2015 48th Hawaii International Conference on System Sciences

A Criterion-Mining Method for Group Idea Selection – Increasing Consensus with Minimal Loss of Efficiency

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Abstract

The fastest way for a group of experts to select raw ideas is in parallel. However, since each expert then no longer sees the large majority of the individual decisions, there is a danger that consensus about the result will be low. Ideally, the result of the parallel selection would be identical to the one that the group would have produced collaboratively.

One cause of deviation of individual selections from the ideal case are hidden profiles: each expert works with their private mental model of the raw ideas and the selection criteria.

Our hypothesis is that it is sufficient to build a shared mental model of the criterion in order to achieve consensus on the overall selection result: it is not necessary to discuss the ideas themselves. Our experimental results with a new selection method suggest that this is the case. In this manner, the motivation of the experts is maintained at little extra cost.

1. Introduction

1.1. Background

In today's innovation process the early phases are increasing in importance, because competitive pressure continues to shorten product cycles and increases the need for generating innovations fast. The back end of the innovation process is often well structured and delivers expected outcomes [16]. By contrast, the front end is less easily manageable and is thus often referred to as "fuzzy".

Instead of waiting for ideas to show up by chance, companies prefer to make their front-end innovation activities more goal-oriented. Creativity techniques can be used to generate *raw ideas* that contain the potential to solve the innovation task. Raw ideas usually consist of little more than a short phrase or sentence, and initially there may be dozens or even hundreds of them to deal with [16].

In the next step of the process, the raw ideas are reviewed by a group of experts. They select which ideas are worth pursuing and which are not. However, commonly used evaluation approaches for selecting raw ideas can deliver unsatisfactory results [1][2][13]; acceptance errors mean that bad ideas are judged to be good, while rejection errors erroneously discard ideas that otherwise could have been successful.

1.2. Motivation

In the most commonly used innovation process – the stage-gate process [6] – the decision for or against the implementation of an idea has a wide range of consequences. In the former case, it will immediately allocate considerable resources for the implementation of ideas. Eisenmann *et al.* [10] claim that this early commitment to an idea contains a high risk of failure. They therefore propose an experimental approach whereby the assumptions necessary to pursuing the idea are tested using an empirical experiment. This decision to move forward with an idea is then much easier for a group to deliver because of the reduced risk that is involved. Our decision approach follows this principle.

Previous work on the group selection of raw ideas has shown that a high degree of efficiency can be obtained by distributing the decisions among the members of the group [13]. However, since this means that group members do not see the large majority of the ideas, their acceptance of the overall selection result is low.

Methods from Multi-Criteria Decision Making such as the Analytic Hierarchy Process [22] or utility-based scoring models [8] are, in principle applicable to this problem. However, in practice they are not appropriate, because they assume more

1530-1605/15 $31.00 © 2015 IEEE
DOI 10.1109/HICSS.2015.48

knowledge about the ideas than is available at the raw idea stage.

An idea is only the beginning of the innovation process. Until the idea can generate economic success, it needs a lot of work and many obstacles must be overcome [6]. Thus, it is important that the team entrusted with the development of the idea is sufficiently motivated [7]. We assume that a lack of consensus about the rejection and acceptance of ideas will reduce this motivation.

We are therefore motivated to search for a method to improve consensus about the result of a distributed selection that does not incur too great an overhead compared to the fastest possible approach. This is the subject of this study.

1.3. Research Question and Goals

Our goal is to build an efficient group raw idea selection method that achieves a high level of consensus. The group should consider the outcome to be "close enough" to be acceptable [7]. In particular, the discussion of each raw idea must be avoided; this would contribute to consensus but is prohibitively time-consuming [14]. We consider this goal to be achieved if …

- we can perform the selection in a time that is not significantly longer than is needed for the distributed selection,
- the group accepts the set of rejected ideas even though they are not able to examine them.

The hypothesis is: *It is sufficient to resolve (only) the hidden criteria profile in order to achieve consensus in distributed group raw idea selection.*

This hypothesis is based on the following three assumptions:

1. The group can develop a shared mental model of the selection criteria by collecting and discussing all the criteria that its members applied in an initial pass through their subset of the ideas.
2. Consensus is achieved by creating trust that the other group members have applied appropriate criteria during their individual selection.
3. This trust can be established by allowing each member of the group to re-evaluate their selection based on the newly discovered shared mental model of the criteria.

