

DELPHI TECHNIQUE: ENHANCING RESEARCH IN TECHNICAL AND VOCATIONAL EDUCATION

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ABSTRACT

Empirical studies conducted within the Technical and Vocational Education (TVE) discipline in Malaysia tends to give greater emphasis to quantitative data collection techniques. Aware of the potential usefulness of combination of techniques, this paper discusses the application of the Delphi technique where qualitative and quantitative data collection techniques are used to reach useful results. The Delphi technique provides the opportunity for researchers to gather input from participants without requiring them to work face-to-face. Often, the process is used to find consensus among experts who have differing views and perspectives. The Delphi technique enables group problem-solving using an iterative process of problem definition, discussion, feedback, and revisions. This paper discusses the basics of the Delphi techniques, its application potential, the selection of expert panels and the means on how consensus can be reached among the participants using examples from our past research using the technique.

Keywords: *Delphi Technique, Technical and Vocational Education, Expert Panels*

1. INTRODUCTION

Technical and Vocational Education (TVE) plays a vital role in developing the country's progress. TVE has been known to produce transformations in producing quality products as well as competitive and skillful work-force. Based on the Malaysian New Economic Model (NEM), the government has underlined the importance of developing and maintaining world-class talent to transform Malaysia into a high income country. Thus, the government is taking initiatives to mainstream TVE into the tertiary education system. However, TVE in Malaysia is seen as a last resort in career development choices because of the perception of limited career opportunities. In contrast, TVE is the preferred choices for students in the developed countries because as TVE is seen as the means to good career prospects for their future. Thus the government is making every efforts to change the perception and to show to the masses that TVE actually provides an alternative platform for the students to realize and maximize their potential.

Each year, a total of 100,000 SPM leavers enters the job market without any skills training. Based on the human labor statistic, only (23%) of the workforce can be categorised as highly skilled workforce. This percentage is much lower compared to other developed countries. Malaysia needs to increase the composition of highly skilled works to (37%) by 2015 to become a developed and high-income country by 2020 (Ministry of High Education, 2012). According to Ilies, Morgeson and Nahrgang (2005), TVE is an educational system that provides specialized training to increase the level of skills and some other skills in leading toward a developing country. To sustain TVE the TVE regional center (UNEVOC) has outlined several strategies for sustaining TVE where research is one the key strategies.

Research in TVE field have predominantly used the quantitative research design approach and less so the qualitative approach. Thus, in this article we will discuss one research approach that effectively combine the quantitative and qualitative approach namely, the Delphi technique which can be used by TVE researchers for structuring a group communication process to facilitate group problem solving and to structure models. The method can also be used as a judgment, decision-aiding or a forecasting tool (Hallowell & Gambatese, 2010), and can be applied to program planning and administration (Linstone & Turoff, 1975). The Delphi method can be used when there is incomplete knowledge about a problem or phenomena (Skulmoski, Hartman, & Krahn, 2007). The method can be applied to problems that do not lend themselves to precise analytical techniques, but rather could benefit from the subjective judgments of individuals on a collective basis (Robert Loo, 2002) and to focus their collective human intelligence on the problem at hand (Linstone & Turloff, 1975). Also, the Delphi is used to investigate what does not yet exist (Czinkota & Ronkainen, 1997; Halal, Kull, & Leffmann, 1997; Skulmoski & Hartman 2002). The Delphi method is a mature and a very adaptable research method used in many research arenas by researchers across the globe. To better understand its diversity in applications, one needs to consider the origins of the Delphi method.

2. UNDERTSANDING THE BASIC CONCEPT OF THE DELPHI TECHNIQUE

Many have examined a variety of studies that have used the Delphi method (Adler & Ziglio, 1996; Linstone & Turloff, 1975; Rowe & Wright, 1999). The range of Delphi possibilities can be seen in Table 1. The Delphi has been used in research to develop, identify, forecast and to validate in a wide variety of research areas. While a three round Delphi is typical, single and double round Delphi studies have also been completed. Finally, the sample size varies in their studies from 4 to 171 "experts". One quickly concludes that there is no "typical" Delphi; rather that the method is modified to suit the circumstances and research question.

