

Using Business Intelligence Capabilities to Improve the Quality of Decision-Making: A Case Study of Mellat Bank

Jalal Haghighat Monfared, Zahra Akbari

Abstract—Today, business executives need to have useful information to make better decisions. Banks have also been using information tools so that they can direct the decision-making process in order to achieve their desired goals by rapidly extracting information from sources with the help of business intelligence. The research seeks to investigate whether there is a relationship between the quality of decision making and the business intelligence capabilities of Mellat Bank. Each of the factors studied is divided into several components, and these and their relationships are measured by a questionnaire. The statistical population of this study consists of all managers and experts of Mellat Bank's General Departments (including 190 people) who use commercial intelligence reports. The sample size of this study was 123 randomly determined by statistical method. In this research, relevant statistical inference has been used for data analysis and hypothesis testing. In the first stage, using the Kolmogorov-Smirnov test, the normalization of the data was investigated and in the next stage, the construct validity of both variables and their resulting indexes were verified using confirmatory factor analysis. Finally, using the structural equation modeling and Pearson's correlation coefficient, the research hypotheses were tested. The results confirmed the existence of a positive relationship between decision quality and business intelligence capabilities in Mellat Bank. Among the various capabilities, including data quality, correlation with other systems, user access, flexibility and risk management support, the flexibility of the business intelligence system was the most correlated with the dependent variable of the present research. This shows that it is necessary for Mellat Bank to pay more attention to choose the required business intelligence systems with high flexibility in terms of the ability to submit custom formatted reports. Subsequently, the quality of data on business intelligence systems showed the strongest relationship with quality of decision making. Therefore, improving the quality of data, including the source of data internally or externally, the type of data in quantitative or qualitative terms, the credibility of the data and perceptions of who uses the business intelligence system, improves the quality of decision making in Mellat Bank.

Keywords—Business intelligence, business intelligence capability, decision making, decision quality.

I. INTRODUCTION

THE decision making process plays an important role in any organization. Therefore, it must be planned, comprehensive, transparent and secure to solve problems [1].

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Decision Support Systems (DSS) are used with analytical information to influence decision making. Recent research into DSS and expert systems, incorporating these analytical tools, is simply intended to evaluate the best decisions and to consider them as a comprehensive environment for supporting the efficient processing of information based on a high understanding of the problem's structure [2].

Business intelligence used by organizations should be commensurate with the business space or the decision-making environment in which it is used and this proportion is the key to the success of business intelligence [3]. Academic research shows that this success has not yet been achieved in many organizations, and users of business intelligence have not established a link between the capabilities of business intelligence and the decision-making environment [4]. Business intelligence capabilities are important functions that can help the organization to improve both acceptance of change and performance [5]. Although business intelligence capabilities have been examined from a technical and organizational perspective, some organizations have failed to succeed in business intelligence [6]. This may be due to the fact that the relationship between decision quality and business intelligence capabilities has not been widely studied. This relationship is very important, because the primary goal of business intelligence is to support decision-making in organizations [7].

The bank is no exception as an organization with extensive financial and commercial activities. So, in this research, we are looking for the following question: Is there any relationship between the quality of decision making and the business intelligence capabilities of Mellat Bank?

II. BACKGROUND

A. Quality of Decision Making

1. Certainty, Uncertainty and Risk Conditions

All managers must judge different ways or solutions when deciding, and most of these decisions are related to future events, which are not easy to predict.

Certainty: Under our conditions of certainty, we are well aware of the objectives and we can obtain accurate, measurable, and valid information about the outcome of the action or the way ahead.

Risk: The risk is when it is not possible to predict the outcome of the action definitively, but enough information is available to predict the likely type that leads to the desired

result.

Uncertainty: In uncertainty conditions, the results of the actions are not known. The phenomenon of uncertainty has two main sources. First, managers often face situations outside the organization, which is almost entirely out of their control. Second, another factor that does not matter is that the manager cannot get basic information [8].

2. Reporting Systems and Decision Making Process

"Decision" of any kind represents a result. That is, the manager justifies the outcome of a process by making a decision (expressing his preference). As a result, it does not suffice to examine the "choice" or "preference" that explains the outcome of the decision. But it is necessary to look at what has happened in the past by going back to the point of selection. If we look at this angle, decision making can be seen as a process; the process of decision making is the process of a set of tasks that has a definite starting point, and from here onwards, work, activity, or thoughts follow each other. Coming to the end and ending up with a preference.

Decision making is information processing, that is, the data manager will examine, analyze and evaluate his data and, ultimately, will define the problem by observing some problems. But, in order to be able to do this, it is necessary to provide the necessary information to himself. This will be provided by the reporting system. The manager will process the information, and will decide and the decision will consign to be implemented. The decision making process, on the one hand, is dependent on the reporting system and, on the other hand, on implementation.

The subject matter of the information used in the decision process and its supplier system is to emphasize this important issue: in business, almost all decisions taken during the present time are related to the future, but much of the information used to make decisions is related to the past. However, what matters to the decision maker is to use future information in decision making. This is possible with the use of quantitative and quantitative prediction methods.

Another case in terms of information is that the decision-making process, which is influenced by the business internal reporting system. It is easy to see that a decision maker who does not know what is in the business and what is happening in it at the moment, finds all the information in his or her own way including sometimes not only what does not require it, but rather totally irrelevant information, without any distinction of importance and all this will make it hard to make a choice. As a result, a very close connection must exist between the internal (and even foreign) reporting system of the business and decision making [9].

