Available online at 2019.creative-construction-conference.com/proceedings/

CCC 2019

Proceedings of the Creative Construction Conference (2019) 089

Edited by: Miroslaw J. Skibniewski & Miklos Hajdu

https://doi.org/10.3311/CCC2019-089

Creative Construction Conference 2019, CCC 2019, 29 June - 2 July 2019, Budapest, Hungary

Assessment of the Use of Delphi Technique in Sustainable Infrastructure Development Research

Simon Ofori Ametepey[a,d]*, Clinton Aigbavboa[b], Wellington D. Thwala[c]

[a]*Department of Civil Engineering, University of Johannesburg, Johannesburg, South Africa*
[b,c]*Department of Construction Management and Quantity Surveying, University of Johannesburg, Johannesburg, South Africa*
[d] *Building Technology Department, Koforidua Technical University, Koforidua, Ghana*

Abstract

The Delphi technique over the recent decades has increasingly become generally recognized and accepted by a vast range of institutions, government departments, and policy research organizations across the globe. The Delphi method was originally developed in the 50s by the RAND Corporation (an American non-profit global policy think tank aimed at offering research and analysis to the United States Armed Forces) after a series of studies and observations in Santa Monica, California. This approach encompasses a survey conducted in two or more rounds and affords the participants in the second round with the results of the first so that they can modify the original assessments if they want to or stick to their former opinion. It is usually presumed that the method makes better use of group interaction whereby the questionnaire is used as the medium of interaction. The Delphi method is especially useful for long-range forecasting; as expert opinions are the only source of information available. The objective of this paper is to outline how the Delphi technique process was used to predict and understand issues surrounding sustainable infrastructure development in developing countries. The paper's objective is based on the premise that the technique has not been widely used to study sustainable infrastructure development, despite several empirical studies that have been conducted in its favour. This is because the Delphi approach solicits experts' views on subjects surrounded with confusion. The methodological approach adopted for the study was a content analysis of published peer reviewed journal articles with regard to the use of the technique in Sustainable Infrastructure Development studies. The Delphi technique is discussed because it is an accepted and reliable research technique that helps to resolve experts' disagreement with issues.

Peer-review under responsibility of the scientific committee of the Creative Construction Conference 2019.

Keywords: Assessment; Delphi Technique; Developing Countries; Research; Sustainable Infrastructure

1. Introduction

The Delphi technique was originally developed in the 1950s as a tool for forecasting and problem solving of complex topics at the RAND Corporation by Helmer and Dalkey [8]. The inspiration behind the naming of this technique is based on Greek mythology. The oracle at Delphi located at an ancient Greek Temple was consulted to forecast the future. This religious ritual was done to enhance accurate and timely decision making before carrying out major societal and state activities such as waging war against other States. The method adopted by the research team at RAND was that, experts of a particular subject matter could be solicited for their opinion about the likelihood of future events or

*Ametepey, SO: Author email: oforipmp@gmail.com

scenarios within that same field of the subject matter. The Delphi technique is part of a group of decision-making (policymaking) techniques that includes the nominal group technique (NGT) and interacting group method (IGM). Where The Delphi technique differs in various ways from NGT and IGM, largely because it is how individual based, anonymous and independent it is.

The element of group interaction is eliminated from the technique and feedback to questionnaires is in written format [33]. According to Loo [33], the Delphi process is mostly used when investigating and drawing up policy-making or policy evaluation strategies that will set the future direction for public or private sector respectively. The thesis adopting this method was aimed at setting a future direction for sustainable infrastructure development in developing countries. Furthermore, the technique is a qualitative methodology seeking to produce a consensus of a group of experts on an issue of concern [36] through a survey consisting of rounds. The method is based on structural surveys and makes use of the intuitive available information of the participants, who are mainly experts within the discussed subject matter. The method provides qualitative as well as quantitative results and has beneath it explorative, predictive and even normative elements. There is an agreement that Delphi is an expert survey in two or more 'rounds' in which the results and findings of the second and later rounds of the survey of the previous round are given as feedback. That is, the participants who are experts answer from the second round under the influence of the other experts' opinions. Thus, the Delphi method is a relatively strongly controlled group communication process, in which matters, on which naturally unsure and incomplete knowledge is available, are judged upon by experts [20]. The technique requires knowledgeable and expert contributors individually responding to questions and submitting the results to a central coordinator or a researcher conducting the study [3]. The coordinator processes the responses, looking for central and extreme tendencies, and their validations [19]. The results are fed back to the input provided by the coordinator (researcher). The experts are then asked to resubmit their opinions, aided by the input provided by the coordinator (researcher). This process continues until the coordinator sees that a consensus has been formed. The technique removes the bias that is possible when diverse groups of experts meet together, which is common with other methods of decision making. In the Delphi method, the experts do not know who the other experts are in the process. Hence, the Standard-Delphi-Method is a survey which is directed by a coordinator (researcher) as already stated, comprising several rounds with a group of experts, who are anonymous among each other and for whose subjective-intuitive prognoses a consensus is aimed at.

