

# A Real Time Online Delphi Decision System, V 2.0: Crisis Management Support during Extreme Events

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## ABSTRACT

The Delphi Decision Maker system has been designed to support the decision making needs of crisis managers, considering factors such as stress, time pressure, information overload, and uncertainty. It has been built as a module for the Sahana Disaster Management system, a free and open source system. The Design Science research paradigm was used in an iterative development process. Triangulation was employed in the evaluation, analyzing the system against the research questions using both qualitative and quantitative statistics as well as proof of concept. Modifications need to be made for real world use. A second version of the system is under development. Research findings and future research are outlined in this work in progress.

## Keywords

Delphi, decision making, real time, Sahana, disaster, extreme events, crisis management, wicked problems

## INTRODUCTION

A software system was designed and developed to support large groups of crisis experts making decisions in time-critical extreme events. It is a first step in instantiating visions of what a dynamic emergency response system can be (Hiltz and Turoff, 1978; Turoff et al, 2004). The overarching question that drove this research effort was: *Is it possible to create a web-based system that will enable dispersed groups of experts or knowledgeable individuals to share and evaluate information and opinions, expose disagreements, and reach decisions more quickly than they could have without such a system?*

The Delphi Decision Maker was created as a module to add to the existing larger Disaster Management System, Sahana (White, 2010; White, Turoff and Van de Walle, 2007). Sahana was originally built by a global team of technical volunteers as a humanitarian response to the Asian tsunami to help manage the response and recovery effort as an international community. The system is a Free and Open Source Disaster Management system. “It is a web based collaboration tool that addresses the common coordination problems during a disaster from finding missing people, managing aid, managing volunteers, tracking camps effectively between Government groups, the civil society (NGOs) and the victims themselves” (www.sahana.lk).

A prototype of the system was built and implemented, thus satisfying Proof of Concept. A series of tests were run on the Delphi Decision Maker including: individuals as system testers, a small group used as a pilot study, and a larger set of participants in a field study. Analysis was conducted by triangulation where proof of concept, quantitative (simple statistics from survey analysis) and qualitative (descriptive) statistics of content coding were used from the discussions in the forums

Fifty students from a university in the United States participated in the field study. Results from the participants taking Pre/ Post Study questionnaires also provided positive support for the overarching question. Further, comments from the participants provided more positive feedback that it was possible to create such a system. Hence, there is support for the main research question.

In order to be successful in the use by crisis experts other research questions were asked: What features or

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functions would be most useful for this objective? And, what would be required to make the design of the system understandable and useable? A basic set of four tools {Voting, List Creation, Feedback Scale, Discussion Forum} was created to help guide a group through the decision making process. People surveyed confirmed that the tools were useful. Also, research findings supported that the design was easy to use. However, in both areas, there was room for improvement.

Thurstone's Law of Comparative Judgment (Thurstone, 1927) influenced the design of the system. A scale based on this method provides further information versus a ranked list where each item is proportioned one against the next equally. Thurstone's method shows how much closer an item A is to another item B, versus that same item A to another item C. This provides more information to the user as it shows how much more one item is desired over another. The research question was posed: *Will using a visual scale based on Thurstone's Law of Comparative Judgment helps the expert make a more informed or confident judgment?* The results were that participants did believe that they were making more informed or confident decisions.

Thurstone's Law of Comparative Judgment also influenced the design of how people would rank a list of items, by paired comparisons. Participants were used to determine the next research question, *Will experts use voting to reflect their opinion over time?* Voting by paired comparisons is not a natural or normal way people create ranked lists, so it was important to determine if users would accept this form of ranking. Most participants voted and further, they used voting to reflect suggested changes they may have had.

## THE DELPHI DECISION MAKER 2.0

An evaluation model was developed to guide the next iteration of studies. The currently underway modifications to the system follow.