3. Factors Affecting the Quality of Decision-Making

a) Innovation in the Decision

In contrast to the thoughts that come to mind, Henry Mintzberg has shown that managers in organizations do very different things and play very different roles. The roles played by managers can be grouped into three main groups in terms of relationships between individuals, the collection and

distribution of information and decision making. The role of managers is about deciding activities such as doing innovations. Therefore, innovation is a quality that managers need to consider in its decision making.

b) Ability to Implement and Evaluate the Decision

In order to make a favorable decision, one should be able to predict the value of each of the possible outcomes that will be achieved after his decision, implicitly comparing these values with a quantitative scale, and examining the probability of success, which will not always be easy. Decision making is an integral part of management and it manifests itself in any management task; Decision making is a key component in determining the organization's policies, defining goals, designing an organization, selecting, evaluating and all management practices.

There are two basic factors in each type of decision:

- a) The value of the results of the decision and its implementation, or, in other words, the expected value of the person.
- b) The odds and probabilities that would occur in the event of action in order to achieve the desired probable outcomes.

According to Herbert Simon, decision making is the main core of management, and even management can be considered synonymous with it. He presented his decision-making theory, "The Manager as the Decision Maker." In his opinion, the decision maker is as a person who is ready to elect one of the routes at the intersection of the roads, at the moment of making choices. If management is synonymous with decision making, then it does not mean just choosing one way among other ways, but the decision-making term refers to the whole process. In many organizations, especially public and administrative agencies, decisions taken with different ratios include both executive decisions and policy making. Decision making and problem solving as outlined in the introduction means that, the process decision is related to solving a problem or problem and is often referred to as the "problem solving".

In many cases, the problem or the question is a very complex situation, and only part of it may be understandable and controllable. Therefore, decisions are usually not designed to provide ideal results or complete answers, but are designed to improve a situation. In some cases, administrators may find themselves facing issues that only reduce the severity of issues so that they are systematically looking for a perfectly correct answer for all issues.

Russell distinguishes between solving, resolving, dissolving, and absolving or digesting the problem, and says:

- ✓ Solution: This is to find the optimal answer, the best choice or the best solution. The rational decision is an attempt to find such an answer.
- ✓ Resolution: This means finding a satisfactory answer that may not necessarily be the best way to access, but also a choice made by circumstances such as time constraints or lack of real understanding of the problem.
- ✓ Dissolution: It occurs when the goals are changed in a

way that it does not seem to be a problem in the current situation and with the implementation of the set measures need to achieving new objectives. The feelings about what should happen now are changed and adjusted in a way that what happens, will be accepted as current reality.

- ✓ Absolved: In the hope that potential problems will not appear, they will be ignored.

c) *Approximation of Decision with Organizational Goals*

Carnegie's model is the foundation of thinkers such as Herbert Simon, James Marc and Richard Jaet at the time when they were at the Mellon-Carnegie University. This method is almost the development of methods related to rational approaches which are limited in individual decision making, but at the organizational decision-making level. Prior to the research of this group, it was thought that, for example, in business decision-making, commercial companies would decide as a unified unit with a unique identity and all information would be passed to the company's head for the adoption of such a decision. Carnegie's study shows that organizational decisions are shaped by a number of managers, and the final choice depends on a coalition between executives. The coalition is a pledge between the various managers who agree on organizational goals and priorities of the organization [10]. The coalition process has important implications for decision-making behavior in the organization. First, decisions are made on the basis of satisfaction of managers and not the optimal solution. Satisfaction means that the organization accepts a kind of solution that addresses various organizational goals, rather than seeking a solution to maximize its benefits. Second, managers are looking for immediate solutions through short-term solutions. To Herbert Simon and his colleagues, this is the same title as the problem-oriented research. In their view, managers find in their immediate environment a solution that quickly solves their problem.

B. *Business Intelligence*

Business intelligence (BI) is an umbrella term introduced by Garner Group and its researcher Howard Wisner, in 1989, to introduce a set of concepts and methodologies in the business which helps to improve decision making through the use of events and systems based on events, BI applications reestablish the action plan of an organization. So the accuracy and success of the company's goals and objectives are measured by them [11]. BI covers the tasks of collecting, processing and analyzing a large amount of data from the internal system and external resources, which is possible because BI uses the advanced tools of rapid analysis and forecasting that help a company make decisions timely and urgently for achievement of organizational goals.

BI systems are combinations of data collection, data warehousing and knowledge management along with analytical tools to provide complete competitive and internal information to decision makers and planners.

An analogy to the above definition is the idea that BI systems can provide prosecutable information to arrive at

decision-makers at the right time, right and wrong. The objective is to improve the timeliness and quality of decision process data, in order to facilitate management work.

i. *Why Do Organizations Need BI?*

BI contributes to operational and strategic decision making. One research by Garner classifies the strategic use of BI as [12]:

1. Corporate Performance Management,
2. Optimizing customer relationships, monitoring business activities and traditional support,
3. BI software packed separately for strategies and operations,
4. BI Management Reporting.

One of the topics in this categorization is the exclusive report of the company's performance and competitors that the potency of many software packages in this field is not enough. The other topic is that many companies still view BI as an internal approach software (like DSS and Executive Information Systems).

BI is a natural way of assembling previous DSS. The advent of data warehouses as a repository, the benefits of data cleansing, which leads to a single reality, more software and hardware capabilities, and the explosion of Internet technology which is the user interface standard, all contribute to creating a stronger BI than what were available in the past. BI draws information from many other systems.

BI transforms data into information and through human analysis into knowledge. Some of the things that are done by BI are:

- ✓ Perform predictions based on historical data, past and current performance, and future direction estimation,
- ✓ Analyze "if - then" effects of changes and alternative scenarios,
- ✓ Access to data in order to respond to unconventional questions,
- ✓ Strategic insight.

