

## Employment of Delphi method in tree vandalism study



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### ARTICLE INFO

#### Article history:

Received 24 February 2020

Received in revised form

1 June 2020

Accepted 1 June 2020

#### Keywords:

Delphi technique

Delphi coordinator

Tree vandalism

### ABSTRACT

This paper draws the author's involvement employing the Delphi method, as the measuring tools in the field of tree vandalism research. Attention is given to aspects such as the selection of method, design of questionnaires, selection of experts, the communication between survey administrator and respondents, and also the analysis of experts' responses. Some of the challenges faced during the surveys are the way they were treated with, and risk mitigation approaches used by the Delphi coordinator are highlighted too. The principal objective of this article is to contribute an insight that can encourage other researchers or practitioners planning to apply the Delphi technique. Furthermore, the article gives to the methodological discussion by revealing the elements of innovative practices that can help overcome some common consequences of the Delphi: electronic mail and web-based surveys and the two round structured questionnaires.

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### 1. Introduction

One of the main debates in the counteracting of tree vandalism (TV) incidence concerns the relationship between monitoring strategies and effectiveness. The underlying postulate in these debates is that some elements of the monitoring strategies (such interpreted tree vandalism status and rectification recommendation) that can promote or hinder vandal for TV act (such as practicality, efficacy, comprehensive, etc.). Analysts attempt to shed light on the connections between monitoring and effectiveness to discern potentially better strategies on how to against tree vandalism incidence. This theme impelled much research due to the increasing TV incidence globally (Jim, 1987; Pauleit et al., 2002; Richardson and Shackleton, 2014). The possible effectiveness impacts of different implementation mechanisms or various conceptual regimes between tree care and decision-makers are also part of this scholarship (Cumming et al., 2008; Morgenroth and Östberg, 2017). Some authors explore the issue of urban layout, both at the

planning stage and the stage of the area, has been inhabiting, and debate possible effectiveness demonstrations (Bhati and Pearce, 2016; Kirkpatrick et al., 2012). The role of key tree caretakers, the fields where they cooperate, and the tier of government responsible for TV rectification is also viewed as relevant features of the monitor set-up of counteracting TV incidence that might influence the effectiveness (Hamzah et al., 2019).

These analyses give essential insights and help gain knowledge of some key mechanisms linking the counteracting issue of TV and effectiveness. However, by only looking at the summation of the effects of isolated rectification interventions, they may fail to capture a more textured view of TV incidence counteracting. The TV incident is a complex multifarious social behavior in which different behavior elements, actors (with multiple influences), and norms coexist (Hamzah et al., 2019). These behaviors are involved and more than the sum of their subjects (Richardson and Shackleton, 2014), and, as such, their analysis can benefit from a conservational perspective that acknowledges that several elements interact and influence each other (Hamzah et al., 2019). In other words, analyses of the relationship monitor-effectiveness in TV incidence can benefit from the recognition of this dynamic character, and the importance of the interplay between different TV criteria.

To operationalize such a configurationally approach, the first step is to recognize and select

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<https://doi.org/10.21833/ijaas.2020.09.009>

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sufficient research variables. Hence, the problem pretended for TV research is to select effectiveness indicators suitable to measure the status of incidence in TV as well as monitor features that might affect incidence consequences.

Hamzah et al. (2019) selected a participatory method, the Delphi technique, to attempt this problem. The Delphi relies on a sequence of questionnaires assigned to selected expert panels in a process conducted by a survey administrator. Following the first round of questions, and introducing any further questionnaire, the survey administrator gives participants with anonymous feedback on answers contributed by all expert panels. Individual expert panels can reflect on this feedback and reconsider their views when answering to subsequent questionnaires. This process, interspersing questionnaires and controlled opinion feedback in protected anonymous circumstances, establishes a convincing mechanism to reveal and articulate various views and to help to create knowledge and to solve complex issues.

