A THEORETICAL MODEL TO EXPLAIN EFFECTS OF INFORMATION QUALITY AWARENESS ON DECISION MAKING

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Abstract: Making high quality decision is dependent upon the quality of the information that is used to support the decision. In most cases, decision makers are not aware of information quality issues. Decision makers frequently believe the information they use is of high quality, however often the decision relevant information is inaccurate and incomplete. With increasing intensity on decision making, information quality awareness is becoming important. In order to analyse the effects of information quality awareness on decision making, in this paper, we propose a theoretical model to address the relationship between information quality awareness and decision quality. Our results show the effects of information quality awareness on decision making and the importance of building IQ culture in organizations.

1 INTRODUCTION

Information Quality (IQ) is seen as a key factor in the decision making field. Keller and Staelin (1987) proposed a model on how decision effectiveness is affected by IQ and information quantity. In their model, they proposed that while retaining the same quantity of information, increasing IQ results in an increase on decision effectiveness. Considering decision outcomes and decision quality, Baron and Hershey (1988) indicated the importance of high quality information in decision making. They implied that IQ has a direct effect on the decision outcomes and the quality of the decision. Regarding the task complexity in decision making, the research of Chengular-Smith et al. (1999) had shown that including information about the quality of data can impact the decision process. Considering the experience level and time pressure in decision making, Fisher et al. (2003) investigated that experienced decision makers will more seriously consider IQ than inexperienced decision makers do. Their research implied that experts paid much more attention to IQ because they have realized the importance of IQ in decision making. From the IQ management perspective, Shankaranarayan et al. (2003) developed an IQ management framework for dynamic decision environments. They also proposed a virtue business environment (VBE) to address the role of data quality management in VBE. Based on the above literatures, we could observe the importance of IQ in decision making.

IQ is also a key factor in information system, which includes (group) decision support systems. With the recognition of the importance of IQ, recently, information system researchers have addressed the impact of IQ in information system. For instance, Ballou and Pazer (1985) proposed a model to assess the impact of IQ within multi-user information decision systems. Poor quality information would incur the social and economic cost. From an economic perspective, Ballou and Pazer (1987) proposed an IQ cost model to ensure the quality of outputs in information systems. In order to evaluate the success of information systems, DeLone and McLean (1992) consider IQ as one of the key factors to the success of information systems.

Over the last decade IQ concepts were developed. Wang and Strong (1995) developed a framework to address the dimensions of IQ that are important to information consumers. Using ontological concepts, Wand and Wang (1996) defined IQ by the relationship between real world and information systems. Further, Wang et al.

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(1998) proposed to manage your information similar to products. Ballou et al (1998) modelled information manufacturing systems to determine the quality of information products. Following these initial works, researchers and practitioners began to concern with the IQ improvements. Wang (1998) proposed the concept of total data quality management (TDQM). In essence it is a systemic methodology that assists improving IQ in organizations. Following this concept, IQ awareness and IQ culture are frequently mentioned elements in a TDQM oriented organization. Furthermore researchers have proposed various IQ assessment methodologies such as Lee et al (2001), Kahn et al. (2002), Bovee (2003) and Parssian (2004).

In summary, we could observe the following essential aspects in current approaches: (1) IQ influences decision making. (2) IQ is a crucial factor in information systems (3) IQ awareness in organizations is a major objective of IQ improvement. thus IQ awareness is typically positive related to IQ and decision making. However, at present little research has investigated the relationship between IQ awareness and decision making.

Addressing the drawback of current research, the purpose of this paper is to investigate how IQ awareness influences on decision making. In our work, we aim to provide indications on how IQ Awareness contributes to decision making. The remainder of this paper is structured as follows: In section 2, we propose a theoretical model describing the relationship between IQ awareness, IQ and decision quality. For facilitating the model validation and providing an emperical scenario, in Section 3, we outline an experiment and discuss indicators in the experiment. Finally, we conclude our research and summarise implications of the necessity of establishing IQ awareness.