Table 1: Published Research

Study	Delphi Focus	Rounds	Sample Size
Gustafson, Shukla, Delbecq, & Walster (1973)	Estimate almanac events to investigate Delphi accuracy.	2	4
Hartman & Baldwin (1995)	Validate research outcomes.	1	62
Czinkota & Ronkainen (1997)	Impact analysis of changes to the International business environment.	3	34
Kuo & Yu (1999)	Identify national park selection criteria.	1	28
Nambisan et al.(1999)	Develop a taxonomy of organizational mechanisms.	3	6
Lam, Petri, & Smith (2000)	Develop rules for a ceramic casting process.	3	3
Schmidt, R., Lyytinen, Keil, & Cule (2001)	Identify and rank software development project risks: an international comparative study.	3	Finland: 13, 13, & 13 Hong Kong: 11, 11 & 9 USA 21, 21 & 9
Keil, Tiwana, & Bush (2002)	Rank software development project risks.	3	15, 15 & 10
Roberson, Collins, & Oreg (2005)	Examine and explain how recruitment message specificity influences job seeker attraction to organizations.	2	171

Based on the review it was identified that there are several versions of the Delphi techniques for example the Modified Delphi technique. While the Delphi is typically used as a quantitative technique (Rowe & Wright, 1999), a researcher can use qualitative techniques with the Delphi method. Qualitative research is interpretivist in the sense that the researcher is interested in how the social world is interpreted, understood and experienced; the researcher is flexible and sensitive to the social context within which the data were collected; and qualitative research is about producing holistic understandings of rich, contextual and detailed data (Mason, 1996). Qualitative research is also about engaging in conversations

with the research participants in a natural setting as opposed to research conducted in a laboratory (Creswell, 1994). The qualitative researcher attempts to make sense of or interpret the phenomena in terms of the meaning the participants place on them (Creswell, 1998). The Delphi method is well suited to rigorously capture qualitative data. It may be seen as a structured process within which one uses qualitative, quantitative or mixed research methods. Such flexibility not only affords the ability of the method to answer many research questions, but also can be well matched to the abilities and aptitudes of the researches.

To reiterate, the Delphi technique is a framework used to conduct a research by collecting and analyzing opinions of a group of experts in the fields of the chosen study. This method was initiated by a group of scholars at the RAND Corporation, Santa Monica, California, United States of America (USA) in 1952 to develop the potential in military, especially in the air force of the country concerned. Originally this method is used to anticipate the development of things in the future along with the time period. This method was first introduced to the public in 1962 and since then Delphi technique has been developed and widely used in various fields such as economy, politics, education, science and technology. The orientation of the Delphi technique has changed a lot with various modifications based on the needs and goals of a study conducted.

In relation to education, Helmer (2002) stated that this technique is efficient in determine the competency of teachers, the curriculum or lesson content and direction of specific goals as an educational system. These techniques meant to provide a different angle and view compared to the usual method such as surveys and questionnaires. Questionnaire and survey method can only provide feedback and information which is limited but also bound to a specific field as fully constrained by the questions in the questionnaire. Instead, the Delphi technique would be able to give a different and more comprehensive view in nature.

In other words, this technique could help researchers gain a more comprehensive and in-depth information. This mainly involves the study of the issues or aspects that are basically untapped widely and there is no sufficient prior information to be referred by the researcher. Therefore, the evaluation and feedback from a group of experts is the best way to get an accurate and sufficient data for a limited period and circumstances.