By forming a Local Delphi in Tree Vandalism ('LDTV'), Hamzah et al. (2019) gathered insights from tree care experts across the Malaysian. The LDTV produced authoritative criteria and ratings of core effectiveness indicators and monitor features affecting effectiveness in TV counteraction. In their study, Hamzah et al. (2019) presented the LDTV's results, as well as their possible implications for the study of TV incidence under an extra textured and systemic lens. The current study, preferably, uses the LDTV as an example of the employment of the Delphi technique to make new generic observations associated with the methodology. The study looks at some of the challenges faced throughout the survey, the way challenges were administered with some risk mitigation strategies, and lessons learned. The description of the LDTV points to the advantages and disadvantages of the Delphi method and thus can assist researchers or practitioners wishing to apply the methodology. In specific, the LDTV proposes innovative practices that can be implemented in new Delphi studies to help overcome some typical pitfalls of the process, as well as to leverage some of the method's strengths: Electronic mail and web-based surveys and the two round structured questionnaires.

## 2. Research strategy

### 2.1. Choice of method

As advanced in Section 1, TV research many times fails to recognize the complex and dynamic criteria of TV incidence and does not comprehensively address the topic. Hamzah et al. (2019) observed that as complicated incidence; however, recent the criterion of tree vandalism incidence is more than the sum of their subjects. They cannot be understood as reducible to general and straightforward relationships between variables. It is thus essential to discover new approaches to analyze the criteria of

TV incidence that allow moving beyond an incremental perspective that simply identifies isolated rectification or variables. An assessment approach thus appears as an alternative to tackle the question on how the effectiveness of counteracting of TV incidence may be affected by the monitoring of the incidence by allowing an examination of the combined effects produced by multiple criteria. For this, however, a significant first step is to identify these criteria that can assist as sufficient research variables.

The specialized literature on the debate on the effectiveness consequences of different features of the counteracting of TV incidence briefly illustrated above constitutes a first relevant input to develop this task and determine suitable criteria assessment factors to be analyzed in combination. However, LDTV's research aim could obtain from also counting the views of other stakeholders beyond academia that also occupy relevant knowledge in the field. Hamzah et al. (2019) offered a similar observation, nevertheless viewing at TV research more broadly. The authors argue that the field has overall concentrated on a limited range of actors, forgetting aside the role played by and the views from significant players, such as local authorities, landscape consultants, landscape contractors, etc.

The Delphi technique appears as an available tool to address the research need just highlighted: identifying the significant factors in the discussion monitor-effectiveness that would recognize threatening TV criteria to counteract with a more systemic lens and, also, perform this task accompanying to views of other kinds of stakeholders beyond academia. Although, as initially thought the Delphi was not designated as an open and inclusive participatory process—and preferably as a methodology to obtain a consensus among a small and selected group of expert panels—over time new modifications of the technique emerged and opened up for inputs from more actors as well. Delphi techniques recognize and explore value in the articulation of diversifying and differentiating thoughts as a tool to assist the clarification of complex subject matters (Shariff, 2015). Kezar and Maxey (2016) supported this perception and highlight that the Delphi technique is excellently suited to resolve complex and multilayered problems that need the attention of multiple stakeholders.

Hence, the Delphi was adopted, and the LDTV considered as a means to determine proper monitoring features and relevant tree vandalism criteria that can help to guide TV rectification recommendation and evaluation but to rely on insight beyond simplistic literature review. The passion for amplifying the extent of TV research to view a wider set of actors is understood and applied with attention, though. In some circumstances (the LDTV situation), not all stakeholders involved directly or indirectly with TV incidence will have related knowledge for debating questions that are typically technical and require in-depth expertise in

the field. The LDTV combines views of academics and practitioners from diverse backgrounds, and this search for a diversity of views will be formed clear in the description of LDTV's process to identify and select expert panels (Section 3.2).

## 2.2. The Delphi

The Delphi technique was formed within the RAND Corporation in the 1950s. It was devised as a structured participatory method for consensus building. By obtaining the opinions of experts, the Delphi technique was formed to build reliable predictions concerning the existence of events or trends. Formerly, the technique was designed and used for decision-making concerning military matters, and only years later, it was exposed to the general public (Dalkey and Helmer, 1963). Nowadays, its practice is widespread in a variety of fields, such as engineering, technology forecasting, and the nursing sector, as well as in various social science fields (Avella, 2016; Li et al., 2014).

