A Visual Measurement of Decision Consensus -An Idea Derived from GAE

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ABSTRACT

It is widely known that the knowledge era has arrived that is changing our work and life styles. New network technology provides us valuable ways to solve the difficult and ambiguous problems. Design In GSS pattern, GAE integrates the frameworks of HWMSE and knowledge creating model to facilitate idea generation process, and it is regarded as a convergent process—idea generation which is the first step of MSA (meta-synthesis system approach) to complex problem solving. To enlarge the use of GAE, the evaluation values of experts' keywords are added to illustrate both arguments and evaluation values on three-dimension snapshots, and based on the three-dimension snapshot, a two-dimension focuses snapshot is proposed to facilitate the decision process by focusing the discussing on the differences of the opinions, which may enhance the efficiency and effectiveness of decision. A measurement of decision consensus derived from GAE is also provided. At last, system realization will be expected later.

Keywords: GAE, Decision Consensus, visualization

1. INTRODUCTION

1.1 Decision Consensus

It is widely known that the knowledge era has arrived that is changing our work and life styles. Employees have become knowledge workers, and companies have become learning organizations. Most of our outdated understandings about the world should be reconsidered for keeping pace with the new Information Age. While, although there are lots of potential chances in new industries, new technologies, and all kinds of other new issues related to this era, the pressure for exploiting the crucial information and knowledge has emerged to be much more serious than it was, And it is more difficult to make the valid and qualified strategic decisions due to more complex and ambiguous issues related to the interior and exterior of the organizations. So, how to make a good decision to achieve high performances means a lot to the whole organizations' future.

What makes a good decision? As Amason argued, decision quality, consensus, and affective acceptance are, together, all necessary for sustainable high organization performance[1]. Consensus among decision-makers is important for senior managers and officials to obtain consistent understandings about the vital aspects of the organizational problems, it can not only facilitate the decision processes by focusing decision-makers' attentions on the vital issues of the organizations, but also can improve the later implementation of those decisions. Without implementation of decisions, high-quality decisions mean little[1], and without participation of these decision-makers with all their hearts during the implementation, the decisions may not result in high performance. So, the senior managers must both understand and commit to the decision thoroughly if the decision is to be implemented effectively[2][3]. Obviously, Consensus is not only simply

"all hands up" –a procedural process, furthermore, it must contain psychological processes that including consistency in the understanding of the problems and commitment during implementation.

Many methods and tools for reaching consensus are widely used to facilitate decision processes in dealing with unstructured or semi-structured problems. Gu[4] discussed the concept of the consensus, and supplied some useful tools to reach consensus during the decision processes, such as AHP, brainstorming, rough set theory(see Gu,2001 for detail). With the development of computer network, it is possible to solve the complex and ambiguous problems by computer-mediated systems. Compared with the traditional Face-to-Face context, computerized support system has been popular for its special characters, such as anonymity, parallel communication, separation etc. In GSS research[5][6], the visual character of GSS is becoming a necessary component for interactive computer-based systems, which can further enhance the decision-makers' understanding and decision quality. Some scholars begin to make use of this character to illustrate the graphic relations of the decision-makers' opinions and the consensus of dynamic decision processes, and GAE[7][8][9] (Group Argumentation Environment) is one of the good examples. This paper will introduce the advantages of GAE, and intend to improve the extension of GAE from idea-generation to problem-solving process.

1.2 Introduction of GAE

GAE developed by Chinese Academy of Sciences is a computerized support system for group interaction for idea generation, which is designed according to the frameworks of Hall for Workshop of meta-synthetic Engineering (HWMSE) proposed by Chinese system scientist Qian Xuesen (Tsien Hsueshen) and Nonaka's knowledge creating model to explore how to effectively facilitate knowledge creating process using computerized supports[7][10].

