Evaluation Framework for Crowdsourced Design Concept Management

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ABSTRACT

Crowdsourced design concepts are reported to be more creative than internal ideas and the cost of idea sourcing from the crowds is less expensive than from the conventional sources. However, the crowdsourced design has not been well utilized especially for complex engineering systems. One of the reasons is that the crowdsourced data, information, and knowledge are not well managed and evaluated to generate the expected quality and feasibility. The aim of this paper is to present an evaluation framework for crowdsourced design concept management and to couple ideas and solutions with the purposes or objectives of new product development, more efficiently. In the paper, features and characteristics of crowdsourcing new product development are discussed, and formal measures are proposed. An illustrative example is presented to describe how the evaluation framework can be used in crowdsourcing design.

1. INTRODUCTION

Crowdsourcing is an emerging opportunity to gather design concepts and solutions from customers in Web 2.0 technology era. Existing research works show that crowdsourced ideas and solutions are often more creative than internal ideas and the cost of idea sourcing from the crowds is less expensive than from the conventional sources, such as specific customer groups or expert surveys and interviews. In order to apply crowdsourcing technologies to the new product development (NPD), many crowdsourcing environment and services are provided such as quirky.com, openIDEO, and jovoto.com. Although the aforementioned benefits are expected, the crowdsourced design has not been well utilized, especially for complex engineering systems. One of the reasons is that the crowdsourced data, information, and knowledge are not well managed and often cause non-guaranteed quality and the different level of feasibility. These gaps should be balanced by providing formal measures that can apply for decision making in design.

The aim of this paper is to present an evaluation framework for crowdsourced design concept management and to couple ideas and solutions with the purposes or objectives of NPD, more efficiently. In this article, we introduce metrics that can be the criteria to refine crowdsourced information as usable knowledge. An initiator concept is used as an idea or design generator and a participant as a respondent respectively. The proposed evaluation framework includes features and characteristics of crowdsourcing NPD for concept management; 'time, reputation, and task-fitness' and 'participating actor and participating method' respectively. This framework can be applied to concept management tool that supports the concept generation, selection, and testing automatically. An illustrative example is presented to describe how the evaluation framework can be used to the design crowdsourcing.

The paper organized as follows. After a brief literature review about concept development and crowdsourcing product development, we discuss the relationship between two concepts. Then we propose key measures for enhancing crowdsourcing and present an illustrative example for the evaluation framework for crowdsourcing design concept management, followed by conclusions and further research recommendations.

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2. LITERATURE REVIEW

2.1. CONCEPT DEVELOPMENT

Concept development is a decision point among four decision categories in new product development projects [1]. Concept development is also called 'concept management'. The starting point of concept development is to identify the customer needs or attributes. This concept development includes the target value of product attributes, core product concepts, product architecture, and the initial design of the product. In order to achieve the proper concept development, the concept design process is conducted with three sub-processes (i.e., the idea or concept generation, concept selecting and screening, and concept development and testing) [2], [3].

The first process of concept development is concept generation. Concept generation (or ideation) is a key process for emerging creative ideas [4]. Concept generation becomes the foundation for developing the final product and serves as a guide for product research, feedback, and testing and experimentation [5]. Griffin [6] introduces three most important market research approaches for new customer-driven idea or concept generation process: voice of customer, customer site visits, and beta site testing. Those approaches stress the role of customers in the process of concept testing. In order words, those approaches are based on the understanding of customer needs and the determination the design direction. Brainstorming [7], focus group interview, customer visits [8], conjoint analysis, and some other approaches are generally conducted to support ideation process of a NPD process [9]. These concept generation approaches are developed to customer needs and solutions.