Procedure-wise, the Delphi relies on a series of questionnaires issued to selected expert panels in a process managed by a survey administrator. After the first round of the questionnaire, and preceding any further questionnaire, the survey administrator provides expert panels with anonymous feedback on answers contributed by all expert panel members, ensuring that opinions are not assigned to particular individuals. Expert panels can reflect on this feedback and reconsider their opinions when answering to the following questionnaires. This process, distributing questionnaires and controlled opinion feedback, continues until a required level of consensus is reached among expert panels or until opinions are constant over survey rounds (Becker and Roberts, 2009; Heiko, 2012).

Heiko (2012) recognized four core aspects in a Delphi survey:

- a. Anonymity: Giving opinions anonymously and free of direct interaction with other expert panels.
- b. Iteration: The repetitious rounds in a Delphi enable expert panels to reassess their judgments and, given the anonymity of the process, reconsider earlier responses.
- c. Controlled feedback: After each round, expert panels are confronted with the group's opinions and helped to re-evaluate their answers. This feedback is usually presented through statistics based on aggregated responses.
- d. Statistical aggregation of group responses: In the final survey, the group's opinion is used as the statistic average (mean/median) of overall opinions of panelists in the final round.

Although the use of the Delphi follows some basic features, the technique is flexible in its application, and the researcher can customize the process to the particular features of the problem in the discussion, or his/her specific objectives. As a result, several

modifications of the method appeared and continue to be developed (Henning and Jordaan, 2016; Li et al., 2014; Salazar-Elena et al., 2016). These modifications accommodate the method in different ways, such as types of questions used, techniques to select expert panels, tools used for the analysis of responses, and kind of outcome sought (De Loë et al., 2016).

## 3. The local Delphi in tree vandalism (LDTV)

### 3.1. Survey structure

The LDTV was structured in two separate stages:

- (i) Brainstorming (respondents could agree or rejected relevant existing TV criteria or propose new relevant criteria in connection to the TV incidence), and
- (ii) Narrowing-down and rating (respondents revalidate relevant TV criteria from the previous stage and rated important TV criteria).

In all of these stages, one questionnaire was applied. This design implied principally spurred by the ranking-type Delphi, although it does not strictly comply with the formation and steps suggested by Schmidt and others who have applied this modification (Paré et al., 2013; Schmidt et al., 2001). Differences are elaborated and highlighted in the remainder of this section. Fig. 1 summarizes the LDTV formation and steps.

The LDTV was entirely carried out with survey questionnaires using an electronic mail and web-based survey platform to collect and aggregate responses. By creating this communication channel, the LDTV managed to avoid complicated conventional surveys that could be rejected by expert panels with limited time availability.

### 3.2. Choice of experts

The selection of expert panels is a crucial step to ensure that the breadth of knowledge is represented among expert panels (Tracy, 2013). Panel selection in a Delphi involves two moments:

- (i) Determining the relative expertise and
- (ii) Identifying individuals with the desired knowledge.

Concerning related expertise, the LDTV attempted to cover knowledge on (i) TV incidence monitoring or evaluation and (ii) TV counteract—particularly the design of TV monitoring structures. Importantly, the LDTV recognizes that this expertise is including outside academic debates and seeks to find the views of different types of practitioners as well.

For the identification of expert panels, the LDTV used a purposive sampling approach based on actor types. This approach seeks representativeness in

terms of perspectives by sampling actors from various affiliations.

The following criteria were used to find the expert panels that could contribute to the survey:

1. Certified Arborist who established academics who have either published their work in international journals or have lectured in the fields of urban tree management; or,
2. Certified Arborist who established practitioners who have extensive experience more than five years in urban tree management; or,
3. Officers with certified Arborist from federal and local government who have been involved for

- more than five years in decision making or in managing urban tree planting programs; or,
4. Public with certified Arborist from non-governmental organizations who have been involved in urban tree planting programs.

A potential expert was identified to support this selection process (Table 1). The potential expert respondents were retrieved from the Malaysia Society of Arboriculture. All potential expert panels were then evaluated more closely to verify the relevance of their profession for the topics being surveyed, i.e., that their works in tree care were indeed connected to tree care governance on its various dimensions.