### Hypothesized Model of Relationships amongst Constructs

The constructs that underlie the evaluation effort are: Usefulness, Ease of Use, and Confidence in the results, satisfaction, usage, and the major functions (discussion forum, linear Thurstone's scale, and the voting process). However, there is a direct relation between a basic set of group support tools and the context in which they are used that influences the Usefulness of this system, including the task the group is working on, the group's proximity and size. These characteristics will be investigated further as testing continues for their positive or negative influences on the usage of the system. Another influence on the construct Usefulness is the accuracy the experts find in the information provided by the Scale and Voting tools provided. This was very important as the experts need to be confident that those tools provide an accurate reflection of what they are thinking and what the group is thinking. Participants found both that using the paired comparisons for voting was an accurate way to reflect what they were thinking, and that the scale provided an accurate reflection of the result. In addition, a system that is easy to use will more likely be used. This model (see Figure 1) will be tested in the

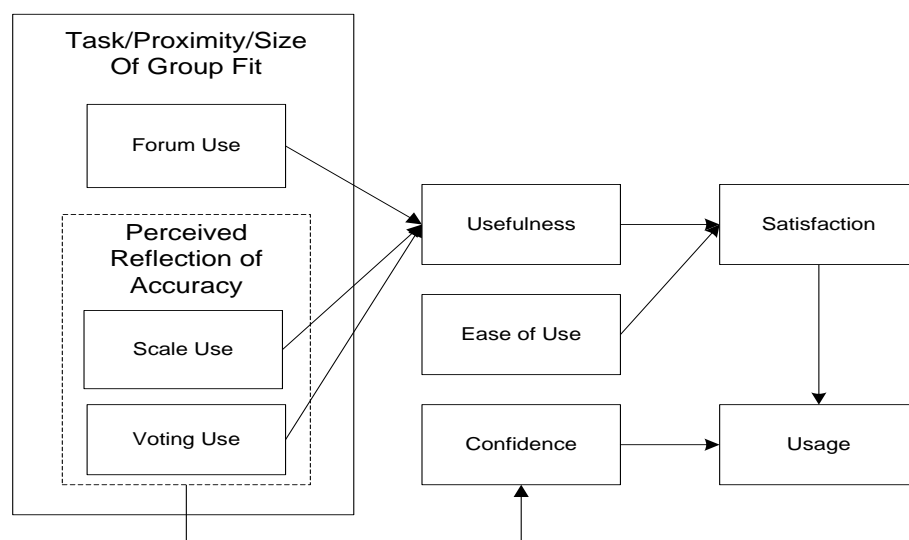


Figure 1 Model of constructs used to analyze Delphi Decision Maker.

next round of studies after the next version (2.0) is developed and implemented. It describes one possible way in which quantification (the scale) could be used to help focus groups on areas of disagreement. However, until a transaction log is created, such patterns of use cannot be confirmed.

### **Transaction Log**

For further studies, it was determined that a log of a variety of transactions needed to be gathered and maintained. This will help researchers determine which tools or actions trigger other tool usage or actions. Each 'Active Problem' will need its own transaction log that only records the actions that are between the members of that particular group.

### **Item Selection for Option List Creation**

This tool has been modified so that larger lists of Options can be managed effectively and efficiently. If a user selects a subset of a larger list, this will expedite the time it takes for the crisis manager to create a ranked list using voting as a tool to reflect what the expert is thinking. Items in a list can be toggled on or off and only those toggled on are used further in the decision making calculation.

The number of paired comparisons required of the user was excessive and needs modification if this system is to be successfully used in the real world. Having so many voting pairs caused great problems given there was a logic check in place checking for cyclic triads. The researcher has worked to modify the system to reduce the number of paired comparisons. The system will internally use a binary search algorithm to insert new items into the internal ranked ordered list for each user. This will start with the first paired comparison made and proceed to choose items remaining to be compared with items already in the list, selecting only from those items the user wishes to include in the current result. This will decrease the probability of the user making inconsistent choices in the paired comparison process.

The user will always be able to see the resulting ranked order of the items he or she has compared and the second list of items not yet compared for entry into the list, and those items the user did not expect to vote on at any time. If the user makes a comment on any item it is added to those he is expected to vote on at some point in the future.

