How Business Intelligence Capabilities Contributed Managerial Decision Making Styles

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Abstract—**Business intelligence(BI) as a socio-technical concept emerged to help managers especially in their decision making tasks. Managers with different styles of decision making began to make use of BI in their own ways. However, could managers with different style in decision making take advantage of BI in the same way? Does BI provide each category exactly what it needs? If not, what do different styles expect from BI? How could BI satisfy them? By using a well-known theory in decision making style and considering theories discussed about BI capabilities, this paper proposes a framework that defines appropriate BI capabilities which best fit each of the decision making styles' requirements. Findings show that in order to serve each decision style, BI capabilities change according to style's features. It is believed that by customizing BI based on decision making manner, BI would be much more successful in serving all categories of managers.**

Index Terms—**Business intelligence, decision making, decision making style.**

I. Introduction

By employing analytical tools, Business Intelligence (BI) has been emerged to present complex internal and competitive information to planners and decision makers through combining data gathering, data storage and knowledge management. One of the main duties of BI is to equip managers with actionable information in right time, right location and right form as one of the vital inputs of decision making process [1]. On the other hand, According to Harrison [2] the ability of managers to make decision is the most important aspect of management. Therefore, Since BI could help organizations profitability by enhancing managers' decision power; the organizations began to invest on it with annual growth of 10%. However, only 24% of these investments were successful in recent years [3]. Researchers started to solve the dilemma and a number of studies have recently been carried out on successful implementation. Some of these studies have considered implementation of BI from the organizational viewpoint [2], [4], [5]. However, hardly any of them considered the effect of decision making style as a factor in BI success.

Not only are there differences among organizations, decision makers are shown to display dissimilarities as the same. According to Reardon et al. [6] decision makers act differently while they frame problems, perceive and analyze information, and determine the extent and quality of data to be analyzed. Moreover, they are different in tolerance for ambiguity, interacting with subordinates and paying attention to details [7]. The fact that decision makers have some different needs proves that BI should serve diverse expectations. In other words, while a BI system satisfies needs of a manager, it may fail to meet expectations of another. Studies, which have classified managers based on their decision making manner, are mostly available in field of decision making style [7]- [9].

The aim of present study is to construct a framework which assumes best status of BI capabilities for each of the decision making styles. The models of Hostmann et al. [10] for BI capabilities and Rowe & Mason [7] for decision making styles are used in framework conceptualization.

This research brings together established theories from the decision sciences and information systems areas of research. First, the concept of Business Intelligence Systems and its' capabilities are explained. Then decision making style concept is illustrated. This leads to a discussion of decision making style impact on BI.

II. Business Intelligence Concept

According to Brackett [11] BI is a set of concepts, methods and processes with ability of monitoring business trends, evolving and adapting quickly as situations change, making intelligent business decisions on uncertain judgments and exploration and analysis of unrelated information to provide relevant insights, identify trends and discover opportunities, the aim of which is to help business decision making.

In order to better illustrate the components of BI and their functions in BI, Ranjan [12] suggest a clear picture revealing basic understanding of BI which is shown in Fig. 1.
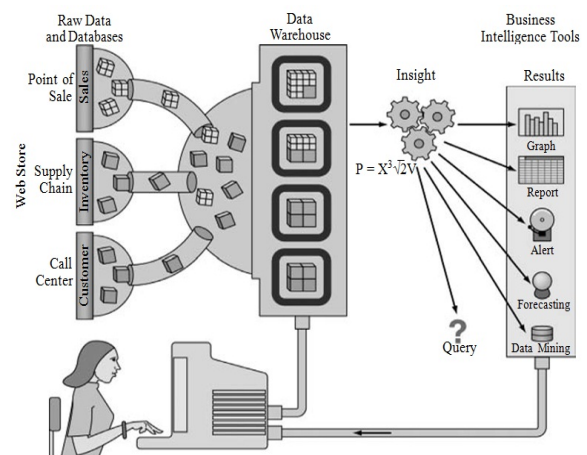

Fig. 1. A basic understanding of BI [12].