After each survey round, a standard feedback about the statistical group judgement calculated from median and interquartile range of single projections is given and if possible, the arguments and counter-arguments of the extreme answers are fed back. In the Delphi process, nobody 'loses face' because the study is done anonymously using a questionnaire. Rowe and Wright [44] and Häder and Häder [20] inform that it is commonly assumed that the method makes better use of group interaction whereby the questionnaire is the medium of interaction. The method is especially useful for long-range forecasting, as expert opinions are the only source of information available [3].

Over time, the method has gained a favourable popularity across many scientific disciplines as a method of inquiry. Czinkota and Ronkainen [13] indicate that the Delphi method has gained considerable approval across disciplines. They inform that it has been used as a study instrument in the fields of library and information science [8], in the medical disciplines [30], in multi-country studies of communications in Europe, and by actuaries to predict economic conditions [48]. Czinkota and Ronkainen further report that those experienced with the Delphi technique report that the method produces valuable results that are accepted and supported by the majority of the expert community.

Similarly, in the business field, the technique has been rated highly by some as a systematic thinking tool, but has been challenged in its ability to serve as an identifier of strategic issues [50]. Mitchell [38] in the review of the use of the Delphi techniques, found in an earlier study [46] that PhD candidates that used Delphi increased from 61 (1970-1974) to 441 (1980-1984), and that they included an incredibly wide range of disciplines and topics. Hence the aim of the thesis that adopted this technique was to attract a wide spectrum of inputs from various geographically dispersed experts in Ghana, proving that the Delphi technique is well suited as a research approach and method. Delphi as a research method has had its fair share of criticism, support and debate on epistemology [39]. Notable amongst the criticism is Delphi's alleged failure to follow accepted scientific procedures, particularly, the lack of psychometric validity [46]. In response to the criticism, Coates [11] states, that if it is believed that the Delphi technique is of value not in the search for public knowledge, but in the search for public wisdom; not in the search for individual data but in the search for deliberative judgement, one can only conclude that Sackman missed the point. However, it should be

noted that the approach deals with areas that do not lend themselves to traditional scientific approaches; hence Helmer [25] argues that the forecasting tendency, one of the major applications of the Delphi, is inevitably conducted in a domain of what might be called 'soft data' and 'soft law'. Helmer further posits that standard operations research techniques should be augmented by judgemental information and that the Delphi method cannot be legitimately attacked for using mere opinion and for violating the rules of random sampling in the 'polling of experts'. Such criticism Helmer argues, rest on a gross misunderstanding of what Delphi is; it should be pointed out that a Delphi inquiry is not an 'opinion poll'. As all the above definitions illustrated, in no instance is reaching a majority opinion the ultimate goal in a typical Delphi study; it is rather the reaching of agreement. According to Buckley [5], Delphi is a tool for discovering agreement and identifying differences rather than forcing consensus. Buckley [5] further informs that: in principle, agreement alone is not a sufficient condition for arguing that Delphi is acceptable. But as with the majority of research methods, the method of use and application has an enormous influence on the eventual success of the inquiry. Hence, where no agreement develops, the Delphi still helps to clarify the issue being investigated. Thus Linestone and Turoff [30] assert that one of the common reasons for failure in a Delphi is ignoring and not exploring disagreements or points of departure. In addition to the above criticism of the Delphi technique, different authors also state different weaknesses of the Delphi Technique [29]. Notable amongst them include: It has not been shown consistently that the results from the Delphi method are any better than those achieved through other structured judgmental techniques [45]. The Delphi study is at the mercy of the worldview and biases of the coordinating or monitors team (researcher), who choose the experts, interpret the returned information and structure the questions. There is an enormous debate whether the experts should be chosen from within or outside the organization initiating the study and whether they should be experienced in the subject area of the study in question [34]. Another limitation according to Linstone [31] is on the way the process and questionnaire is structured, which Linstone believes can lead to a bias (like IQ tests), which assumes a certain cultural background. Hence, the experts may give responses they think the monitoring group wants to hear, or they may not respond at all. Consequently, the cultural background of respondents will impact upon the results. Likewise, Simmonds [51] debates that one of the key flaws in the Delphi technique is that certain questions are not asked as they do not seem important when the study begins.

Nonetheless, once the study begins, new questions cannot be added, which in turn can weaken the study considerably. Also, Lang [29] states that the process of choosing the panelists or expert participants is often not considered thorough enough. Yet, it is the calibre of the panelists that determines the quality of the outcomes of the study [29]. A major consideration was given to this particular criticism; hence a list of criteria was set for the panelist to fulfill. In the process of achieving consensus, extreme points of views run the risk of being suppressed, when in fact they may provide important new information or insights [29]. The flexibility of the technique means it can be adapted to a whole range of situations that in turn can make it vulnerable to misrepresentation and sloppy execution. Amara [4] found that the Delphi technique can be extremely sensitive to: the level of panelists' expertise; the composition of the panel; clarity of the questions; the way the research or coordinator reports reasons for outliers and the administration of the questionnaire. Despite the limitations noted above from different scholars, Brill et al. [7] describe the Delphi as a particularly good research method for developing consensus among a group of entities having expertise on a particular topic where information required is subjective and where participants are separated by physical distance [30]. Brill et al. [7] further state that the Delphi method has been validated in the literature as a reliable empirical method for consensus reaching in a number of areas. Amongst these areas include distance education [54], journalism [53], visual literacy [7], electronic commerce [1], health care [55] and others. Beside these areas, the method has also been used in many other disciplines such as in information technology (IT) research to identify and rank key issues for management attention [15, 27] scientific study of GIS [23], quality management [47], terrorism [40], banking [5], social sciences [28], privatization of utilities [12], education [57], amongst others.