2. Related Work

2.1. Previous Work: Efficient Idea Selection

More efficient idea selection methods in groups would improve decision making. The threshold algorithm by Goers *et al.* [13] proposes an approach for the fast selection of raw ideas in groups. In order to achieve efficiency, the algorithm divides the selection task among the group members. Each group member is assigned a distinct subset of raw ideas. Their individual judgments build the final group-wide selection result. In order to establish a group-wide standard, each group member selects a representative of their subsets and the group discusses these representatives. This approach delivers a fast selection result. Unfortunately it lacks the acceptance of the group. A visualization approach by Bobles *et al.* [3] tried to solve this problem; the consensus was improved, but was still not satisfactory.

In retrospect, it seems clear that discussing the ideas was not appropriate. Each raw idea is unique to a group member; revealing its hidden profile cannot yield much useful information to the other members of the group. Instead, the discussion should improve group-wide understanding of the selection goal, and should be applicable to all the ideas under consideration. This is the selection criterion.

In addition, the study [13] revealed that the group members would like to re-evaluate their ideas after the discussion. (This was not permitted by the algorithm). They reported that the discussion gave them new insights into their evaluation task and should lead to a modification of their original selection decision.

The threshold algorithm could therefore be improved by two different modifications: first, replace the idea discussion by one that uncovers the hidden criterion profile and second allow correction of the selection decisions. These improvements should result in improved consensus without loss of efficiency.

2.2. Consensus

Our goal is to obtain the support of a group of experts for the raw ideas they will be asked to work on. One contributing factor to this support is consensus about the selection result. We therefore need a definition of consensus that is consistent with this goal.

Briggs [4] defines consensus as a state in which a group reaches agreement that all group members support. Similarly, Cowings [7] describes consensus as *an outcome which is "close enough" to be acceptable.* Scholtes [23] stated that consensus in group decision making means *everyone understands* *the decisions, everyone can live with the decision.* These definitions do not require unanimity to achieve consensus.

In this study, we define consensus as having been achieved if every group member accepts the rejected ideas, even if – given the opportunity – they individually would have made a different choice. Our definition does not address the accepted ideas, since acceptance errors may still be detected at a later stage of the innovation process. Rejection errors, on the other hand, cannot be rectified: they are opportunities for successful business innovations that are lost forever.

Scholtes [23] suggests that a consensus process contains of two phases: first the topic is discussed and then evaluation results are checked. If results are not in consensus, then return to the first step. In our context, this approach is much too expensive; the sheer number of raw ideas to be processed prohibits it.

Another psychological decision-making model was proposed by Gigone *et al.* [12] – the lens model for the group judgment process. It describes the psychological view on a decision making process in two steps. First, the members build their judgment regarding the alternatives and a criterion based on cues. Cues are indicators regarding a given criterion that lead a judge to build his judgment. Secondly the individual group member judgment build the group judgment. Gigone *et al.* [12] claim that the group's judgment accuracy depends on the accuracy of the individual judgments. They discovered that group members tend to discuss their preferences rather the available (individually available) information to build their decision on [11]. So, they propose to build in a discussion step, which should be used to identify unknown (to other group members) judgment-relevant cues. This new insight could then lead to a better, revision of individual judgments.

2.3. Mental Models and Hidden Profiles

One major difficulty in creating consensus is the nature of raw ideas. Unlike the alternatives in many other decision areas raw ideas are ill-defined. They consist only of a sentence or less. Evaluating these ideas in regard to a criterion leaves much space for ambiguous interpretations [21][7]. These characteristics of ideas influence the group's decision significantly. So, it is very possible that individual decisions differ due to different interpretations of ideas, criteria or both. Our approach pays respect to different interpretations of criteria.

Van den Bossche *et al.* explained that when the judgments of group members are in dissent, sharing their mental models could increase the consensus [27]. A mental model corresponds to an interpretation of an idea or a criterion. Each group member develops in decision processes those mental models of ideas as well as of the criterion. Usually group discussion focus on common information, these discussions tend to be inefficient [17]. However, many studies indicate that unshared mental models made explicit [25] supports the building of consensus in groups, i.e. by constructive conflict [27], devil's advocate [15], a script for the facilitator [14], cognitive group diversity [18] [19] [28] or solving actual dissent by facilitation discussions [24].

