

Reflections on the Delphi method

Abstract

The Delphi Expert Method, named after Delphi, the oracle of Ancient Greece, uses the intuitive judgment of a group of experts to reach a consensus. It is an important method for researchers who wish to **create** or **validate** their proposals with the support of a group of experts on the subject. This article outlines the steps to follow: expert selection, the calculation of the statistics tables, and how the experts reach a consensus, both for creating and validating proposals. The article "Reflections on the Delphi Method" is a scientific article on the topic, detailing the methodology used for its application in scientific work. It is not written as a review article. The details for using the scientific method, which has been applied by the author in numerous theses, are explained.

Keywords: delphi method, experimental design, qualitative and quantitative methods, research methodology, validation of criteria

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C Manuel E Cortés,¹ C Miriam Iglesias León,² Manuel Cortés Iglesias¹

¹Department of Applied Mathematics, University of Cienfuegos, Cuba

²Department of Biomedical Sciences, University of Cienfuegos, Cuba

Correspondence: C Manuel E Cortés, Department of applied mathematics, University of Cienfuegos, Cienfuegos, Cuba

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Objective

The goal is to enable researchers to apply one of these two methods in their scientific work in economics, education, production, health and the environment

Introduction

Preliminary ideas

This paper presents a study of the Delphi Expert Method. Its name comes from Delphi, the oracle of Ancient Greece. This method is the systematic use of the intuitive judgment of a group of experts to reach a consensus. It is an important method for researchers who wish to validate their proposal with the support of a group of experts on the subject.

Its main characteristics are:

- i Anonymity.
- ii Facilitator-controlled feedback.
- iii Statistical group response. The information obtained is processed using statistical-mathematical techniques of experimental design.

Considered by some specialists as a qualitative method due to the way information is obtained, by others as a quantitative method due to the application of statistical methods. It is more accurate to consider it a mixed method. The number of experts required ranges from 9 to 30.

The coordinator: The coordinator should be selected based on their interest in the development of the topic.¹

Requirements for the selection of experts:

- i Experience in the topic
- ii Demonstrate interest in the work and creative thinking.
- iii Must be interested in the work, reflective, decisive, and available to participate.
- iv If faculty, must have teaching and research experience. If not faculty, must have proven knowledge of the topic.
- v Scientific publications.

Select from the list of candidates those experts who meet the predetermined requirements of experience, years of service, subject

matter knowledge, and who possess a high competence coefficient. Among the selected experts:

Determination of each expert's competence coefficient:²

K comp. = $\frac{1}{2} (Kc + Ka)$ Competence coefficient of each expert

Where,

Kc: Knowledge Coefficient. A survey is conducted in which the candidate assigns a value to each question, based on their perceived knowledge of the topic. The coefficient is the average of the values assigned to the candidate.

Ka: Argumentation Coefficient. This is the sum of the values representing the degree of influence of each argumentation source with respect to a standardized table.

Competence

Given the coefficients Kc and Ka, the competency coefficient K comp is calculated for each expert according to the following criteria:

- i The expert's competency is HIGH if $K_{comp} > 0.8$
- ii The expert's competency is MEDIUM if $0.5 < K_{comp} \leq 0.8$
- iii The expert's competency is LOW if $K_{comp} \leq 0.5$ ^{3,4}

Discussion

Types of Delphi

Three types of the Delphi technique are identified, according to how they are applied:

- i Traditional Delphi (**Create**) for the creation of criteria or alternatives, or for the rounds: This is the classic method for obtaining expert opinions on a selected topic. It consists of rounds or submissions of a questionnaire sent to a group of experts, with a second round or questionnaire based on the results of the first. There may also be a third round or questionnaire to discard less frequently used questionnaires. Finally, statistical processing is used to determine the experts' consensus.^{2,3}
- ii Delphi for the validation of criteria or alternatives by experts (**Validate**): This is characterized as a shorter variant where the process is carried out in a single round, using statistical mechanisms.⁴

iii Political Delphi, proposed in the 1970s, aims not for a group to make a decision, but rather for a group of experts to present all possible options for a problem and evidence to support their arguments, instead of having a group make a decision. This type is not studied at work.

The two classical methods:

A. Traditional Delphi Method (Creating Alternatives)

The Delphi Method for generating alternatives by experts consists of three rounds.^{3,5}

i First round: Table of Observed Frequencies.

In the first round, the facilitator should write a brief explanation to the experts as to why they were selected and what the objective of the research project is. The facilitator explains how they are involved due to their knowledge and experience in the field. Next, the open-ended question is clearly and precisely formulated, asking the experts to provide their written opinions and respond via correspondence, primarily email nowadays. Once the facilitator receives the responses, they can construct a table where the rows are reserved for the experts (let's say m) and the columns for the opinions they expressed (let's say n). An X is placed in the table at the intersection of each expert's entry and the opinion they formulated.

