December 1998

A Hypermedia Based Delphi Method System for the World Wide Web

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Abstract

We apply hypermedia objects – typed nodes, typed links, global/local viewers, annotation, guided tours, etc. to develop a general Delphi Method System for the Delphi team to execute a Delphi exercise. The hypermedia objects will enhance the Delphi Method, and allow users to access, create, and navigate the related information in the Delphi exercise. We also integrate the system into the WWW to increase its accessibility.

Introduction

The Delphi technique is a method for soliciting and combining the opinions of a group of experts, and prevents any one member of these panelists from unduly influencing the responses of other panel members. It involves the use of a series of questionnaires designed to produce group consensus and eliminate face-to-face confrontation as experienced on panels or committees. It also attempts in a rapid and relatively efficient way, to combine the knowledge and abilities of a diverse group of experts in quantifying variables that are either intangible or vague [TH96].

In most applications, the use of the Delphi Method, two phases can be identified – "exploration phase" and "evaluation phase". The exploration phase may include the two questionnaires where the subject under discussion is fully explored and additional information is provided [AZ96]. The first questionnaire poses the problem in broad terms and invites answers and comments. The second questionnaire is summarized by the replies to the first questionnaire, represents the results of the first one, and gives the respondents an opportunity to re-evaluate their original answers in the light of comprehensive feedback on the responses of the whole group.

The evaluation phase involves the process of assessing and gathering the experts' view on various ways of addressing the issues under investigation [AZ96]. This phase may include several rounds of questionnaires if there is a significant disagreement. Further rounds of questionnaires can be used to explore further to bring out the underlying reasons for differences among experts and possibly to evaluate them.

Basically, the hypertext/hypermedia concept grows from a fundamental idea - information is related to one another. Hypermedia is the science of relationship management [ISB95], which entails creating, storing, maintaining, retrieving, customizing, presenting, commenting on, and navigating relationship [BV97]. The heart of the Delphi method is a structure that interrelates all the individual contributions and produces a group view or perspective. Most Delphi structures can be considered to be types of items (nodes) which have a variety of relationships (links) to one another. Therefore, it is possible to view a specific Delphi as a particular instance of the Hypertext system [TH96].

The goal of this paper is (1) to develop a hypermedia supported Delphi Method System, and (2) to integrate it into the World Wide Web. We believe that the Delphi Method System will be enhanced by hypermedia's supporting rich navigational features, annotating with comments and providing links among related items [BV97]. Integrating the Hypermedia Based Delphi Method System into the WWW will also increase the accessibility of the system.

Hypermedia Based Delphi Method System (HDMS)

Based on the requirements of the Delphi Method, we propose a Hypermedia Based Delphi Method System that includes eight nodes and eight links. The nodes and links are shown in the following table. The typed nodes and links will provide users a consistent structure to prevent them from disorientation [Co87, THH95] during a Delphi exercise. We only propose eight nodes and eight links since we believe that the use of too many link and node types will also create 'cognitive overhead' [Co87] and 'premature organization' [CB89] problems.

Typed Nodes
Issue
Position
Collection
Survey
Annotation
Definition
Summary
Other

Typed Links
Response
Aggregation
Retrieval
Survey
Annotation
Association
Process
Other

Nodes and Links in the HDMS

The Delphi exercises create a lot of items and comments (nodes). There will also be relationships between them. The possible nodes are issue, position, collection, survey, annotation, definition, summary and other nodes.

- Issue node: contains issues to be solved in a Delphi exercise.
- Position node: contains items responding to an issue. For example, the item such as "Set up specific training in project methodology for health and other professionals" is responded to the issue such as "How to improve the public health in the short term".
- Collection node: an aggregation node that contains questions posted by the design team or items proposed by panelists, which respond to issues or to questionnaires. For example, a questionnaire is a collection node.
- Survey node: a survey result that responds to a questionnaire.
- Annotation node: in a Delphi exercise, the panelists and design team members can comment on (annotate) any item or issue as they wish. This creates an annotation node
- Definition node: the questionnaire for a survey needs a set of instructions to explain how to answer or enter the questionnaire in a Delphi exercise. The instructions constitute of a definition node.
- Summary node: the final Delphi result includes all appropriate items responding to solve the issue, which are agreed upon by panel members. The final result creates the summary node, since it is a final summary of the whole Delphi exercise.
- Other node: a catch-all category of nodes, i.e. if a node is not one of the above node types, then it belongs to other type.

The possible relationships between nodes are aggregation, retrieval, annotation, association, response, survey, process, and other links.

- Response link: created when panel members, design teams, or experts create items to respond to the issue. Items represent the different viewpoints or suggestions to the issue to be solved in a Delphi exercise.
- Survey link: there are normally several rounds of survey by different questionnaires in a Delphi exercise. The relationship between questionnaire and survey is a survey link.
- Aggregation link: the items responding to the issues or the survey results returned by participants form the basis of the next round questionnaire. The relationship between the issues and the items, or between the survey and the questionnaire, is an aggregation link.
- Association link: in a Delphi exercise, there will exist some generic relationship between nodes, for example, side conversation of the group may produce the conclusion, which supports the final result, or panelists or design team members may create an *ad hoc* link between nodes. These create an association link between nodes.
- Process link: this represents the logical sequence between each stage of the Delphi exercise. For example, survey results are retrieved for a statistical analysis, or an exceptional minority report is added to a questionnaire, which is creating a process link.
- Annotation link: panelists and design team members in the Delphi exercise can comment on any items, or survey results, etc. as they wish. These comments constitute annotation nodes, and also create the annotation link among them.
- Retrieval link: the design team members can use the survey results to perform a statistical analysis or use a content or structure query to retrieve survey results over a criteria to create the next questionnaire. All these relationships are retrieval links.
- Other link: we also added 'Other link' as a catch-all category of links. It also contains an *ad hoc* link.