The solving of hidden profiles usually leads to the one correct solution. In innovation processes many solutions are possible. Here the goal is more to identify decision-relevant information that supports each group member to come to understand other group members' decision and trust their ability to select ideas that they would have selected as well. It should be noted that various mental models of a criterion could be valid. Our selection method respects that and allows the group to discard or approve of mental models.

Studies usually do not differentiate mental models. Horton *et al.* [14] describe that a group member could hold a mental model of a criterion. As studies show discussions for eliciting hidden profiles are often inefficient. Our approach consciously limits the discussion only for sharing mental models regarding the criterion. We assume that discussions of mental models of ideas would fracture discussion. It would presumably quickly become inefficient.

2.4. Collaboration Engineering

De Vreede and Briggs [9] define Collaboration Engineering as *an approach to the design of re-usable collaboration processes and technologies meant to engender predictable success among practitioners of recurring mission-critical collaborative tasks*. We view the procedure presented in this paper as a contribution to Collaboration Engineering, since it provides a blueprint for solving this type of task.

Within Collaboration Engineering, Briggs *et al*. describe six "Patterns of Collaboration" [5]. These patterns are called *Generate*, *Reduce*, *Clarify*, *Organize*, *Evaluate*, and *Build Consensus*. They represent the fundamental building blocks of any collaborative activity. At the top level, our procedure is of type *Reduce*, since its goal is to reduce the number of raw ideas under consideration. At the same time, it may be considered to be an example of the *Build Consensus* pattern, since this corresponds to its secondary goal. Viewed at the step-by-step level, the procedure contains *Organize*, *Clarify* and *Evaluate* patterns.

3. The Mining Procedure

3.1. Preliminaries

In this Section we present the group procedure for raw idea selection. The method takes as input a set of raw ideas and assigns to each the status GO or NO-GO. GO means that the idea is to remain under consideration; NO-GO means that the idea should be discarded.

Two types of criterion are allowed. Ideas that fail a "must-have" criterion receive a NO-GO status. Ideas that fulfil a "should-have" criterion may be assigned a GO status.

The procedure solves the problem that each group member will in general have a different mental model of the criteria that may be applicable, i.e. that the criteria have a hidden profile. This may result in "incorrect" evaluations, in other words ones that would have been different based on the shared profile.

3.2. Procedure

Our selection procedure is designed to achieve a sequence of three sub-goals: First, each group member forms a private mental model of relevant selection criteria (Steps 1 and 2). Second, the group forms a shared mental model for the entire set of relevant criteria (Steps 3 to 6). Lastly, each group member applies the shared criteria to his/her subset of the ideas.

1. Distribute the raw ideas equally between the members of the group.
2. Each group member assigns a preliminary status of GO or NO-GO to each raw idea in his or her set. This step is carried out individually.
3. The group assembles for a discussion.
4. For each idea, its owner states the criterion he/she used to arrive at the selection status.
5. If the criterion is new, the group may elect to discuss it. As a result of the discussion, the criterion may be accepted, rejected, or rephrased.
6. Steps 4 and 5 are repeated for all ideas.
7. Each group member then reviews their set of raw ideas and may choose to revise their preliminary evaluation based on the new set of criteria.

3.3. Discussion

The most important aspect of the group procedure is only stated implicitly: In the discussion step 4, the raw ideas are not presented – the discussion is restricted to the criterion only. This seems unnatural, but is crucial to the efficiency of the method.

The goal of the discussion is to resolve the profile of the evaluation criteria, i.e. to replace a hidden profile by a shared profile. Group members learn of criteria that they themselves had not thought of. This may enable them in step 7 to improve their evaluation, for example because one of their raw ideas had a previously unrecognized advantage.

By experiencing the resolution of the hidden criterion profile, we hypothesize that each group member's confidence in the others' evaluations is increased.

We speculate that the time saved compared to a full discussion of the ideas improves as the number of ideas to be evaluated increases. This claim is based on the observation that the number of criteria applied by the members of the group is limited and that after a time, no new criteria enter the discussion. This leads to a natural ending for the discussion steps 4 and 5 which is independent of the number of ideas. Thus the ratio of time saved compared to the full discussion of ideas improves as the number of ideas grows.

Step 5 contains the collaboration patterns *Clarify* and *Organize*, as the group interprets each new criterion and integrates it into the existing set. Steps 2 and 7 belong to the *Evaluate* pattern.