The facilitator here should group the criteria, eliminating verbatim repetitions and rephrasing similar ones, so that all experts see their ideas reflected. The criteria should be grouped in order of appearance, never in order of importance, since the facilitator should not participate directly in the process. (Table 1)

Table 1 Table of observed frequencies

Experts	Criteria 1	Criteria 2	.....	Criteria n
Expert 1		X		
Expert 2	X			X
.....				
Expert m	X	X		

ii **Second round:** The criteria grouped in the table above are sent to the experts so they can mark with an X those they consider most important. The criteria themselves are listed, but not the person who issued them, as anonymity must be maintained until the end. The facilitator receives the experts' results and then begins the process of eliminating those that do not represent the majority of the experts. Criteria supported by less than the percentile chosen for the research (for example, those representing less than 20% of the experts) are eliminated. Some experts work with confidence intervals of 1%, 5%, or 10%, while others leave the values within the confidence interval (Mean-3 Standard Deviations, Mean+3 Standard Deviations). Generally, this round successfully eliminates the minority criteria. If there are problems with this, an additional round should be conducted to clearly define the eliminated criteria. With the finally accepted criteria, the process moves to the next round.

Note: Additional rounds can be done as needed according to the interests of the discussion.^{2,3}

iii **Third round:** Evaluation round

Expert Evaluation of Criteria 1 through m (1 being the highest)

Obtaining the Payoff Matrix.

Here, the ligatures assigned by the experts are calculated.

The table of evaluations given by each expert to each criterion is constructed.

Using the table obtained in Round 3, the statistical calculation begins:

- i Cumulative Values by Rows and Columns.
- ii Calculation of the Ligatures.
- iii Calculation of Kendall's W coefficient for expert agreement.

This is the **Weighting Round** for the criteria for each expert. The definitively accepted criteria are sent to the experts, who are then asked to determine the weight of each criterion, from 1 (the best or most important criterion) to N (the least important or last criterion selected). This means that the experts must assign a value to each criterion, a number between 1 and N. Criteria that the experts consider to be of equal importance can be assigned the same value; this is called binding. The facilitator then obtains a table similar to the one seen previously, but with the numerical values assigned by each expert to each criterion (Table 2).

Table 2 Evaluation round

Experts	Criteria 1	Criteria 2	.....	Criteria n
Expert 1	R11	R12		R1n
Expert 2	R21	R22		R2n
.....				
Expert m	Rm1	Rm2		Rmn

Where Rij is the evaluation given by expert i to criterion j, this value is in the range (1, n), n is the number of criteria, and m is the number of experts.

Now we come to the statistical aspect of the Delphi Method, which up to this point has been purely qualitative. Kendall's W coefficient must be calculated for the expert assessment. This is simply a linear regression coefficient that gives us the degree of correlation between the experts, or the so-called agreement. This index ranges from zero to one. $W = 0$ would mean that there is no agreement between the experts; they do not agree with the ideas reflected in the work. $W = 1$ would mean that there is perfect agreement between the experts with the criteria and their order. If the value is negative, it would indicate that the order of the criteria is not agreed upon by all.

The hypotheses formulated using W (Kendall's coefficient) are of the following type:

Null hypothesis: H0: W = 0 There is no community of interest among the experts regarding the criteria.

Alternative hypothesis: H1: W ≠ 0 The experts agree with the criteria; there is a community of interest.

Working with SPSS for the results:

- SPSS
- Analyze
- Nonparametric methods
- Legacy programs
- K relative samples
- Pass variables to the test box
- Test type: Kendall W ok

For a significance level ($\alpha = 0.05$) and a 95% confidence level, the following results are obtained:

Asymptotic significance $\leq \alpha = 0.05$ indicates that H1 is true (there is a shared interest among the experts).

Asymptotic significance $\geq \alpha = 0.05$ indicates that H0 is true (there is no shared interest among the experts).

B. Delphi method for validating alternatives^{3,6}

The Delphi method for evaluating alternatives by experts consists of a single round.

There is a group of m alternatives or stages (provided by the coordinator).

A set of k cut-off points or evaluation categories is established using a Likert scale:

Very suitable, quite suitable, suitable, somewhat suitable, and not suitable

Very good, good, fair, poor, very poor

The facilitator constructs the table of total results for the N experts:

Table of statistical treatment

- i Observed Frequency.
- ii Cumulative Frequency Table.
- iii Construct the relative cumulative frequency table.
- iv Work with the normal distribution table.
- v Calculate the cut-off points.