The above instance proves that the Delphi method in research is an accepted practice. However, as discussed above, it is not entirely appropriate for all research activities. Consequently, the objective of this paper is to assess how the Delphi technique was used to predict and understand issues surrounding sustainable infrastructure development in developing countries. This was done in order to determine the criteria and indicators that influence successful sustainable road infrastructure project implementation in developing countries. The paper describes the Delphi technique by investigating its advantages and disadvantages, before illustrating the process of execution. The paper commences by describing the technique through an investigation of its advantages and disadvantages, before illustrating the process of execution. This was followed by a brief statement on the epistemological approach of the

Delphi techniques for the study; when to use the method; components of the techniques and the process of execution of the technique for the referenced study.

2. Epistemological Approach towards the Delphi Design

The differences amongst the various group techniques and the definition of the Delphi method as identified by various scholars, as well as acknowledgment of the various criticisms, forms the epistemological foundation for defining the approach towards a typical Delphi study design. Amongst these include reducing the effects of personal bias. This is done by ensuring that all expert feedback is anonymous. Through this, the technique captures the opinions, experience, and knowledge of each expert participant. Personal knowledge is harvested and interpersonal interaction biases are stripped away. According to Scheele [49], the concreteness of the framework of the Delphi technique is vital in researching the overall objective of the study. The basic premise of the Delphi research technique towards a typical sustainable infrastructure development study, is entrenched in some form of general agreement and consensus regarding the core ingredients and components of the subsequent framework. Given the current status of implementing sustainable development in infrastructure development in developing countries, and the absence of generally agreed upon sustainable infrastructure development issues, the search for consensus and a point of departure in issues on sustainable infrastructure development policy that will better serve developing countries is therefore justified through the use of this technique.

Hence the objective of the Delphi design for this study is to obtain the most reliable consensus of opinions of a group of experts in the specific field being studied. According to Lang [29], the Delphi technique is mostly used to solicit the opinions of experts to determine the timing and possible occurrence of future events. It is a method that is best used where there is little past data available to generalize from, and where social, economic, ethical and moral considerations are pre-eminent. Considering the outcome of a literature review of the current research (there is no structured research so far carried out which has adopted the technique with regard to a sustainable infrastructure development study in a developing country) and definition, function and nature of Delphi technique, it is justified that, Delphi technique was the best method to explore the subject of the research and to achieve the aims and objectives.

3. When to Use the Delphi Technique

The Delphi method is mostly used when long-term issues have to be assessed such as the subject of the current research. This is mainly due to its procedural outlines used to identify statements (topics) that are relevant for the future; it reduces the tacit and complex knowledge to a single statement and makes it possible to judge upon [18]. Hence, its use in combination with other methodologies like survey design can be interesting. On the other hand, it is applicable in more complex issues, when the themes cannot be reduced that much or when thinking and discussions in alternatives are the major target. It is also suitable if there is the (political) attempt to involve many persons in processes [17]. Hence, Linstone and Turoff [32] argue that one or more of the following properties could lead to the need for the use of the Delphi technique: when the problem of inquiry does not lend itself to precise analytical techniques but can benefit from subjective judgments on a collective basis [9]; when the research needs to contribute to the examination of a broad or complex problem with no history of adequate communication and may represent diverse backgrounds with respect to experience or expertise, which was a major premise of the research; when more individuals are needed than can effectively interact in a face-to-face exchange; when time and cost to make frequent group meetings is limited; when the efficiency of face-to-face meetings can be increased by a supplemental group communication process; when disagreements among individuals are so severe or politically unpalatable that the communication process must be refereed and/or anonymity assured; when the heterogeneity of the participants must be preserved to assure validity of the results, such as the avoidance of domination by quantity or by strength of personality called the “bandwagon effect”.

According to Grisham [19], the Delphi method as a foresight tool seems to possess certain degrees of invariance to survive in the changing challenges of the past 50 years. Hence, the process could serve different understandings of

prediction or premonition and is probably understood by the users as being relevant for covering technical perspectives, organizational perspectives, and personal perspectives. Grisham [19] further emphasizes that what the users of the Delphi technique especially like, are the sets of data about the future that are collected. Writing down future topics seems to have an immense psychological effect because it transfers implicit to tacit knowledge to the more visible, explicit, and therefore transferable knowledge [19].