The Fig. 1 shows that data can be collected from disparate

sources and transformed, cleansed, loaded and stored in a warehouse. These data can be in various forms, from structured ones such as data extracted from ERP or CRM, to unstructured ones such as images, spreadsheets and business processes [1]. Data is analyzed and retrieved by specific business areas. Figure 1 also reveals BI functions and reports [12].

Academic works which have studied impact of organizational elements on BI are mostly available in BI success literature. However, studies in BI success seem immature and this subject requires more concentration. Among various factors affecting BI success, managerial factors are the ones which rely on organization features rather than BI competencies. McMurchy [13] considered management support as one of the BI success factors. Furthermore Williams & Williams [4] underlined connecting BI with organization strategy, culture and organizational strength to achieve BI profits. Hostman et al. [10] defined four organization environments and showed how BI is used in each of these four worlds. The differences between these environments were subject to two factors: first decision type which was divided into structured and unstructured parts, and second, information access and analysis that contained controlled and open dimensions. Employing Hostman et al. [10] model of BI capabilities, Isik [14] offered a model for BI success based on impacts of BI capabilities and decision environment. In his model, He discussed impacts of level of management and decision types on BI as a moderate factor on influence of BI capabilities on BI success, however, similar to Hostman et al. [10], he only considered impacts of structural features of decision (structured or unstructured) on BI success. Moreover Chasalow [15] proposed a model of organizational and individual competencies for BI success. He not only realized organizational variables in his model, but paid attention to some personal traits such as leadership style which has democratic and autocratic dimensions.

As seen in the literature, the impacts of decision maker style differences on BI have not been discussed.

A. BI Capabilities

Information technology (IT) research has mostly employed IT capabilities to discuss the role of IT in enhancing firm performance [16]. Similarly, studies in BI field manage to use BI capabilities in the same way, although there are not still enough studies in this area. Watson & Wixom [17] paid attention to this concept and called BI capabilities as functionalities of BI, playing a critical role in organization agility. Furthermore, eight important BI capabilities categorized into organizational and technical aspects have been discussed by Hostmann [10]. Since this study employs BI capabilities list proposed by Hostmann et al. [10], each BI specification is defined as below:

1) Data Source: Data source is where data resides and is retrieved for analytical usage which could be either internal or external.
2) Data Type: Data could be either dimensional or non-dimensional and numerical or non-numerical. Dimensional data is structured and subject oriented and non-dimensional data is unstructured. Hostmann et al. [10] refer to dimensional and numerical data as

quantitative and non-dimensional and non-numerical data as qualitative data.
3) Data Reliability: data reliability is dependent on data source whether it is qualified and controlled.
4) Flexibility: Flexibility as a BI capability indicates the amount of interaction a BI system have with variety of data sources and analytical tools.
5) Intuition Involved in Analysis: Analyzing with intuition is based on feelings rather than facts.
6) Interaction with Other Systems: BI interactions with other systems indicate the level of communicability BI has with other parts.
7) Risk Level: risk taker organizations have high tolerance for uncertainty and expect BI to support exploring new opportunities while organizations which are not risk takers have low tolerance for ambiguity and face specific problems.
8) User Access: BI systems could be classified into web-centric systems and specific desktop applications. The difference between these two is based on amount of control and limitations that users have in system access. [10], [17]

III. DECISION MAKING STYLES

According to Driver [18] decision style is a habitual pattern that individuals use in the decision making process. All the individuals start with a default decision style in their carrier while this style could strengthen through frequent success or take replace with a new style by repeated failures [19]. To better illustrate decision style concept, there has been a number of various models proposed by researchers such as McKeeney & Keen [20], Driver et al. [8] and Scott and Bruce [9] to name a few.