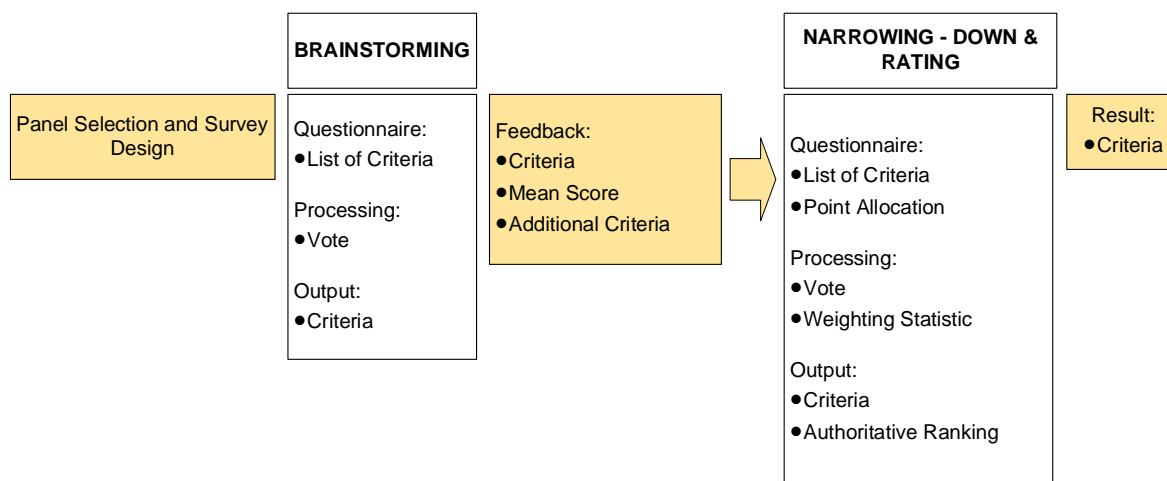


Fig. 1: Schematic representation of the LDTV

The matrix demonstrates the primary objective of the LDTV to incorporate a broader set of views on the debate monitoring-effectiveness. The study comprises a broad set of practitioners from several backgrounds. A minor imbalance in favor of the local authority and landscape consultant participation is also visible through Table 1.

Table 1: Matrix for the Identification of Experts

Field of expert/knowledge	Potential Experts
1. Researcher	9
2. Academia	5
3. Local Authority	15
4. Consultant	21
5. Contractor	8
6. Federal Government	2
Total	60

Faced with this initial result in the matrix construction, a trade-off became evident: reduce the potential expert panels to avoid that the survey could be skewed towards a local authority and landscape consultant view or stick to as many participants and views as possible as a way to prevent the risk of a meager rate of responses. This trade-off is any way relevant because it is related to a possible pitfall of the Delphi method: the survey administrator has no control over response rates, and there is a high risk of having just a few expert panels responding, or a high rate of withdrawals

during survey rounds, what can compromise the entire Delphi process.

A formal letter of invitation was sent out via email to each of the 60 potential respondents identified in the sample selection process. The first communication with potential participants described the overall goals of the survey, indicated the planned number of questionnaires and the expected duration of the entire process. This gives a total of 47 experts who gave their consent to participate. The first questionnaire was distributed among the 47 experts who have agreed to participate. Of these, 30 responded to the first questionnaire, and finally, 18 experts concluded the second and last questionnaire.

### 3.3. Round 1: Brainstorming

#### 3.3.1. The questionnaire

In the first round of the Delphi survey, the questionnaire was to identify relevant criteria for TV incidence and to ascertain the content validity of criteria based on experts' perceptions. The questionnaire contained Likert-scale questions consist of a list of 21 TV criteria, which was used as a basis for the experts to select relevant criteria. The TV criteria in the list had to be rated using a Likert-scale from 1 to 4. Using the four-point Likert scale by omitting, then 'neutral' position is an advantage in



the validity of results as respondents may not want to express their accurate opinions. Therefore, the study intends to retrieve valid data from experts' opinions by using the four-point Likert scale in round one Delphi survey questionnaire ranging from 1 (strongly disagree) to 4 (strongly agree). The experts were encouraged to modify or delete any criteria that they believed duplicating other criteria, and also to suggest new criteria that they believed were important but were not included in the list to increase the richness of the data.