HDMS System Architecture

The Hypermedia Based Delphi Method System (HDMS) is a Delphi application system that applies hypermedia objects such as nodes, links, global/local viewers, guided tours, annotation, etc. to execute a Delphi exercise and link all related information together. The HDMS (figure 1) consists of four subsystems: 1) Hypermedia Functionality Subsystem (HFS), 2) Delphi Method Subsystem (DMS), 3) Statistical Analysis Subsystem (SAS), and 4) Data Storage Subsystem (DSS).

1. The Delphi Method Subsystem allows Delphi design teams to create templates for generating questionnaire, conducting a survey, creating minority and final reports, etc. based on their instructions, in order to apply the Delphi technique to execute a Delphi exercise
2. The Statistical Analysis Subsystem consists of statistical function packages that are used to calculate Mean, Standard Deviation, Rank, etc. for Delphi survey results.
3. The Data Storage Subsystem is a database system, which is used to store all Delphi exercise users' information, questionnaires, survey results, minority reports, survey instructions, statistical analysis results, final reports, and so on. The stored information will be used for designing local and global viewers, and for creating nodes, links, user notifications and reports.

4. Hypermedia Functionality Subsystem is the heart of the HDMS, and provides the hypertext engine functionality such as creating static and dynamic links, nodes, guide tours, annotation, global and local viewers, history log, and so forth. It also controls the data flow among WWW Browser, DMS, SAS, and DSS.
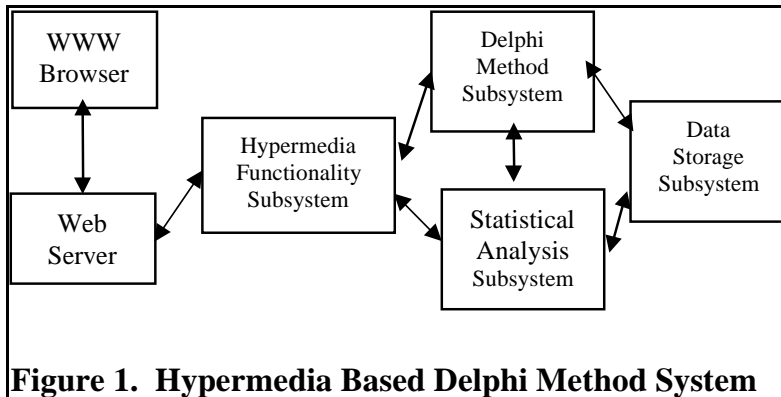

Figure 1. Hypermedia Based Delphi Method System

Functionality of the HDMS

The Hypermedia Based Delphi Method System will at least include the following functionality:

1. Access control: all users need to login by their individual ID and password. One concern of the access control is for security purposes; the other is used to separate the author mode for committee members and the reader mode for panelists.
2. Notification: when panelists sign on the system, they will be notified of what is the current status of the system and what they need to do at the current stage such as to respond items or answer a questionnaire.
3. Text editor: for users to create the content of the node including writing and simple drawing.
4. Create typed nodes and links: to create the typed nodes and links based on 8 node types, 8 link types, and modes. Since the Delphi exercise is divided into several modes, the node and link types can be induced by the system automatically in each mode. For example, in the "survey mode", when the panelist creates a node, the system will know it is a survey node. So the system will provide associated node types in each mode for users to choose from (this is a template).
5. Create guided tours: allow Delphi committee members to create guided tours or paths to represent the whole Delphi exercise–from the first round to the final stage of reaching consensus by panelists.
6. Global and local viewers: this is a graphical structure that shows the users where they are, where they are from, and where they can go from there.
7. Annotation: Delphi committee members and panelists can add annotations to nodes, which represent their opinions to the pros, cons, or comments on nodes.
8. Create a template: committee members can create the template. For example, in the author mode, the HDMS will ask committee members the following questions, which are used to create the template for a Delphi exercise. 1) How many rounds are in the Delphi application? 2) What questions will the committee members ask in each round? 3) What kind of rating scale is used in each round of questionnaire?
9. Modes: the Delphi exercise needs to be divided into reader and author modes in the HDMS. The author mode is for the design team to control the Delphi exercise. Each mode may have sub-modes.
10. Supporting Collaboration: this includes supporting side conversation, survey, and voting in the Delphi exercise, or brainstorming section in the group work.

Conclusion

The Delphi method was commonly applied utilizing a paper-and-pencil communication process in groups in which the members were dispersed in space and time [TH96]. It has limitations such as the time lag of feedback, and the lack of continuity of discussions. It was then enhanced by Computer-Mediated Communication System (CMCS). However, it is still difficult for users to comprehend the whole information within and about the Delphi exercise since the linkage of the information is loose. Our Hypermedia Based Delphi Method System provides hypermedia objects to enhance the Delphi Method and integrates the system into the World Wide Web. These will not only help users have easy access to and navigate related information, but also increase the accessibility of the system through the Internet. Therefore, the integration of the hypermedia system, Delphi Method and WWW will improve the performance of human groups in the Delphi process. Also, according to DeSanctics and Gallupe's foundation of GDSS [DG87], the Delphi Method is a level 2 GDSS. However, the HDMS can support filter and structure information exchange for the large and dispersed group. So it can be characterized as one of the level 3 and category 4 GDSS system in this foundation.

References

References available upon request from the first author (rschen@pegasus.rutgers.edu).