In a wider perspective, institutions need to use intelligence for the two main purposes. First, to do an analysis that can help them make better decisions. Analysis helps them recognize sales trends and provide care for customers and critical issues. Second, it helps them a lot to predict future customer behavior and market demand. Some other reasons include:

- a) It help companies achieve their main goals, such as reducing costs, improving productivity, product development, customer service development, increased earnings, and so on. By analyzing input and output data, BI can help companies achieve these goals to an enough extent.
- b) BI provides strategic information for decision makers. It allows institutions to exploit large amounts of information through the analysis of information in order to find behavior patterns for customers and competitors. This can adequately help an organization that properly adapts its plans and programs in various aspects of business such as production, distribution, pricing and capacity planning.

Online access to such information can help decision making and provide dynamic changes that help the improvement of a company's main line.

- c) Identification of transaction behavior: Using the BI tool, an analysis of transaction models can provide an important insight into customer behavior. Customer behavior, payment pattern, and transactions can be used to evaluate customers. Banks widely use BI to stimulate their strategic organic implementation by utilizing information assets to optimize costs, enhance customer profitability, and develop new products. In order to increase customer profitability, a bank can sell overwhelmingly a range of proprietary financial products, such as bank bonds, loans, and investment solutions, in addition to a combination of three-tiered products, such as stocks and government bonds.
- d) Transfer of value management channel. Analyzes attract banks' attention to using knowledge to manage customer value. Banks need to understand aspects such as those of customers whose savings grow over a certain period of time, and areas where their balance is decreasing or stagnant. Based on these perceptions, banks can provide security for downlink transmission, acceleration of upward transfer, and moving a stagnant user's portfolio into a transfer path.

1. BI Capabilities

Based on the model presented in chapter four of this paper, BI capabilities have two dimensions:

The technical dimension:

Data quality

Correlation with other systems

User access

Organizational dimension:

Flexibility

Risk Management Support

a. Data Framework for BI (Data Quality)

Structured versus Semi Structured Data

The types of structured and semi structured data can be classified in terms of the external and internal resources of the organization.

The switch between structured and semi-structured data types and between internal and external sources of data has not been precisely clarified. For example, semi-structured data from emails and websites relates to both external and internal sources of data -Internet and Extranet Sites. Nevertheless, this matrix is useful for guiding the search and browsing of analytical tools available for BI. For example, ERP systems take operational data (internal) in a structured format, while CRM focuses on customer information (external). On the other hand, semi-structured data are extracted from other documents, news sections, and business processes. As a goal of this paper, news sections and business processes have been used to display external and internal data sources.

b. Correlation with Other Systems

Correlations between components: One of the most important features of the system is the existence of a correlation between its components. The correlation means that each component in the system is in some way related to other components, and due to the existence of this correlation, if it is partially intact, other components are also affected by it.

The fit between components: The components of each system are proportional, homogeneous and complementary. The existence of proportionality between components helps maintaining the identity and integrity of the system. If the components of the system do not fit together, it will not work well. In university system, the number of students should be proportional to the number of professors, as well as the fit between the scientific staff and the office and the service unit.

Circular process: The process of input, conversion, and output is a continuous flow. This means that by issuing output, the system is once again ready for power and renewal, and this flow continues as circular process. In a production system, when a commodity is produced, it is sold to the market, and when it is sold, it earns an income that is used to purchase raw materials and the system feeds on it and continues to move.

c. User Access

Authorized persons should and unauthorized persons should not be able to access. For this purpose, access control methods and techniques are described here.

Access to information should be limited to people, computer programs, processes and systems that are authorized to access the information. This requires the existence of a mechanism to control the access to protected information. The complexity of access control mechanisms should be in accordance with the value of the information to be protected. More sensitive and valuable information requires a more robust access control mechanism. Access control mechanisms are based on the issue of authentication.

Authentication is the identification of someone or something. This identity may be claimed by the individual or we recognize ourselves. If a person says "Hello, my name is Ali" this is a claim. But this claim may be right or wrong. Before allowing Ali to have access to protected information, it is imperative that his identity be checked, if he is who he is claiming to be.

Once the person, program or computer successfully authenticated, then it should be determined which information sources and actions they are allowed to perform (implementation, display, creation, deletion, or modification). This is called licensing.

Licensing for access to computer information and services begins with policy and management procedures. Access policy explains what information and computer services can be accessed by whom and under what conditions. Access control mechanisms are then installed and set up to enforce these policies.

Different access control approaches exist. There are three known approaches: discretionary, non-discriminatory, and compulsory approaches. In the discretionary, the creator or the

owner of the information resource determines the accessibility of these resources. The non-discriminatory approach focuses on all access controls and is not at the discretion of individuals. In the compulsory way, access to information or deprivation of access depends on the classification of information and the number of people who want access.

d. Flexibility

The Concept of Flexibility in the Organization

Flexibility, in general, is the ability of an organization to understand environmental change and then respond quickly and efficiently to that change. These environmental changes can be a technological change and a change in customer demand. The term "flexibility" describes the speed and potency of responsiveness when confronted with internal and external events of the organization.

Flexible organizations should not only be responsive to existing changes but also be able to obtain competitive advantages with a proper arrangement. In recent years, most manufacturing organizations have focused on cost reduction, many organizations have been able to maintain their profitability, even when their product prices dropped by 40% or more. These organizations identify and eliminate value-added activities, which will reduce their waste of resources. They have implemented concepts like pure production, timely production, six sigma, and so on, but these are not just enough for agility. Some organizations create ecosystems that are only effective in sustainable environments and with the smallest change.

The two general definitions of a flexible organization are as:

- a) A flexible organization, with sudden events and changes, simply does not go away.
- b) A flexible, fast-paced, consistent and powerful organization that responds to sudden changes, new market opportunities and customer requirements.
- c) Integrating dispersed components including customers, suppliers and co-workers in virtual organizations.

e. Risk Management Support

Risk Management in Banks

According to the rules of the Wing Committee, banks had been required to implement risk management until 2007, and the best way to do this was to use risk management software to reduce not only the amount of administrative bureaucracy, but also speed up the operation through mechanization, trying to reduce costs and increase customer satisfaction.