### 3.3.2. Analysis of responses

Upon completion of the Delphi round one survey by 30 respondents, descriptive analyses were conducted to identify the criteria that the group of experts considered as relevant in causing tree vandalism incidents. The determination of these criteria was based on consensus among the experts using group mean of relevance. The group mean of relevancy refers to the score of respondents who rated the criteria either agree (score of 3) or strongly agree (score of 4). Thus, the mean value within 0.0 to 2.0 is determined as irrelevant criteria, and the mean value within 2.01 to 4.0 is determined as relevant criteria. Based on the group mean agreement of relevance ( $\geq 2.01$  group mean value), the results indicate that all of the 21 criteria examined in this survey achieved consensus among experts, and, thus, were selected as relevant criteria for tree vandalism incidents and were included in round two of the Delphi survey. Table 2 shows TV Criteria Derived from the Delphi Round One Survey.

Out of 30 respondents, 16 experts took the opportunity to suggest several new criteria. Experts took the opportunity to suggest eleven new relevant criteria. These generated a consensus list of 32 criteria (Table 2). These criteria were sent out to all 30 experts who had completed the previous round one of the Delphi surveys for further analysis.

## 3.4. Round 2: Narrowing-down and rating

### 3.4.1. The questionnaire

In Round 2, experts were asked to rate TV criteria among all those listed in the criteria produced in Round 1. The wording used in this questionnaire was consistent with the previous round and requested experts to prioritize criteria better able to provide insights on the most critical aspects of TV incidence. Each questionnaire contained a list of the selected criteria and a summary of their respective group mean scores from the previous round (round one). To determine the criteria prioritization, respondents were asked to identify those criteria that they believed to be important for assessing the tree vandalism incidence based on a five-point Likert scale of importance. A five-point Likert scale, ratings ranged on '0=Not important at all', '1=Least important', '2=Average important', '3=Very

important', and '4=Absolutely important', was used to rate each of the criteria. A 'Not Important at All' rating was given when the criteria were irrelevant for tree vandalism incidence. While 'Least Important' gave the least contribution when used to assess the tree vandalism incidence levels of particular areas. In contrast, an 'Absolutely Important' rating suggests that the criteria make a crucial contribution to tree vandalism assessment.

**Table 2:** TV criteria derived from the Delphi round one survey

Criteria
<b>Specific motive and action (10 criteria)</b>
1. Species of tree
2. Age of tree
3. Size of tree
4. Location of tree
5. The owner of the tree
6. Tree characteristic
7. Tree health condition
8. Tree growth rates
9. Tree debris
10. Tree value
<b>Ideology and practices (11 criteria)</b>
1. Religious and cultural beliefs
2. Level of knowledge
3. Socioeconomic status
4. Rule and regulations
5. Design and layout
6. Tree maintenance approaches
7. Tree maintenance status
8. Coordination and cooperation
9. Demographics (Age)
10. Tree care monitoring
11. Information on Tree Benefits
<b>Victim of circumstances (11 criteria)</b>
1. Tree for structure attachment
2. Interference or obstruction caused by the trees
3. Conflict with other activities
4. Priority of space usage
5. Use of tree parts for other purposes
6. Tree without protection structure
7. Infrastructure upgrading/extension and urbanization/development
8. Event and occasion
9. Rate of the human population
10. Memorial display
11. Tree as a protective structure

### 3.4.2. Analysis of responses

Following the determination of the relevant criteria in round one, this stage aims to confirm these relevant criteria and examine their level of importance for urban tree care monitoring. A descriptive analysis was conducted to identify the mean score of each criterion in the round two data. The mean value within 0.0 to 1.0 is determined as irrelevant criteria, and the mean value within 1.01 to 4.0 is determined as important criteria. A  $\geq 1.01$  group mean agreement of importance (scores of 1 to 4) was used to determine a consensus for each criterion. The criteria that surpassed 1.01 group mean agreement were classified as important criteria.

The results indicate that the agreement of relevant criteria ranged from the highest, 3.78 to lowest: 1.83 agreement of relevance. This indicated that all 32 criteria achieved a consensus of  $\geq 1.01$

group mean value. The analysis to reveal the level of importance for each criterion was conducted based on rank orders by the mean value (Table 3).

#### 4. Impressions and imperatives

The experience with the LDTV highlights some significant strengths of the Delphi technique. It first verifies that the Delphi can be an excellent research tool to enhance access to the valuable, and many times hard to reach, opinion of experts. The information provided in the LDTV originates from a wide variety of technical perspectives that other research methods would hardly be able to collect.