This technique is said to be a unique method, especially in the process of collecting and refining the review of all the information thus obtained feedback from a group of experts who have been selected. In the Delphi technique, there are three resources that will determine the final outcome of the study. The three resources are knowledge, suggestions and speculative submitted by each expert. Through these three sources, the agreement or consensus on the decision to be made by a group of experts will be more accurate and true. Knowledge is the key resource in making a decision because it can be used as a basis in giving the right suggestion and information. With knowledge, speculation can be made so that it can be used as a source of information despite the lowest status to make decisions. Thus, the use of speculation, suggestions and knowledge among experts in decision making is the most suitable for predicting a future expansion (Olaf Helmer, 2002).

2.1 The Limitation of Delphi Technique

Each method of study certainly has its strengths and weaknesses. However, according to Saedah (2013), there are seven advantages of using the Delphi technique namely; (i) to obtain a genuine consensus of experts as per experts do not know or have never met each other; expert consensus can be achieved without favoritism, influence and pressure from any other party, (ii) experiment was repeated with the data from each round of Delphi technique will screened through data analysis, (iii) fast and effective, (iv) the experts view are consistent with their respective areas of expertise, (v) can be used to make future expectations, (vi) can be used effectively and to get a lot of opinions on complex issues and (vii) based on Basu and Schroedar (1977) error percentage in Delphi technique was only three to four percent while the error for the quantitative technique is ten to fifteen percent, and errors of approximately twenty percent of the expected traditions subjective and unstructured.

The limitation of this method according to Saedah (2013) are several. First, the reliability of the data are highly dependent on the experts involved. If researchers fail to choose good experts, the credibility of the findings will be affected. In other words, the accuracy of forecasting are constrained by the quality of the views given by the experts. As the data collection are repeated on the same sample, boredom may set in, affecting the quality of responses. Furthermore, the Delphi is a technique for the foreseeable future, loss of reliability means lose hope and determination. Additionally, the small number of experts are not able to solve all the pertinent aspects of the issue. Lastly, there is little chance of getting an emotional reply which may be relevant to the issue under study.

2.2 Procedures in THE Delphi Technique

The starting point of the Delphi method is subject to many interpretations. Some previous Delphi research has recognized that preparatory effort is necessary before the start of the rounds, but does not distinguish this work as a separate stage. Furthermore, the development of the initial base of knowledge has been traditionally considered as a first round of the study. The starting position for the Delphi (the first version of the questions) can be established by either exploratory or confirmatory in nature. The former is best implemented by seeking the views of the informants through an initial open-ended question or a set of preliminary interviews (Hasson et al. 2000). This approach is particularly apposite for the more vague, ill-defined or contradictory situations often found in social, political and/or organizational worlds. It emphasizes the qualitative dimension to the Delphi and hints that it might be successfully integrated with other research methods. The confirmatory form of the Delphi initial stage is traditionally carried out by circulating a predefined list of issues to the panel (Niederman et al 1991). This is the typical mode of working for follow up studies (Brancheau et al 1996, Gottschalk 2000).

In the present work the introduction of the stage-organization allows for the initial round to be distinguished from the rest of the Delphi iteration, based upon the differences in goals: that is, 'generation' vs. 'evaluation and extension'. This refinement allows for further development of Delphi variants, allowing application for theory testing and extension, where the theory is generated through either secondary or primary research. In this particular application of the method for evaluation of a conceptual framework, the list of issues presented to the participants reflected the perspectives and components of the proposed

framework, thus negating the need for an initial 'generation' round. The remainder of the present study was focused on developing a group consensus about the components and adhered to the normal form of inquiry for a 'ranking type' Delphi (Schmidt, 1997). This included a series of four rounds, conducted over a period of twelve months. After collecting the participants' scores, a convergence ratio was determined. This represents the extent of participant agreement about the ranking of the leadership elements. Measuring the inter quartile of votes that fall within a prescribed range is a common approach to assess consensus.