The second process is concept selection. Concept selection is the process to reach to ultimate one from a set of concepts that are introduced and needs to be evaluated in terms of the criteria (i.e., performance and cost). This process is an important activity in a NPD process, because it influences the up- and downstream activities in a NPD environment. As important as aforementioned, many concept selection methods (CSMs) have been introduced. King and Sivaloganathan [10] categorized five main types of CSMs as follows: utility-based, AHP-based, graphical, QFD matrices, and fuzzy logic based CSMs. Among these methods, the analytic hierarchy process (AHP) has been widely applied for concept selection in NPD because AHP is easy to handle qualitative criteria [11]. In addition to the AHP approach, the analytic network process (ANP) is intended to handle more complex interrelationships among decision elements [12].

Concept testing is the last process of concept development. It is usually considered as a term for marketing research procedures to include testing of product/marketing executions. However it is supposed to conduct a market evaluation of the proposed ideational content rather than any particular executions of that content. As the result of the concept testing, firms make "go/no go" decisions and other early strategic planning decisions are made using consumer inputs. This process is accomplished by presenting an idea or a concept to consumers early in the planning process before the large amounts of resources for NPD are executed [14], [15]. In other words, firms evaluate the viabilities of their new products before making major resource related commitments into their product development, by surveying the potential buyers of their new products about the intention to purchase firms' new products.

2.2. CROWDSOURCED NEW PRODUCT DEVELOPMENT

After the concept of crowdsourcing coined by Howe [16], new crowdsourcing services are introduced in the NPD field with the rising of open R&D and innovation [17].

Current research effort shows that crowdsourcing has become the most popular form to encourage customer participation in the design of new products [18]. Huang and her colleagues classify the three types of sourcing for new product design ideas depending on customer participation types [19]. The first type is that the customer participation covers the creation of a roughly specified product and depends fully on customer input. As the example of the first type, Threadless.com collects the finished t-shirt designs from customers. The second type of crowdsourcing is related to the first type. The similar point is that the final design depends fully on the customer submission but the difference is that a specifically defined task or problem has to be solved by customers [20]. Topcoder corresponds to this type. Topcoder gathers design, development, and data science to work on challenging problems. In other words, the idea generators or designers are not necessary to be problem solvers. Third type of crowdsourcing is related to a permanent open call for contribution. This type of crowdsourcing is not related to any specific task or problem [21], [22]. Dell Ideastorm is an example of this type. In this type of crowdsourcing, customers contribute and evaluate various ideas. The decision to develop and implement those ideas depends on the firm.

In the next section, we will discuss the relationship between concept development (or concept management) and crowdsourced design.

3. CONCEPT MANAGEMENT FOR CROWDSOURCING DESIGN

3.1. ACTIVITIES FOR PRODUCT CONCEPT DESIGN IN CROWDSOURCING

As aforementioned in the previous section, the main activities for concept development and management are related to 'design' of new products. Project initiators propose the new product concepts and other team members develop those concepts with designers and engineers who are assigned as the product development team. In crowdsourcing environment, on the other hand, idea generators and designers as initiators are not involved in a firm. They provide their own ideas and designs to crowdsourcing services as a new product concept and the rest participants as respondents contribute with votes, comments, or alternative designs. The critical difference related to concept management in between current design environment and crowdsourcing environment is the origin of the resource. Although outsourcing concept exists, crowdsourcing is different from outsourcing. The new features of crowdsourcing design concept management are extracted from these differences. Geiger and his colleagues propose the four dimensions of crowdsourcing [23]. The first dimension, pre-selection of contributors, is concerned with restrictions regarding the pool of potential participants. The second dimension, the accessibility of peer contributions, indicates to what extent participants can see each participant's contributions. Aggregation of contributions as the third dimension describes how the crowd contributions within a crowdsourcing NPD are applied by the crowdsourcing service to achieve the desired outcome. The fourth dimension, remuneration for contributions, determines how contributors are rewarded for their work.

These four dimensions are relevant to the concept management. 'Pre-selection of contributors' in crowdsourcing as the process of finding participants who will conduct the given project is similar to consisting a project team for concept selection and concept testing in a general firm. 'Accessibility of peer contributions' is the possibility of collecting information that is used for identifying and analysing the expertise of participants in the process of finding participants. Also 'remuneration for contribution' is the process to evaluate the participant's ability and expertise based on the object assessment measures such as total earning in Quirky.com. As noticed, the management of idea and design source such as respondents or participants is the most important factor to success the crowdsourcing design.