4. Research Methodology

The research was conducted with reference to existing theoretical literature, published and unpublished literature with a deep exploration of their context in order to meet the research objectives. The study is mainly a literature review and looks at how the Delphi technique can be used to predict and to understand issues surrounding sustainable infrastructure development in developing countries. This is presented through the discussion of how the Delphi technique was employed in the study. This approach was adopted to overcome the confusion surrounding the constructs that influences successful implementation of sustainable road infrastructure projects in developing countries, because the Delphi approach solicits experts' views on issues in a systematic approach.

5. Components of the Delphi Technique

The main components of the Delphi technique according to Loo [33], consists of five major characteristics, which was also adopted in the study: The study should consist of a panel of carefully selected experts representing a broad spectrum of opinion on the topic or issue being examined; the participants are usually anonymous; the coordinator (researcher) constructs structured questionnaires and feedback reports for the panel over the course of the Delphi; it is an iterative process often involving three to four iterations called 'rounds' of questionnaires and feedback reports; there is an output, typically in the form of a research report containing the Delphi results, the forecasts, policy and program options (with their strengths and weaknesses),recommendations to senior management and possibly an action plan for developing and implementing the policies. Likewise, Hasson et al. [22] recommended that the following research guidelines for using the Delphi technique be addressed in designing a Delphi approach: Research problem identification; Understanding the process; Selection of experts;

Informing /invitation to experts; Data analysis; and Presentation and interpretation. Therefore, given the nature of the research, it was further believed that the Delphi technique is well suited to obtain credible inputs from experts in industry, academics, government and NGOs to serve as key input towards the research objectives. The next sections provide an overview of how the Delphi technique was used in this study.

5.1 Designing, Constructing and Executing the Delphi

Given the rationale behind the Delphi technique and the main features explained above, the design, construction and execution of the Delphi study for the current research followed a sequential process as suggested by Loo [33]. According to Loo, four vital planning and execution activities were to be followed, which are: Problem definition; Panel selection; Determining the panel size; and Conduction of the Delphi iterations. Supporting Loo's [33] approach, Delbecq et al. [15] suggest a basic Delphi methodology that includes distinct stages such as, Delphi question development (objective), expert panel selection, sample size, first questionnaire, first questionnaire analysis and follow-up questionnaires. This methodology forms the basis of the research study and is explained in the subsequent sections.

Stage 1 - Delphi question development

The formulation of the Delphi question is vital to the whole process. It is paramount that the panel of experts understand the broad context within which the questionnaire is designed. In order to achieve the objectives of the study, key questions were asked. The foundation for constructing the questions for this study was based on the guidelines given in Table 1, with corresponding wording and phrasing given for this study.

Table 1: Delphi question formulation

Key Delphi questions?	Phrasing for this study
Why are you interested in this study?	This study was initiated because of the belief that there is no holistic framework to guide the implementation of SRIP in developing countries. This assumption is solid because there is a discrepancy about the criteria and indicators that determine successful SRIP implementation.
What do you need to know that you do not know now?	Despite the existence of some frameworks for sustainable infrastructure project implementation, these are not comprehensive and do not capture all the requisite features. The criteria and indicators that will determine successful SRIP implementation will come out clearly at the end of this study.
How will the results from the Delphi Study influence Sustainable Road Infrastructure Project Implementation?	The results of the Delphi Study will enable the development of a conceptual framework for the SRIP implementation framework to be developed. The criteria that would collectively predict and assure successful SRIP implementation framework will be established.

Stage 2 – Delphi Expert Panel Selection

A critical part of conducting a Delphi interview technique is selecting the right experts (also known as panellists, participants or respondents) and their role is crucial to the success of the research [22]. Experts must be sufficiently interested and involved in the subject being examined to ensure high commitment response rate. According to Hasson et al [22], controversial debate rages over when a professional becomes an 'expert'. The claim that one group represents valid expert opinion has been criticised as scientifically untenable and overstated [22]. For the purpose of this research McKenna's [35] definition of 'expert' as being a panel of informed individuals otherwise called experts hereafter was used. McKenna's [35] definition was further supported by Goodman [18] stating that the Delphi technique "tends not to advocate a random sample of panelists, instead, the use of experts or at least of informed advocates is recommended". Likewise, Helmer [24] argues that since a "Delphi inquiry is not an opinion poll, relying on drawing a random sample from the population of experts is not the best approach, rather, once a set of experts has been selected (regardless of how – but following a predetermined qualifying criteria), it provides a communicative device for them that use the conduct of the exercise as a filter in order to preserve anonymity of responses" which is core to the Delphi technique. Therefore, Linstone [32] states that the most significant danger in selecting the panel of expert lies in the path of 'least resistance' through the selection of a group of cosy friends and / or like-minded individuals, which thus negates the strength of the process. Panellists form the cornerstone of the Delphi technique and clear inclusion criteria should be applied and outlined as a means of evaluating the results and establishing the study's potential relevance to other settings and populations [26]. According to Dalkey and Helmer [14], there are detailed criteria for the selection of panel experts; recommending that in a typical Delphi study, experts should meet the following two recommendations which were also postulated by Rodgers and Lopez [43]. The first recommended criterion is that the experts should exhibit a high degree of knowledge or experience in the subject matter. Another criterion is that they should be the representatives of profession so that their suggestions may be adaptable or transferable to the population. Similarly, Adler and Ziglio [2] stated that the Delphi participants in any study should meet four "expertise" requirements, which are: knowledge and experience with the issues under investigation; capacity and willingness to participate; sufficient time to participate in the Delphi; and effective communication skills. In choosing panellists for this study, each expert was required to meet at least five of the following minimum criteria:

Residency: Have lived or is living within one of Ghana's Metropolis, Municipality or District; at least more than one year; Knowledge: Has knowledge of infrastructure development and Sustainable development; Academic Qualification, has been presented an earned degree (National Diploma/B-Degree/M-degree/PhD) related to any field; Experience: Has a history of currently is performing consultation services for Ghana's organ of State, individuals, businesses, agencies, companies, and/or organizations, relating to infrastructure development or other sustainable development context. Employment: Currently serves (or has previously served) in a professional or voluntary capacity (e.g., at place of employment - institution, business, agency, department, company) as supervisor or manager of establishment that is involved with infrastructure development or sustainable development related issues in Ghana;

Recognition: Has served / currently is serving as a peer-reviewer for one or more manuscripts received from a journal editor prior to its publication in the primary literature, with focus of the manuscript(s) on infrastructure development or sustainable development; Authorship: Is an author/co-author of peer-reviewed publications in the field of infrastructure development with emphasis on developing countries; Research: Has submitted one or more proposals to or has received research funds (grant/contract) from national, local government, regional, and/or private sources that support infrastructure development and sustainability in developing countries;

Teaching: Has organized, prepared, and successfully presented one or more infrastructure development or sustainable development training workshops focusing on the group for which expertise is sought; Membership: Member of a professional body. Should be the representative of a professional body so that their opinions may be adaptable or transferable to the population;

Willingness: Panel members must be willing to fully participate in the entire Delphi studies. The adoption of five criteria was considered stricter than the recommended number of at least two criteria by Rodgers and Lopez [43] and Dalkey and Helmer [14]. The five minimum criteria were framed after the four recommendations made by Adler and Ziglio [2], with the inclusion of experts' residency status, which was considered to be compulsory for all selected experts. Also, a minimum number of five criteria were set because the method may be undermined if panellists are recruited who lack specialist knowledge, qualifications and proven track records in the field amongst others. Although of course expertise comes in many guises and may include those who are 'experts by experience' [21]. In general, a varied panel is considered best in producing a credible Delphi study and individuals who might provide a minority or differing perspective should be actively recruited to the panel [32], which was adopted for the study. With regard to the recruitment process itself, panellists were recruited via e-mail, with a brief overview of the study objective. Thereafter, those that consented to the preliminary invitation were sent a detailed description of the Delphi study. Hence all experts selected for the current study met the five criteria set for the study. After the verification exercise, selected experts were then sent the first round questionnaire survey that was presented in the form of both closed and open-ended questions.

Stage 3 – Determining the Panel Size

Since the nature of the Delphi technique calls for a qualitative rather than a quantitative approach, the use of experts for input indicates that the number of participants should be expected to be much lower than normal quantitative surveys. Determining the minimum number of experts to participate in a typical Delphi survey has been a subject of debate overtime. Various scholars have recommended different sample sizes. For instance, Darkey and Helmer used a panel of seven experts in their original Delphi experiment in 1953 [23]. Linstone [31] finds that "a suitable minimum panel size is seven". Linstone justified this by saying that the research runs the risk of accuracy deteriorating rapidly as number increases. Hence Linstone's observation was supported by Cavalli-Sforza and Ortolano [10] who postulated that a "typical Delphi panel has about eight and twelve members", while Phillips [41] also informs that the optimum number of participation should be between seven and twelve members both citing the same reason as Linstone. Miller [37] refers to the economics of scale in large groups of Delphi surveys. Miller assumes that beyond the first thirty responses, additional responses do not generate much new information. Similarly, Dunn [16] suggests a ten to thirty participants, apprising that as the complexity of the policy issue increases, the sample size needs to be larger to include the entire range of participants both for and against the policy issue area.

According to Aigbavboa and Thwalla [3], if the group of experts is fairly homogeneous (sharing similar opinions) then ten to fifteen panelists will be enough and if there are diverse interests present among the experts, then the size of the group will need to be increased to ensure balance [58]. Skulmoski, Hartman and Krahn [52] highlighted a number of factors that should be considered in order to determine sample size for a Delphi technique: Heterogeneous or homogeneous sample [15]; Decision quality/Delphi manageability trade off [32]; Internal or external verification. Therefore, a sample size of 15 panellists was adopted based on the following premise in conjunction with the qualifying criteria's as established in stage two of the Delphi study which are: Experts should have a fair and practical split between academics and practitioners; Panellist in both categories should have an extensive experience relating to infrastructure development and sustainable development context. Beside the above criteria, the current study also adopted Rowe, et al [45] recommendations that the resultant selected participants should represent a wide variety of backgrounds to guarantee a wide base of knowledge and experience. The adopted experts' number of 15 seems appropriate, given the amount of data and subsequent analyses each panellist generates.

