A Scenario-Based System Approach for Idea Discovery in Market Innovation

Hao Wang and Yukio Ohsawa

Abstract. Chance Discovery, initiated by Ohsawa in 2000, focuses on detecting rare but important events or situation for decision making in complex real world, which has attracted wide attentions and is extensively applied in many research areas, especially in business arena. In this paper, we propose a scenario-based system approach for idea creation, integration and evaluation, as an extension of Chance Discovery. There are two key components in the approach: (1) IdeaGraph, an algorithm to discover more latent information for human insights; (2) Market Innovation Storming (MIS), a scenario-based creativity support technique for actionable ideas generation. We have realized this system approach in a Web-based collaborative creativity support system named iChance where enterprises can make collaborative innovation with their customers. A case study has validated the effectiveness of proposed approach and system.

1 INTRODUCTION

Chance discovery is a human-computer interaction process to detect rare but important chances for decision making. A chance is defined as an infrequent but significant event or situation which strongly impacts on human decision making. In the past few years, chance discovery has attracted wide attention and been extensively applied in many research areas, especially in business arena [2].

KeyGraph [3] is as a vital tool to generate scenario map for aiding human value cognition in the process of chance discovery. Some companies have developed new products with the help of Keygraph, and succeeded in the market [4]. However, a new problem in chance discovery is realized that KeyGraph failed to visualize a latent structure behind observation. Therefore, Ohsawa proposed a method of data crystallization where dummy nodes corresponding to unobservable events are inserted into the target data, and then are visualized by KeyGraph [5]. Maeno and Ohsawa subsequently presented a new method named human-computer interactive annealing for revealing latent structures and discovering dark events [6]. This method has been used to design new products in a real company, and the result illustrates its effect for industrial decision making [7].

In order to further improve human understanding of KeyGraph scenario graph, Innovators’ Market Game (IMG) and Innovators’ Marketplace are invented as a tool of chance discovery [8, 15]. IMG is a kind of table game and has been successfully held separately in the special section of international symposium in China and international workshop in the USA [9, 10]. Due to the limitations of IMG, a customer-centric creativity support technique named 4W-IMG is designed and has been implemented in a Web-based creativity support system iChance regular version [10-12].

Many creativity techniques have been developed to support creative thinking, such as brainstorming, morphological analysis, checklists and mapping process, and have also been classified some ways, such as divergent thinking and convergent thinking, individual creativity and group creativity, analytical techniques and intuitive techniques. At present, interests have increasingly focused on computer support for creative problem solving [17]. Moreover, research has shown brainstorming and other creativity techniques supported by a computer system are more effective [18]. Many computer systems have integrated various creativity support techniques for creative individuals who work in isolation, but group interaction and collaboration is more critical [19]. With the rapid development of Internet technology, individuals can access to the Web 2.0 applications easily to get together, share ideas, spread and share their knowledge in various ways [20].

Although previously mentioned research has achieved good performance, there are still two problems to be settled:

1. The KeyGraph algorithm is originally designed for extracting keywords in a document. Thus, scenario graph generated from Keygraph is machine-oriented so that sometimes it is hard for users to understand and interpret. Moreover, KeyGraph fails to capture more rare and significant event points and especially event relationships.

2. Enterprises are eager for an efficient creativity support technique to generate more actionable ideas since fewer ideas are eventually accepted by enterprises to further invest in.

Therefore, we propose a scenario-based computational systematic approach for high-quality ideas cultivation, construction and generation through human-computer and human-human interaction. Figure 1 shows a research framework of idea discovery as an extension of chance discovery. In this approach, latent information and structure can be shown in a scenario graph generated by IdeaGraph algorithm introduced in Section 2. In Section 3, we introduce a creativity support technique where designers and technical experts in enterprises, collaborating with their customers, obtain valuable insights from IdeaGraph scenario graph, and creative and actionable ideas are obtained finally. In Section 4, we implement this system approach in a Web-based creativity support system called iChance. Section 5 presents a case study to validate the effectiveness of proposed approach and system. The conclusion is summarized in Section 6.
2 IDEAGRAPH: A NOVEL ALGORITHM FOR ELICITING MORE HUMAN INSIGUTS