**Table 3:** The valid TV criteria with the ranking order

Criteria (N=18)	Mean	VAR	Ranking Order
<b>Specific motive and action (10 criteria)</b>			
1. Species of tree	2.78	0.54	5
2. Age of tree	1.94	0.53	10
3. Size of tree	3.17	0.85	2
4. Location of tree	3.61	0.37	1
5. The owner of the tree	2.72	0.57	6
6. Tree characteristic	2.72	0.80	7
7. Tree health condition	3.11	0.58	3
8. Tree growth rates	3.11	0.81	4
9. Tree debris	2.61	0.37	8
10. Tree value	2.06	0.64	9
<b>Ideology and practices (11 criteria)</b>			
1. Religious and cultural beliefs	2.72	0.80	8
2. Level of knowledge	3.67	0.24	1
3. Socioeconomic status	1.83	1.44	11
4. Rule and regulations	3.67	0.35	2
5. Design and layout	3.11	0.58	4
6. Tree maintenance approaches	3.06	1.00	6
7. Tree maintenance status	2.94	0.64	7
8. Coordination and cooperation	2.67	1.41	9
9. Demographics (age)	2.33	0.82	10
10. Tree care monitoring	3.06	0.88	5
11. Information on tree benefits	3.22	0.65	3
<b>Victim of circumstances (11 criteria)</b>			
1. Tree for structure attachment	3.67	0.35	5
2. Interference or obstruction caused by the trees	3.67	0.24	4
3. Conflict with other activities	3.78	0.18	1
4. Priority of space usage	3.72	0.21	3
5. Use of tree parts for other purposes	2.67	0.71	8
6. Tree without protection structure	3.06	0.64	6
7. Infrastructure upgrading/extension and urbanization/development	3.78	0.18	2
8. Event and occasion	3.00	0.71	7
9. Rate of the human population	2.39	0.72	9
10. Memorial display	2.39	0.84	10
11. Tree as a protective structure	2.39	0.96	11

Additionally, the national range of the survey, facilitated by the use of electronic mail and web-based survey questionnaires, is a definite asset of the Delphi: engaging expert panels nationally is notably hard if conventional face-to-face interviews are to be used for instance. As a consequence, and describing another of the method's advantages, the Delphi can provide a broadness of views that makes it virtually unparalleled as a building block for continued and more in-depth analysis—for example based on interviews, workshops or case studies for instance (Nayak and Narayan, 2019).

Also remarkable is that the Delphi enables tailoring the survey according to the researcher's requirements. This adaptability emerges as one of its prominent strengths, evidenced by the continuous and heightened use of the method observed since its inception (Landeta, 2006). Although the LDTV is mainly motivated by the ranking-type Delphi, it involves a series of modifications to the initial design of this type of survey.

The first significant modification proposed in the LDTV refers to the use of available and usable information concerning the target issue is derived from the literature and previous research, which omits the qualitative round. Having this change was helpful in keeping participants engaged with the structured questionnaire and shortening their time with the two-round surveys.

Another novelty of the LDTV was the use of the ranking-type questions in round 2. Ranking-type questions in round 2 lead to structure the rank order of the subjects being study. This is not only to assess the consensus within expert panels but also to structure the rank order of the subjects being study.

On the other hand, some limitations are determined in any research work. Some difficult trade-offs are involved in developing a Delphi. Selecting expert panels needs choosing within engaging either a large or more diverse set of respondents, getting close interaction a more challenging task for the Delphi administrator, or a smaller group of expert panels that may be easier to close interaction, possibly forming essential commitment by respondents. While the first route was adopted for the LDTV, an ample effort was also given to keep expert panels engaged (e.g., with the use of the electronic mail and web-based surveys with two rounds structured questionnaires). Furthermore, interaction with expert panels had to ensure adequate provision of information that could encourage the participation of expert panels with shortening their time to contribute.

Also, impossible to ensure that the expert selection procedure used in the LDTV confirms that all relevant individuals were incorporated in the panel, or that the final list did not suffer from any bias. Here may be the state for different reasons: databases related may be deficient, expert panels may not always expose their work, and other circumstances may not be geographically pluralistic, experts may not have been recommended due to personal reasons, etc. However, the criteria and procedures followed are aligning with best practices in Delphi studies (Avella, 2016).

