1998) claims that both data and information have parallel meaning.

In this research we employ Strong et al (1997) view of quality, fitness for purpose of consumers, which focus on the nature of quality given that this also involve dimensions such as effectiveness, usefulness and usability which is not stressed in an operational view by Wang et al. (2008).
3.4 Evaluation of information quality

Low quality of data generation that exist within organizational databases can produce false intuitions that can affect on capability of decision maker to acquire wisdom of business and make precise and efficient business decisions (Huang, Lee and Wang 1999; Redman 1995). In addition, it is far better to be aware that there are data quality problems than to be uninformed of them- if decision makers understand that there are measurable data quality matters, they will be more tending to be careful during decision making process (Snow 2007). Perceiving the implication of the key issues or characteristics that make information precious is therefore significant.

Comprehensive literature review helped us to find three frameworks that provide a superior commencement for this assessment through identification of specific quality attributes. The next section discusses each framework one by one and deduces with a consolidated view of their similarities and dissimilarities.

3.4.1 Framework of Strong et al. (1997)

Strong et al. (1997) define four groups of data quality perspectives, which are mentioned below:

<table>
<thead>
<tr>
<th>Groups</th>
<th>Perspectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic data quality</td>
<td>Accuracy; Objectivity; Believability; Reputation;</td>
</tr>
<tr>
<td>Accessibility data quality</td>
<td>Accessibility; Security issues;</td>
</tr>
<tr>
<td>Contextual data quality</td>
<td>Relevancy; Timeliness; Completeness; Amount of data;</td>
</tr>
<tr>
<td>Representation data quality</td>
<td>Interpretability; Ease of understanding; Consistent representation;</td>
</tr>
</tbody>
</table>

| Table 3-2: Groups of data quality perspectives (Strong et al., 1997) |

- **Intrinsic data quality**: when there are variations across various sources of data, believability matters are increased respecting credibility and accuracy of the fundamental data. After while these issues become common knowledge, a bad reputation of the data and data source develops, resulting in data not being utilized, given that users are reluctant to use data that they think unreliable or which does not meet their requirements.
Data that are generated or derived as a result of human elucidation are often viewed subjective and possible biased, which can also produce believability matters.

- **Accessibility data quality**: human and technological aspects like insufficient specific skills and proficiency, and likewise deficient computing sources (inadequate of physical devices, computing power, network space and memory), can hinder access to information that is saved in central databases or shared repositories. Moreover, it often takes time to obtain these sources, which may cause needed information not being accessible when required.

On top of the above accessibility problems, security restrictions can also, resulting in information to become unreachable as it usually takes time to gain the essential approval(s) due to gain access. Although in different cases, these restrictions are essential or obligatory as they are often compelled by organizational policies or government acts concerning privacy and secrecy of information.

- **Contextual data quality**: mass quantity of data can influence approachability of information because of the time it takes to process. If information is not accessible when it is required, it will not accomplish its purpose and not be considered helpful to a decision making process.

If data is shortened or lost due to integration, operational, scheduling, or internal errors, it is improbable that the output to be of high relevance. This is also factual if the available information is not adequate to satisfy new reporting or decision-making requirements.

- **Representation data quality**: difficulties happening in shortening, integration, and analyzing incompatibly represented data cause information unreachable for utilization because of the least amount of value that it will have for a user’s decision-making process.

Information is also viewed inaccessible if it is displayed in a sense that makes it excessively complicated or difficult to perceive and or interpret. Consequently, it is significant that information is represented in a sense that makes it instinctive to comprehend and considers language, signs, and comprehensible definitions into account (Pipino et al. 2002).
3.4.2 Framework of Lui and Chi (2002)

Data flow through stages life cycle, that each of them generally consists of some form of conversion for the purpose of satisfying its expected use (Lui and Chi 2002; Strong et al., 1997). Reconsidering the quality of data in the field of this life cycle is significant as each stage of conversion or ‘evolution’ can introduce different kinds of quality matters that can impact the effectiveness of data in various ways.

- **Collection quality**: The collection phase is associated with processes that gain and/or generate data and consists of attributes like observer bias, data accuracy issue, credibility of data collector or producer, and comprehensiveness regarding sufficiency for use.

- **Organization quality**: associated with how data are stored. It is affected by the characteristics that belong to collection quality, as well as factors like deficiency of consistency of data or information throughout different data repositories (probably due to deficiency of mechanized processes that update corresponding data in different places), timelines of recall of data and simplicity of information navigation.

- **Presentation quality**: this comprises characteristics that associate with collection and organization quality, in addition to those, which include receiving and/or generating information. Presentation quality mainly associates with consistent data semantics and format (the corresponding data should be defined with the equivalent meaning and format) and stresses that data should be unambiguous and easy to interpret and should reflect ‘neutrality’ (bias regarding which data should be displayed and which data should be concealed from a data user).

- **Application quality**: quality or use of application ties in all those characteristics that are not in presentation quality, and therefore organization and collection quality, involving those that affect efficient use of information, for example:
  - Information Availability
  - Accessibility due to security and privacy agreements
  - Relevancy in terms of amount of data and/or whether the displayed information is useful
  - The degree to which data or information can be simply analyzed and manipulated for its expected use
3.4.3 Framework of Helfert et al. (2002)
They propose an approach that meets particular needs by connecting user defined relevant quality characteristics to different semiotic levels.

- Syntax level: handles matters that relate to representation, formatting and transferring data from source to destination. It consists of characteristics such as consistency, security, and accessibility.
- Semantic level: handles the data semantics issues such as content and meaning. Imperative characteristics at Semantic level comprise characteristics such as objective essence of the data, which comprises reliability and believability, understandability, accuracy, interpretability, consistency throughout different data sources.
- Pragmatic level: copes with employment of information and address characteristics such as timeliness, completeness, and relevance.

3.4.4 Result of Information quality assessment
Even though the discussed frameworks applied different approach to categorize various quality dimensions, relationship exist in terms of the dimensions that are formed. These similarities and differences are summarized in the figure 3-4 and table 3-3 as follow.

<table>
<thead>
<tr>
<th>Framework</th>
<th>Description of applied approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four groups by Strong et al. (1997)</td>
<td>No basic theory or practical clarification for sorting out these characteristics into the four groups. The defined characteristics are based on a qualitative study of three companies that have initiated data quality projects.</td>
</tr>
<tr>
<td>Data quality from the perspective of data evolution by Lui et al. (2002)</td>
<td>The identified quality dimensions are mapped to each of the data life cycle phases as it is claimed that each stage introduces additional issues.</td>
</tr>
<tr>
<td>Semiotical view by Helfert et al. (2002)</td>
<td>The majority of dimensions which are consistent with those that are underlined by Strong et al. (1997) and connected to a variety of semiotic levels. Helfert et al. (2002) also specified that the precedence and value of these aspects should be labelled by the data consumers in terms of their requirements.</td>
</tr>
</tbody>
</table>

Table 3-3: Dissimilarities in sense of the underlying theory used

The frameworks argued in the earlier sections are joined into the framework that is going to be utilized in this thesis (figure 3-4). The blocks in figure 3-4 correspond to the dimensions common to all the referred frameworks except the one with two stars (ease of navigation) only refers to the framework of Lui and Chi (2002), and the one with a star (insufficient computing resources and skills) only refers to the framework of Strong et al. (1997). The arrows specify the effect that a dimension can have on another dimension. These characteristics are further categorized into three groups (figure 3-4). These three promotes data regarded as not constructive and beneficial; consequently not fit for
purpose (adopted definition of data quality in this thesis). The suggested framework is demonstrated in Figure 3-4 below.

**Figure 3-4:** Proposed framework merging similarities in sense of the identified quality dimensions
* Only refers to the framework of Strong et al. (1997)
** Only refers to the framework of Lui and Chi (2002)
4 Empirical findings

In order to answer the research question and especially study issues that can be cause of poor quality of information as well as how such issues can impact and change direction of decision making, we conducted a qualitative study in BI and business unit of a big and famous chain stores in Iran, called Shahrvand. The company sells different categories of products such as, groceries, health and beauty, packaged and fresh foods, home appliances, kitchen utensils, furniture, clothes, computing and digital devices.