3.2. DIFFICULTIES FOR DESIGN EVALUATION IN CROWDSOURCING ENVIRONMENT

In order to conduct a new product development project in the current firms, it is important who design a concept for a new product. However, it is difficult to figure out the designer in the crowdsourcing environment where the anonymities of participants are guaranteed. Only information to distinguish and identify a specific participant is based on the information that is given by participant him- or herself. Based on the information given by a participant, it is hard to fully trust the expertise of the participant. In crowdsourcing environment, it is also difficult to find designers who fit on a specific crowdsourcing NPD project. It is not guaranteed to find a designer who can provide proper ideas or contributions for a crowdsourcing NPD. In order to support this difficulty, functions or services to find proper participants such as idea generator and designer who meet criteria should be provided. After finding such participants, it is important to check the availability to contribute to the project. The availability is mainly related to time issue. Waiting time to participate in a project and due date for a project can be examples of availability. Measures should be provided to overcome such difficulties in crowdsourcing environment for implementing functions to find proper participants.

4. EVALUATION MEASURES FOR CROWDSOURCED DESIGN

4.1. PREFERENCES

As referred in the previous section, the measures to gather information about anonymous participants or contributors should be developed since the concept development in crowdsourcing is not processed with specific and known ones. In this section, we discuss the measures related to preferences, *time*, *task-fitness*, and *reputation* with sub-measures in detail.

4.1.1 TIME

The first preference type is *time*. It is used to compare the difference between time preference of idea generators and participants. In a crowdsourcing NPD project, two types of time concepts conflict each other. One is the time that an idea or design generator waits for participants who contribute to evaluate the generated ideas or designs by providing feedback, comments, votes, and so on. The other is the time that a respondent waits for a NPD idea or a

design that is proper to participate in as a contributor. In other words, reducing the waiting time until a respondent starts its work for an initiator is important.

In order to resolve the conflicts between an initiator and a respondent by reducing the waiting time, it is necessary to find the fitness between the two as fast as the crowdsourcing service can. Though participants can contribute to a certain project without the waiting time concern, it is not guaranteed that the participants meet the most fitted projects.

4.1.2. TASK-FITNESS

The second type of preferences is *task-fitness*. The task-fitness preference consists of two measures: categories and types of contribution. Although the participating actors expect to be accepted their comments or contributions by idea or project initiator, it is just probabilistic expectation. It is because it is not guaranteed to get the benefit from accepted contributions, which requires the efforts to post contributions. In other words, if the actor can meet the project requirement that has the higher probability with less effort for finding such project, it will reduce the cost and increase the actor's utility. In order to achieve this purpose, we introduce the preference of 'task-fitness'. As confirming the task-fitness to a project, two subsidiary measures are proposed. The first measure is the importance of the category of ideas that an actor generated. The second one is to measure the fitness using the methods of contribution to other actors' ideas and posts. In case of Quirky.com, a participant can contribute eight types of contributing domains with his/her product idea initiation such as Electronics and Power, Health and Fitness, Home and Garden, Kitchen, Parenting, Play, Travel and Adventure, and Wild Card. Quirky.com also has eight types of influence product types including 'Idea', 'Research', 'Design', 'Enhance', 'Style', 'Name', 'Tagline', and 'Price'.

The first measure to propose for the Task-Fitness is the ratio of category expertise. In order to identify actor's category expertise, a category expertise for each category has to be identified respectively. In this research, we acquire the actors' category expertise based on the ratio of the idea and project initiation on a certain category from the total number of initiated ideas and projects. The second measure for the task-fitness is the average of influence earned from a certain method. It is a set that has its elements as the averaged influence earned for each contribution method.