McKeeney & Keen [20] carried out a research into decision making process with a regard to variation in decision makers. Their proposed framework combines factors of perceptive or receptive (based on relationships or details) and intuitive or systematic. This leads to a framework with four decision making styles: 1) systematic-perceptive, 2) systematic-receptive, 3) intuitive-perceptive, and 4) intuitive-receptive. Driver et al. [8] focused on the amount of information decision maker use in order to make decision besides the number of alternatives they developed to choose between them. By combining these two factors they introduce a framework with five dimensions: 1) decisive, 2) flexible, 3) integrative, 4) hierarchic, and 5) systematic. Scott and Bruce [9] introduce decision making a habit-based propensity to react in a certain way rather than a personality trait. They identified four decision making styles in their proposed framework including: 1) rational, 2) intuitive, 3) dependent, and 4) avoidant.

Among all frameworks on decision making style, Rowe and Mason [7] framework has managed to shed more light on the information technology subject and to attract more attentions [21], [22].

Rowe and Mason [7] proposed a framework with four decision styles which is shown in Fig 2. Their model considered how individuals (especially managers) take a particular decision based on two main dimensions. The first

dimension is cognitive complexity. Cognitive complexity determines the way individuals make use of various levels of information. In other words, Individuals have this ability to extract a number of dimensions from data or to utilize varied constructs to evaluate information. Consequently, individuals were found to have either a need for structure or a high tolerance for ambiguity. Second dimension is technical aspect of decisions which mostly relates to the accepted degree of contribution of other people (or employee) by leader in decision making process. Moreover, the model considered left-brain or right-brain orientation of individuals. Left hemisphere of brain is mostly devoted to verbal and logical thinking while the other hemisphere is used for emotional and artistic aspects of life. Therefore, according to Rowe and Mason [7], individuals fall into four categories while making decisions: directive, analytical, conceptual, and behavioral. Each of these categories will be illustrated in framework description.
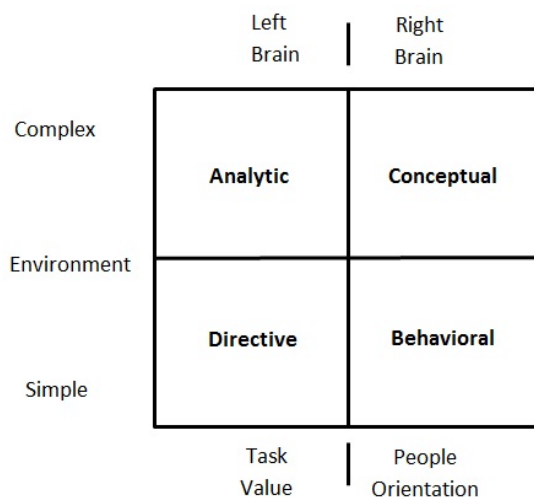

Fig. 2. Decision Style Model [7].

Further studies on Rowe and Mason decision style model showed that senior managers demonstrate higher conceptual style and lower behavioral style in comparison with lower level managers [23]. Moreover female managers received higher scores in behavioral style (according to Rowe and Mason standard decision style inventory) than did male managers [24].

IV. METHODOLOGY

Synthesis Quality methods are one of the well-known techniques in social science. The basic concept of these techniques is to obtain an interpretation by using other articles in a specific area of research.

Meta-ethnography is one of the most popular synthesis methods. This method was first introduced by Noblit & Hare in 1988 and continued to develop in forthcoming years [25]. The aim of meta-ethnography is to form a whole by individual studies as ingredients. However this whole is more than a combination of its part and contains some degree of conceptual innovation [26].

To accomplish this goal Meta-ethnography recommends three main phases: (1) reciprocal translational analysis: the findings of different primary research studies will be translated into each other to generate overarching themes, concepts, or metaphors; (2) refutational synthesis : contradictions and differences that exist between the various studies will be identified and explained; and (3) line-of-argument synthesis: a picture of the whole phenomenon under study from studies of its parts will be developed [27]. Considering these phases, Meta-ethnography encompasses seven steps [25]:

1) Getting started
2) Deciding what is relevant
3) Repeated reading of studies
4) Determining the relationships between the studies
5) Translating the studies into one another
6) Synthesizing the translations
7) Expressing the synthesis