In order to collect the empirical data we conducted focus group interviews with 7 persons from different section of BI unit as well as people from business sections who use BI application to analyze business environment and providing bases to make decision about signing contract with different suppliers and offering product/services according to the market demand and customer needs. From developer perspective, we wanted to:

- identify data quality issues
- causes of these issues (why these issues may happen)
- impacts of such issues on business environment according to the users feedback

On the other hand, from BI users’ perspectives, who are also involved in decision-making, we interested in:

- Studying influences of poor information quality on decision-making
  - to be clear, from user perspective we need to know about difficulties and problem that they may encounter due to low quality of information and how such problems can change the direction of decision making and quality of products/services.

In addition, defined dimensions of information quality in previous section (figure 3-4) were used as a basis to guide the interview and finding potential impacts of those issues.

Moreover, the position of interviewees is summarized in table 4-1.

<table>
<thead>
<tr>
<th>Head of BI</th>
<th>Business Analyzers</th>
<th>Metadata team</th>
<th>Data warehouse</th>
<th>OLAP team</th>
<th>Information delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewee 1</td>
<td>Interviewee 2-3</td>
<td>Interviewee 4</td>
<td>Interviewee 5</td>
<td>Interviewee 6</td>
<td>Interviewee 7</td>
</tr>
<tr>
<td>First group of interviewees</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Internet interview 2012/04/17</td>
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<td></td>
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<tr>
<td>Second group of interviewees</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Internet interview 2012/04/23</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Table 4-1: list of interviewees

4.1 About the BI unit

According to interviewee 1 Four teams are working in BI unit of the company, and they worked jointly to supply required information for the business in a satisfactory level so they can make informed business decisions in a timely manner. Each of these team and their responsibilities are going to be discussed further below.

4.1.1 Business Analyzers

A team of business analyzers consists of persons, with a good knowledge and experience regarding to the business environment, from each business functions such as, health and beauty, home appliances, and so on.
The main responsibility of the team is to support business functions by interpreting and converting requests of the business for reporting and decision making into business requirement specifications which in turn system analyzers employ these specifications to develop system specifications. (Interviewee 3)

4.1.2 Metadata team
The metadata team has two areas of responsibilities as follow (interviewee 4):

- They work as an intermediary between business analyzers, and data warehouse team. In this area, they deal with information related to data (metadata) and logical data structures through study, design, and documentation of the issues such as ETL requirements, characteristics and description of the tables, and so on. By doing these, they can meet needs identified by business analyzers and accomplish requirement for delivering required information to the business units.
- Also because of encountering some issues regarding to the quality of information that had a great influence on business activities they realized the value of concerning information quality issues in BI system. Therefore, these quality issues lead them to make a group of specialized people within metadata team who are responsible to deal with data quality issues. This specialized group is in charge enhancing and sustaining quality of the delivered information by BI system through continuous prevention, inspection, and correction of quality issues.

4.1.3 Data warehouse team
According to the interview 5, this team is in charge of

- Offering the Metadata team with technical support
- Implementing changes in database
- Communicating and coordination with database administrator regarding issues such as data backup and security, and managing required space to store data
- Enhancing and developing performance of Data-warehouse to satisfy service level agreements.
- Maintaining infrastructure of data-warehouse to assure the quality of information and business requirements

4.1.4 OLAP team
This team is accountable for administrating, creating, and retaining of OLAP cubes (they have 14 OLAP cubes), which are set of data in an aggregate form and managed in a way that ease rapid and accurate analysis of large quantity of data (interviewee 6).

4.1.5 Information delivery team
The team is responsible for providing (buying, installing, and maintaining) BI analytical and reporting solutions and users training. They are responsible to implement modern BI applications and common interface across different units of the organization, such as marketing, and sales, to support information presentation and ease the burden of accessing and analyzing important data (interviewee 7).
4.2 Areas and benefits of using BI system

As interviewee 1 told us, the company implemented three different BI applications, namely ‘store operation management’, ‘supply chain management’, and ‘customer analytics’. The benefits and area of using these application further investigated by inviting two persons from business analyzers team and head of BI department to a focus group interview.

*Interviewee 1*

The implemented BI system can be used in different area of business activity especially for reporting and analyzing the business situations. People from different sectors can easily access information from different sources via tools installed in their desktop to take report and view data from different perspective. For example, they can take a report for a certain product in a certain branch by revenue/cost and/or by time (this implies OLAP cube) and then gaining knowledge about the situation by analyzing these reports. In addition, these data can be viewed in different formats such as table or chart, which make it easier to understand and interpret business situation.

He also added that since the company has objective of expanding its activity in other countries in the future, they have plan of developing an extranet for vendors so they can have access to the analyses of sales in real time. Hence, they will be able to adjust their production level and decide on shipping time according to the customer demands and system alert. This will help both sides to coordinate and collaborate with each other and increase the performance of supply chain by delivering the right product at right time and lowest cost to the customers.

*Interviewee 2*

He mentioned that before implementing of BI practice, managing the inventory level was really challenging issue since they had to keep track of large number of products from different suppliers/ producers. For example, they encountered panic situation in case of deciding on amount of foods and vegetables to order. If they ordered too many, foods would become old and if they ordered few they would become out of stock so in both situations there were a possibility of dissatisfaction and losing customers.

However, the inventory decisions have been improved after running ‘supply chain management’ application. This system assists company to assess best-selling products/brands, make price cut decision according to the seasonal trends, react rapidly to customers demand, terminate order for low selling merchandises. Since this application gathers relevant information from different sources it can provide a prediction about potential customers’ demand and market trend and presents them in an organized way so managers can easily make an accurate and timely decision about order quantity, and preferred vendors.

After implementation of ‘store operation management’ application, store managers got rid of old fashion paper base reporting. He believes that store managers can control the store more effectively when they are out of their office and show up in shopping area. The “store operation” application gives such mobility to managers. For example, every day the application provides sales information at regular period and comparing them with exact time in last year so manager can use this information to improve store operation. The other information provided by this application regarding to the performance of
store include average amount of products that customers buy in each transaction (units per transaction), as well as analyzing amount of sale at different time of day against cost of operation (e.g. electricity cost, labors salary).

Such information can help managers to decide, in real time about number of staffs that must be available, opening hours, promotions, and inventory. For example after analyzing these information managers has decided to keep some branches and specific sections in each branch open until 2 AM during weekends and even 24/7 near the New Year. The system is also able to analyze the performance of each salesperson by analyzing number of working hours in each month, number of clients that received advice, as well as amount and revenue of sales from each salesperson. Insight on staffs’ performance helps to identify, reward, and retain competent staff as well as encourages employees to improve their performance and competency. This way of dealing with employees can have significant contribution on total revenue.

The other application used by the company is ‘customer analytic’ application. According to interviewee 2, the Company realized the need of this application to segment market more effectively, analyze the profitability of each segment, and target customers according to their buying preferences and patterns. This in turn enables the company to increase profit and customer satisfaction and loyalty by offering products that meet their actual needs.

He declared that, for example, the application could gather and present transactional data from several sources and analyze changes in shopping basket of customers, after a certain promotion, and what merchandises they buy normally. The application analyzes customer behavior by making relationship between customers, branch name, section, merchandises, and promotions. This kind of analysis helps business analyzers to get insight about shopping behavior and interest of consumers and then targeting customers more effectively by providing what they exactly need which in turn can improve shopping experience and their loyalty.

*Interviewee 3*

‘Supply chain management’ application is utilized to analyze supply chain issues such as most reliable vendor. System provides information about the history of the vendors from different perspective (e.g. time of delivery, quality of product, delivery cost, etc); therefore, system can help users to realize closing deal with which of the suppliers can be more valuable. In general, such comprehensive and organized information about supply chain (vendors, inventory, and customers) enable the company to remove unnecessary inventory expenses and negative effects of becoming out of stock or overstock.

‘Store operation management’ tools of the BI system utilized to have broad insight about profitability of the different products across different business units. For instance, when the same product from different brands is available, analyzers can use ‘store operation management’ tools to study customer interest, and their attitudes toward each particular product from different manufacturer to understand their needs and better serve them. The other example of using this application is to analyze success of different campaigns, and promotions as well as study shopping behavior of customers.

These kinds of information help the company to improve their marketing programs. The application helps business analyzers in different sections (e.g. health & beauty, home appliances, etc) to have a broad view about customer’s needs, popular brands and prod-
ucts, as well as most profitable products/brands. In addition, managers can use the result of the analysis to negotiate the contract with different suppliers/producers or even cancel the contract when the result of analysis shows poor quality of the product or much lower profit compared to same product from other competitors.