4.1.3. REPUTATION

The second preference type is *reputation*. Reputation in social communities is treated an important extrinsic motivation, since its instrumental value in enhancing contributing actors' job prospects. Most of crowdsourcing service platforms provide reputation-related measures in two perspectives. One is the size of networking and the other is amount of influence. Usually the size of networking denotes the number of followers and followings (e.g., 'followers' in Quirky.com and jovoto). 'Following' is the number of other actors who the actor is following. On the other hand, 'follower' is the number of other actors who follows the actor. The amount of influence to the project can be measured by various methods. In Quirky.com, for example, an actor can earn percent-like influence value as the reward of their contribution, while the actors in jovoto grant 'karma' based on how active a person is and what quality the community member's activity has.

The first measure for reputation is related to the number of followers and followings in a crowdsourcing service. Especially, the changing trend of network size with respect to the number of followings and followers is the key measure for the reputation. This measure will be provided with the illustrative example in the section 5. In addition to this, if a network size of a participant is bigger than others, the possibility of the participant to find more fitted project is greater.

The second measure for reputation is total earning in crowdsourcing environment. Total earning is the min-max normalized value of total earning of actor in crowdsourcing design network (or crowdsourcing design service). Using the min-max normalization, total earning is the relatively compared value of total earning with other actors. In this case, the highest earned actor has one in the crowdsourcing design network. Since the normalized total earning of an actor getting close to one means relatively higher earning than other actors, the actor can get higher reputation and vice versa. In time series perspective, it is important to check the change of total earning. If the total earning is in increasing trend, it means that the actor's current efforts harvest significant results and the reputation of the actor changes positively. If an actor's total earning shows decreasing trend, it means that the current reputation of the actor turns negatively.

4.2. CHARACTERISTICS

In addition to the features for measuring the preferences in crowdsourcing NPD, we propose two characteristic categories: participant related and participating method related.

4.2.1 PARTICIPANT RELATED

Anonymous participant: Basically initiators and respondents are anonymous in crowdsourcing NPD. Since those participants expose their identities partially, other participants should consider the incompleteness of provided information relevant to the participants.

Not qualified participant: As the similar concern about participant's anonymity, the qualification issue is related to trust and reputation among participants. To overcome this issue, many crowdsourcing services provide historical information such as participating project lists, roles and rewards in those projects, and detailed work descriptions. Based on that information, other participants distinguish the proper participant from others.

Various contexts: The context of participants is various. Current collaboration technologies support that the participants can join the crowdsourcing NPD project with the relaxed constraints such as time and location that has been considered as the hard constraints in traditional NPD firm.

Various roles: The various roles of participants are one of the main characteristics in crowdsourcing environment. A customer can play not only as an idea generator but also as an idea evaluator. Playing various roles means that the measure for finding proper contributors should be different.

4.2.2 PARTICIPATING METHOD RELATED

Text: Text is the main participating method in crowdsourcing NPD. Since the participants provide their text-based descriptions, opinions, and comments mainly, the function to extract information from provided texts for understanding other participants' assessment about the crowdsourcing NPD projects. In addition, since participants can also understand the problems, solutions, and needs using provided text, it is important to provide the function of supporting initiators to input their initial information more precisely.

Drawing: Drawing is usually used as the supplement of text-based information. Though it is encouraged to provide with text-based inputs, it generates confusion from time to time when the drawing is not provided precisely. Also it does not have specific data to be converted as useful information automatically.

CAD/CAM: CAD/CAM is an unusual method to communicate in general crowdsourcing environment because it requires specific knowledge to use. Even though it can contain technical specifications that can be converted as useful information automatically, the actual usage in current crowdsourcing services is very rare since the users are limited. In order to CAD/CAM as a communication method, the crowdsourcing NPD project has to be clarified in early stage whether it is proper to use CAD/CAM technology.

Prototype: It is very rare that the prototype is provided as the communication method. Usually, a prototype is an intermediate result in the process of crowdsourcing NPD. If an initiator provides a prototype as the initiative idea or design, it can reduce the development time significantly. In this case, however, the room for modification is limited.