KeyGraph algorithm is originally designed for extracting keywords in a document. Thus scenario graph generated by KeyGraph is a machine-oriented graph so that Keygraph scenario graph sometimes is hard for users to understand and interpret because of its complexity and inadequate information. In this section, we introduce a human-oriented algorithm called IdeaGraph which can generate a rich scenario graph for users’ comprehension, interpretation and innovation. IdeaGraph not only works on discovering more rare and significant chance events, but also focuses on uncovering latent relationship among them. Suppose that data has been preprocessed into $D'$

$$D' = \text{item 1, item 2, item 3, item 4}$$
$$\text{item 2, item 7, item 5}$$
$$\text{item 3, item 6, item 9, item 10, item 5}$$

Figure 2 shows a scenario map creation process by IdeaGraph and the algorithm is presented as below:

**Step 1: Generating general clusters.** The relationship between two items is measured by their conditional probability. That is, the relationship of any two items, $I_i$ and $I_j$, is calculated by Eq. (1). And then the pairs whose $R(x, y)$ are greater than preset threshold $\tau$ are linked by line in the graph $G$. Finally, general clusters are obtained and denoted by $C_i$.

$$R(I_i, I_j) = P(I_j|I_i) + P(I_i|I_j)$$

**Step 2: Obtaining cognitive clusters.** Cognitive Cluster is defined that a cluster embraces rich information but should be small enough for human cognition and interpretation. To obtain cognitive cluster, two indicators, information and information density, are employed to quantify general clusters generated in Step 1. The definition of information is the sum of $R(I_i, I_j)$ of all the edges in a general cluster. The information density is defined that the information of a cluster is divided by the number of items in the cluster. That is, the information density of a cluster is the information of each item in this cluster. Thus the equations of information and information density are

$$Info(C) = \sum_{I_i, I_j \in C} R(I_i, I_j)$$

$$InfoD(C) = \frac{Info(C)}{Ne}$$

where $I_i$ or $I_j$ is an item of a cluster $C$ and $N_e$ indicates the number of items in the cluster $C$.

Therefore, each general cluster is measured by the harmonic average of these two indicators. Eq. (4) is derived from merging Eq. (2) and Eq. (3). Finally, the value of each general cluster is measured by the harmonic average of these two indicators, see Eq. (6).

$$ClusterVal(C) = 2Info(C)/(N_e + 1)$$

Eq. (4) indicates it favors the cluster which has fewer items when two general clusters have the same information. Therefore, all general clusters are ranked by their $ClusterVal(C)$ in a descending order and parts of them are chosen as cognitive clusters denoted by $CC$ through picking up top $N_c$ clusters.

**Step 3: Capturing valuable links.** Calculate the relationship between each item and each cognitive cluster by Eq. (5)

$$PR(I_i, CC) = \sum_{c_k \in CC} R(I_i, c_k)$$

Item-cluster pairs are sorted and top $N_1$ pairs are selected to be linked by red dot line. New items are added if they are not in the graph $G$.

**Step 4: Extracting key items.** A key item is the item which has strong relationship with all other cognitive clusters and newly added items in Step 3. It is calculated by Eq. (6)

$$Key(I) = \sum_{I_i, I_k \in G} PR(I, CC) + \sum_{c_k \in CC, I_k \in G} R(I, I_k)$$

All items are sorted by their $Key(I)$ and top $N_k$ items are taken as key items which are shown if they don’t exist in the graph $G$.

3 MARKET INNOVSTION STORMING: AN EVOLUTION OF CREATIVEITY SUPPORT TECHIQUE

Many relevant techniques have been proposed to foster creativity of individuals or groups, such as brainstorming, mind mapping, morphological analysis, patent mapping, IMG and 4W-IMG etc.
These technologies for innovation employ different scenario graph, different interactive rule, different role-centric playing or idea source, but the same interactive pattern is found that new product ideas emerge through cooperation and communication between firms and their customers. In other words, new value is co-created by interaction between designers and customers see Fig. 3(a).

![Value Co-creation](image)

(a) Current Model  (b) Tri-circle innovation model

Figure 3. Value synthesis and co-creation model

### 3.1 Tri-circle innovation model

Research has defined some stages as the “fuzzy-front-end” of the product innovation process before a new product is decided to develop, even though firms have their own product innovation processes [13]. Several studies have shown that product innovation activities conducted at the fuzzy-front-end of product innovation process identify successful and unsuccessful new products based on the most important factors [14, 15]. However, it’s widely recognized for firms that fewer ideas are eventually accepted to invest in, when technical experts further evaluate these ideas which are generated by these innovation technologies. Therefore, how to build an effective breakthrough method for more accepted ideas generation remains to be settled.