He also mentioned that ‘customer analytic’ application mostly helps company in defining the suitable marketing strategy that suits different group of customers. For example, marketing department uses this application to identify different category of clients according to their shopping baskets. Then they can plan for appropriate promotions and products for different period of the year (e.g. promotions on home appliances and clothes near the New Year, fruits during summer, writing accessories before fall). Such accurate marketing strategy that can fulfill customers demand in different period of the year can increase the sale and company’s profit.

4.3 BI architecture
According to the interviewee 1, head of BI department, data about transactions are captured and stored through use of different systems such as barcode readers, customer relationship management, scanners, sales force etc.

The ETL tool is responsible for extracting, cleansing, profiling, and staging data from the source systems and then loading these data into data warehouse.

Data warehouse keeps data such as order and delivery information, sales information, account payable, inventory data, information about expenses etc.

The last layer of BI system includes OLAP and other applications that we discussed in previous section. These applications apply business logic to analyze business environment, generate reports. For example, OLAP cubes facilitate analyzing data from multiple dimensions (e.g. by branch name, date, cost, and sales).

4.4 Reasons and influences of poor information quality (BI developer perspective)
These issues identified through inviting four technical people from BI department to a focus group interview (interviewee 4, 5, 6, and 7)

According to the interviewee 5, Information from different data sources are extracted and loaded into data warehouse by using ETL tool. Sometimes data consumers had reported that data from data sources were not the same as data, which were displayed by data warehouse. In such situation, users lost their confidence on precision and credibility of presented data by the system. Such inconsistency was most likely to happen because of storage issues in the system, technical problem in ETL, or failure of OLAP in process of aggregating, organizing, and summarizing data. Also sometime data about transactions needed to be updated in master file at a certain time or after it reached a certain amount of transaction. For example, when a sales person enters sales data the system will update the inventory level on real time but the amount of daily sales and accounting files is going to be updated at the end of each day this is called “batch processing.” Therefore, failure in batching process was reason of difference between data source and data warehouse.

Interviewee 4, from Meta data team, mentioned that they had reports of divergence between two different tables in data warehouse. Data warehouse has two different tables
for same data the first table is created according to the information transferred from source systems which is called ‘stage 1’ tables, these tables than aggregate into another table, called ‘stage 2’ table. For example, the marketing department needed information about consumers based on their age. Such information collected from different ‘stage 1’ tables and then aggregated into a ‘stage 2’ table. Then statistical analysis conducted to decide on marketing strategy, target one or more generation, and provide what they need according to the aggregated data for each generation.

Interviewee 6 added that there are several OLAP operations to aggregate and analyze data such as roll up, slice, dice etc. When system initiated any of these operations before ETL had loaded latest data, this led to data being excluded from the ‘stage 2’ table. Moreover, sometimes the program algorithm designed to execute a certain operation when transaction date was in a predefined range. This was problematic if received transaction was not within the defined range. Also in some cases, it was required to change and update data in the source system. Whenever such situation happens and data changes in the source system it is mandatory to redo OLAP operations in order to apply these changes to higher stage tables and prevent any discrepancies.

Interviewee 7 argued that they received feedback from data consumers that presented information seems to be not valid. This means that, for example, the amount of sales for a certain product in a certain period was more than the amount of purchase and inventory level or vise versa. This means that result of query from sales tables was in contradiction with the result of query from inventory tables. This happened because of wrong database modeling, and data mapping. For example, inappropriate primary keys were selected so duplication happened in either data warehouse or data sources. Also due to malfunction in ETL processes, something went wrong during the loading data from source and aggregation process in data warehouse.

Interviewee 4 added more to above argument by saying that sometimes algorithms that were designed to analyze and estimate business measures (e.g. last season sales, or prediction of next season sales, which can be estimated by using complex mathematical logics and algorithms) were wrong and erroneous. These business measures were specified according to the business requirements and then translated into the system requirements. This must be done by analyzing business requirements and documented business queries as well as reviewing the data warehouse model to gather comprehensive information about existing ‘fact’ and ‘dimension’ tables. It is important to know about type of tables (dimension or fact) to select the right tables for aggregation or joining them. Otherwise, the result of calculation will be a wrong number. The interviewee 4 also mentioned, since the detail of programming and ETL requirements are too much complicated and technical, he clarified a real situation by simulation. For instance, when you want to calculate amount of sales you input the amount of sold furniture two times in calculator or you forget to account it at all or when you want to calculate the market share, the market share of 15% in area ‘x’ and 25% in area ‘y’ does not imply the overall market share of 40%. In computerized IS environment any semantic and logical error in programming can produce such miscalculations. Although, they always test the programs before use to find and correct any miscalculation and failure in the system but sometimes business unit asked them for rapid delivery of a system or information so they had to ignore some testing procedures and doing the rest after implementation through considering the users’ feedback. Therefore, the process of documentation, data-
base modeling, defining business and system requirement, and programming logic are all-important to be able to present accurate information.

According to interviewee 6, there were different problems in data warehouse tables and fields that were seen as cause of poor information quality. For example, a table in the source database had a field named BRAND_NAME in which the data type was Varchar 15 but in data warehouse, the data type of BRAND_NAME field was Varchar 10. Since the defined data type in source database was bigger than defined field in data warehouse the system had to cut 5 characters and truncating data. Obviously here, they missed some part of data and they were not complete anymore.

The other example is when two different data type defined for the same data. For instance data warehouse stored date as dd/mm/yyyy but in other system it stored as mm/dd/yyyy, so 2-6-2007 in data warehouse implied 2nd of June but the same date in other system implied 6th of February. Consequently, if user sent a query about the amount of sales in 6th of February the data warehouse understood it as 2nd of June and could not retrieve any information since they were in April. As a result, they received complaints about missed data. Therefore, during the database design it is critical to have comprehensive documentation of Meta data and updating it continuously to apply latest changes.

These two examples also caused data duplication and failure of OLAP cubes which in turn affected the availability of data and users confidence on system. Therefore, during the database design it is critical to have comprehensive documentation of Meta data and updating it continuously to apply latest changes.

Interviewee 7 also mentioned that in order to reduce probability of such issues and provide accurate and consistent information for user it is necessary to pay attention on documentation (e.g. User requirement, requirement analysis, interface specification, testing documentation) which plays an important role in all stages of software development, from design to implementation, testing, and maintenance. Since documentation is very time consuming and expensive they did not consider it at first. He said that he noticed several problems and inconsistencies in BI system during testing. Therefore, a team of experts started to reevaluate the system and they found out lots of inconsistencies and out-of-date documentation about fields, data formats, data mapping, and ETL requirements and logic. These problems occurred due to inappropriate analysis performed by inexperienced analysts as well as lack of attention to importance of accurate documentation. In order to solve these problems they spent many resources in term of money, time, and human recourses. These resources could instead be utilized to improve the performance of system and better business support. Solving these issues left little time to focus on important tasks of system improvement. Other interviewees also agreed that most of these inconsistencies could have been inherited in each stage of development and cause of serious information quality issues, if not discovered during testing and reevaluation phase.

Moreover, interviewee 5 added that during the system design it is critical to document privacy policy and security requirements, since company cannot allow everyone to have access to sensitive and confidential information. This information mostly includes graphs and charts about the market analysis, research, and trend that can be used for strategic decision-making. He also believed that this could not be seen as information
quality issues since they want to protect information against unauthorized access that may expose sensitive information to competitors.

According to interviewee 7, during the system analysis, they interviewed several people in the company and they had regular meeting with key organizational members who would be the main users of system to extract and specify business requirements and metrics. Afterward these requirements translated into what systems were required, what systems should do, and what level of quality needed in order to meet specified business requirements. However, they had problem in documentation of requirements. For example system analysts either misunderstood what users needed or defined requirements improperly and incomplete. Consequently, the designed system and logic of programming could not compute business metrics appropriately (revenue, ROI, supplier's average response time, etc) and did not meet business requirement properly. On the other hand, in some cases they received an urgent requirement to change design in a short time notice. Therefore, they had to shorten the development process (e.g. ignoring iteration, doing a quick analysis and testing). Implementing changes in this way caused serious problems in business environment due to misunderstanding of what business wanted.

Interviewee 5 also talked about Users need to get report about the different business transaction in different time of day to fulfill their daily tasks. However, they had some reports that users could not retrieve the required information during their working hours. Since some of these reports were critical and could not be postponed to next working day, the employee had to stay at work for few more hours and the company had to pay overtime salary. In addition, Users, especially from inventory section, had some complain that “their work is time critical” and they cannot postpone the daily tasks of inventory management and ordering. Therefore, information would not be useful any more when they could not retrieve it on time.