Finally, challenges including the questionnaires or simply expert panels fatigue may have restricted further participation in the LDTV. If the Delphi process seems too complicated or, time-consuming expert panels may not participate or may later drop-out throughout the survey (Avella, 2016). One possible cause of obstruction in the LDTV was language: questionnaires were developed both in English and Malay, which may have shied away non-native speakers. This track was adopted to ensure

that all expert panels were answering the same questionnaires. Professional dialect may also be a source of misinterpretations, both by the Delphi expert panels and by the survey administrator.

## 5. Conclusion

This article described a particular application of the Delphi method on the LDTV and, based on this experience; reflect on the method's strengths and weaknesses. The Delphi demonstrated its values by facilitating the LDTV to push beyond some of the limitations that are common to participatory methods and conventional face-to-face interviews: it gives participants anonymity, which enables the free expression of opinions, and, facilitated by ICT technologies. It also allows the consultation of expert panels from various parts of the country acting in different capacities, avoiding the difficulty of aggregating all participants in a single place at the same time.

Moreover, by resorting to the Delphi, the LDTV authors were capable of engaging with actors that are not often part of tree vandalism research more broadly, or of the specific debate on the relationship monitoring-effectiveness. The survey demonstrated efficiency in bringing together and articulating various views from professionals of different affiliations, as well as from various technical and geographic backgrounds (Table 1). As a consequence, the LDTV served a qualitative and qualitative exercise-by design with content and statistically significant results-with an output that could hardly be achieved differently. The expert insight given by the Delphi can be a great component of a mixed-method research design if the outcome is complemented with more in-depth research.

Tough trade-offs are faced by the Delphi administrator while arranging and administering the survey, such as determining the number of expert panels to approach and the way to engage them to interest and retain participation, dealing with expert panels' responses, and balancing information conciseness and richness in the analysis. These trade-offs highlight the crucial part played by the survey administrator, which is a possible source of weakness of the Delphi process. While highlighting these challenges, though, the article also gave recommendations on how to tackle them. The flexibility of the Delphi, the LDTV, presented positive methods that not only accommodated its remarkable research objectives but also extend the Delphi's toolkit and thus can be applied in future applications. The electronic mail and web-based surveys and the two round structured questionnaires offer researchers ways to avoid or mitigate limitations of the Delphi, while still taking advantage of the method's potential.

## Acknowledgment

The authors are appreciative of the willingness and time that the survey respondents provided,

without which this study could not have been done. We gratefully acknowledged Universiti Teknologi MARA Cawangan Perak, Malaysia, in providing the Geran Khas Insentif Penyelidikan Perak (GKIPP) Grant.

## Compliance with ethical standards

## Conflict of interest

The authors declare that they have no conflict of interest.