The risk management software in banks, one of the most important components of the monetary and financial sector, is the design and implementation of a model that identifies and reduces the negative effects and shocks that the organization experiences, or prevents them from happening, through accurate and on time prediction. This software manages the risk in the bank instead of covering. In fact, what is currently happening in banks, especially in the credit sector through bail, introducing the guarantor and inventory, etc., is risk

coverage; while, risk coverage is a very small part of the risk management process.

Today, the risk category is used all over the world; therefore, in order to reasonably assess and decide on a customer, the customer must first be evaluated at the bank itself, then between the banks in the country and then globally and in international exchanges.

At the beginning, the process of activity is that each bank only provides its predetermined needs, and after that, the stability of the operation in this system expands and attempts to reduce the risk in other activities. It is also noteworthy, in a risk management software, the greater number of years and raw data are the more accurate forecast with less error probability is. This software is modeled on the core and then transmits its operation between the connected systems. One of the tools for evaluating software is the speed of computing and sorting the data, and for risk assessment, different functions such as the Poisson function, MATLAB software, and so on are used.

After entering all the information, the software filters the data and identifies faults, and also based on statistics and evaluations of the past, it can make inferences regarding the accuracy of customer claims based on tax returns and the type of economical section which he runs his business in it and the request for facilities is related to.

One of the principle objectives of risk management is the establishment of an on-line information network. The initial installation of such a software takes up a given time to enter all the past information, but then the information used to make decisions could be made for a moment.

Considering the research background, the following domestic and foreign researches are referred:

- The Effect of Decision Making Environment on the Success of Business Intelligence; Master's Thesis Zahra Jafari and Supervisor Mohammad Reza Jaberansari at Islamic Boroujerd Azad University, Science and Research Branch 2012 [13].
- The Effect of Business Intelligence on Business Processes and Organizational Performance in Iepco; The Paper presented at the First National Business Intelligence Conference, based on the master's thesis, Ali Avaz Malayeri, supervisor Jalal Haghighat Monfared at Tehran Azad University, Tehran Center branch, 2010 [14].
- New Approaches to Business Intelligence; Seyyed Mojtaba Banayi, Seyyed Hadi Mousavi, Birjand University of Technology, 2012 [15].
- Business Intelligence; Sayedeh Zohreh Miran Bachelor's thesis; Samira Asadpour; Ramsar Payam Noor University, 2010 [1].
- Requirements for assessing business intelligence in ERP in Iran Trade Development Organization; Novin Economics and Business Quarterly, No. 13; Ghazanfari, Jafari, Taghavi Fard, Rouhani, 2008 [16].
- The success of business intelligence: the empirical assessment of the role of business intelligence and decision-making environment; Ph.D. Oyku Isik; North Texas University; 2010 [17].

- Impact of business intelligence and decision support on decision making quality in five-star hotels in the capital of Oman; Master's Thesis by Hadeel A Mohammad at the Middle East University 2012 [18].
- In the interests of the success of business intelligence systems: the impact of puberty and culture on analytical decision-making; Ales Popvic, Ray Hackney, Pedro Simoes Coelho, Jurij Jaklic at the University of Nova Portugal 2012 [19].
- The main drivers of success in business intelligence systems; William Yeoh, Andy Koronios; South Australia University in 2008 [20].

III. RESEARCH METHODOLOGY

This research investigates the relationship between BI and quality of decision making in Mellat Bank. The current research is applicable in terms of its purpose and is a descriptive survey in terms of its method of data collection. The statistical population of this study consists of all managers and experts of Mellat Bureaus (including 190 people) who use commercial intelligence reports. After random sampling, the sample size was determined by searching randomly among the names of experts and managers in the automation system of Mellat Bank. The sample size required by this study was 123 individuals, which calculated statistically.

The questions of the survey are limited and based on Likert's seven-option range and the components of the research variables. The content validation of the questionnaire was confirmed by consult with experts and managers of the bank and its construct validity was assessed using the Kolmogorov-Smirnov test. For confirmation of its reliability, a preliminary sample of 15 questionnaires was pre-tested and then using the data collected and applying SPSS software, the reliability coefficient was calculated using Cronbach's alpha method. The Cronbach's alpha coefficient for the research variables is higher than 70% and is acceptable.

A. Research Objectives

The Main Objective:

- Investigating the relationship between decision quality and BI capabilities in Mellat Bank.

Sub-goals:

- Determining the components of decision-making quality in Mellat Bank.
- Identifying the BI capabilities associated with the quality of decision making at Mellat Bank.
- Determining the impact of BI on the quality of decision making in Mellat Bank.

B. Research Hypotheses

The Main Hypothesis:

1. There is a relationship between the quality of decision making and the capabilities of BI in the Mellat Bank.

Hypotheses:

1. There is a relationship between the quality of decision making and the quality of data in the Mellat Bank.
2. There is a relationship between the quality of decision making and the correlation with other systems in the Mellat Bank.
3. There is a relationship between decision making quality and user accessibility in the Mellat Bank.
4. There is a relationship between decision making quality and flexibility in Mellat Bank.
5. There is a relationship between decision making quality and risk management support at Mellat Bank.

C. Conceptual Model of Research

The conceptual model of this research is shown in Fig. 1. The model is based on the Oyku Isik PhD dissertation model at North Texas University in 2010 [17], with the topic of the success of BI: the empirical assessment of the role of BI and decision-making environment and the master's thesis model Hadeel A Mohammad at Middle East University 2012 [18] with the topic of BI and decision making support impact on the quality of decision making in five-star hotels in the capital city, Oman, which have been adapted after adjusting for the subject matter of the present study.