Such problem was mostly due to interruption and malfunction in one of the networking component or ETL processes of extracting, transferring, and loading data from source into data warehouse. Even when the problem was due to the network failure or problem with other systems, BI department was seen responsible. This could easily undermine their hard work in BI department and affected the reputation of both BI system and BI department.

Interviewee 4 pointed out that the business situation is changing continuously and there are potential threats and opportunity that must be considered. Therefore, to be responsive to any external or internal changes, managers need to make rapid and innovative decision. In order to understand the situation accurately people from business units required new set of information, analytical logic (complex mathematical procedure that programs use to analyze given data), and OLAP cube to gain a broad insight about the business environment from multiple dimensions. Moreover, they had situation in which they misunderstood business requirements and designed a system that could not deliver required information as intended.

Interviewee 4 stated that during the meetings with business units to specify business requirement they always put emphasis on having access to correct and up to date information. People from business units have to deal with large number of customers and suppliers; on the other hand, they need to make fast decision to be capable of responding to market trend in a timely manner. For example, people from marketing department
believe on “world-of-mouth” as a marketing strategy. Therefore, any inconsistency even for a one day can be result of millions of dissatisfied consumers, which in turn can have great impact on reputation of company.

Interviewee 6 also mentioned, “When you implement an advanced system like BI, since it is latest technology, users would never tolerate a mistake at all. They have high level of expectancies, and they would lose their confidence on system rapidly if any inconsistencies happen.” When they implemented the BI system because of complexity of the system and existence of some inexperienced developers, they had problem of discrepancy between data sources and data warehouse. Whenever users encountered such problem, they had to spend lots of time to look at different sources to find right information. However, most of the time they became confused, which source of information could be correct one. This obviously made the decision making difficult and tedious for them. Therefore, they were reluctant to accept new system in defense of legacy system.

4.5 Influences of poor information quality (business perspective)

Interviewee 2

“Over the last few years, we have tried to decrease considerably the likelihood either of being overstocks or out of stock by implementing Business Intelligence system based on applications that are capable to forecast demand and sales at product level.” Purchasing decisions are made by considering latest level of inventory, in addition to daily sales quantity, product life cycle, lead-time, safety stock availability, and seasonality.

Correct and up to date Information has an important role, regarding prediction of demand at products level, to be successful in competitive business environment. For instance, as it mentioned before wrong demand information about products that have a short life like vegetables and fresh meat caused these products remain in stock for more than their expiration dates or ordered less than customer demand due to fear of becoming overstock. “If we order too many, foods would become old.” On the contrary, “if we order few, we would become out of stock so in both situations there were a possibility of dissatisfaction and losing customers.” In this case, most of the customers who put so much stress on buying healthy, fresh, and high quality foods dissatisfy with the level of quality and availability. Therefore, they will go somewhere else to do their business.

The interviewee stated, “We put ourselves in customers' shoes.” “Customers had commuted to our store, to purchase some products, and they find that we did not have the certain product in stock.” Since lack of correct and up-to-date information about inventory and market demand, caused being out of stock, and dissatisfaction would certainly inevitable. They also mentioned although similar products have been available in stock to offer consumers, and they may definitely settle for the similar products, but they will leave the store unpleasant.

Interviewee 3

Another disadvantage of poor quality of information revealed when “customers who had been loyal to our organization unexpectedly make decision to go to the competitors since they had the products that they required with better quality or lower price, while we were out of stock or we had contract with unqualified supplier in term of price and
quality. Therefore, Customers might go to the competition for their wants and believed that our competitor was better, and we lost them easily.”

Interviewee stated that customer relationship management (CRM) is one of the critical success factors of the organization. They spend so much time and energy in order to build customer loyalty program and decrease customer defection through utilizing information delivered by ‘customer analytic’ application. Since ‘Shahrvarand’ is the large retail store, to be the best and successful in the market, will not be only depend on CRM, although it plays a significant role. Customers of such large retail anticipate best business deal comparing with other competitors in the market and 24/7 availabilities of goods and items.

In addition, supplier relationship management has important role in retail success to provide what customers needs. Accurate, complete, easy to understand information from ‘Supply chain management’ application assists the retail store to identify best suppliers in terms of delivery time, quality, and price then merging them in their business to make success situation for both side. He also mentioned that with the help of SRM, the gap between retail’s grasp of customer demand and suppliers is filled and accordingly making a success situation by alignment of sales pattern of retail and suppliers’ production plan together. It guarantees that retail gets the best agreement and suppliers have an obligation for long period. All of this heavily depends on collecting comprehensive and well-organized information about both customers and suppliers.

Incomplete, inaccurate, distracting, and poor information makes it difficult for Managers to recognize the most qualified suppliers. “We need good information about suppliers to assess and choose them based on different factors such as items, price, brand, quality, and popularity.” Then make an agreement with the best one based on factors such as price, return/ordering policy, and delivery time. “In addition, when we do not have good Information about sales volume, demand, customer satisfaction level, and profitability of each product, it is impossible to identify most valuable suppliers for each product category.” “Consequently, we will encounter customer satisfaction issue and loosing reputation.” Therefore, it is important for retail managers to have access to adequate and reliable information regularly to check and supervise the suppliers’ performance.
5 Analysis

5.1 Areas and benefits of using BI system

As it mentioned in section 3.2 importance of BI for organization is mainly articulated in the fact that BI systems cast some light on information that may serve as the base for accomplishing radical changes in a specific enterprise, i.e. creating new cooperation, attracting new clients, developing new markets, offering products (Chaudhary, 2004; Olszak, & Ziemba, 2004; Reinschmidt, & Francoise, 2002).

It is claimed that BI may uphold decision making on all managerial levels. Figure 3-3 point out the varieties of decisions range from ad hoc (strategic) to operational and tactical (Olszak, & Ziemba, 2003; Karen, 2010).

The area of using BI in the Shahrvand and its subsequent benefits can be categorized in three areas include, customer relationship management, supplier relationship management, and store operation management (table 5-1).

<table>
<thead>
<tr>
<th>Area of usage</th>
<th>Activities</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer relationship management</td>
<td>• Define marketing strategy and activities</td>
<td>• Superior decision on marketing program and strategy</td>
</tr>
<tr>
<td></td>
<td>o Segmentation</td>
<td>• Improving customer satisfaction and loyalty</td>
</tr>
<tr>
<td></td>
<td>o Targeting</td>
<td>• fulfilling customers’ needs</td>
</tr>
<tr>
<td></td>
<td>o Shopping behavior analysis</td>
<td>• Identify potential threats or opportunities</td>
</tr>
<tr>
<td></td>
<td>• Evaluate customer satisfaction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Evaluate effectiveness of marketing activities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Predict customer demand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Insight into market trend</td>
<td></td>
</tr>
<tr>
<td>Supplier relationship management</td>
<td>• Evaluate vendors’ performance</td>
<td>• Selecting most reliable vendors</td>
</tr>
<tr>
<td></td>
<td>• Evaluate product quality and profitability</td>
<td>• Facilitate contract negotiation</td>
</tr>
<tr>
<td></td>
<td>• Evaluate brands and products Popularity</td>
<td>• Improve merchandising</td>
</tr>
<tr>
<td></td>
<td>• Information exchange with suppliers</td>
<td>• Improve supplier relationship</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o coordinate and collaborate with suppliers</td>
</tr>
<tr>
<td>Store operation management</td>
<td>• Working hours</td>
<td>• Better insight on revenue against cost of operation</td>
</tr>
<tr>
<td></td>
<td>• Evaluate salespersons’ performance</td>
<td>• Cost effective decision regarding to the number of available staff during rush and quiet hours.</td>
</tr>
<tr>
<td></td>
<td>• Staffing</td>
<td>• Insight on staffs’ performance</td>
</tr>
<tr>
<td></td>
<td>• Managing inventory</td>
<td>o identify, reward, and retain competent staff</td>
</tr>
<tr>
<td></td>
<td>o Stock level</td>
<td>o improve staff competency</td>
</tr>
<tr>
<td></td>
<td>o Order level</td>
<td>o improve total revenue</td>
</tr>
<tr>
<td></td>
<td>• Sales analysis</td>
<td>• effective management of inventory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o prevents negative effects of becoming either out-of-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o stock or overstock</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o removes unnecessary inventory expenses</td>
</tr>
</tbody>
</table>

Table 5-1: Area of usage and benefits of BI system in retailing
**Customer relationship management**

According to the empirical findings, The BI system is utilized by the company to facilitate marketing and sales activities and manage interaction with clients.