In this paper, Meta-ethnography method was conducted to form a conceptual model considering relationship between Decision making stylistic variables interfering in BI performance and BI. With this goal in mind, all the studies in the field of leadership's styles or decision maker's personal traits impacting BI success or BI performance was collected from multiply data bases. In addition to articles on BI subject, literature on Decision making style and Information System's relation was reviewed. In the next step, four basic research articles were selected and the key concepts identified which were the data for the synthesis. Then, the relation of existing data was determined. Next step was devoted to translating the chosen studies to each other based on the decision factors they considered in their papers. The concepts with different labels describing the same idea were specified and translated. After the reciprocal translation phase, the relations between metaphors (the translated concept) were determined. Finally, the analyzed concepts were synthesized. This leads to formation of the final framework which correlates decision making styles and BI aspects regarding all the previous works on decision styles and BI relation.

V. FRAMEWORK PROPOSITION

While BI tries to satisfy decision maker's needs, there are some differences between decision makers' interests due to their specific decision making style. Therefore this study suggests a conceptual framework that concentrates on BI capabilities according to characteristics of each of the decision making styles.

According to meta-ethnography method the findings of four related studies were analyzed. In synthesizing phase of method process, the Rowe & Mason model was chosen in order to cluster all the previous findings in a comprehensive category. As a part of framework formation, Table I illustrates the logic relation between the organization factors impacting BI in the previous studies and two basic dimensions of selected decision styles model.

The proposed framework applied Hostman et al. [10] BI capabilities as BI dimension of the framework. In fact the eight dimensions discussed as the main aspects of BI contribution in business. On the other hand, Rowe and Mason [7] decision styles including four specific styles are placed on Decision dimension of the framework. The

conceptual frameworks relating these two aspects are depicted in Table II, Table III, Table IV, and Table V.

TABLE I: CLASSIFICATION OF DECISION STYLES' FACTORS

Basic dimensions of decision styles model	Factors Influenced BI identified by literature
Cognitive complexity	Decision process engineering culture (using structured, fact-based, and standard decision process) [4]
	Culture around use of information & analytics (using an analytical framework) [4]
	Cognitive style (Heuristic vs. Analytical) [15]
	Structured or Unstructured decision making process [10]
	Decision Type (Structured or Unstructured) [14]
People orientation	Leadership style (Autocratic, Participative, and Laissez-faire)[15]

TABLE II: BI CAPABILITIES AND DIRECTIVE DECISION STYLE FRAMEWORK

Decision Making Style	BI capability	Status
Directive	Data Source	Internal
	Data Type	Quantitative
	Data Reliability	Individual
	Flexibility	Low
	Intuition Involved in Analysis	Always
	Interaction with	Low
	Risk Level	Low
	User Access	Specific

1) Directive. Individuals with directive style tend to acquire information by sensing and prefer to receive brief reports with limited data verbally. Therefore, in receiving data they rely on individuals. In analyzing information, they use intuition, experience and rules. Pure facts, rules and procedures are kinds of information that are most valued by directive individuals. Internal orientation in organization, high need for security and control, and having structured pattern in decision making are other characteristics of this style.

TABLE III: BI CAPABILITIES AND ANALYTICAL DECISION STYLE FRAMEWORK

Decision Making Style	BI capability	Status
Analytical	Data Source	Internal& external
	Data Type	Quantitative & qualitative
	Data Reliability	System
	Flexibility	High
	Intuition Involved in Analysis	Seldom
	Interaction with	High
	Risk Level	Low
	User Access	Specific

Analytical. Analytical decision makers are known for their careful analyzing of every aspect of the given problem by using large amount of data. As a result, not only are pure facts important for analytical managers, but also they make use of all kind of information from all available sources to make decision. A BI system which has better interaction with other systems and provides a better set of information could be helpful for this style in decision process. Evaluating information in this style is through abstract thinking based on number of data. Therefore, intuition decisions are limited. Innovation in solving problems, focusing on technical decisions, and the need for control are other aspects of this style.