As Figure 3(b) shows a tri-circle innovation model is developed. The design of accepted idea is considered as the sum of the triple bottom line of customer, designer, and technical expert.

### 3.2 Market Innovation Storming

Based on tri-circle innovation model, a new method of market innovation storming (MIS) is designed for generating more accepted ideas, obtaining clear voice of customers and design ideas of designers, accelerating the innovation process.

The Roles

Market innovation storming is also a customer-centric innovation process where technical expert as a new role is added.

- **Customer.** Propose potential demands or complaints.
- **Designer.** Create innovative ideas.
- **Technical Expert.** Verify ideas from designers, such as the realizability, cost, development cycle, etc, and point out valuable information from customers to designers.
- **Facilitator.** Manage and control the whole of innovation process.

### 3.3 Creativity Support Methodology

We show the interactive process of market innovation storming among customers, designers and technical experts.

Step 1: Make sure of objective, collect relevant data and make scenario graph at last. Facilitator prepares to set up MIS.

Step 2: Based scenario graph, customers propose new demands or complaints which should be recorded by 4W-Demand format. Here demands or complaints are divided into internal and external ones. If proposed demands or complaints are related to scenario graph, they are regarded as internal demands or complaints; on the contrary, they are external demands or complaints.

Step 3: Technical experts recommend useful complaints or potential demands although all requirements and complaints are sent to designers. In Fig. 5, labeled complaints and demands means they are strongly recommended to designers.

Step 4: Based on scenario graph and customer demands or complaints, designers create new idea (solution or strategy) by H-W idea format presented in 4W-IMG. Similar to demands or complaints, ideas also have two prosperities: internal and external. If an idea is generated due to scenario graph, it is an internal idea. Otherwise, it is external idea. If possible, designers make the design sketching for clearly expressing their ideas.

Step 5: Technical experts validate each idea from designers. If an idea is considered valuable and practical, technical experts will further give technical information on this idea, such as technical implementation, development cycle, cost, etc. Validated ideas will be suggested to customers.

Step 6: Customers and designers communicate and interact with each other about their demands/complaints or innovative ideas. Customers will score their favorite ideas, and designers will mark useful complaints and demands for their new ideas generation.

Step 7: Repeat Step 2 to 5.

### 3.4 The Evaluation of Roles

The evaluation method is designed to encourage customers to propose as more demands as possible, and to trigger inventors to create more high quality ideas. The customer who achieves the most number of product certificates will win in all of the customers. The designer who creates the most high quality ideas will win in all of the inventors.

**Customer:** The evaluation of each customer is to use Eq. (7) to calculate the total number of product certificates each customer obtains from designers.
where \( m_i \) means the number of product certificates the \( i \)th customer obtains.

**Designer.** The performance of each designer is assessed by Eq. (8), which evaluates the quality of ideas that each designer creates.

\[
\text{IdeaValue} = \frac{T_i}{n_i}
\]

where \( T_i \) indicates the total number of virtual money the \( i \)th designer earns; \( n_i \) is the number of ideas the \( i \)th designer creates.

4 **ICHANCE: A CREATIVITY SUPPORT SYSTEM FOR COLLECTIVE INTELLIGENCE**

4.1 **System Overview**

The approach of IdeaGraph and MIS has been integrated in a Web-based creativity support system called iChance. Compared with regular version in [10-12], iChance business version provides more powerful functions for better user interaction and experience. The layout of the interface in these two versions is nearly similar. As shown in Fig. 6, there are four modules:

- Scenario graph module. It provides users to make insights and cognition. Users can obtain useful basic information, publish their views and evaluate each other’s comments.
- Knowledge management module. Ideas and demands as important knowledge are managed in this module. Besides, a ranking function is provided to users to check.
- Communication module. Users can communicate each other by using different font, color or size.
- Toolbar. Some function buttons are in this module for users to operate.

4.2 **The operation and interaction of roles**

The following contents will explain how they operate and interact with each other on iChance Web platform.

**Facilitator**

The facilitator should configure necessary information in iChance before they start a MIS for a creativity activity, see Figure 5. First, they should register users’ basic information, set username and password for each user to log in system and group them into different role. Second, they need to fill up necessary information about project (project name and project content), and upload scenario map into the system. Finally, they choose users to join in MIS through dragging a user item from user list into selected user list.