On strategic level, BI helps the Shahrvand Company to evaluate effectiveness of different promotions, offers, and marketing campaign to formulate best marketing strategy. It also provides information that can help managers to decide on market to be served and most profitable market. This information help the company to segment market more effectively then target potential customers according to their buying preferences and patterns. In addition, it makes it easier for the company to predict future market trends and change in customers need so deciding on range of product categories and level of quality, which can attract consumers.

Strategic decision about marketing, as well as range and quality level of products can provide bases for making specific tactical decision in sale and marketing such as offering discount, promotions on certain products on certain period of years, selecting products/brands, etc.

Information organized and delivered by the BI system provides a better insight on customer demands and best way of fulfilling their needs, which in turn contributes in improving customer satisfaction and loyalty.

**Supplier relationship management**

As it illustrated in table 5-1, the BI system facilitates the evaluation of suppliers’ performance in term of quality, price, profitability, speed of delivery, and popularity of the products. This helps the company to make tactical decision on selecting most profitable and preferred supplier. On the other hand, when the result of evaluation shows poor performance, managers can decide to terminate the contract or negotiate to cut the price. Therefore, the evaluation of suppliers’ performance can improve merchandising by offering best deal in term of price and quality to the consumers.

In addition, using BI in conjunction with extranet technology can grant suppliers access to the analyses of sales. Hence, they will be able to adjust their production level and decide on shipping time according to the customer demands and system alert. This will help both sides to coordinate and collaborate with each other and increase the performance of supply chain by delivering the right product at right time and lowest cost to the customers.

**Store operation management**

On the operational level The BI system are employed to fulfill sale analysis. The analysis of sales information, such as units per transaction and analyzing amount of sale at different time of day against cost of operation, assists managers to decide on operational issues includes working hours, number of staffs that must be available, salespersons’ performance, and managing inventory.

Moreover, this information provide basis to calculate safety stock level and order level more accurately which consequently reduces the probability of being either out-of-stock or over stock and removes unnecessary inventory expenses.
The system is also able to analyze the performance of each salesperson by analyzing number of working hours in each month, number of clients that received advice, as well as amount and revenue of sales from each salesperson. Insight on staffs’ performance helps to identify, reward, and retain competent staff as well as encourages employees to improve their performance and competency. This way of dealing with employees can have significant contribution on bottom line improvement of the company.

To sum up, during the analysis of empirical findings, we noticed that large amount of information flows in supply chain of the company from suppliers, and stores toward customers and vise versa. The BI system organizes and represents information from different sources in form of tables or charts, which make it easier to understand and interpret. In addition, the BI system enables them to analyses complex information from different perspective easily.

Accurate and up to date information delivered by the system help the Sharvand Company to make correct and timely strategic, tactical, and operational decisions. Making the consistent, suitable, and right decision helps the company to make a better relationship with suppliers and improving merchandising process. On the other hand improved merchandising in conjunction with analyzing market needs and trends assists them to have better insight on popular products/ brands, expected level of quality and expending power of consumers. Therefore, it would be possible to segment market more effectively and formulate best marketing strategies that can fulfill exact customers’ need from different market segment, which in turn increases customer satisfaction and loyalty as well as the company’s profitability and market share.

5.2 Issues affecting the quality of the information

Data provided by BI system flow from different sources through BI component (such as ETL, data warehouse, data mart, OLAP, reporting and analytical applications) to reach the data consumers who require these information for reporting, analyzing, and decision-making. Therefore, it is necessary to study the architecture, and, data flow of implemented BI system to discover issues, and failure points that may happen at each stage of information processing and transferring, this in turn can affect the quality of the information. The architecture of BI system in the Shahrvand Company can be seen in figure 5-1.

![Figure 5-1: BI architecture of Shahrvand Company](image)

According to the figure 3-4 in the ‘theoretical frame of reference’, we identified several factors that can affect the proper utilization of information. These factors extracted from reviewing several literatures and considering different authors’ point of view.

In addition to the theoretical finding, four persons within the Shahrvand’s BI unit were interviewed, through focus group interview to investigate different information quality
issues that can affect proper employment of information in the Company. These quality problems and possible causes are described in table 5-2.

<table>
<thead>
<tr>
<th>IQ dimension</th>
<th>Identified issues from the case</th>
<th>Description of problem</th>
<th>Causes of IQ problems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Availability</strong></td>
<td>New set of information required</td>
<td>In order to understand the situation accurately people from business units required new set of information, analytical logic, and OLAP cube.</td>
<td>1- The business situation is changing continuously. Therefore, managers need to make rapid and innovative decision by using new set of information.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2- Business requirements were documented inappropriately in term of completeness and accuracy.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3- Business requirements were misunderstood and designed system could not deliver required information as intended.</td>
</tr>
<tr>
<td><strong>Delay in information delivery</strong></td>
<td>Users could not retrieve the required information during their working hours. Since, their tasks were time critical they could not postpone them.</td>
<td></td>
<td>1- network down time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2- interruption and malfunction in ETL processes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3- security issues:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Not everyone was allowed to have access to all information, so unauthorized employee had to send inquiry to authorized people for information retrieval.</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>divergence between two different tables in data warehouse</td>
<td>Data warehouse has two different tables for same data the first table is created according to the information transferred from source systems which is called ‘stage 1’ tables, these tables than aggregate into another table, called ‘stage 2’ table.</td>
<td>1- dependency among processes and delay in loading source data into data warehouse:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>When OLAP operations ,such as roll up, slice, dice etc, were initiated before ETL had loaded latest data, led to new data being excluded from the ‘stage 2’ table</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2- Program logic:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Algorithm designed to execute a certain operation when transaction date was in a predefined range. This was problematic when late transaction was received.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Changing or updating data in the source system: Whenever such situation happens and data changes in the source system it is mandatory to redo OLAP operations in order to apply these changes to higher stage tables and prevent any discrepancies.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1- Storage issues in the system</td>
</tr>
</tbody>
</table>

Discrepancies between data: data consumers had reported, data from data sources were not
| Sources and Data Warehouse | the same as data, which were retrieved from data warehouse | 2- Technical problem in ETL  
3- Failure of OLAP in process of aggregating, organizing, and summarizing data  
4- failure of batch processing  
5- requirement for batch processing instead of real time data processing:  
e.g. Data about transactions needed to be updated in master file at a certain time or after it reached a certain amount of transaction  
6- deficient documentation of business and system requirements |
|---|---|---|
| Presentation of illogical and invalid data value | Data consumers reported that presented information seem to be not valid. For example, the amount of sales for a certain product in a certain period was more than the amount of purchase and inventory level or vise versa. | 1- duplication as a result of inappropriate database modeling and data mapping  
2- Malfunction in ETL processes of loading data from source to Data warehouse.  
3- Failure that happened in aggregation process in data warehouse |
| Wrong and erroneous algorithms designed to analyze and calculate business measures. | For example, the market share of 15% in area ‘x’ and 25% in area ‘y’ does not imply the overall market share of 40%. In computerized IS environment any semantic and logical error in programming can produce such miscalculations. | 1- Business stressed for fast delivery and/ or inexperienced development team, led to:  
   - Lack of systematic and comprehensive testing  
   - semantic error in programming  
   - Deficient documentation of business requirements, meta data, and/ or ETL specification  
   - Inappropriate data modeling |
| Understandability | Improperly specified or understood business requirements. Consequently, the designed system and logic of programming could not compute business metrics appropriately and did not meet business requirement properly. | 1- They received Urgent requirement to change design in a short time notice.  
2-Therefore, they had to shorten the development process by ignoring iteration, doing a quick and brief analysis, and testing.  
Implementing changes in this way caused serious problems in business environment due to misunderstanding of what business wanted. |
| Inconsistency | Uncommon or inconsistent data types  
For example,  
1- A table in the source database had a field named BRAND_NAME in as Varchar 15, while in data warehouse the data type was Varchar 10. The | 1- out of date or incomplete documentation of meta data  
2- Ignoring importance of complete documentation of requirements since it was time consuming and expensive. |
result was data truncation and possibility of duplication

2- Two different data type defined for the same data. Data warehouse stored date as dd/mm/yyyy but in other system, it stored as mm/dd/yyyy. The result was complaints about missing data.

3- poor requirement analysis and interface specification
4- incomplete testing
5- lack of experienced and qualified system analyzers and developers

Table 5-2: Identified issues affecting the quality of information in the company

5.3 Influences of poor information quality (BI developer perspective)
Participated technical experts in focus group interview from BI unit underlined influences associated with the issues that are explained in table 5-2. Their responses was analyzed and consolidated in table 5-3 to obtain a holistic view of influences of these issues on business environment of the company.