To summarize the discussion in this section, Figure 1 illustrates taxonomy of items, which are used for crowdsourcing design concept management.

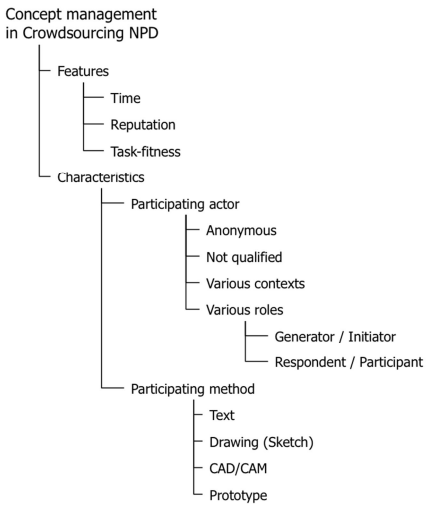

Figure 1. Taxonomy for the evaluation framework of crowdsourcing design management.

5. ILLUSTRATIVE EXAMPLE

In order to validate the proposed measures, we present an illustrative example in this section with actual dataset from Quirky.com. In order to illustrate the proposed features and characteristics to identify the behaviours of participants; we chose one sub-feature of reputation, 'changing trend of network size'. We collected data from Quirky.com for six participants from December 12th to December 30th, 2013.

As we explained in the section 3, the changing trend of network size (Δn_i) is one of measure to identify the reputation of a participant in crowdsourcing. If the changing trend shows convex upward, the loyalty of a participant was increased at the beginning and currently the loyalty is in reducing trend, and vice versa.

Figure 2 illustrates six different patterns of this measure. In the case of (1), the number of followings of participant *i* was increased rapidly (probably by generating big ideas or significant contributions in early days). However, the ratio of increasing the number of followings has been reduced by the lack of the impressive efforts recently. In the case of (3), on the other hand, the participant *i*'s contributions are not significant in early days, but participant *i* has given significant impressions to other participants recently with meaningful contributions. The graph of case (2) has the constant slope, which means that the evaluation of participant *i*'s contribution is positive continuously. Graph of case (4), (5), and (6) are explained the opposite situation of (1), (2) and (3) respectively.

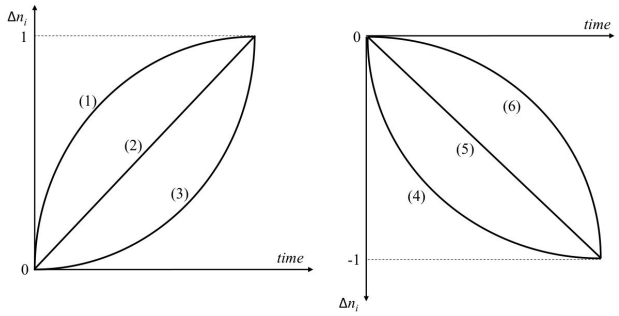

Figure 2. Changing trend of network size.

We collect the data about the number of following and followers for six participants in Quirky.com. Table 1 shows the part of collected dataset. The positive values in Table 1 means that the network size is increased whereas the negative means the network size is shrunk. The absolute values in Table 1 show how much the network sizes have been changed in a day. The greater value means the greater network size change.

Table 1. Sample collected dataset of changing trend of network size.

Δn_i		Dates						
		12/12/13	12/13/13	12/14/13	12/15/13	…	12/29/13	12/30/13
Participants	Participant_1	0.008154	0.017619	0.001188	0.001576	…	-0.000379	0.000000
	Participant_2	0.005678	0.005336	0.000000	0.001398	…	0.000000	0.000000
	Participant_3	0.003173	0.009800	0.002957	0.000586	…	0.001090	0.002159
	Participant_4	0.001240	0.000495	0.000988	0.001232	…	0.001664	0.000711
	Participant_5	0.038621	0.000000	0.000000	0.000000	…	0.000000	0.000000
	Participant_6	-0.024368	0.000530	-0.001455	0.004171	…	-0.001062	-0.000782