TABLE IV: BI CAPABILITIES AND CONCEPTUAL DECISION STYLE FRAMEWORK

Decision Making Style	BI capability	Status
Conceptual	Data Source	Internal & external
	Data Type	quantitative & qualitative
	Data Reliability	individual
	Flexibility	High
	Intuition Involved in Analysis	Always
	Interaction with	High
	Risk Level	High
	User Access	Web-centric

2) Conceptual. Decision makers with this style prefer to acquire information by using intuition and discussion with others. They are known as creative and people-orientated. While making decisions, they focus on broad aspects of problem and solve it through providing many options by returning to multiple sources. They are known as risk takers and flexible decision makers.

TABLE V: BI CAPABILITIES AND BEHAVIORAL DECISION STYLE FRAMEWORK

Decision Making Style	BI capability	Status
Behavioral	Data Source	Internal
	Data Type	qualitative
	Data Reliability	individual
	Flexibility	High
	Intuition Involved in Analysis	Seldom
	Interaction with	High
	Risk Level	Low
	User Access	Web-centric

3) Behavioral. Focusing on social concerns, supporting and communicating with subordinates, best characterize individuals with this style. In decision making process they receive information by sensing, listening, and interacting with others and analyze by using feelings and instincts. As they have low tolerance for ambiguity, they hardly take risk [7], [28].

VI. CONCLUSION

Bidirectional relation between decision styles' concept and BI capabilities has been discussed in this paper. Despite increasing application of BI in organizational decision

making, it is important to consider the manner of decision maker to fulfill managers' informational needs. There are numerous research articles on success of the BI which consider only technical factors or designs' reasoning of BI. However, BI was designed to meet the user expectations and at the last step, it has to serve the user. Moreover it left for the user to judge on the performance of BI. Therefore, the user of BI plays a critical role in the success of BI. Considering this logic, our contribution is to consider users' needs and expectations in designing of BI systems. The concept of decision making style which was employed in this study is a well-known pattern for categorizing decision makers based on habitual patterns of them in decision making and some of their personal attributes.

Considering presented framework, managers and business specialists could look after the most appropriate BI capabilities while they are applying a BI in their organization. In this way, organizations could implement BI projects more successfully regarding managers' needs in decision making process. We believe that all of BI capabilities are not achievable easily in action, so that would be more helpful if managers specify their decision making styles and concentrate on the style prerequisites base on submitted framework.

The proposed framework is based on a general theory on decision making style; therefore, it could be applied for all types of users besides managers. Rowe provided a standard category (Appendix A) classifying some of professions and positions in the organization based on his decision style model. Consequently, considering proposed framework, BI could be easily applied in any kind of organization and for any type of professions according to their related decision style.

Current study utilized BI capabilities as indicators for BI concept in order to define much more suitable system for any decision styles. However studies on BI concept have not clearly defined all BI capabilities or BI components which best describe this emerging concept. Therefore, this study has had limitations in finding appropriate BI capabilities for all of the decision maker differences in terms of style. As a result, there are still some needs of decision styles that this framework was unable to address them such as relationship between managers and subordinates that we propose to be study in upcoming researches.

The framework presented in this study is one of the few studies focusing on relationship between BI and organizational elements. Therefore, still it needs to be more investigated in order to validate the relationship represented in this primal framework. Moreover, variables of decision style are not limited to above features. There are numbers of other models based on other stylistic traits of managers or individuals which future works on BI could consider. Finally, this study focused on "style" which is only one aspect of decision making process; however decision making is a complex process with diverse elements which has been studied from various viewpoints. As such, there are still some dark points in decision maker characteristics from BI view that could be a subject for future studies.

APPENDIX

APPENDIX A: ROWE'S BASIC STYLE PATTERN

Pattern	Score	Typical of:
Left brain (analytical + directive)	165 or higher	Science, finance, law
Right brain (conceptual + behavioral)	135 or higher	Psychology, teachers, artists
Idea orientation (analytical + conceptual)	170 or higher	Senior executive, leaders
Action orientation (directive + behavioral)	130 or higher	Supervisors, sales people, athletes
Executive (conceptual + directive)	155 or higher	Entrepreneurs, crossover executives
Staff (analytical + behavioral)	145 or higher	Technical managers
Middle management (directive + analytical + conceptual	245 or higher	Flexible management style

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