2 THEORETICAL MODEL

In this section, we propose a theoretical model, which is described by three main hypotheses:

(1) IQ and decision quality
(2) IQ and IQ awareness
(3) IQ awareness and decision quality

IQ and decision quality: Many researchers (Keller and Staelin 1987, Baron and Hershey 1988, Chengular-Smith et al. 1999, Fisher et al. 2003, Shankaranarayan et al. 2003) have proposed or implied that higher IQ has a positive impact on decision making. In order to address relationship between IQ and decision making. Jung and Olfman (2005) proposed an experiment to study the effects of contextual IQ and task on decision performance. Ge and Helfert (2006) proposed an experiment to address the relationship between IQ and decision quality. Based on these observations, we propose the following hypotheses:

Hypothesis 1: Decision quality will increase with the increasing of IQ. IQ is positively correlated with Decision quality.

IQ and IQ awareness: Researchers have recognized the importance of IQ awareness in organizations. For example, Huang K.T. et al. (1999: 28) implied that top managers in organizations should possess IQ awareness in the form of visible continuous interest in IQ activities. Redman (2001: 197) stated the importance of advancing IQ awareness for business process. Olson (2002: XV) advocated increasing IQ awareness and include building IQ awareness as one of the goals in his book. Based on above literatures, the following hypothesis is proposed:

Hypothesis 2: The positive effect of IQ will be intensified by the assistance of IQ awareness.

IQ awareness and decision quality: Chengular-Smith (1999) proposed that effective decision makers could compensate for various deficiencies the data may possess, especially if the decision maker is acquainted with the data's idiosyncrasies. That implied decision makers would enhance the positive effect of IQ in decision making by using their IQ awareness. Therefore the following hypothesis is proposed:

Hypothesis 3: IQ Awareness can enhance the decision quality when the decision relevant information is containing quality problems. Decision makers who possess IQ awareness will make higher quality decision than people who do not possess IQ awareness.

Based on the above hypotheses, we propose the following relationship model between IQ, IQ awareness and decision quality.

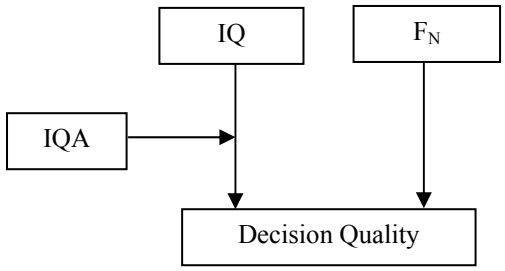

Figure 1: Effect factors on decision quality.

In this relationship model, four elements are described: information quality (IQ), IQ Awareness (IQA), Decision Quality and other influencing factors. IQ has an impact on decision quality meanwhile IQA plays as a moderating factor in intensifying IQ. In addition, besides IQ and IQA, decision quality is also influenced by many other factors such as personal preference, information quantity, task complexity, time pressure, decision maker's experience and so on. In our model we consider the effects of other factors as constant which is represented as F_N in figure 1. The measurements of IQ, IQA and Decision Quality are discussed as follows:

2.1 Information Quality

Many IQ dimensions have been explored over the last decades, such as accuracy, timeliness, relevancy and completeness. (Zmud 1978, Fox et al. 1993, Wand and Wand 1996, Huang K.T. et al. 1999, Olson 2002). Among these dimensions, accuracy is identified as crucial dimension to measure IQ. Olson (2002) proposed the notion of "If the data is just not right, the other dimensions are of little importance". He considered accuracy as a fundamental IQ dimension. Based on the review on IQ dimensions, Huang K.T. et al. (1999) concluded that most IQ studies include accuracy as a key dimension. Therefore, in the preliminary research of our model, we focus on accuracy as one IQ dimension. There is no commonly accepted definition of accuracy in IQ field. For example, from a metadata view, Redman (1996: 255) define accuracy as the nearness of the value to the standard value, from a dataset view Olson (2002: 29) define accuracy as correct data values stored for an object. However, correct value may simply be unknown or an assumed standard may be incorrect [20]. From an ontological view, Ballou and Pazer (1985) define accuracy as the recorded value that is in conformity with the actual value. In order to quantify the accuracy, we combine the dataset view and the ontological view and expressed the accuracy measurement as follows:

$$\text{Accuracy} = \frac{\sum_{k=1}^{n} \text{Accuracy}(d_k)}{n} \quad (1)$$

Where n is the total number of data item d_k. If d_i is the actual value, we calculate accuracy by the following relations:

- $d_k = d_i \Rightarrow \text{Accuracy}(d_k) = 1$
- $d_k <> d_i \Rightarrow \text{Accuracy}(d_k) = 0$