## References

- Avella JR (2016). Delphi panels: Research design, procedures, advantages, and challenges. *International Journal of Doctoral Studies*, 11(1): 305-321.  
<https://doi.org/10.28945/3561>
- Becker GE and Roberts T (2009). Do we agree? Using a Delphi technique to develop consensus on skills of hand expression. *Journal of Human Lactation*, 25(2): 220-225.  
<https://doi.org/10.1177/0890334409333679>  
**PMid:19414824**
- Bhati A and Pearce P (2016). Vandalism and tourism settings: An integrative review. *Tourism Management*, 57: 91-105.  
<https://doi.org/10.1016/j.tourman.2016.05.005>
- Cumming AB, Twardus DB, and Nowak DJ (2008). Urban forest health monitoring: Large-scale assessments in the United States. *Arboriculture and Urban Forestry*, 34(6): 341-346.
- Dalkey N and Helmer O (1963). An experimental application of the Delphi method to the use of experts. *Management Science*, 9(3): 458-467.  
<https://doi.org/10.1287/mnsc.9.3.458>
- De Loë RC, Melnychuk N, Murray D, and Plummer R (2016). Advancing the state of policy Delphi practice: A systematic review evaluating methodological evolution, innovation, and opportunities. *Technological Forecasting and Social Change*, 104: 78-88.  
<https://doi.org/10.1016/j.techfore.2015.12.009>
- Hamzah H, Othman N, and Mohd Hussain NH (2019). The tree vandalism model (TVM): Quantifying urban tree vandalism status. In the 1<sup>st</sup> International Conference on Green Technology and Sustainable Development (ICGTSD'19), Community of Research GTSD, IRMI UiTM, Shah Alam, Malaysia.
- Heiko A (2012). Consensus measurement in Delphi studies: Review and implications for future quality assurance. *Technological Forecasting and Social Change*, 79(8): 1525-1536.  
<https://doi.org/10.1016/j.techfore.2012.04.013>
- Henning JI and Jordaan H (2016). Determinants of financial sustainability for farm credit applications-A Delphi study. *Sustainability*, 8(1): 77.  
<https://doi.org/10.3390/su8010077>
- Jim CY (1987). The status and prospects of urban trees in Hong Kong. *Landscape and Urban Planning*, 14: 1-20.  
[https://doi.org/10.1016/0169-2046\(87\)90002-8](https://doi.org/10.1016/0169-2046(87)90002-8)
- Kezar A and Maxey D (2016). The Delphi technique: An untapped approach of participatory research. *International Journal of Social Research Methodology*, 19(2): 143-160.  
<https://doi.org/10.1080/13645579.2014.936737>
- Kirkpatrick JB, Davison A, and Daniels GD (2012). Resident attitudes towards trees influence the planting and removal of different types of trees in eastern Australian cities. *Landscape and Urban Planning*, 107(2): 147-158.  
<https://doi.org/10.1016/j.landurbplan.2012.05.015>

- Landeta J (2006). Current validity of the Delphi method in social sciences. *Technological Forecasting and Social Change*, 73(5): 467-482.  
<https://doi.org/10.1016/j.techfore.2005.09.002>
- Li Y, Ehiri J, Hu D, Zhang Y, Wang Q, Zhang S, and Cao J (2014). Framework of behavioral indicators for outcome evaluation of TB health promotion: A Delphi study of TB suspects and TB patients. *BMC Infectious Diseases*, 14: 268.  
<https://doi.org/10.1186/1471-2334-14-268>  
**PMid:24884569** **PMCID:PMC4030006**
- Morgenroth J and Östberg J (2017). Measuring and monitoring urban trees and urban forests. In: Ferrini F, van den Bosch CCK, and Fini A (Eds.), *Routledge handbook of urban forestry*: 33-48. Routledge, Abingdon, USA.  
<https://doi.org/10.4324/9781315627106-3>
- Nayak MSDP and Narayan KA (2019). Strengths and weakness of online surveys. *IOSR Journal of Humanities and Social Science*, 24(5): 31-38.
- Paré G, Cameron AF, Poba-Nzaou P, and Templier M (2013). A systematic assessment of rigor in information systems ranking-type Delphi studies. *Information and Management*, 50(5): 207-217.  
<https://doi.org/10.1016/j.im.2013.03.003>
- Pauleit S, Jones N, Garcia-Martin G, Garcia-Valdecantos JL, Rivière LM, Vidal-Beaudet L, and Randrup TB (2002). Tree establishment practice in towns and cities—Results from a European survey. *Urban Forestry and Urban Greening*, 1(2): 83-96.  
<https://doi.org/10.1078/1618-8667-00009>
- Richardson E and Shackleton CM (2014). The extent and perceptions of vandalism as a cause of street tree damage in small towns in the Eastern Cape, South Africa. *Urban Forestry and Urban Greening*, 13(3): 425-432.  
<https://doi.org/10.1016/j.ufug.2014.04.003>
- Salazar-Elena JC, Sánchez MP, and Otamendi FJ (2016). A non-parametric delphi approach to foster innovation policy debate in Spain. *Sustainability*, 8(5): 487.  
<https://doi.org/10.3390/su8050487>
- Schmidt R, Lyytinen K, Keil M, and Cule P (2001). Identifying software project risks: An international Delphi study. *Journal of Management Information Systems*, 17(4): 5-36.  
<https://doi.org/10.1080/07421222.2001.11045662>
- Shariff N (2015). Utilizing the Delphi survey approach: A review. *Journal of Nursing and Care*, 4(3): 246-251.
- Tracy SJ (2013). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. 1<sup>st</sup> Edition, Wiley-Blackwell, Hoboken, USA.