Define each element of the table above among the number of experts (Table 3).

Table 3 Table of statistical treatment

Alternatives	Evaluation category				
	C1	C2	.....	Ck	
A1					
A2	Expert evaluation				
Am					

	C1	C2	C3	.....	Ck
A1	T11	T12	T13	.....	T1k
A2	T21	T22	T23	.....	T2k
.....
Am	Tm1	Tm2	Tm3	.....	Tmk

Statistical treatment

Define each element of the table above among the number of experts.

- i Construct the cumulative frequency table (Table 4a):
- ii Construct the relative cumulative frequency table (Table 4b):

There are k criteria and k-1 cut-off points will be found, so column k is not necessary since it always represents 100% or the number 1 in the cumulative total.

c) Working with the inverse normal distribution³ (Table4c).

Table 4a Construct the cumulative frequency table

	C1	C2	C3	.....	Ck	Total
A1	T11	T12	T13	.....	$\sum_{j=1}^k T1j$	$\sum_{j=1}^k T1j = T1$
A2	T21	T22	T23	.....	$\sum_{j=1}^k T2j$	$\sum_{j=1}^k T2j = T2$
.....
Am	Tm1	Tm2	Tm3	.....	$\sum_{j=1}^k Tmj$	$\sum_{j=1}^k Tmj = Tm$

Table 4b Construct the relative cumulative frequency table

	C1	C2	.....	Ck-1
A1	Define each element of the table			
A2	above by the number of experts			
	$\frac{\sum_{k=1}^k Tik}{N}$			
Am				

Table 4c Inverse normal distribution

Inverse normal distribution	C1	C2	.....	Ck-1	Sum	p average
A1	Z11	Z12	.....	Z1k-1	$\sum_{j=1}^k Z1j$	$\frac{\sum_{j=1}^k Z1j}{k-1 = Z1}$
A2	Z21	Z22	.....	Z2k-1	$\sum_{j=1}^k Z2j$	$\frac{\sum_{j=1}^k Z2j}{k-1 = Z2}$
.....
Am	Zm1	Zm2	.....	Zmk-1	$\sum_{j=1}^k Zmj$	$\frac{\sum_{j=1}^k Zmj}{k-1 = Zm}$
Cut-off points	$\frac{\sum_{i=1}^m Zi1}{PC1}$	$\frac{\sum_{i=1}^m Zi2}{PC2}$	.....	$\frac{\sum_{i=1}^m Zi{k-1}}{PC{k-1}}$	$\sum_{i=1}^m \sum_{j=1}^{k-1} Zmj$	N

Working with the inverse normal distribution table, find the z-value corresponding to the inverse normal distribution in each cell of the previous table, obtaining the following table.

Cut-off points

The cut-off points are used to determine the category or degree of suitability of each stage of the procedure according to expert opinion.

The confidence intervals give us (Figure 1):

The location of the N-P values for each alternative on the numerical ray of the cut-off points will give us the criteria that the experts assign to each of the alternatives.

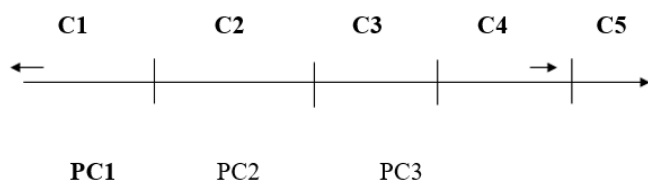


Figure 1 Cut-off points.

Among the main disadvantages of applying the Delphi method are:

The results depend on the quality of the experts.

- i Risk of bias from the leader or facilitator.
- ii Lack of generalizability if the experts come from similar backgrounds or have similar knowledge.
- iii Dependence on the panelists' commitment to remain in the process.
- iv A lengthy process if the maximum number of rounds is not determined beforehand.

Various scientific articles with applications of the Delphi Method to Health Sciences, published by the authors, can be studied in the references.⁷⁻⁹

Conclusion

The Delphi Method has three types of applications: Create, Validate, and the Political, which is not covered in this paper. Delphi is a method for working with experts for research purposes. This article presents the theory, its working process, and the statistical procedures used in the different types of the Delphi Method.

In the Create phase, experts provide the steps or activities that must be carried out to begin the proposed task.

In the Validate phase, experts provide their consensus on the activities or steps that the researcher has carried out.

The Delphi method offers advantages for scientific work: results arise from the perspectives of several experts, not just one;

communication is maintained; results are shared by all; and ideas and judgments are well-linked.

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Conflict of interest

The authors declare that there are no conflicts of interest.

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