**Customer**

Customers make value cognition to scenario map and proposes their potential demands/complaints. They click the button ‘Add Demand/Complaint’ in toolbar module and a dialog box is popped up, see Figure 6. Customers firstly should determine whether they will propose a demand or complaint, and then fill up 4W demands or complaints. Secondly, they should make sure if the demand or complaint is internal or external, and internal demand will be shown on the scenario map. Finally, a demand/complaint icon will be created and appear on the map and Customers then drag the demand/complaint icon to an appropriate place of the scenario map.

**Designer**

Designers make value creation according to Customers’ demands/complaints and scenario map, and creative ideas are created finally. Designers click the button ‘Add Idea’ in the toolbar and an idea information box is popped up, see Figure 7. Then they fill their idea information up in the box with the format of how and why. They also need to indicate the idea is either internal or external. Most importantly, Designers ought to upload design sketching for better describing their ideas. All ideas are shown in the idea list of idea/demand management and evaluation module.

**Technical Expert**

Technical Experts take charge of verifying the realizability and effectiveness of creative ideas from designers. That is, technical experts will confirm if current existing technologies can shape designers’ ideas into business. Once an idea is proved, technical expert will further provide necessary technical information, such as development circle, costs, and relevant technologies, see Figure 8. In addition, technical experts also recommend useful complaints or potential demands to Designers.
5 CASE STUDY

We have successfully carried out a project in a famous auto company. The objective of the project is to explore Chinese users’ preference on human-machine interface (HMI) system for further development. We provide Idea Discovery system approach as a complete innovation solution to help the company discover potential business opportunities. There are two sections to support the company’s innovation:

(1) Group Brainstorming. Thirty-one members of the company participate in discussion with brainstorming method. The topic of discussion is focused on creating new ideas on product functions for MMI further development. The discussion went on for one hour. We obtained twelve ideas and some of these ideas cover and repeat each other. These ideas are summarized into 4 ideas at last. We find these new product ideas are fuzzy and still need to further explore their details. However, we consider that 4 of 12 ideas are accepted since summarized ideas are very useful information data. The acceptance rate of ideas is 33.3 percent.

(2) iChance Creativity Support. Firstly, according to the project objective, we selected relevant data - 96 questionnaires from market investigation. The data is preprocessed into 650 basket data sets where each item represents a specific function of HMI. We also obtained valuable data from group brainstorming and finally collected 733 basket sets and visualize them into an IdeaGraph scenario graph, see Figure 9. Secondly, IdeaGraph scenario map is employed by iChance for company making collaborative innovation with their customers on the Web. Five customers are invited to join in iChance, and one Facilitator, two groups of Experts, two groups of Designers from the company participate in iChance as well. This section lasted for one and a half hour. iChance introduction for thirty minutes and iChance creativity for one hour.

In the end, 9 of 10 product ideas are accepted and used by the company for further development. The acceptance rate of ideas is up to 90 percent. Moreover, these product ideas are very clear and beneficial for further development.

Figure 10 shows a comparison of group brainstorming and iChance creativity support. It indicates iChance creativity support has more high-quality ideas accepted by the company, and achieves much higher acceptance rate, although the total number of created ideas is a bit fewer than group brainstorming.

In addition, the following dynamic discovery helped the enterprise discovering additional creative ideas regarded as potential business opportunities and timely develop their new strategies to respond ever-changing customer demands and market opportunities.
6 CONCLUSION

Although many studies on innovation have paid more attention to customer knowledge, fewer effective ideas are decided to invest in by firms. Most innovation methods follow a general pattern: set a topic or a fixed scenario graph, and then generate creative ideas through some innovation activities. However, real world data-driven innovation technologies are regarded as the best practice for firms. According to the practical problems enterprises encounter, select necessary data and then make scenario graph by analysing the data. At last, generate creative ideas are emerging through make insights to scenario in a game-like environment.

In this paper, we propose a scenario-based systematic approach which is a dynamic process for idea cultivation, construction and generation through human-computer and human-human interaction. iChance, a Web-based collaborative creativity support system has integrated IdeaGraph scenario graph and MIS creativity support technique to provide an online platform where enterprises can make collaborative innovation with their customers. A case study has validated the effect of Idea Discovery.

This research contributes new knowledge in such fields as creativity support system, decision support system, chance discovery, knowledge discovery, data mining, data synthesis and visualization, knowledge acquisition and management, etc.

ACKNOWLEDGEMENTS

The author was supported through the Global COE Program “Global Center of Excellence for Mechanical Systems Innovation,” by the Ministry of Education, Culture, Sport, Science and Technology, Japan.

REFERENCES