<table>
<thead>
<tr>
<th>Information quality issue</th>
<th>Influence(s)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
<td>1- users considered information as unusable</td>
<td>Users could not retrieve the required information during their working hours. Since some of these reports were critical and could not be postponed to next working day, the employee had to stay at work for few more hours and the company had to pay overtime salary. In addition, some of the tasks were time critical and they cannot postpone the tasks (e.g. inventory management and ordering). Therefore, information would not be useful any more when they could not retrieve it on time. Moreover, according to the company policy and security issues they cannot allow everyone to have access to sensitive and confidential information that can be used for strategic decision-making. Security matters could not be seen as information quality issues since they want to protect information against unauthorized access that may expose sensitive information to competitors.</td>
</tr>
<tr>
<td></td>
<td>2- delayed or postponed decision making and reporting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3- increased expenses due to paying overtime salary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4- protect information against unauthorized access (positive influence)</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>1- users lost their confidence on precision and credibility of presented data and the BI system</td>
<td>Users lost their confidence on system and information when data from data sources were not the same as data displayed by BI system. They confused whether data at source system was correct or data displayed by BI system. Therefore, they had to spend much more time to seek the truth and this made the decision making process more difficult. In addition, inaccurate and wrong information could be cause of making in appropriate and ineffective decision, for example in term of deciding marketing strategy, customers targeting, and offering exact customer need.</td>
</tr>
<tr>
<td></td>
<td>2- uncertainty about correct source of data</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3- Ineffective, challenging, and time consuming decision making process</td>
<td></td>
</tr>
</tbody>
</table>
Understandability

1- Inappropriate calculation of business metrics
2- Failed to meet all business requirement properly
3- Low level of service quality
4- Ineffective use of available resources (time, money, and Labors)
5- Serious problem in business environment

Inconsistency

1- Data duplication
2- Data truncation
3- Complaints about missing data
4- Failure of OLAP cubes

Requirements were defined improperly and incomplete due to incomplete documentation and misunderstanding of users need. Consequently, the designed system could not compute business metrics appropriately (revenue, ROI, supplier's average response time, etc) and did not meet business requirement properly. This way of Implementation caused serious problems in business environment due to misunderstanding of what business wanted. Therefore, they forced to spend many resources to reevaluate the system and solving these issues left little time to focus on important tasks of system improvement.

As it is mentioned in table 5-2, duplication could happen due to data truncation if the data size exceeds predefined value. Additionally, when truncation happened, they missed some part of data, and it was not complete anymore.

Such inconsistency also caused failure of OLAP cubes, which in turn affected the availability of data and users confidence on system.

As can be seen in other corresponding example in table 5-2, inconsistent data types could cause of problem when users got used to a particular data format. When users sent a query to retrieve information by typing different data format, from what was defined for the system, no information was retrieved, so they thought that data was missed.

Table 5-3: Influences of defined information quality issues on the company

According to Strong et al. (1997), intrinsic data quality issues can be cause of increase in believability matters respecting credibility and accuracy of the fundamental data. After while these issues become common knowledge, a bad reputation of the data and data source develops, resulting in data not being utilized, given that users are reluctant to use data that they think unreliable or which does not meet their requirements.

As it is stated in empirical findings, when the company implemented an advanced system like BI, since it is latest technology, users would never tolerate a mistake at all. They have high level of expectancies, and they would rapidly lose their confidence on system and information if any inconstancies happen. In addition, it did not matter for user whether BI was the source of problem or failure in other systems (e.g. network downtime). As a result, BI had to take all blames, and its reputation was at danger.

People from the business units of the company have to deal with large number of customers and suppliers; on the other hand, they need to make fast decision to be capable of responding to market trend in a timely manner. The problems regarding to the information quality caused either delay in decision-making or inappropriate decision were
being made, so information was perceived ineffective and unusable. Therefore, they were reluctant to accept new system in defense of legacy system.

Besides influences listed in table 5-3, it was also stated that resolving information quality issues influenced the efficiency of the BI team and additional costs being incurred. They had to spend most of their working hours on inspecting and resolving these issues. Therefore, they had left little time to carry out other important tasks, such as designing mechanism that is more efficient, so it would prevent, or reduce the likelihood and influence of such problems.

5.4 Influences of poor information quality (business perspective)

According to interviewing business analyzers (interviewee 2 & 3), it was evident that inventory management, customer loyalty, competitiveness, and supplier management were key concerns directly influenced by information quality.

**Inventory management:**

Lack of consistent and accurate information increased the likelihood of being overstocks or out of stock. Business Intelligence applications must be able to forecast demand and sales at product level accurately. Purchasing decisions are made based on latest level of inventory, in addition to daily sales quantity, product life cycle, lead-time, safety stock availability, and seasonality. Therefore, any problem regarding to the information quality caused them to be either overstock, which incurred unnecessary inventory expenses and waste of products as they expired. On the other hand, in appropriate decision regarding to the inventory level could also cause of being out of stock and losing sales. In addition, in both situations there were possibility of dissatisfaction and losing customers.

Information quality has an important role for success of this technology regarding predicting demand at product level. For instance, poor quality of information in products that have a short life like vegetables and fresh meat causes these products remain in stock for more than their expiration dates. In this case, most of the customers who put so much stress on buying healthy, fresh, and high quality vegetables and meat might encounter too old products with bad quality. Therefore, they went somewhere else to do their business.

**Customer loyalty:**

The interviewees stated, “We put ourselves in customers' shoes”. Customers had commuted to their store, expecting the purchase of some products they had been looking for to acquire, and just to find that the certain product was not available. Therefore, lack of appropriate information caused being out of stock, and dissatisfaction would certainly ensue. Although similar products had been available in stock to offer consumers, and they might settle for the similar products, but they left the store unpleasant.

**Competitiveness:**

Another disadvantage of poor quality of information revealed when customers who had been loyal to the company decided to go to the competitors that had their required products with better quality or lower price, while they were out of stock or had contract with unqualified supplier in term of price and quality. Unsatisfied customers might go to
other stores and start to persuade others to do the same, since they believed that competitors offer better products in term of availability, price, and quality.

BI helped them to segment market more effectively, analyze the profitability of each segment, and target customers according to their buying preferences and patterns. This in turn enabled the company to increase profit and customer satisfaction and loyalty by offering products that meet their actual needs. The BI application could gather and present transactional data from several sources and analyze changes in shopping basket of customers, after a certain promotion, and what merchandises they buy normally. The application analyzes customer behavior by making relationship between customers, branch name, section, merchandises, and promotions. This kind of analysis helped business analyzers to get insight about shopping behavior and interest of consumers and then targeting customers more effectively by providing what they exactly need which in turn can improve shopping experience and their loyalty.

Any inconsistency regarding the quality and accuracy of information could be cause of ineffective segmentation, targeting, and offering inappropriate products and promotions that could not fulfill customer’s needs appropriately. Therefore, it would be probable to loss competitiveness in the market.

**Supplier management:**

Customer relationship management is an important factor for the Shahrvand. They spend so much time and energy in order to build customer loyalty program and decrease customer defection. Customer relationship management plays a significant role to be the best in the market, although it is not the only important factor. Customers of such large retail anticipate best business deal comparing with other competitors in the market. Consequently, supplier relationship management has important role in their success.

Supplier relationship management assists them to identify their fundamental suppliers and merging them in their business to make success situation for both side. With the help of BI analytical tools, the gap between suppliers and retail’s grasp of customer demand is filled. It enabled them to make a success situation by aligning sales pattern of retail and suppliers’ producing plan. It guarantees that retail gets the best agreement and suppliers have an obligation for long period.

It was clear that they could improve supplier relationship management if they had access to highly qualified information. Lack of information quality could affect supplier relation management negatively as well as accuracy of suppliers’ performance evaluation. Suppliers’ performance is evaluated based on information such as product price, quality, profitability, popularity, and delivery time. Incorrect performance assessment influences contract negotiation or deciding if the contract should be canceled or renewed. Making such decisions based on inappropriate information could be result of either penalizing supplier unreasonably or signing non-profitable contract. Moreover, when they do not have high-quality Information about sales volume and products demand, and popularity, not only the key supplier could not be identified but also wrong order in term of quantity, brand name, and product category could be made.
5.5 Importance of documentation (additional analysis)

One of the main issues, affecting the quality of information, which was emerged from the empirical finding, was the value and significance of proper documentation include user requirement, requirement analysis, interface specification, testing documentation, etc. In order to deliver a system that can support business activities efficiently, the business metrics (revenue, ROI, supplier's average response time, etc) and requirements must be defined accurately and comprehensively. These specified requirements then must be carefully considered to specify system requirement and level of service quality as well as design consistent algorithm and database modeling.