Stage 4 – Conducting the Delphi Iterations

Sequences of questionnaire rounds are used to obtain iterative responses to issues in a Delphi study [3]. For instance, Woudenberg [56] proposes two or ten rounds as appropriate numbers of rounds, supporting the assertion that accuracy is expected to increase over rounds, because of the repetition of judgement and group pressures for conformity. Likewise, Critcher and Gladstone [12] suggest between two and five rounds. The Delphi study for the research consisted of three rounds. In average, each round took about a month to be completed. A questionnaire was designed for each round based on responses to the previous one. Round one's questionnaire was designed based on a summary of the comprehensive review of literature highlighting sets of criteria and indicators that are potentially relevant to the implementation of sustainable road infrastructure projects in developing countries. These were structurally and constructively put together to frame the first round of the Delphi survey. Closed and open-ended questions were used in this round; thereafter, this was analysed and formed the basis of round two and three of the study. Frequencies were obtained to measure the degree of consensus reached amongst participants regarding the criteria, indicators that influence successful implementation of sustainable road infrastructure projects in developing countries and for other related questions. Also, content analysis methodology was adopted to analyse responses to the open questions to "minimise redundancy" [3] The purpose of the second round of the study was to allow experts to review and comment on the criteria and indicators that influence successful implementation of sustainable road infrastructure projects in developing countries, which were proposed by expert participants in round one. Closed and opened questions were used in this round to investigate participants' comments, expressing agreement, disagreement or clarification concerning proposed criteria and indicators that influence successful implementation of sustainable road infrastructure projects.

The specific nature of the closed-ended questions stimulated participants' reactions. Frequencies were likewise obtained to measure the degree of consensus reached amongst participants. Furthermore, content analysis approach was adopted to analyse responses to the open questions. The final round was specifically designed to: Inform the experts of the findings of the analysis of responses to the questionnaire of round two; request their final affirmation / comments on attributes and issues that did not receive any consensus in round two. The questionnaire of round three was designed based on the findings of content analysis and measures of frequencies responses to the questionnaire of round two. Closed and opened questions were also used and frequencies were obtained to indicate consensus reached among experts regarding criteria and indicators that influence successful implementation of sustainable road infrastructure projects issues as presented in the study. Where consensus was not reached, the reasons for the disagreements were noted and reported in the findings section of the study.

Over the three round Delphi survey, consensus was reached regarding most of the criteria and indicators that influence successful implementation of sustainable road infrastructure projects in developing countries. Based on the findings of the analyses of responses to the Delphi rounds, a list of criteria and indicators that influence successful implementation of sustainable road infrastructure projects was prepared which informed the conceptual framework for the broader study, while issues surrounding sustainable road infrastructure project implementation in developing countries were highlighted which responded accordingly to the set objective of the Delphi study. The Delphi survey was conducted via electronic mail, and follow-up emails were used to encourage prompt responses to the questionnaires.

6. Conclusion

The paper deliberated on the Delphi technique as an accepted and reliable research technique, with participants or expert panel members responding to a series of questionnaires (three rounds) to achieve a consensus in identifying the criteria and indicators that influence successful implementation of sustainable road infrastructure projects in developing countries. The technique was adopted as a preliminary investigation into the wider quest to determine the criteria and indicators that influence successful implementation of sustainable road infrastructure projects because it is intended to remove the bias that is possible when diverse groups of experts meet together which is common with other methods of decision making. Therefore, based on the premise of the outlined process, it is recommended that when the Delphi technique is to be adopted as a research tool for sustainable infrastructure development studies, the questions for the experts should be well formulated because questions are vital to the whole process. It is also paramount that the panel of experts understand the broad context within which the questionnaire is designed. Also, in the selection of experts, strict measures should be adopted that will not compromise the process. Likewise, in determining the panel size, it should be ensured that selected participants represent a wide variety of backgrounds to guarantee a wide base of knowledge and experience.