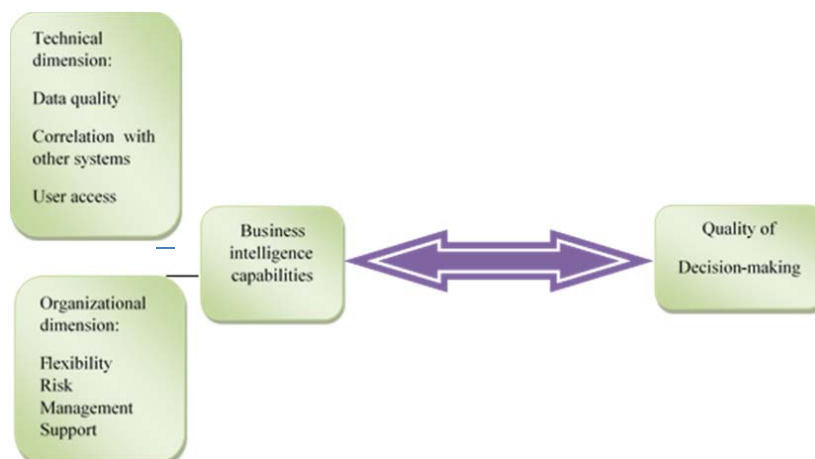


Fig. 1 Conceptual model of research

D. Data Analysis

In this research, after data extraction by forming a frequency distribution table, statistical data are summarized and classified and the demographic information of respondents is also categorized using the descriptive statistics as follows and presented in graphs:

- ✓ 25.2% of respondents are between 20 and 30 years old, 22.8% are between 31 to 40 years, 35.0% are between 41 and 50 years old and 17.0% are older than 50 years.
- ✓ 19.5% of the respondents have associate Degree, 65.9% have bachelor's degree and 14.6% have master degree.
- ✓ 15.4% of respondents have a work experience less than 5 years, 31.8% have work experience between 6 to 10 years, 23.5% have work experience between 11 to 15 years, 19.5% have work experience between 16 to 20 years and 9.8% have work experience between 16 to 20 years.

In order to investigate the validity of the questionnaire and verifying the factors considered, factor analysis using the orthogonal axis rotation (Varimax) has been used to achieve pure factors. For this purpose, the KMO index and the Bartlett Sphere test have been used.

TABLE I
INVESTIGATING THE ADEQUACY OF DATA VOLUMES

Dimensions	KMO	sig
Data quality	0.755	0.000
Correlation with other systems	0.696	0.000
User access	0.681	0.000
Flexibility	0.812	0.000
Risk management support	0.701	0.000
Innovation in decision	0.743	0.000
Ability to implement the decision	0.700	0.000
Ability to evaluate the decision	0.741	0.000
Approximation of decision with organizational goals	0.533	0.000

As shown in the table above, since the KMO index is greater than 0.6, the sample number (here is the number of respondents) is sufficient for factor analysis. Also, the significant value (Sig) for the Bartlett test was less than 5% and this shows that factor analysis is suitable for identifying the structure of the factor model.

Various analyzes have been used to analyze the research data. In the first stage, the data normality were investigated using Kolmogorov-Smirnov test and Pearson correlation coefficient between the variables of the research. In the next stage, the structure validity of the research variables and their resulting indicators were examined using confirmatory factor analysis. Using the structural equation model which is in fact a combination of path analysis and confirmatory factor analysis, the research hypotheses were tested.

Considering that the significance level for the research variables and its dimensions is greater than 0.05, the assumption of the normalization of the data is confirmed and we conclude that the data collected for research variables and their dimensions are normal.

Table III shows the correlation matrix between research

variables.

Given that the correlation coefficient of the variables is more than 0.6; this means that there is a strong correlation between the two variables.

The results of factor analysis show that all the indicators related to the variable of BI capabilities have t values (more than 1.96) and acceptable factor load (more than 0.3) and to measure the quality of the variables, BI capabilities are considered as good indicators.

TABLE II
KOLMOGOROV-SMIRNOV TEST FOR RESEARCH VARIABLES AND ITS DIMENSIONS

Variable	Test value	Dimensions	Test value
BI capabilities	0.684	Data quality	0.633
		Correlation with other systems	0.245
		User access	0.208
		Flexibility	0.161
		Risk Management Support	0.112
Quality of decision making	0.226	Innovation in decision	0.066
		Ability to implement the decision	0.094
		Ability to evaluate the decision	0.062
		Approximation of decision with organizational goals	0.080

TABLE III
CORRELATION MATRIX BETWEEN RESEARCH VARIABLES

Variables	Quality of Decision-making	
	Correlation coefficient	Sig
BI capabilities	0.894**	0.000
Quality of Decision-making	0.895**	0.000
Correlation with other systems	0.684**	0.000
User access	0.615**	0.000
Flexibility	0.799**	0.000
Risk Management Support	0.655**	0.000

**p<0.01, *p<0.05

TABLE IV
CONFORMITY INDEXES OF CONCEPTUAL MODEL OF THE RESEARCH

Indicator name	Limit	The value obtained
$\frac{\chi^2}{df}$ (Chi-square per freedom degree)	Less than 3	2.64
GFI (Goodness of Fit Index)	Above 0.9	0.93
RMSEA (Root Mean Square Error of Approximation)	Less than 0.08	0.073
CFI (Comparative Fit Index - Adjusted)	Above 0.9	0.96
AGFI (Adjusted Goodness of Fitness Index)	Above 0.9	0.90
NFI (Normed Fit Index)	Above 0.9	0.92
NFII (Non-Normed Fit Index)	Above 0.9	0.94
IFI (Incremental Fit Index)	Above 0.9	0.89
RMR (Root Mean square Residual)	Less than 0.05	0.026