However, there was evidence showing several problems and inconstancies in BI system as a result of incomplete, out of date or wrong documentation. Therefore, a team of experts started to reevaluate the system and they found out lots of inconstancies, shortage, and out-of-date documentation about fields, data formats, data mapping, and ETL requirements and logic. These problems occurred due to,

a) Inappropriate analysis performed by inexperienced analysts
b) Analyzers misunderstood and misinterpreted requirements which were defined by users
c) Urgent requirement to change design in a short time notice, so they had to ignore complete documentation to be able to deliver the system in a short notice
d) Overlooking the importance of accurate, up to date, and comprehensive documentation, since it was time consuming and expensive.

In order to solve these problems they spent many resources in term of money, time, and human resources. These resources could instead be utilized to improve the performance of system and better business support. Solving these issues left little time to focus on important tasks of system improvement. Other interviewees also agreed that most of these inconsistencies could have been inherited in each stage of development and cause of serious information quality issues, if not discovered during testing and reevaluation phase.

Out of date, deficient, misunderstood or inaccurate documentation during the system development life cycle, from design to implementation, testing, and maintenance, could be cause of delivering information that was greatly incoherent and erroneous. Information could be incoherent when the logic used to obtain same business metric was different in various programs, and it could be erroneous when requirements were misunderstood or specified deficiently and inaccurately.

5.6 Summary of the analysis

Large amount of information flows in supply chain of the company from suppliers, and stores toward customers and vice versa. The BI system organizes and represents information from different sources in form of tables or charts, which make it easier to understand and interpret. In addition, the BI system enables them to analyses complex information from different perspective easily. BI system is used by the company to improve business performance and make efficient and effective tactical, operational, and strategic decisions. BI helps Company to make informed decision to improve relationship with customers/ suppliers and manage stores efficiently (table 5-1).
BI facilitate decision regarding most appropriate marketing strategy by providing comprehensive information about the customers’ demand and shopping pattern, effectiveness of current marketing activities, and market trend. Therefore, managers can segment market more effectively and decide on most profitable market to serve. Moreover, BI system facilitates the evaluation of suppliers’ performance in term of quality, price, profitability, speed of delivery, and popularity of the products. This helps the company to make tactical decision on selecting most profitable and preferred supplier. Finally, information provided by BI system assist the Company to make appropriate operational decision regarding to the opening hours and number of staffs that must be available in different time of day.

For BI system to be considered supportive and to deliver benefits that it is intended (refer to section 5.1), it should provide information with a certain level of quality. The information must be accurate, consistent with each other, available at any time and understandable to be able to support business activities of the Shahrvand Company and deliver intended advantages (table 5-2). Information quality can have great impact on quality and accuracy of decisions. Subsequently, result of decisions influence revenue, competitiveness, customer loyalty, customers/ suppliers’ relationship and quality of inventory management. Moreover, information quality issues can have impact on outcomes indirectly, as they are likely to shrink efficiency, productivity, utilizing resource capability. It also consumes significant amount of time and effort to inspect and address causes of failures.

Furthermore, evidence proves that documentation during the system development lifecycle is an important task that can reduce amount of failures and deficiency in the newly designed or upgraded system. Therefore, it is crucial to consider comprehensive documentation during the system development and updating it continuously after implementation of the system during the operational and maintenance phase. Moreover, by doing this the knowledge and experiences gained from resolving information quality can be documented and applied to future problems. This implies improved knowledge sharing and organizational collective memories.

Comprehensive and structured system testing is a supplementary factor that can enhance the information quality to guarantee information meets intended users’ requirement. Therefore, further effort can be put on creating practical measures to inspect and prevent information quality issues from reaching to the users. Obviously, chronic believability and confidence issues can be resolved and the Company will have more confidence on the system when it is free of any serious malfunctioning and failure. Therefore, throughout testing must be considered as a fundamental task during the system development lifecycle to be capable of delivering information at a satisfactory level.

The identified main aspects, include comprehensive testing and documentation, are crucial dimensions obtained from the empirical investigation. If they are considered and addressed carefully by the Company should result in enhanced quality of information that is delivered by the BI practice.

Moreover, figure 5-2 is the theory that developed based on empirical findings. It illustrates reasons of encountering information quality issues and associated impact on external and internal business environment.
Figure 5-2: Reasons of encountering information quality issues and associated impact on external and internal business environment
6 Conclusion

Dealing with quality of the information can be challenging for the company when implementing BI practice. BI system is a set of advanced components that work together to perform complicated analysis and deliver valuable information for decision-making. However, the complexity of BI system necessitates high level of commitment and proficiency to be able to deliver intended result. Hostmann (2007) argues that even though implementing BI system is becoming increasingly popular investment across organizations, they seem to be failed in utilizing required information as intended. Redman (1995) also highlights that even a small sign of problem in quality of information may prevent or delay businesses from reaching an appropriate decision. Burns (2005) argues that nearly 50% of data warehouse project were unsuccessful due to overlooking the importance of IQ. Strong et al. (1997) highlight that certainly 50 to 80 percent of criminal records in IS systems in the U.S. were discovered to be wrong, deficient, or confusing. Such information quality issues impact social/ economic and imposes billions of dollars additional costs.

Since one of the factors that affect the successful implementation of BI system is information quality, this research was planned to identify the reasons of information quality issues and their associated impact on business performance. In section 3, a theory regarding dimensions that can affect the IQ is developed by considering different authors perspectives (figure 3-4). However, this theory just identified IQ dimensions and could not provide answer to the reason of failures and their influences on business environment. Through conducting empirical investigation this theory further developed and two more layers are added (figure 5-2). The lowest layer in figure 5-2 shows the reasons of poor quality of information and top one impacts of poor quality of information on both external and internal business environment.

Answers to research questions are given after analyzing the Shahrvand Company as follow.

1) How does poor Quality of Information delivered by BI system influence the decision-making in business environment?

This is the main question of the research. A comprehensive answer to this question lies within the answer to other sub-questions, which is discussed below.

According to the empirical findings and frame of references, information provides bases to make informed decisions in a timely manner. Table 5-1 provides the area of using BI system along with associated activities and obtained benefits from the BI system. Poor quality of information, delivered by BI system, can potentially have negative influence on the decisions regarding to the identified area of usage, namely customer relationship management, supplier relationship management, and store operation management. Additionally, the encountered problems and difficulties due to the poor quality of information are described and categorized in section 5.4, as inventory management issues, problem with customer loyalty, losing competitiveness, and ineffective supplier management. As it is illustrated in the figure 5-2, which is the main contribution of this study, poor quality of information generally can affect both internal and external business environment of the organization negatively, as it is described in pervious section.
a) What issues can affect the quality of information in BI system?

According to the figure 3–4 in the theoretical frame of reference, there are thirteen dimensions that can affect the quality of information. These dimensions further investigated through empirical study to identify IQ issues as well as the reasons of encountering such issues.

Figure 5–2, which is result of empirical study, is divided into three parts include, reasons of poor quality of information, information quality dimensions, and impacts of poor quality of information on business environment. The first two parts provide answer to this question.

Figure 5–2 illustrates different information quality that the company encountered. These issues were due to

- Technical failures
- Lack of competent system developers
- Changes in business environment
- Inappropriate documentation during the system development lifecycle
- Logical error in programming and designing algorithms

Moreover when weighing the evidences, it appears relatively more likely that other information quality issues, which are identified in table 5–2, can also affect on the accuracy dimension of the information quality. For example, when data is missed or not available when needed, it also implies inaccurate presentation of information. Therefore, the causes of other information quality issues can also be cause of inaccuracy. It means that when information is neither consistent with each other nor available when needed due to any of causes highlighted in table 5–2; therefore, calculation and analysis based on incomplete (some part of data are not available) and inconsistent data can be result of delivering inaccurate information. As can be seen in table 5–2 the causes of inaccuracy are almost the combination of causes that underlined for other information quality issues.

b) What are consequences of these issues on business performance?