References

[1] Addison, T. (2003). E-commerce project development risks: evidence from a Delphi survey.International Journal of Information Management 23(1): 25-40. https://doi.org/10.1016/S0268-4012(02)00066-X
[2]Adler, M. and Z. E. (1996). Gazing into the oracle: The Delphi Method and its application tosocial policy and public health. London, Jessica Ki ngsley Publishers
[3] Aigbavboa, C. and Thwala, W. (2012). An exploration of the use of Delphi methodology in housing satisfaction studies *In:* Laryea, S., Agyepong, S.A., Leiringer, R. and Hughes, W. (Eds) *Procs 4th West Africa Built Environment Research (WABER) Conference*, 24-26 July 2012, Abuja, Nigeria, 147-161.
[4] Amara, R. (1975). Some Methods of Futures Research. Menlo Park, Institute for the Future.
[5]Beales, R. (2005). Delphi creates fresh CDS challenge: a new cashsettlement method forsimplifying credit derivatives faces a stern test with the latest bankruptcy, writesRichard Beales (capital markets and commodities). The Financial Times 43.
[6]Brill, J., M. Bishop, et al. (2006). The competencies and characteristics required of aneffective project manager: a webbased Delphi study. Educ ational TechnologyResearch and Development 54(2): 115-40. https://doi.org/10.1007/s11423-006-8251-y
[7]Brill, J. M., D. Kim, et al. (2000). Visual literacy defined: the results of a Delphi study: canIVLA (operationally) define visual literacy? Internat ional Visual Literacy, Ames, IA.
[8] Buckley, C. (1995). Delphi: a methodology for preferences more than predictions. Library Management 16(7): 16-19. https://doi.org/10.1108/01435129510093737
[9] Buckley, C. C. (1994). Delphi technique supplies the classic result? Australian Library Journal 43(3): 158-64. https://doi.org/10.1080/00049670.1994.10755684
[10]Cavalli-Sforza, V. and L. Ortolano (1984). Delphi forecasts of land use – transportation interactions. Journal of Trnasportation Engineering 110(3): 324-39. https://doi.org/10.1061/(ASCE)0733-947X(1984)110:3(324)
[11]Coates, J. F. (1975). Review of Sackman Report Technological Forecasting and Social Change - Vol. 7 No. 2. New York, American Elsevier Publishing Co.
[12]Critcher, C. and B. Gladstone (1998). Utilizing the Delphi technique in policy discussion: a case study of a privatized utility in Britain. Public Administration 76(3): 431-49. https://doi.org/10.1111/1467-9299.00110
Cuhls, K. (2003). Delphi method. Retrieved 26 October, 2016, from http://www.unido.org/fileadmin/import/16959_DelphiMethod.pdf.
[13]Czinkota, M. R. and I. A. Ronkainen (1992). Global marketing 2000: a marketing survivalguide. Marketing Management January/ February: 37-44.
[14]Dalkey, N. C. and O. Helmer (1963). An Experimental Application Of The Del-phi-Method To The Use Of Experts. Journal of the Institute of Management Sciences 9: 458-467. https://doi.org/10.1287/mnsc.9.3.458
[15] Delbecq, A. L., A. H. Van de Ven, et al. (1975). Group Techniques for Program Planning.Glenview, IL, Scott.
[16] Dunn, W. N. (1994). Public policy analysis: An introduction. Englewood Cliffs, NJ, PrenticeHall.
[17] Eto, H. (2003). The suitability of technology forecasting/ foresight methods for decisionsystems and strategy. A Japanese view, in: Technological Forecasting and Social Change, no. 70: 231-249. https://doi.org/10.1016/S0040-1625(02)00194-4
[18]Goodman, C. M. (1987). The Delphi technique: a critique. Journal of Advanced Nursing 12:729-734.
[19] Grisham, T. (2006). Cross cultural leadership, Doctor of Project Management, School of Property, Construction and Project Management , RMIT, Melbourne.
[20]Häder, M. and S. Häder (1995). "Delphi und Kognitionspsychologie: Ein Zugang zurtheoretischen Fundierung der Delphi-Methode." ZUMA-Nachrichten 37(19): 12.
[21] Hardy, J. D., A. P. O'Brien, et al. (2004). Practical application of the Delphi technique in abicultural mental health nursing study in New Zealand. Journal of Advanced Nursing 46(1): 95-109. https://doi.org/10.1111/j.1365-2648.2003.02969.x
[22] Hasson, F., S. Keeney, et al. (2000). Research guidelines for the Delphi survey technique. Journal of Advanced Nursing 32(4): 1008-15. https://doi.org/10.1046/j.1365-2648.2000.t01-1-01567.x
[23]Hatzichristos, T. and M. Giaoutzi (2005). Landfill siting using GIS, fuzzy logic and the Delphi method (author abstract). International Journal of Environmental Technology and Management 6(1/2): 218.
[24] Helmer, O. (1977). Problems in futures research: Delphi and causal cross-impact analysis Future 9(1): 25-52. https://doi.org/10.1016/0016-3287(77)90049-0
[25] Helmer, O. (1983). Looking Forward: A Guide to Futures Research. Beverly Hills, Sage Publications.
[26]Iqbal, S. and L. Pipon-Young (2009). The Delphi method. Psychologist 22: 598-601. Keeney, S., F. Hasson, et al. (2001). A critical review of the Delphi technique as a research methodology for nursing. International Journal of Nursing Studies 38(2): 195-200.
[27] Keil, M., P. E. Cule, et al. (1998). A framework for identifying software project risks. Communications of the ACM 41(11): 76-83.
[28] Landeta, J. (Current validity of the Delphi method in social sciences). Technological Forecasting and Social Change. 73 5(467-82).
[29]Lang, T. (1995). An Overview of Four Futures Methodologies (Delphi, Environmental Scanning, Issues Management and Emerging Issue Analysis). The Manoa Journal of Fried and Half-Fried Ideas (about the future) 7 (Occasional Paper Number Seven) - Hawaii Research Center for Futures Studies, Honolulu.
[30] Linstone, A. and M. Turoff (1975). The Delphi method: techniques and applications. Readi ng, MA, Addison-Wesley.
[31] Linstone, H. A. (1978). The Delphi technique. Handbook of futures research. J. Fowlers.Westport, CT, Greenwood Press: 273-300.
[32] Linstone, H. A. and M. Turoff. (2002). The Delphi method: techniques and applications.Retrieved 12 December, 2017, from www.is.njit.edu/pubs.php.
[33]Loo, R. (2002). The delphi method: a powerful tool for strategic management, policing. An international journal of police strategies and management 25(4): 762-769. https://doi.org/10.1108/13639510210450677
[34] Masini, E. (1993). Why Futures Studies? London, Grey Seal.Masser, I. and P. Foley (1987). Delphi Revisited: Expert Opinion in Urban Analysis. Urban Studies 24(3): 217-224. https://doi.org/10.1080%2F00420988720080351
[35] McKenna, H. (1994). The Delphi technique: A worthwhile research approach for nursing? Journal of Advanced Nursing 19(6): 1221-1225 https://doi.org/10.1111/j.1365-2648.1994.tb01207.x
[36]Miller, G. (2001). The development of indicators for sustainable tourism: Results of a Delphisurvey of tourism researchers. Tourism Managem ent 22: 351-362. https://doi.org/10.1016/S0261-5177(00)00067-4
[37] Miller, M. M. (1993). Enhancing regional analysis with the Delphi method. Review of Regional Studies 23(2): 191-212.