TABLE V
ROUTE COEFFICIENTS, T STATISTICS AND COEFFICIENT OF DETERMINATION (DEPENDENT VARIABLE: BI CAPABILITIES)

Predictor variable	route coefficient (β)	t statistic	coefficient of determination (R^2)
Decision quality	0.85	9.13**	0.72

**p<0.01, *p<0.05

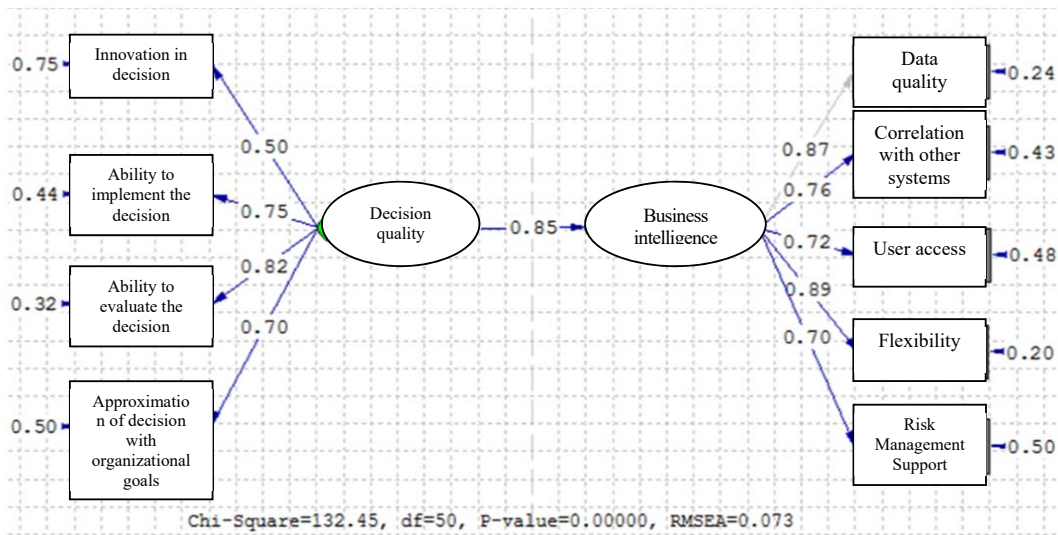


Fig. 2 Structural equation modeling of conceptual model of the research (standard estimates)

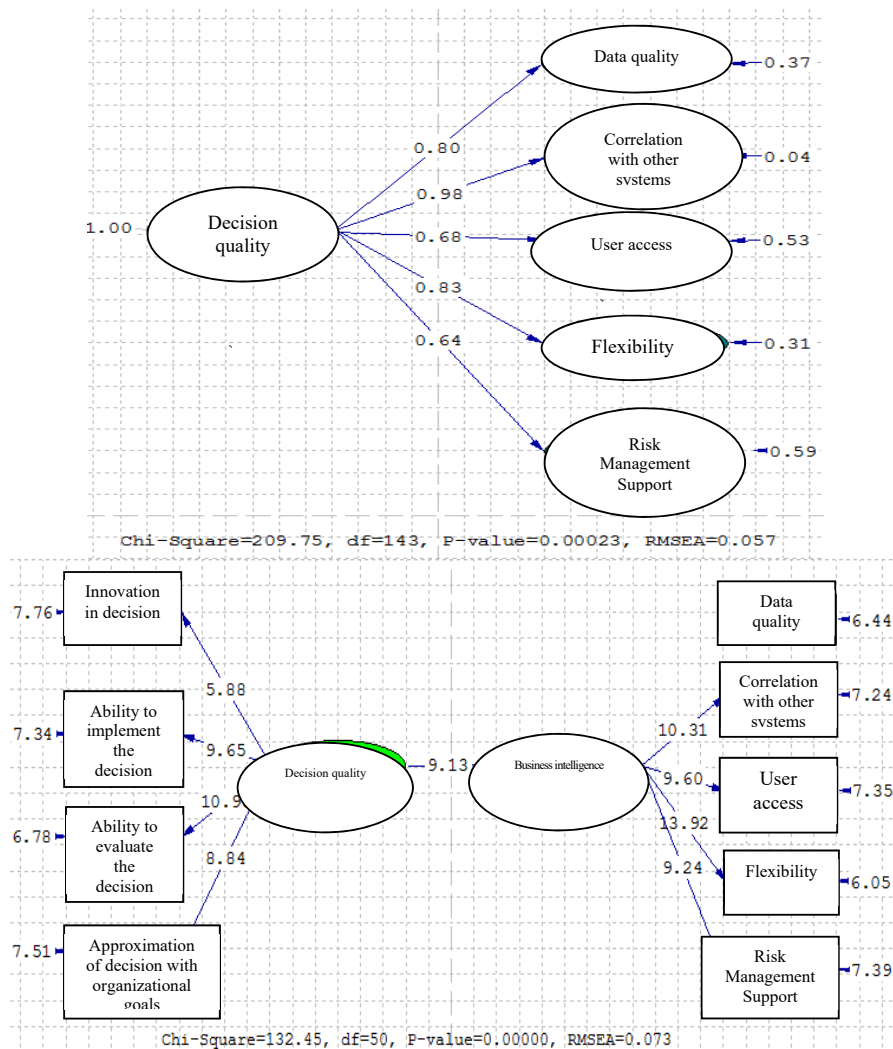


Fig. 3 Structural equation modeling of conceptual model of the research (Significance of the coefficients)

Main hypothesis: There is a relationship between decision quality and BI capabilities.

Considering the route coefficient of 0.85 and also the t statistic of 9.13, it can be said that decision-making quality has a significant and positive relationship with the capabilities of BI at 95% confidence level; therefore, the main hypothesis of

the research is significant and confirmed.

