

Chapter 21

Forecasting using Delphi method: an Overview

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The Delphi is a structured communication technique. It involves iterative process of data collection and analysis until consensus is reached among anonymous experts in relation to complex situation. The method is named after Greek oracle at Delphi who was said to be consulted about important decisions by Greek citizen especially in relation to uncertain future.

Evolution of the method dates back to cold war era. The method was developed by Norman Dalkey of the RAND corporation in the 1950's for a U.S. sponsored military project. It was presented in the public domain in 1964. T.J.Gordon and O.Helmer used Delphi method to assess the future development in six broad specific areas and submitted the findings titled "Report on a Long-range Forecasting Study", (Delphi Survey tutorial, T&I, 2030)

The method has got variety of applications, from decision-support and forecasting (Rowe and Wright, 1999) to program development and administration (Delbecq et al., 1975). The method is preferred in situations where knowledge about a problem or phenomena is incomplete or not available. (Adler and Ziglio, 1996; Delbeq et al., 1975). The method is especially applicable to the context where subjective perceptions based on experience and expertise are preferred rather than interpreting the available information by subjecting it to the analytical techniques. (Adler and Ziglio, 1996). It tries to capitalise on the potential of collective wisdom for problem solving and forecasting (Linstone and Turloff, 1975).

The method was used by many researchers for seeking consensus on complex phenomena in addition to its utility in expert elicitation and forecasting. With the increasing popularity and use, functional classification has emerged overtime like policy Delphi, advisory Delphi, decision Delphi etc. (Lang, 1998).

Rowe and Wright (1999) characterized the classical Delphi method with four key features:

1. Anonymity of the respondents: The respondents are not informed about the details of other respondents. The intention is to facilitate free flow of opinion and responses, without any biases and undue pressure to agree with the response of a dominant participant.

2. Controlled feedback: The collective perspective or summary of the responses of the participants is provided to the respondents after the collection and analysis of their response to help them to revisit their perspective.

2. Iteration: The techniques allow number of rounds of information collection and feedback. It helps the respondents to refine their responses considering the overall

feedback in the previous round. It should be taken care that respondents are simply agreeing to the majority's opinion in the previous round. Rather it should be based on their expertise.

4. Statistical analysis of group response: The method has provisions for a quantitative analysis and interpretation of responses which are qualitative in nature.

Rowe and Wright (1999) suggested that only those studies which are true to their origins and that have the four characteristics should be classified as Delphi studies, while others (Adler and Ziglio, 1996; Delbeq et al., 1975; Linstone and Turloff, 1975) advocated that the technique can be effectively modified to meet the needs of the given study.

Delphi procedure

The Delphi exercise involves number of steps to elicit the response of group of experts or members of intended audience and further to modify it. (Rothwell and Kazanas, 1997). The process starts with selection of experts. It is followed by development of questionnaire which can be structured (Rothwell and Kazanas, 1997), and comprehensive of the area of study or unstructured which mainly involves the open ended questions related to area of investigation (Lang, 1998). The questionnaire is sent to the respondents through online or offline modes. The responses collected are analysed and used to develop questionnaire for next round. The procedure is repeated until there is consensus.

The information generated is processed and used by the investigating team to develop a subsequent more focused questionnaire, which is distributed together with the results of the previous round to participants in the third step of the procedure. This process of synthesizing data and refining the questionnaire continues until there is agreement of opinion among participants (Lang, 1998).

Delbecq et al., (1975) described the Delphi technique with the following steps:

1. Formulation questionnaires: The questionnaire may be open ended or require response on a rating scale. They are revised for each round based on the responses from previous round

2. Selection of experts: Experts are selected using snow ball technique, where key informants identify and recommend the experts in the particular area.

3. Sample size: The sample usually varies between 10-30. Anecdotal evidence points out that a sample between ten to twenty is sufficient.

4. Distribute the questionnaire: Sent the questionnaires to selected respondents and collect the responses in prescribed time.

5. Data analysis.: Collected responses are analysed using appropriate statistical techniques to see whether sufficient degree of consensus exist among respondents.

6. Formulation of questionnaire for second round, distribution and collection of feedback: The questionnaire for second round has to be developed based on the feedback from first round. The respondents should be requested to review their responses in this round

7. Data analysis: The responses from second round also analysed for possibility of consensus among experts. If sufficient consensus is reached, the iteration can be stopped. Otherwise the process will continue to next round.