1.2.1 Two Cognitive Processes Derived from GAE

In Face-to-Face decision context, the relations among participants' views are often ambiguous and entangled. But designed in GSS pattern, GAE focuses on group thinking activities and presents the experts dynamic visual snapshots that illustrate explicitly the convergent and divergent relations among these experts' views. By clustering the experts' views in a two-dimension snapshot, there may be two cognitive processes. First, experts can know the consistency of the views generated, i.e. the affinity among the views, and then experts can know who are in common. These participants whose views are similar may continue to enhance these keywords in close fields, which is manifested by enlarging one of the keywords' clusters during the decision process[8]. Second, the divergence of the views' clusters may also inspire the participants to conceive of the different research areas and generate more new ideas or keywords, which is the most advanced function of GAE that orients to maintain participants' interactions and facilitates the divergent thinking processes. The more different of these views, the more new and hidden ideas related to the complex problem may come out.

GAE provides a good connection between the arguments and snapshots. It illustrates the views in common and personal panels separately, so the participants can not only find out how common of their views, but also can easily understand how the views owners explain them and the relationships between each participant's mental processes. In this way, it may help the participants to get consistent understandings after they brainstorm, and then may positively affect the implementation of outcomes.

1.2.2 Orientation of GAE

In fields of decision-making, tasks can be divided into

idea generation task and problem solving task, and idea generation task can be considered as the first step of problem solving task. Tang and Liu also argued that the GAE has been explored to support qualitative meta-synthesis, and it is regarded as a convergent process—idea generation which is the first step of MSA (meta-synthesis system approach) to complex problem solving[8]. Problem solving tasks need convergence to form a consistent understanding and commitment to implementation of the decision outcomes. One example of problem solving approach recommended In ullman's book "12 Steps to Robust Decisions: Building Consensus in Product Development and Business" includes a summary of components as following: group training, process documentation, information source identification, problem identification & clarification, development, alternatives evaluation in terms of criteria, and preferred alternative selection[11]. Idea generation task may include all the components except the alternatives evaluation and preferred alternative selection, so adding the evaluation values of these participants in terms of criteria is a way to further GAE.

In conclusion, GAE has many advantages for improving the consensus in problem solving processes, such as brainstorming, visualization, and information intelligence. We just do some augments to enlarge its functions of group decision support.

2. DECISION CONSENSUS MEASUREMENT IN PROBLEM SOLVING

2.1 Consensus in Decision Process of Problem Solving

In the process of problem solving, Experts will not only provide the facets which they care about, but also show how they evaluate these facets respectively and individually, i.e. the consensus of problem solving process should contain both keywords and the evaluation of these keywords.

According to HWMSE approach proposed by Prof. Qian et al[12], experts' opinions should be synthesized in GAE to get a consensus. But it is often the case that experts focus on their own fields and experience and their evaluation values are quite different, so as discussed above, consensus should be aimed at the full understandings of the problems and other's opinions, i.e. experts should not merely concentrate on their own focuses ignoring other's arguments.

2.2 Framework of Measurement and New Way to Visual Arguments Snapshots

Based on GAE, we add the numerical evaluation of experts' arguments on their focuses, and expand the two-dimension snapshots to three-dimension to illustrate their focuses and these evaluation numbers.

2.2.1 Evaluation input of experts' keywords

Like GAE, the information inputted into the systems includes viewpoints and the keywords filtered out from the arguments. Each utterance has several keywords that are selected by the expert himself, and we design for the experts to input their evaluation values of these keywords that can stand for their meanings of the utterances on a seven-point scale. The question for the evaluation may be "how do you think about your keywords' effects to the problem solving" or "how important do you think about the keywords for the problem solving". Figure 1 shows a simple example of the interactive area for input.

After submitting the evaluation values, there are three components of the experts' arguments: utterances, keywords and evaluation values. To visualize the important information inputted, the dual scaling method [13] is still important for synthesize the relations. Tang and Liu discussed the principle and its use of this method. We propose to use this multi-variant statistical

method to deal with the utterances and keywords, which is similar with the work of GAE.