[38] Mitchell, V. W. (1991). The Delphi technique: an exposition and application. Technology Analysis and Strategic Management 3(4): 333. https://doi.org/10.1080/09537329108524065
[39] Muller, P. (2003). Delphi: Myths and Reality. Journal of Health Organisation and Management 17(1): 37-52. https://doi.org/10.1108/14777260310469319
[40]Parente, R. J., T. N. Hiob, et al. (2005). The Delphi method, impeachment and terrorism:accuracies of short-range forecasts for volatile world events. Technological Forecasting and Social Change 72(4): 401-411. http://dx.doi.org/10.1016/S0040-1625(03)00024-6
[41] Phillips, R. (2000). New applications for the Delphi technique. Annual San Diego Pfeiffer and Company. 2: 191-196.
[42] Rieger, W. G. (1986). Directions in Delphi developments: dissertations and their quality. Technological Forecasting and Social Change 29: 195-204. https://doi.org/10.1016/0040-1625(86)90063-6
[43]Rogers, M. R. and E. C. Lopez (2002). Identifying critical cross-cultural school psychology competencies'. Journal of school psychology 40(2): 115-141. https://doi.org/10.1016/S0022-4405(02)00093-6
[44] Rowe, G. and G. Wright (1999). The Delphi technique as a forecasting tool: Issue and analysis. Int. Journal of Forecast 15(7): 1-23. https://doi.org/10.1016/S0169-2070(99)00018-7
[45] Rowe, G., G. Wright, et al. (1991). Delphi - A Reevaluation of Research and Theory. Technological Forecasting and Social Change 39: 238-251. https://doi.org/10.1016/0040-1625(91)90039-I
[46] Sackman, H. (1974). Delphi Assessment: Expert Opinion, Forecasting, and Group Process. Santa Monica, CA, Rand Corporation.
[47]Saizarbitoria, I. H. (2006). How quality management models influence company results – conclusions of an empirical study based on the Delphi method (ISO 9000 And EFQMquality management standards of Europe). Total Quality Management and Business Excellence 17(6): 775-94. https://doi.org/10.1080/09593960600597768
[48] SAO. (1999). Final report of the 1999 Delphi study. Retrieved 16 January, 2017, from www.soa.org.
[49] Scheele, D. S. (2002). Reality construction as a product of Delphi interaction. The Delphi Method: Techniques and Applications Retrieved 14 December, 2017, from http://is.njit.edu/pubs/delphibook.
[50] Schoemaker, P. J. H. (1993). Multiple scenario development: its conceptual and behavioralfoundation. Strategic Management Journal 14(3): 193-213. https://doi.org/10.1002/smj.4250140304
[51]Simmonds, C. (1977). The Nature of Futures Problems" in Futures Research: New Directions, H. Linstone and C. Simmonds. London, Addison-Wesley Publishing Company.
[52] Skulmoski, G. J., F. T. Hartman, et al. (2007). The Delphi method for graduate research. Journal of Information Technology Education 6.
[53] Smith, M. A. (1997). Perceptions of quality in journalism and communications education: aDelphi study. Journal of the Association for Communication Administration 1(32-50).
[54] Thach, E. C. and K. L. Murphy (1995). Training via distance learning. Training and Development 49(12): 44.
[55] Whitman, N. I. (1990). The committee meeting alternative: using the Delphi technique. The Journal of Nursing Administration 51(1): 57-68.
[56]Woudenberg, F. (1991). An evaluation of Delphi. Technological forecasting and social change 40: 131-150.
[57] Yousuf, M. I. (2007). The Delphi technique. Essays in Education 20: 80-9.
[58]Zami, S. M. and A. Lee (2009). A review of the Delphi technique: to understand the factorsinfluencing adoption of stabilised earth constructio n in low cost urban housing. The Built and Human Environment Review 2: 37-5 https://doi.org/10.1007/s10668-011-9301-0