2.2 Decision Quality

Decision quality could be measured by many factors, such as decision accuracy, decision consistency and decision consensus (Nie et al. 1975, Libby and Blashfield 1978, Ashton 1985, Chewning and Harrell 1990). In those decision measurements, Chewning and Harrell (1990) reviewed the decision measurements and proposed that the accuracy of the decisions reached is the primary measure of decision quality. Accordingly, we consider decision accuracy as our decision quality measurement. In this manner, decision quality could be measured by the following equation:

$$\text{Decision quality} = \frac{\sum_{k=1}^{n} \text{Decision}(d_k)}{n} \quad (2)$$

Where d_k is considered as the decision in the decision collection. When the decision is right Decision (d_k) = 1 and when the decision is wrong, Decision (d_k) = 0.

2.3 Information Quality Awareness

Meager et al. (2002) define awareness as "Awareness occurs when an individual is sufficiently informed about a subject for him/her to be conscious of its existence and its broad subject matter". We adopt this definition to our context. IQ awareness occurs when the decision maker is sufficiently informed about IQ for him/her to be conscious of IQ problems. If People possess IQ awareness, he/she will benefit from the IQ awareness to avoid the decision risk when the quality of decision related information is low. People who do *not* possess IQ awareness will ideally trust the information they use even if the information is of low quality. Thus IQ awareness is considered as one of the key factors influencing the decision quality.

In order to measure IQ awareness, we could implement a survey or semi-structured interviews. In the survey, some IQ concepts and cases, which are failed because of IQ problems, are used. By testing the understanding level of IQ concepts and the ability of locating the IQ problems, we could initially distinguish whether testers possess IQ awareness or not.

2.4 Model Formulation

Based on the above discussion, our model is proposed as follows,

$$\text{Decision Quality} = d(IQ^{\alpha}) + f(F_N) \quad (3)$$

Where IQ represents the quality of the provided information. The exponent α is used to express the awareness of IQ. F_N represents other factors influencing the decision quality, such as decision makers' subjective preference or experience. $d(\cdot)$ and $f(\cdot)$ reflect functions that have an impact on decision quality.

Once we only initially consider accuracy as the IQ dimension, equation (3) becomes:

$$\text{Decision Quality} = d\left\{\left[\frac{\sum_{k=1}^{n} \text{Accuracy}(d_k)}{n}\right]^{\alpha}\right\} + f(F_N)$$

In order to facilitate the model validation and estimate function $d(\cdot)$, following we propose an application scenario with several experiment indicators.

3 EXPERIMENT

In our earlier research (Ge and Helfert 2006), we proposed an experiment to address the relationship between IQ and decision quality. Here, we extend this approach and develop an experiment, which is characterised in the following sections.

3.1 Participants

After the IQ awareness survey, we could divide the participants into two groups. One group possess IQ awareness, and the other group do not. In this way, we can compare the decision quality of the two groups and can approximate the IQ awareness function in decision making. Those participants who possess IQ awareness will be referred as Group A, while those participants who do not possess IQ awareness will be referred as Group B. This research focuses on decision quality difference between Group A and Group B. Group A members may use their IQ awareness to complete a subjective IQ assessment whereas Group B members may ignore the IQ problems that are in the decision relevant information.

In order to reduce the effects of other factors, (1) Participants are selected to have the same decision experience on the decision tasks. (2) Constructions (age, male and female proportion, education background, etc.) of the group who possess IQ awareness should be similar as that of the participants who do not possess IQ awareness. (3) Participants will not obtain any IQ hints in the experiment.

3.2 Decision Scenario

The participants are required to complete a number of decisions using the provided information. For instance, the participants are instructed to complete six decision tasks and all six decision tasks are Yes or No questions in relation to investment issues. One decision task could be, "Are we going to invest on this bank project?" The six decision tasks are different in the content but with the same format on investment issues. Participants make their decisions according to available information. The information is limited by providing answers to the following ten questions:

- What sort of investment is this?
- Who is involved in providing it to me?
- How much do I pay?
- What are the charges?
- What returns will I get?
- What are my risks?
- Can the investment be altered?
- How do I cash in my investment?
- Is there anyone to whom I can complain if I have problems with the investment?
- What other information can I obtain?