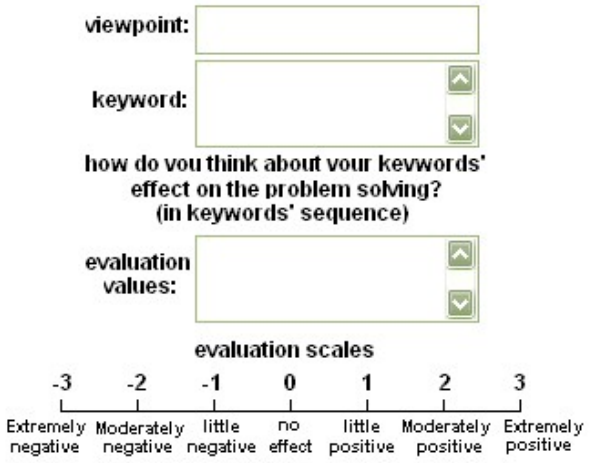

Fig. 1 Interactive area for input

2.2.2 New Two-dimension Snapshot from an example

Dual scaling provides the principal components for given relations between the given *n* utterance-objects and *m* keyword-objects which construct a *n*×*m* matrix. The math underlying dual scaling is based on calculations of eigenvectors and eigenvalues of the utterance-keyword frequency matrix. In GAE, Tang and Liu just selected the maximal and the second maximal eigenvector and eigenvalue as the new coordinates to rotate the original coordinates and to cover most of the data traits and relations[13].

Then the two-dimension snapshots as Figure 2 were illustrated according to the new coordinates, and it is a dynamic process as the frequency matrix is always changing[8].

As we have added the evaluation values of keywords for problem solving, we then provide a new simple product investment example to explain the three-dimension snapshots. Example: in a company's investment decision, the decision-makers who are usually senior managers may argue utterances including the competitive environment, former operational state, new technology and its future, old technology and market, intends of the board, amount of expected investment, expected increase of market share, and the probability of success.

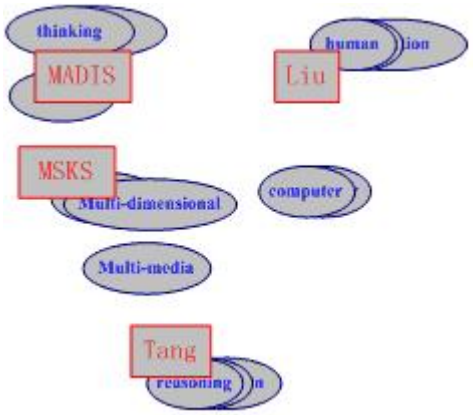

Fig. 2 The snapshots of the common viewer of GAE[8]

After the brainstorming stage, the two-dimension snapshot may be figure 3 below. Brainstorming stage may be limited, because too many focuses may be harmful for decision efficiency.

Fig. 3 The new two-dimension snapshots

2.2.3 The Three-dimension Snapshot

Then the participants have the focuses that they think are important for problem solving. But there are also some keywords one did not put forward. For example, Bai may consider operational state, expected invest amount, and expected share during the brainstorming stage, but he did not consider the other keywords like market and success probability. So he may reconsider his focuses and the other aspects of problem by reading other participants' arguments, and give the arguments and evaluation values to revise his opinions. Figure 4 is the three-dimension snapshot during the whole discussion process including evaluation values.

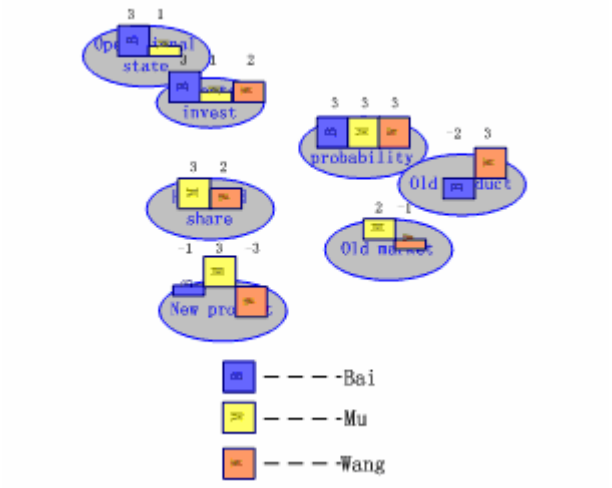

Fig. 4 The three-dimension snapshot

According to GAE, we propose that when moving mouse to the rectangular, all utterances of the focused participant will be displayed.