2.3 The Selection Sample Size of Experts

Previous researchers have put forward several suggestions in determining the sample size or number of expert panels through Delphi technique. Based on the opinion of Sekaran (2003), an expert panel formed with members of 7 to 100 people are suitable to obtain robust findings. However, according to Linstone and Turoff (1975) the large number of expert panels will make it more difficult and often reflects negative implications while performing fieldwork. Next, they propose a suitable number of the expert panel, which is about 5 to 10 people only. Dalkey (1972) recommended that in every Delphi study it is sufficient to involve more than 10 expert panels to generate robust findings.

Meanwhile, according to (Delbecq, Van de Ven, 1975) and (Ludwig, 1997) they asserted that the number of 3 to 5 people is too small and not able to provide feedback on an issue that has been identified. Next, they propose a panel of expert, as a group of specialists from the same discipline and this requires the involvement between 10 to 20 people. Consistent with the view of (Dalkey, 1971), Linstone (1975), (Delbecq, Van de Ven, 1975), (Ludwig, 1997) and (Lanford, 1972) the researchers have established a total of 10 panel experts in a Delphi study. This amount was appropriate in the range. Delphi study was conducted in four rounds but can be run over more than four rounds or less depending on the information needed (Delbecq, Van de Ven, 1975).

2.4 Criteria for Choosing the Delphi Technique Expert

The Delphi technique is used because it is designed to optimize the input which will be sought from the individuals involved in the group that formed the expert panel. The most important thing to be considered in the use of the Delphi technique is the selection of experts. Based on the view of (Olaf Helmer, 2002) defines an expert as someone who has mastered the field very well and can respond very fast in the matter concerned (This response appears sometimes without thinking and may well emerge from the subconscious).

In the meantime (Bogdan, R.C & Bliken, 2002) defines an expert as a person who is knowledgeable in a particular field. While Zainudin (2012) suggest some of the following criteria as a guide for choosing a person to become an expert panel. Among them is a good appearance and respected by professionals, the number of papers that have been produced and presented to the public at the national or international level, and publications that have hit the market and the number of studies that have been performed.

2.5 Consensus in Delphi Technique

All information and insights gained from the questionnaire in the Delphi technique controlled repeatedly by researchers. This monitoring is done by notifying each member of the group on the tendency of the answer in each round and accompanied by a recent decision made by the group of experts on issues and research questions (Martino, 1972). By controlling every feedback given repeatedly, the researcher can ensure that members of the expert group always provide feedback needed to meet the objectives of the study only and not answer individual goals based on interest or any other member.

For the first round of the Delphi technique, the questions in the interview protocol were initially examined by an expert in the areas of studies and qualitative. Furthermore, a pilot study has been conducted in order to check on the validity and reliability of the questions in the interview protocol. This was to ensure that the questions reflected the main research questions and were able to generate accurate answers for the research findings. Furthermore, the transcripts produced in the transcription process also been checked by the participants. The participants had verified the contents of the transcript and corrected an error that could deviate the meaning of the original interview being conducted.

For the second round, the questionnaires which contained the indicators and item were distributed to all experts to gain for their approval on each item. It then followed by the third, fourth and more round surveys in order to get the highest consensus from all experts on the content of the questionnaires. With several rounds of studies, Delphi techniques managed to achieve the reliability of its findings. All the experts were given opportunity to improve the content of the questionnaires in the first two third rounds with the final answers in the last round while reaching the highest consensus of all experts.

3. EXAMPLE APPLICATION OF THE DELPHI TECHNIQUE IN TVE

The Delphi Technique is illustrated here based on a past study conducted by a group of researchers (authors) in TVET. The objective of this particular study was to obtain indicators of good educational leaderships for the Malaysian polytechnic system using the Delphi technique of four rounds. The purpose of these indicators were to obtain characteristics that should be developed by leaders in the context of the Malaysian polytechnics. These leaderships characteristics are very important in the efforts to transform the Malaysian polytechnic system in particular and developing educational organizations in general. This study involved ten experts in the related fields of TVE, education and leadership in the context of TVE. Interviews were conducted in the first round, and questionnaires were distributed in the second, third and fourth round. Only four rounds were run because the findings had reached high consensus and agreement among participants after the fourth round. A total of 188 indicators were obtained from the first round and subsequently circulated to the experts for the following rounds (two, three and four).