Besides the above information, a virtual financial setting is provided for the participants. According to the above decision environment, participants will process the provided information and make six investment decisions. In addition, because time pressure decreases decision accuracy [28] and can impair the decision performance [1]. There is no time pressure on the decision making tasks. However communications among participants are forbidden. Finally participants will submit their decisions via our server based software system.

3.3 Decision Complexity

Yes or No decisions questions are employed in the experiment for the following reasons. First the Yes or No questions are the most common. Second, the decision makers will not invest much time on option trade-off. This is also the approach to protect the participants from using their own experiences on the option evaluation. Third, Yes or No questions are easy to measure and friendly to the participants. In order to decrease the effect of other personal factors such as subjective experience and preference, an investment decision scenario is employed because we can choose participants who have principle in the same knowledge level on the investment issues. Consequently, participants will make decision only according to the provided information, and other influence factors are highly decreased. We will use the following table to evaluate the decision from the participants:

Table 1, Decision evaluating specification

Yes- Invest **No** – No investment is done		
Decision / Objective	Yes	No
Yes	Right	Wrong
No	Wrong	Right

In the decision row of table 1, Yes represents decision makers will invest on the project whereas No represents decision makers will not invest on the project. Before we carry out our experiment, we have already identified the best practice answer to each decision task. The best practice decisions are set as the objective column. In the decision part, they are decisions that come from the decision makers. If the decision part conforms to the objective part, it is the right answer. Otherwise it is the wrong answer.

3.4 Information Accuracy

According to the decision tasks, we could use information points to calculate the information accuracy. Information points are the metadata whose status can be changed between accurate and inaccurate. Continuing the example in task section, the information is the answers to the corresponding 10 questions. In each answer, we develop 10 information points to calculate the accuracy. Information point is the word or number in each answer, whose state could be changed between accurate and inaccurate. Thus we could obtain 100 information points in each decision task. Based on Ballou and Pazer's accuracy definition, accuracy in our experiment is defined as the ratio of the correct information points in relation to the provided information points. For instance, when we set 20 accurate information points in the decision task, the information accuracy is 20 percent.

3.5 Limitations

Guarantee on Participants' Encouragement

In order to guarantee all the participants will seriously consider the decision relevant information, we could use an award to encourage the participants. For example, we could use an iPod award to encourage and motivate the participants. Those who made the highest quality decisions will win the iPod award in the end.

Reducing the Human Learning

When participants make decisions on different tasks, they may learn the task scenarios and IQ problems and then use this experience to finish the following tasks. Thus decision makers' experiences will influence decision quality through learning. In order to protect human learning in the experiment, we could develop several decision environments and IQ levels. For example, six decision environments and six IQ levels are developed. Those decision environments are related to IT project investment, Banking project investment, Hotel project investment, Tourism project investment, Education project investment and Healthcare project investment. Six IQ levels are 10%, 20%, 40%, 60%, 80% and 90%. We will provide different decision environments with different IQ levels to each participant. So to a single participant, he/she will experience six different decision environments as well as different IQ levels. In this manner, we could reduce the human learning on decision environments and IQ problems.

4 CONCLUSION

As IQ awareness becomes more and more important, it is increasingly valuable to assess the effects of IQ awareness in the context of decision making. In this paper, we propose three hypotheses which are demonstrating the relationships among IQ, IQ awareness and decision quality. Then we propose a theoretical model to address that relationship. Four variables are shown in the model: IQ, IQ awareness, decision quality and other influencing factors. For

each variable, we propose a measurement methodology. The main contribution of this model is to address the moderating functionality of IQ awareness in the relationship of IQ and decision quality.

Based on the model, we provide an empirical scenario to facilitate the model validation. In the application scenario, we point out several experimental indicators such as human learning, decision issue selection and measurement calculation.

The model in this paper has several possible extensions. First, more IQ dimensions could be included in the IQ measurement. For example, we could include completeness, relevancy, consistency etc.. Second, more decision quality measurements could be taken into consideration, such as decision consistency and decision consensus. Third, more experiment indicators could be included to a more comprehensive and concrete application scenario. For instance, we could develop a concrete finance situation for each decision maker or increase the task complexity of the decision environments. Overall future work of this research is improving the theoretical model and building a comprehensive empirical scenario.

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