8. Formulation of questionnaire for third round, distribution and collection of responses: Provide the summary of second round to respondents and ask them to review their responses in light of the collective feedback. The collect the responses

9. Data analysis: Consensus is examined using different measures.

10. Develop the conclusion and prepare final report.

Measuring Degree of Consensus

It was observed that, most of the researchers used quantitative and statistical measures such as mean, median, mode, standard deviation, skewness index, interquartile range, and rank for assessing the degree of consensus (Trexler et al., 2006). Some researchers have opined that criteria of consensus need to be identified based on the topic of the research (Kantz, 2005). The method is lacking a universally accepted measure of consensus. It is one of the major drawbacks of Delphi method. (Hung et al., 2008; Murry and Hammons, 1995). Single measure of consensus was followed earlier, but to add more rigour to the method 2-3 criteria are used in recent researches. This could help overcome the problems associated with single measure of consensus.

Some of the measures of consensus are listed below (Birko, Dove and Özdemir, 2015; Rayens and Hahn, 2000; English and Kernan, 1976).

1. De Moivre index (DM): It takes a value of 0 or 1 only depending on whether all respondents have agreement in their opinion.

2. Interquartile Range: It is a measure of variability in data, which can be calculated by taking the difference between largest and smallest values in the middle half of observations.

3. Coefficient of variation (CV): It is the measure of relative variability calculated as the ratio of standard deviation to mean in a set of observations.

4. Pairwise Agreement: Pairwise Agreement is the corresponding average measure of pairwise agreement over all possible pairs of experts

5. Clustered Pairwise Agreement: Based on the pairs of agreement in each consensus cluster.

6. Extremities Version of the Clustered Pairwise Agreement: It is modified Clustered Pairwise Agreement, it takes only the agreements falling in upper or lower bound of the scale (e.g., 1-2-3 and 8-9-10 respectively in our simulation).

English and Kernan (1976) reported that if the value of the coefficient of variation (CV) more than 0.5 and less than or equal to 0.8, it means less than satisfactory degree of consensus and there is possible need for additional round. If CV is less than or equal to 0.5, there is no need for additional round. Elwyn *et al.*, (2006) opined that consensus will not be there if 30 per cent or more of the ratings fall simultaneously in the lower third and in the upper third of the scale. Hackett *et al.*, (2006) considered Fifty-one per cent of experts responding to the highest category as the criteria of consensus, while Beattie and Mackway-Jones (2004) and Roberts-Davis and Read (2001) argues for agreement by more than 75 per cent of experts. The concept of applying more than one consensus criteria is based on the premises of methodological triangulation wherein the methods will substantiate one another (Creswell, 2007; Mason, 2002; Silverman, 2005).

Number of Rounds

The number of rounds in the process of iteration varies depending on the nature and purpose of the exercise. Normally, consensus is reached in two or three rounds (Delbecq et al.,1975). In case of heterogeneous audience, more rounds will be required. In case of homogenous groups, one or two rounds are sufficient. As the number of rounds increases there is a threat of reduction in response rate (Alexander, 2004; Rosenbaum, 1985; Thomson, 1985).

Panel Size

There exists no clear cut rule regarding the size of the panel. It depends on the nature of the study, degree of complexity, required precision and expertise. It can be large or small, geographically dispersed or confined, homogenous or heterogeneous etc. But the rule of thumb is 15-30 people for a homogeneous population i.e., experts coming from the same discipline (e.g. nuclear physicists) and 5-10 people for a heterogeneous population, people with expertise on a particular topic but coming from different social/professional stratifications such as teachers, university academics and school principals (Delbecq et al., 1975; Uhl, 1983; Moore, 1987). According to Adams (2001), by increasing the size beyond 30, reliability and validity hardly improves. It has been pointed out that more than 13 respondents are sufficient to achieve satisfactory level of reliability (Dalkey,1969). Hasson, Keeney, and McKenna (2000) points out that achieving impartiality in recruiting panel members is often difficult. There will be selection bias very often make a case for seeking impartiality in recruiting panel members, but this

Survey Instrument

Delphi questionnaires can be open ended or requiring response on 5-point likert type scale. In some cases, open ended questionnaires are used in first round to have sufficient information base. In the repeated round likert type scales are used based on the first round.

Confidentiality

Responses to the Delphi questionnaires need to be treated with complete confidentiality, and the anonymity of experts in panel was thoroughly maintained throughout the data collection.

Mode of Communication

The mode of communication may be on line or through mailed questionnaires. With the advent of Information and communication technologies there are many possibilities to fasten the process. The applications like 'Google form and Survey monkey' can be effectively used for the purpose

Statistical analysis used

Descriptive statistical analysis such as mean, median, mode, percentage, interquartile deviation (IQD), standard deviation and coefficient of variation were used for analysing the data.

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