3.1 Selection of experts

In this study, the Delphi technique is using purposive sampling method to get a sample. The researcher will take into account a sample's criteria that were discussed earlier. Based on these two definitions, the researcher set the selection of experts based on four criteria: (i) holds a Doctor of Philosophy (PhD), (ii) has good knowledge and in-depth knowledge areas

studied, (iii) those directly involved in the areas studied, (iv) those who produce a lot of writing including journals, books, articles, studies and project in the area studies. Zainudin (2012) stressed that the selection of the individual as an expert panel is depends on the objective of which was built as the question in the Delphi technique. What is important is the quality of the expert panel members and not the quantity. French (2005) also explained that a panel of experts selected on the basis of their willingness and ability to express an opinion on the topics to be discussed and have in-depth experience on the matter.

3.2 Procedures in “The First Round of Delphi Technique (Interview)”

Before implementing the first round of interviews for the Delphi study, researchers have identified certain individuals who meet the criteria as a participant. The researcher then contact the selected experts to state their agreement to participate in this Delphi study. Next, an appointment letter was to follow. Once the date, place and time of the interview were set, the researcher began the interview. During the initial meeting with the participants of the study, the researcher described the following aspects of the study (i) the conceptual framework and design of the study, (ii) the Delphi technique concepts and, (iii) conditions to participate in the research through a letter of consent to the participants. The first interview about Delphi study was conducted once they understood the conditions. Interviews took 1 to 1 hour and 30 minutes for each participant based on the script and the interview protocol which was systematically arranged. The implication was that the interview would be focusing on the objectives of the study and the participants would be easily understood the questions posed by the researcher (Johnson, B., & Christensen, 2000).

To ensure the process of data analysis can be carried out efficiently and effectively, researchers had implemented the following actions during the first round of interviews (i) to record every conversation so that researchers can concentrate on the feedback. This will facilitate the process of data analysis if they record the conversations thoroughly (Kahn, 2006), (ii) the main content of the conversation recorded in general so the researchers would be able to construct questions to gather the next stage of the conversation. The collected data is more detailed and meaningful if combined with data recorded earlier (Gay, 2006). However, before the audio recording is made, the researcher will ask for permission from all participants in the study.

The researcher has to comply with certain procedures on the first round of this study. According to (Gay et al., 2006), to produce a robust findings from interviews (i) researchers need to adopt a neutral attitude in giving their views and to respond to the feedback given by the participants. Such action is done to avoid distracting the participants to give their view and (ii) researchers need always to be in a calm situation, cheerful and convincing the participants that their response would be kept confidential. This will make the participants more confident to give their view. When the researcher believes the data were adequate and did not require any new data, they terminated the interview. The next action was to immediately transfer the data from the voice recorder to the hard disk in the computer and then to label it with a code ‘P1’ (First Expert). This was done repeatedly until the tenth expert. For the transcriptions, the researcher listened, analyzed, understood and decode each sentences that were recorded manually and using Atlas Ti software. Efforts to examine each transcription is very important because there is a difference between the language of the

written language (Poland, 2002). The analysis of the coding were to be included in the questionnaire for the next round.

3.3 Procedures in “The Second Round of Delphi Technique (Questionnaire)”

The development of the indicators was continued through to the second round of the Delphi technique which was achieved by distributing questionnaire to ten experts. The questionnaire consists of 188 items which were based on the findings from experts in the first round of the construction process of the leadership indicators. In the second round, each expert panel was asked to indicate their level of agreement, either strongly disagree, disagree, somewhat agree, agree and strongly agree to the statements presented in the questionnaire.