2.2.4 The Two-dimension Focuses Snapshot

Based on the three-dimension snapshots, the conflict focuses should be found out to remind the participants that there may be seriously conflicting opinions about the problem, so a two-dimension focuses snapshot should be presented to facilitate the decision process by focusing the discussing on the differences of the opinions, which may enhance the efficiency and effectiveness of decision.

Fig. 5 The two-dimension focuses snapshot

In figure 5, the red represent significant conflict on these focuses; the pink represent moderate conflict, and the gray represent no significant conflict. In the example, the principles used to separate the different colors are:

(1) If the evaluation values have reverse symbols, we mark the keyword ellipse red, for there must be someone choosing positive effect and another choosing negative effect, which shows essentially different in opinions.

(2) If no reverse symbols exist, the mediate values selected for separating the colors are:

$$\text{color}_i = \begin{cases} red & \sigma_i > \sqrt{14}/3 \\ pink & \sqrt{6}/3 < \sigma_i \le \sqrt{14}/3 \\ gray & \sigma_i \le \sqrt{6}/3 \end{cases}$$

Note: σ_i is the standard variation of the evaluation values of keyword$_i$. And the values $\sqrt{14}/3$ and $\sqrt{6}/3$ is selected for the simple example.

2.2.5 Visual Measurement of Example's consensus

Based on the three-dimension snapshot, we can get all the focuses with x-y coordinates from dual scaling method and z coordinate from evaluation values and a point set A={ $a_1^1,...a_1^k, a_2^1,...a_2^k,.....a_m^1,...a_m^k$ }. k

represents the number of the participant, m represents the number of the focuses. There is a point x that the sum of distances between x and a_i^j (i=1,…,m, j=1,…,k) has a minimum value q. We call x consensus point. We use q to measure the consensus of snapshot. For the same problem, the smaller q represents higher consensus of the decision-making.

In our example, there are 21 points $\{a_1^1,...a_1^3,a_2^1,...a_2^3,.....a_7^1,...a_7^3\}$, and we simplify them to $\{a_1,.....a_{21}\}$($a_h = a_i^j,\ h=(i-1)\times 3+j$). The optimal solution x^* of $\underset{x\in R^3}{Min}\sum_{i=1}^{21}\|x-a_i\|$ is the consensus point. Therefore, decision consensus can be measured by $q=\sum_{i=1}^{21}\|x^*-a_i\|$.

3. CONCLUSION AND REMARK

GAE presents a visual environment for knowledge exchanging and idea generation during the problem solving process. In this paper, we rely on GAE to give an example of a new two-dimension common viewer's snapshot, and based on it we extend the snapshot further to increase the evaluation values of the participants on keywords. A three-dimension snapshot including keywords, participants, and evaluation values and a two-dimension focuses snapshot emphasizing the conflict focuses were provided to facilitate the problem solving process.

GAE is an argument environment to support divergent thinking instead of convergent thinking, and debate is not supported by GAE. How to detect conflict from 2D space map from GAE is even an issue by GAE developers. This paper wishes to provide a new way to make use of the visual character of GAE to problem solving, and the 3D snapshot and the conflict focuses snapshot may help the participants to concentrate attentions on the most important issues about the problem, and by discussing the most conflict issues, we hope that the consensus of the participants' understanding may be much higher to provide team members a common direction [1]. So this paper is attempt to change GAE from supporting divergent thinking to convergent thinking.

While based on the visual three-dimension snapshot, we supply a measurement of consensus, which indicates the extent of divergence on keywords. The measurement value of consensus may prevent some process loss during the discussion. For example, for the same problem, if the level of consensus reaches very high at the beginning of the process, there may exist groupthink[14] that may be very harmful for decision process and decision outcomes.

In this paper, we just give a simple example for explanation our ideas derived from GAE, but in real life, more people will participate the discussions, and may provide more keywords. Therefore, further studies should be focused on how to illustrate more keywords in one snapshot compactly and transparently, and the measurement should maintain more parameters. The snapshots we proposed to improve GAE's 2D snapshots have not been realized by now, so system realization will be expected later.

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