4. Experiments

4.1. Experimental design

Our experiment was conducted as part of the coursework for a module on idea generation. A total of 20 late-stage Bachelor and Master students (8 male, 12 female, aged 21 to 25) from various departments participated in the experiment, which lasted for approximately 90 minutes. Students were divided into four groups of five, each of which was led by a facilitator.

Each group was given the task of evaluating 25 raw ideas for making sure that they (as individuals) choose the right job after graduation. This topic was chosen because it is relevant to all the participants. Two sets of ideas were used, one for the control experiment, and another for evaluating the procedure itself. Some examples of the ideas are shown in Figure 1. No evaluation criteria were specified *a priori* by the facilitator.

A control experiment was conducted using the first set of 25 ideas. The experiment began with steps 1 and 2 in Section 3.2: each participant received and evaluated a set of five ideas. Then each participant was given a questionnaire to fill in (see Figure 2). This will be referred to in the next section as "Control 1".

In the second experiment, the procedure described in Section 3.2 was executed completely using a second set of raw ideas. Then the participants were asked to complete the questionnaire of Figure 2 twice – once for the procedure just carried out and once for the control experiment. These will be referred to in the next section as "Procedure" and "Control 2", respectively. The goal of the Control 2 survey was to determine whether the participants' opinion of the control experiment changed after having experienced the new method.

4.2. Results and interpretation

All answers were given on a five-point Likert scale, whereby a score of 1 indicated "not true" and a score of 5 indicated "true". In all tables, the mean arithmetic values across all participants in all groups is shown.

Table 1. Group understanding of criteria

Everybody had the same understanding of the evaluation criteria.	
Control 1	3.75
Procedure	4.13
Control 2	2.50

Table 1 shows to what extent the participants believed that all group members understood the evaluation criteria. Immediately after the control experiment, the participants were weakly confident that the criteria had been understood (Control 1: 3.75 points). However, after having experienced the new procedure, the participants revised their estimation of the control method down to a value slightly below neutral (Control 2: 2.50 points). We attribute this to the fact that the discussion in the new procedure reveals the scope of the hidden criteria profile, of which they had previously not been aware. Thus the danger of an erroneous selection is high. The value for the new mining procedure (4.13 points) is significantly better, which suggests that it was successful in generating the feeling that the criteria were well understood by the group.

Table 2. Own understanding of criteria

I understood the evaluation criteria.	
Control 1	4.15
Procedure	4.25
Control 2	2.86

Table 2 shows analogous results for the individual estimation of the understanding of the selection criteria. The values are similar, and we attribute this to the same cause as in Table 1.

The results in Tables 1 and 2 support the first assumption in Section 1.3.

Table 3. Subjective rejection errors

No good ideas were rejected.	
Control 1	3.35
Procedure	4.38
Control 2	2.63

Table 3 shows results for the statement "No good ideas were rejected". Again, the participants' confidence in the control method is reduced (from 3.35 to 2.63) after experiencing the mining procedure, which achieves a significantly better result of 4.38. This lends support to assumptions 2 and 3 in Section 1.3.

Table 4. Trust in others' judgements

I can trust the others' evaluations.	
Control 1	3.45
Procedure	3.81
Control 2	2.40

Table 4 shows the participants' trust in the other group members' ability to make the correct judgments. The same pattern results as in the previous Tables: the initial weak confidence in the control method (3.45 points) is reduced significantly by exposure to the mining procedure (2.4 points), which itself scores higher (3.81 points).

This result provides the support for our hypothesis that criteria mining can increase acceptance of the selection result. This is significant, because it shows that the central object of discussion – the ideas themselves – need not be processed by the group in order to achieve a high level of confidence in the others' judgments.

Table 5. Trust in own judgements

I did not reject any good ideas.	
Control 1	3.89
Procedure	4.38
Control 2	4.33

Table 5 shows the participants' trust in their own ability to make the correct selection decisions. Here, it is interesting that knowledge of the mining procedure actually increased the score from a level that was already higher than the trust in the other group members. The score for the mining procedure does not differ significantly. Since the confidence in the overall result was improved by the new method, each participant felt that the new method was able to help the others, but they themselves did not need it. This we attribute to the participants' over-estimation of their own abilities.