Besides stating their level of agreement, expert were given the opportunity to add a new items in the spaces provided if these items were deemed relevant but was not recommended in the first round of Delphi. The results of the second round of the questionnaire was analyzed using median and inter quartile range (IQR). Range between quartiles (IQR) were used to describe the consensus among experts for each item whether high, medium deal or no deal, and the median for each item indicate the level of agreement (Peck and Devore, 2011). Table 1 shows how the IQR from the questionnaire for a second round Delphi Technique were to be interpreted.

High consensus	= IQR 0 to 1.00
Moderate consensus	= IQR 1.01 to 1.99
No consensus	= IQR 2.00 and above

(Peck & Devore, 2011)

High agreement	= Med 4 to 5
Moderate agreement	= Med 2.01 to 3.99
No agreement	= Med 0 to 2

3.4 Procedures in “The Third Round of Delphi Technique (Questionnaire)”

During the third round, the experts were asked to re-analyse the results from the second round without opportunity for adding new items. Justifications were required if levels exceed the scale of the consent agreement for the majority of the previous round. In short, the third round was to reduce the difference of opinion among the participants of the panel of experts.

3.5 Procedures in “The Fourth Round of Delphi Technique (Questionnaire)”

The purpose of the fourth round was to reduce the difference of opinion among the expert panel participants towards the analysis in the third round. In this final round, all items used in the study have reached a consensus among the experts. Thus, this fourth round of Delphi technique was discontinued and the items selected were used for research purposes. Decision to stop the number of rounds was made when a high degree of consensus had been reached was consistent with the opinion of (Asnul Dahar Minghat, 2012). They have pointed out that it should be in between 2 to 10 rounds to get the best results that comply with the objectives of the study. However, they also state that the number of rounds can be stopped after researchers have obtain enough information or if there is a preliminary agreement with a

number of rounds the researchers need to conduct. Table 2 illustrates how the result was to be presented on the assessed indicator.

Table 2: Data Analysis result of for the Second to Fourth Round of Delphi Study to Obtain the Indicators of Leadership

dicators	Second Round			Third Round			Fourth Round		
	Med	IQR	Consensus	Med	IQR	Consensus	Med	IQR	Consensus
Vision and mision	4	0	High	5	2	No Consensus	5	1	High

Med = Median, IQR =Inter Quartile Range

4. CONCLUSIONS

This article presents the basic concepts of the Delphi technique and provides examples related to the TVE. The Delphi technique provides a platform for participants to give their views and ideas. It also provides different opportunities for participants to conduct the research. What is important in this technique is the quality of communications that transpires, the quality of selected experts and the quality of feedback from each expert. The most important strength of this technique lies in its ability to get opinions and a consensus among a diverse group of participants, covering various rounds. Thus, this technique is a flexible research technique well suited when there is incomplete knowledge about phenomena. Furthermore, as illustrated, the technique is not purely a quantitative method, but works very well in qualitative research. We believe that this method is well suited to TVE research because it is a fluid discipline ripe for research. There are many varieties of Delphi ranging from qualitative to quantitative, to mixed-method Delphi. While there are many varieties of Delphi, common to all are design considerations that need to decide upon including sample composition, sample size, methodological orientation (qualitative and/or quantitative), the number of rounds, and mode of interaction. Considering these choices help to add rigor to the method. Increased rigor contributes to a successful Delphi and deeper understanding of the phenomenon. Finally, two important considerations; first, the Delphi approach can be aggressive and creatively adapted to a particular situation. Secondly, when adapting the approach, there is a need to balance between validity with innovation. In other words, the greater the departure from classical Delphi, the more likely it is that the researcher will need to validate the results, by triangulation, with other methods. The contributions of other researchers are therefore vital to break through this conceptual barrier. Their efforts will be well-rewarded since they will acquire a flexible and simple way for exploring and evaluating many challenging topics in the realm of technological, managerial and organization studies in TVE.

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