Figure 3 shows the changing trend of six participants' network size. In case of participant_4, the network size based on the number of followers and followings is hardly changed during data collection. It means that participant_4 did not try to extend the network. In addition, the awareness of participant_4 from others is also hardly changed since participant_4 did not contribute significantly for other participants. Unlike the case of participant_4, the graph of participant_5 shows that the number of followers changes highly positive in the beginning. It has continuously positive changes during the data collecting duration, which means that participant_5 puts the significant efforts for other participants in crowdsourcing NPD services, Quirky.com, during this duration. Difference from partipant_4 and participant_5, participant_6 did not positively increase the awareness of other participants in this duration. However, participant_6 conducted various activities in this crowdsourcing NPD service since participant_6 continued to follow other participant by increase the size of network itself. It would be a positive signal to other participants about the attitude of participant_6.

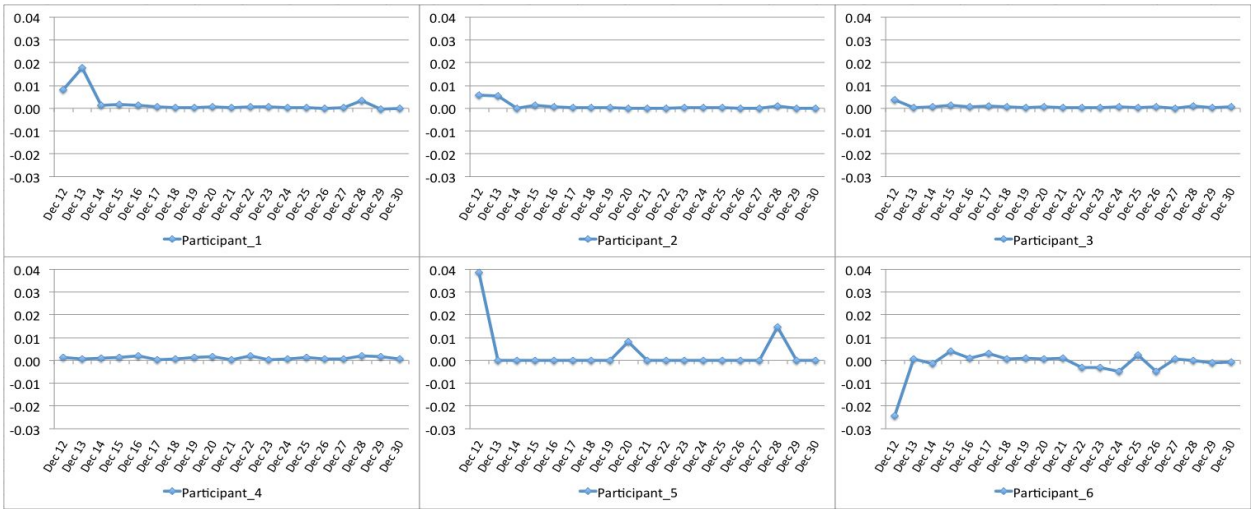

Figure 3. Changing trend of network size for six participants.

6. CONCLUSION

Crowdsourcing NPD provides an excellent opportunity to realize the fully involving environment of customers to develop new products. Crowdsourced design is more than just a design concept of a product; it is the concept that already includes the evaluation of market by various participants. To enhance the generating crowdsourcing concept development or management, it needs to identify the main characteristics and features of crowdsourcing.

The main contribution of this paper is that we have proposed an evaluation framework that includes features and characteristics of crowdsourcing NPD for concept management; 'time, reputation, and task-fitness' and 'participating actor and participating method' respectively. This framework can be applied to concept management tool that supports the concept generation, selection, and testing automatically.

Despite the future works remain, the proposed framework of this paper would provide the practitioners with the insights to discern what are actually features and characteristics of crowdsourcing design concept management in comparison from legacy NPD, and to build a more automatic crowdsourcing NPD environment to be used in the future NPD.

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