Table 6. Cognitive load

The method was strenuous.	
Control 1	1.73
Procedure	3.25

Table 6 shows the subjective cognitive load experienced by the participants measured as the response to the statement "the method was strenuous". As expected, the mining method was felt to require substantially more effort than the control method. (It took about six times as long to execute.) However, the value of 3.25 indicates an indifferent, rather than an extreme response, which means that the group did not experience the method as being hard work.

4.3. Other Observations

In informal discussions with the participants that took place after the experiments were complete, we learned that the participants expected that increasing the number of ideas to evaluate would not significantly increase the time needed for the discussion, since most interpretations of the selection criteria had already been uncovered. This would hold true even if the selection of the additional ideas were to take place at a later date.

Some participants also stated that the criteria mining discussion led to a more uniform application of selection criteria (at that point in time they had not yet been informed about the goals of the experiment.)

The question was posed, why step 2 of the procedure was necessary; could the method not kick off with the criteria discussion? Several participants confirmed our suspicion that this should not be the case: exposure to raw ideas is needed in order to form an initial mental model of appropriate selection criteria.

The final comment of interest was that during the discussion, the participants had often felt the need to discuss the ideas (as opposed to just the selection criteria). This rule had always been strictly enforced by the facilitators. However, the participants agreed that this enforcement was ultimately beneficial, since a discussion of the ideas would have consumed a large amount of time.

The facilitators observed that participants often found it difficult to describe the criteria they had applied to evaluate each idea. Much of the time needed for step 5 was spent not discussing the merits or the formulation of the criteria but interpreting the presenter's meaning.

4.4. Limitations

The experiments were conducted with a relatively small number of participants; although the measured values differ significantly enough to draw tentative conclusions from them, a larger sample would provide a more reliable basis.

Our procedure is motivated by the fact that consensus is a desirable outcome, because the decision-makers will be responsible for the ideas that are selected. This was, however, not true for our experiment: the student participants knew they would not be required to work on the ideas they had selected. This may have led them to be more generous in their selection than would be the case in a real-life application.

5. Conclusion

This paper is concerned with finding the fastest possible selection method for raw ideas by a group which still attains a high level of acceptance. Evidence is provided that the selection task can be distributed among the group and performed concurrently, if a shared mental model of the evaluation criteria is built. It is not necessary for the group to consider the ideas themselves. An agreement score of 4.38 out of a possible 5 for the statement "no good ideas were rejected" was achieved, even though 80% of the ideas and selection results were not seen by the participants.

Compared to the alternative of discussing the ideas themselves in order to achieve consensus, this represents a substantial saving in time and cognitive load – a saving which grows as the number of ideas is increased.

We envisage application of this result in the first stage of an ideation process, in which a large number of raw ideas must be quickly processed by a group of experts. A typical example of this would be a corporate project which begins with the generation of ideas for product or service innovations. By making it possible to make the GO/NO-GO decisions in parallel and limiting the discussion to uncovering the shared mental model of the criteria, the process becomes both more convenient and less expensive.

Our results open the question whether there are other situations in which consensus can be achieved without subjecting the entire subject matter to discussion by the group: are there "critical" subsets of the material which the group needs to process in common and other subsets which can be safely ignored? This could be of particular interest in the field of multi-criteria group decision-making.

Further research is needed to validate the hypothesis that the growth of the shared mental model of the criteria slows down as more ideas are processed by the group.

In an ongoing project, the mining method is being implemented on mobile devices connected by the Internet. The goal is to determine the feasibility of carrying out the method in a virtual team that is distributed across different locations. In this case, the individual selection tasks can be executed asynchronously and the mining discussion would be an interactive process moderated by a human facilitator.

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7. Examples

This section contains example contributions from the experiment described in Section 4.

Study a product or service that I would enjoy creating.

Discuss it with my best friend.

Post a question in an online Q&A forum such as Quora.com about how to choose a job.

Invent my dream job.

Go to a trade fair and talk to people who have already found the right job for themselves.

Figure 1. Examples of raw ideas

Everybody had the same understanding of the evaluation criteria.

I understood the evaluation criteria.

No good ideas were rejected.

I can trust the others' evaluations.

I did not reject any good ideas.

The method was strenuous.

Figure 2. Survey questions

Is based on expert knowledge

Allows me to gather experience first-hand

Helps me to become aware of my own priorities

Information is out of date

Takes too long

Figure 3. Example criteria