The value of the multiple determination coefficient (R^2) is 0.72. This coefficient examines the ability to predict the dependent variable by the independent variable. Based on this, the decision-making quality variable has been able to predict 72% of the changes in intelligence capabilities.

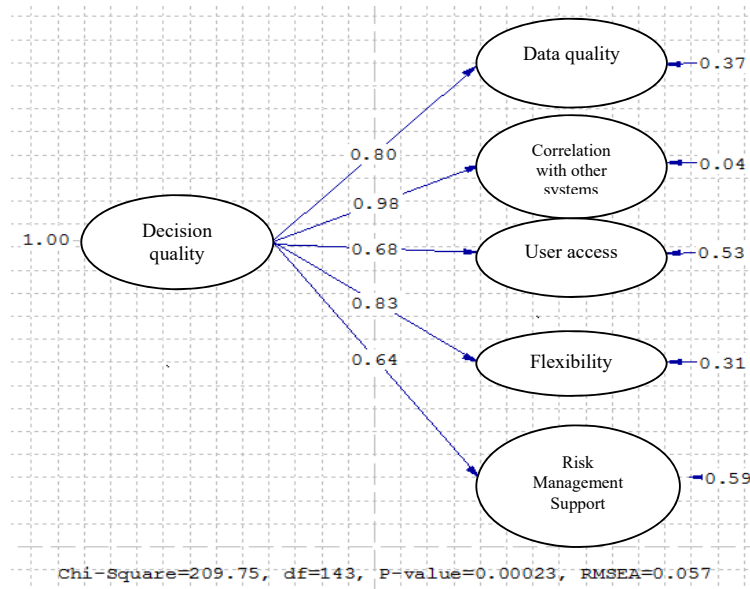


Fig. 4 Structural equation modeling of conceptual model of the research (standard estimates)

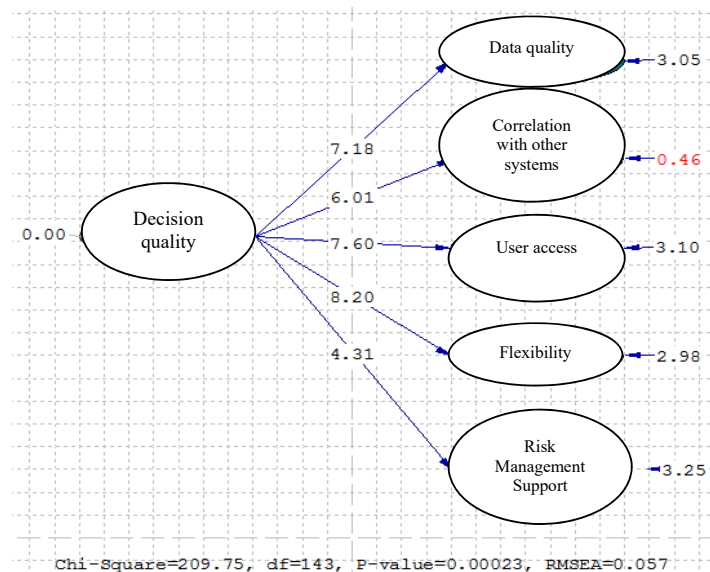


Fig. 5 Structural equation modeling of conceptual model of the research (Significance of the coefficients)

Sub-hypotheses:

1. There is a relationship between decision quality and data quality capability.
2. There is a relationship between decision quality and the capability of correlation with other systems.
3. There is a relationship between decision quality and the capability of user accessibility.
4. There is a relationship between decision quality and the capability of flexibility.
5. There is a relationship between decision quality and risk management support capability.

TABLE VI
ROUTE COEFFICIENTS, T STATISTIC AND DETERMINATION COEFFICIENT
(PREDICTOR VARIABLE: DECISION QUALITY)

Predictor variable	Route coefficient (β)	T statistic	Coefficient of determination (R^2)
Data quality	0.8.	7.18**	0.64
correlation with other systems	0.98	6.01**	0.96
User accessibility	0.68	7.60**	0.46
Flexibility	0.83	8.20**	0.69
Risk management support	0.64	4.31**	0.41

**p<0.01, * p<0.05

Considering the route coefficient of 0.80 and also the t-statistic of 7.18, we can say that the quality of data has a significant and positive relationship with decision quality at the 99% confidence level; therefore, the first sub-hypothesis of the research is significant and confirmed.

The value of the multiple determination coefficient (R^2) is 0.64. This coefficient examines the ability to predict the dependent variable by the independent variable. Based on this, the data quality capability variable has been able to predict 64% of the changes in the quality of the decision making.

Considering the path coefficient of 0.98 and also the t-statistic of 6.01, it can be said that the capability of correlation with other systems has a positive and significant relationship decision quality at the 99% confidence level with; therefore, the second sub-hypothesis of the research is significant and confirmed.

The value of the multiple determination coefficient (R^2) is equal to 0.98. This coefficient examines the ability to predict the dependent variable by the independent variable. Accordingly, the capability of correlation with other systems together can predict 98% of the changes in the quality of decision making.

According to the route coefficient of 0.68 and also the t-statistic of 7.60, it can be said that the capability of user accessibility has a positive and significant relationship with decision quality by 99% confidence level; therefore, the third sub-hypothesis of the research is significant and confirmed.

The value of the multiple determination coefficient (R^2) is 0.46. This coefficient examines the ability to predict the dependent variable by the independent variable. Accordingly, the variable of the capability of user accessibility has been able to predict 46% of decision-making quality changes.

According to the route coefficient of 0.83 and also the t-statistic of 8.20, it can be said that the capability of flexibility has a positive and significant relationship with decision quality at the 99% confidence level; therefore, the fourth sub-hypothesis of the research is significant and confirmed.