Making decision is an essential component of performing business activities, including formulation of future objective and strategy. Therefore, information, which provides basis to make such decisions, is critical and fundamental assets, which can affect the company’s success and competitiveness in the market place. Quality of information supplied by BI system can affect both internal and external environment of the company in different way.

As it can be seen in top layer of figure 5–2, low quality of information can affect both internal and external business environment. Internally it can affect users’ perception of system. Users considered information as unusable when they are not available in timely manner. Moreover, users lose their confidence on precision and credibility of presented data and the BI system when they encounter contradiction in different sources of data.
These issues can also be cause of data duplication, truncation, and failure in creating appropriate OLAP cubes. Therefore, these issues make decision-making process ineffective, challenging and time consuming.

Additionally, proper information is required to be able to manage the business environment effectively. Figure 5-2, highlighted ineffective inventory management because of poor quality of information. Inappropriate information can be cause of ordering wrong amount of product due to poor information about latest level of inventory, daily sales quantity, product life cycle, lead-time, safety stock availability, and seasonality, so being either out of stock or over stock. These situations can impose additional cost to the company as well as impact the external business environment by increasing possibility of dissatisfaction and losing customers. This in turn can greatly influence the loyalty of customers, since dissatisfied customers may try to shop from competitors and pursue other to do the same. Information quality has an important role for success of this technology regarding predicting demand at product level, pricing, selecting most popular brand/product, and formulating effective marketing strategy. Therefore, any inappropriate decision regarding inventory management and marketing strategy, which is made based on wrong information, can influence the customers’ satisfaction level and losing competitiveness in the market place.

Finally, company could improve supplier relationship management if they had access to highly qualified information. This is the other impact of low quality of information on external business environment, as it is identified in figure 5-2. Lack of information quality could affect supplier relation management negatively as well as accuracy of suppliers’ performance evaluation. Incorrect performance assessment influences contract negotiation or deciding if the contract should be canceled or renewed. Making such decisions based on inappropriate information could be result of either penalizing supplier unreasonably or signing non-profitable contract.
7 Discussion

BI is an effective tool that assists business users to make best decision in different situations. BI offers set of tools that enables rapid analysis of information and translating them into knowledge. Although, evidence from empirical finding shows that sometimes information is neither represented a high level of quality nor fulfilled the expected requirements, which results in challenges, difficulties, or delays in decision making. In addition, low quality of information results in inefficient and ineffective decisions and business operations, which in turn influence the overall productivity of the company.

Data consumers, managers and BI team of the company, should be conscious of information quality issues and associated influences on the business environment. Quality of the Information provided by the BI system should be monitored and evaluated regularly to guarantee that quality criteria are fulfilled and information keeps on to satisfy the expected users’ requirement. Different information quality frameworks from deep literature review and empirical findings that are represented and explained in this thesis supply an excellent commencement for this evaluation.

Moreover, commitment and support of management from business and IT units is important factor to realize the information quality. Requirements and standards to achieve information quality must be defined accurately to enforce realization of information quality, especially during testing phase, specified requirements approval, and interface documentation.

Even though applying efficient techniques, quality framework, testing procedures, monitoring mechanism as well as comprehensive documentation are critical to deliver high quality of information. However, depth analysis of these factors was beyond the objective of this thesis and should be further studied in future to suggest way that can facilitate realization, improvement, and sustaining of information quality.

The empirical study shows that utilizing BI system to process and employ information for making decision in business environment is definitely challenging and tricky. The suggested framework from the literature review (figure 3-4) highlighted dimensions that negatively affect on the quality of the information if not considered carefully. The empirical findings also provide answer to the research question, “How does Quality of Information delivered by BI system influence the decision making in business environment?” However, the purpose of this thesis was exploratory and only one case studied to get new insight about the topic, which is not much known/researched about it. Therefore, it can be considered as initial phase of research to better understand the topic and identify variables. It certainly requires more detail to be added in term of possible causes of information quality and its associated influences on business. Hence, identifying other possible variables, finding relationship between them (explanatory study) and even most important one (descriptive study) through further comprehensive study of more cases are extremely essential. In this way, it would also possible to generalize the result of the research through ‘replication logic’.

Although the result of the research (figure 5-2) confirms the issues encountered by the BI unit, more study is necessary to investigate the extent of these issues in other business units, such as marketing, financial etc. Additionally, further investigation is vital to verify whether the same results can be achieved in other industrial categories or they are applicable only to the retail industry. Since we looked for exposing patterns in empirical
data and identifying association between categories, the hypothesis is developed for testing. The inductive hypotheses, come out of the findings, could be tested, for example by exploring alternative interpretation and negative instances in other cases. Therefore, it is important to consider this issue and test the developed theory (figure 5-2) in another research.

A comprehensive insight about influences of information quality on decision-making is necessitated to conduct fine tune supplementary study. Moreover, the suggested framework (figure 3-4) must be tested practically to find out and verify its value by users and data consumers. The framework (figure 3-4) and the flow of data represented by figure 3-2 were valuable commence to get insight about the phenomena and potential information quality issues in BI environment. Finally, it may be required to consider the influence of utilized BI applications, technologies, and tools to recognize how technical factors influence realization of information quality.

‘Multiple sources of evidence’ is another issue that must be concern in a case study. Collecting data from different sources such as archival records, conducting questionnaire across all branches, as well as interview could improve the validity of the findings. The archival records can provide exact references and detail of events with a broad coverage on long span of time. Since archival records are precise and usually quantitative, it could improve the validity by enabling triangulation and collecting secondary quantitative data as well as qualitative data. However, the archival research was denied due to security issues. It must also notice that the exploratory nature of this study aims to gain basic ideas, insight, and understanding about the problem area, identifying variables, and hypothesis generating through a focus group interview. The goal of exploratory study is not to conclude a study but to develop ideas, at an early stage of research, for further study. The theory can be tested in a larger scale thorough, for example, survey at the next stage of research. In this way, the result of interview would inform the content of questionnaire.

Most importantly, we were aware that single case study needs a strong justification for a critical, unique, or representative case in testing a well-formulated theory. Therefore, we desired to conduct multiple-cases to study more than one company. In this way, we could institute if the findings of the first case happen in other cases and, consequently, the requirement to generalize from these findings through replication logic. Although, multiple-case study could not be achieved, since companies either refused to have an interview or did not implement BI system. Therefore, we decided to investigate the only company that agreed to have an interview with us, and consequently following single-case strategy.
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Appendixes

Appendix1
Interview questions for BI users

❖ About interviewee
   1. Please introduce yourself, along with the position and department you are working in.
   2. Could you explain the tasks of the department?
   3. What tasks are you in charge of?

❖ BI architecture (only asked from interview 1 through email to figure out who can answer questions regarding “BI developer perspective”, and inviting them to the focus group interview)
   4. Can we have an overview of BI architecture so we can understand how data flow from sources to reach data consumers?
   5. Could you please give us an introduction of the BI department (different section, team and their responsibilities)

❖ The area and benefit of using BI
   6. For what purposes do you use BI? And what are the benefits of utilizing BI system?
   7. Is the current BI system effective enough to facilitate decision making? Or required to be further improved? (this question came up during the interview)

❖ Influences of Information Quality issues on quality of decision and organization’s performance
   8. How the quality of information can change the direction and outcome of decisions? What are its influence on business activities and performance? (Information quality was explained before the interview for the respondents)
   9. Regarding to the situation before implementing of BI, How implementation of BI system can facilitate and affect decision-making process in the organization? Please clarify usage area and benefits by example. (this question came up during the interview)

To Sum up

10. Is there anything else about the IQ, its influences on efficient use of BI, and better decision-making that you would like to add or you think it is missed?
11. Do you have any more comment or any questions what so ever?
Appendix

Appendix 2
Interview questions for BI developers

❖ About interviewee
  1. Please introduce yourself, along with the position and department you are working in.
  2. What tasks are you in charge of?

❖ Identifying data quality issues:
  3. What are the possible failures, errors, or issues, which can affect the quality of information negatively, during processing of information in each stage of data flow?
  4. What are the reasons of such failures? Why do they happen? (this question came up during the interview)

❖ Possible Impacts of data quality issues on business environment (focus on user’s feedbacks on such issues and problem they encountered)
  5. What are the possible impacts of such failures and problems with information quality on Business environment?
  6. How much time and effort do you put on investigating and resolving data quality issues? And how do you recognize issues? (this question came up during the interview)

❖ To Sum up
  7. Is there anything else about the IQ, its influences on efficient use of BI, and better decision-making that you would like to add or you think it is missed?
  8. Do you have any more comment or any questions what so ever?