### **Discussion Forum**

In version 2.0, each item on the list will have its own Discussion Forum. The Discussion Forum will also be improved by adding more flexibility for the users and more alternatives on what functionalities are available for them. We would like to have hypertext ability where, given you are in Option A's Discussion Forum and mention Option X, Option X will automatically be a keyword which will link the Option X keyword to Option X's Discussion Forum. This would hold true for any Option's Forum. If any Option on the list is referenced, when the keyword is typed in, a link will automatically be created linking this option's keyword to the option's discussion forum.

### **User Permissions**

User permissions need to be implemented such that groups can have more control over membership. The users of such a system will be groups of experts working together to solve a variety of problems. Although the system is built to support emergent and dynamic needs, it can be used for any problem where there is a problem requiring a prioritized list of alternatives under consideration. This happens with all groups, all organizations and under all phases of emergency management, military and civilian alike. The groups can be large or small but the system is best when used by larger groups of hundreds, thousands, or even millions. This is important for a variety of reasons but primarily so that one person can be in control of the implementation and has the ability to shape the group to better fit the needs of the problem. Leadership, command and control, and other roles need this support. There could be a need for a closed group of members who are representatives and have a vote for or against some policy. This will also allow more structure in large groups, e.g., some people may have the ability to vote, and others to contribute ideas but not vote.

## FUTURE FEATURES FOR THE DELPHI DECISION MAKER

Some other features that should be developed (in version 3.0) to support further the efforts of the Delphi Decision Maker are briefly described in this section.

### Expert Domain Group Identification

When a New Problem is entered into The Delphi Decision Maker, there needs to be a way for emergent groups of experts to be formed. Groups could be formed using a number of alternative methods. Existing databases of experts can be used or new ones created. Experts can also have RSS feeds and artificial intelligence methods can be used to identify and aggregate experts on an ongoing basis.

These systems could use multiple methods of communications in order to quickly contact experts and confirm if they are willing, ready, and available. Expert lists could be updated in real time so that the most efficient use of experts could be deployed.

### Dynamic Discussion Forum

Although there are standard forums that can be used to satisfy the discussion aspect of the system, a more versatile format would be better for the complexities and information needs of experts for this system. If forums could act more as wikis, this would be a beneficial technology to implement where terms could be linked and interlinked and new information better managed. Other information from the Sahana system should be available and integrated into the discussion area such that real time information exists and information exchange can be seamless.

### Future Research Questions

A set of research questions that were left unanswered from the Version 1.0 system will drive the study efforts where the Version 2.0 system will be implemented and tested. They are:

- ❖ *Will emergency management experts use such a system?*
- ❖ *What do they see as the advantages and disadvantages?*
- ❖ *Will the discussion from disagreements lead to more new options being proposed?*
- ❖ *How can voting be used to aid experts in 'muddling through' an initial set of items to create a subset which the experts determine to be the most important items for the group to work with?*
- ❖ *What modifications need made such that the system can better fit the user group and also fit their environment?*

## FUTURE STUDIES

Future studies are planned where groups of crisis experts will be used. A request was posted to the International Association for Emergency Managers mailing list. From this post both groups and individuals volunteered, sufficient to form four test groups for the future. It is from these studies of actual crisis managers that the true effects of the system will be tested. To help the researchers better understand the needs of the users, additional studies are in the works where the researcher would be part of a relief effort that will hold a series of Sahana Testing exercises

It is very difficult to test the system using hypothetical problems or scenarios. Testing the system in its environment will provide researchers with a more realistic picture of the situations in which the system can be best used and where other modifications can be realized to better fit the needs of the users. Once the system is deployed with the Sahana Disaster Management System, real cases can be evaluated. To be able to study the system from a behavioral perspective may aid the research effort to further support the needs of the users. It is important to study how people use the system. New information can be derived from these studies where the users could use the system for situations not considered by the researchers previously.

## CONCLUSION

Overall, this research effort went well. The system proved useful at the core, but many improvements need to be implemented so that The Delphi Decision Maker can be used by the emergency domain community to support them in the most critical times. Future studies are planned where the new version of the system will be tested again and further modified according to the needs identified through analysis. The goal is better managed extreme events, where the death toll is minimized and a more efficient recovery is actualized.

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