The value of the multiple determination coefficient (R^2) is 0.69. This coefficient examines the ability to predict the dependent variable by the independent variable. Accordingly, the variable of the capability of flexibility has been able to predict 69% of the quality decisions changes.

According to the route coefficient of 0.64 and also the t-statistic of 4.31, we can say that risk management support capability has a positive and significant relationship with

decision quality at the 99% confidence level; therefore, the fifth sub-hypothesis of the study is significant and confirmed.

The value of the multiple determination coefficient (R^2) is equal to 0.41. This coefficient examines the ability to predict the dependent variable by the independent variable. Accordingly, the variable risk management support capability has been able to predict 41% of the quality decision changes.

TABLE VII
SUMMARY OF ASSUMPTIONS TEST RESULTS

Hypotheses result	T statistic	Route coefficient	Research hypotheses
confirmed	9.13**	0.85	Main hypothesis
confirmed	7.18**	0.80	Sub-hypothesis 1
confirmed	6.01**	0.98	Sub-hypothesis 2
confirmed	7.60**	0.68	Sub-hypothesis 3
confirmed	8.20**	0.83	Sub-hypothesis 4

* Significant at 99% confidence level. ** Significant at 95% confidence level. *** Significant at 90% confidence level.

IV. CONCLUSIONS AND SUGGESTIONS

A. Results

- According to the route coefficient of 0.85, as well as the t-statistic of 9.13, we can say that the quality of decision making has a positive and significant relationship with the capabilities of BI at 95% confidence level; therefore, the main hypothesis of the research is significant and confirmed. The value of the multiple determination coefficient (R^2) is 0.72. This coefficient examines the ability to predict the dependent variable by the independent variable. Based on this, the decision-making quality variable has been able to predict 72% of the changes in intelligence capabilities.
- According to the route coefficient of 0.80 and also the t-statistic of 7.18, we can say that the capability of data quality has a positive and significant relationship with decision quality at the 99% confidence level; therefore, the first sub-hypothesis of the research is significant and is confirmed. The value of the multiple determination coefficient (R^2) is 0.64. This coefficient examines the ability to predict the dependent variable by the independent variable. Based on this, the variable of data quality capability has been able to predict 64% of the changes in the quality of the decision.
- According to the route coefficient of 0.98 and also the t-statistic of 6.01, it can be said that the capability of correlation with other systems has a positive and significant relationship with decision quality at the 99% confidence level; therefore, the second sub-hypothesis of the research is significant and confirmed. The value of the multiple determination coefficient (R^2) is equal to 0.98. This coefficient examines the ability to predict the dependent variable by the independent variable. Accordingly, the capability of correlation with other systems together can predict 98% of the changes in the quality of decision making.
- According to the route coefficient of 0.68 and also the t-statistic of 7.60, it can be said that the capability of user

accessibility has a positive and significant relationship with decision quality at the 99% confidence level; therefore, the third sub-hypothesis of the research is significant and confirmed. The value of the multiple determination coefficient (R^2) is equal to 0.46. This coefficient examines the ability to predict the dependent variable by the independent variable. Accordingly, the capability of user accessibility has been able to predict 46% of decision-making quality changes.

- e) According to the route coefficient of 0.83 and also the t-statistic of 8.20, it can be said that the capability of flexibility has a positive and significant relationship with decision quality at the 99% confidence level; therefore, the fourth sub-hypothesis of the research is significant and confirmed. The value of the multiple determination coefficient (R^2) is 0.69. This coefficient examines the ability to predict the dependent variable by the independent variable. Accordingly, the capability of flexibility has been able to predict 69% of the changes in decision quality.
- f) According to the path coefficient of 0.64 and also the t-statistic of 4.31, we can say that risk management support capability has a positive and significant relationship with decision quality at the 99% confidence level; therefore, the fifth sub-hypothesis of the study is significant and confirmed. The value of the multiple determination coefficient (R^2) is equal to 0.41. This coefficient examines the ability to predict the dependent variable by the independent variable. Accordingly, the variable risk management support capability has been able to predict 41% of the changes in decision quality.

B. Suggestions Based on Research Findings

- i. Based on the original research hypothesis that was approved and since the growth and prosperity of the bank requires innovation in decision making, the ability to execute and evaluate decisions, it is recommended to senior executives of the banking system to employ and deploy a smart and robust reporting system to focus on IT issues.
- ii. It can be said that the strong and stable relationship between the data quality of BI systems and the quality of decision making (first sub-hypothesis) makes it possible to recommend senior managers and experts at Mellat Bank to pay attention to the source of data internally or externally, the type of data quantitatively or qualitatively, the credibility of the data and personal perceptions that make use of the BI system. This will improve the quality of decision making in Mellat Bank.
- iii. Given the irrefutable relationship between the ability to interact with other systems in the BI system and the quality of decision making (second sub-hypothesis), it is suggested that the senior managers of the Information and Informatics Department at the banks focus on the ability to interact with other systems in choosing their own BI system.
- iv. According to the results, it is obvious that there is a strong

relationship between the accessibility of the user of the BI system and the quality of the decision making (third sub-hypothesis). Accordingly, it is suggested that relevant managers should have a deeper look at the ease and availability of users of the BI system in order to be more effective in improving the quality of their organization's decisions.

- v. Confirming the establishment of a positive relationship between the flexibility of the BI system and the quality of decision making (fourth sub-hypothesis) and that this capability has the most correlation with the dependent variable among the variables of the present research, it is suggested that in choosing the BI system required by banks, more flexible systems in terms of the ability to submit custom format reports should be more considered.

Given the strong relationship between the capability to support risk management and the quality of decision making (fifth sub-hypothesis), and in light of the new business model at Mellat Bank, which pays great attention to risk management decisions, it is recommended that senior managers at the bank use an IT system that has the ability to calculate and predict the risk of different choices based on existing data.

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