

The application of the Delphi method in architectural research

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ARTICLE INFO	ABSTRACT
<p><i>Article history:</i> Received July 07, 2023 Received in revised form Jan. 10, 2024 Accepted January 26, 2024 Available online April 01, 2024</p> <p><i>Keywords:</i> Architecture Delphi method Procedural implementation</p> <p>*Corresponding author: Arman Arisman School of Architecture, Planning and Policy Development, Institut Teknologi Bandung, Indonesia Email: arman.wu@gmail.com ORCID: https://orcid.org/0000-0002-6823-0588</p>	<p><i>Research in the field of architecture plays a significant role in the advancement of architectural knowledge and encourages architectural professionals to produce better architectural works. Choosing the right research methodology is essential to producing high-quality research. Research methodologies are employed to determine the best scientific strategy for testing hypotheses provided by a particular theory. Thus, selecting the right methodologies has a big impact on how well a research project turns out. However, because there is such an extensive variety of research methods accessible, researchers frequently have trouble deciding which one is best for their objectives. The objective of this study is to investigate the Delphi method, one of the methods that can be applied to architectural research. Experts on a particular topic are surveyed and their opinions are gathered using the Delphi technique. This research will explore several architectural research journals that have utilized the Delphi method, focusing on the methodology section of each study. Through this exploration, the reasons for employing the Delphi method in each research and its procedural implementation will be examined. The findings of this research can serve as a basis for consideration in selecting and appropriately utilizing the Delphi method in architectural research.</i></p>

Introduction

The Delphi method was originally discovered in health-related research, particularly in nursing (Foth et al. 2016). This is because nursing knowledge is tacit knowledge, which is very sensitive to human life and difficult to explain and formalize. The Delphi method is the best option when urgent circumstances call for research whose methods are not yet well standardized (Chan 2022; Naji, Gunduz, and Naser 2022), because the method is fully dependent on the opinions and consensus of competent experts in the field (Barth and Carr 2014; Mozuni and Jonas 2017; Kumar 2021), so that the results can be

expected to be the most optimal solution for the problems faced.

Nursing and architectural science are two very separate fields. Nursing science is primarily concerned with issues that are directly related to human health concerns, most of which are urgent. In the meantime, human habitats—that is, places, structures, spaces, and the built environment—that are a component of the human experience are of greater importance to architectural studies (Sudradjat 2020; Widodo 2019; Subroto 2019). Scientists in the field of architecture have paid little attention to the Delphi Method because of the contrasts in the characteristics of the two sciences.

Recently, the field of architectural science has broadened to include non-physical aspects of humans as building architects, such as perspective, behavior, preferences, comfort, privacy, and lifestyle, which either directly or indirectly involve other scientific disciplines like philosophy, psychology, sociology, health, and others. These issues are in addition to issues of visual aesthetics, function, structure and construction, and materials science. The Delphi method is one of the cross-disciplinary issues that have made architectural scientists realize how important it is to learn different techniques, the benefits of which were previously underestimated.

The motivation for researchers' decision to utilize the Delphi method, its use in architectural research, and the advantages and disadvantages when utilizing the Delphi method in architectural research will all be covered in this article.

Delphi method

The Delphi method (Hasson, Keeney, and McKenna 2000; Malkawi, Bakar, and Dahlin 2023; Essam Khamis 2022; Gerosa, Argentin, and Spada 2024) is a consensus-based research method that employs group facilitation techniques. This technique is typically applied when the available data is ambiguous or contradicting (Hafiz 2016). With this strategy, researchers can reconstruct the communication process in groups so that all persons in the group can engage in dealing with difficult problems efficiently (Linstone and Turoff 2002; Brook 2020; Przybylski 2020).

As the Delphi technique is thought to be appropriate only for examining specific research problems (Hasson, Keeney, and McKenna 2000), it is crucial to identify issues early on before selecting this approach (Essam Khamis 2022). Research objectives that are generated from the identification of the problem can serve as a foundation for deliberating over the Delphi technique selection. When selecting the Delphi method, the following four pertinent research objectives should be taken into account (Linstone and Turoff 2002): (1) Exploration or exposition of assumptions or information that leads to differences of opinion; (2) Search for information that can produce consensus; (3) Correlation of information assessment on a topic involving various scientific disciplines; (4) Educate the group about various and interrelated aspects of the topic.

Data collection is carried out by asking for opinions from experts or specialists who are usually referred to as panelists, respondents or participants. The data collection technique was carried out by administering a structured questionnaire in several stages or rounds (Meijering et al. 2015; Mozuni and Jonas 2017; Tamošaitienė et al. 2021). Direct interaction between panelists is avoided. Panelists may know the identities of their fellow members, but their opinions will remain anonymous (Sherriff 2012). The goal is that their opinions and reactions to various opinions do not become biased due to the opinions and pressure of other panelists (Goodman 1987).

The Delphi method is an adaptive research method (Sumsion 1998). here are no standard universal guidelines for using the Delphi method. However, the validity of the results from research using this method must still be accountable. An important factor that really determines the validity of the results from this method is the response level of the panelists. The expected response rate in research using the Delphi method is around 70% (Derendorf et al. 2023).

From preparation to results, the stages of the Delphi method are partially lengthy. The steps of exploration, distillation, and usage can be roughly categorized into three stages (figure 1) (Skinner et al. 2015). The method's first step, known as the exploratory stage, concentrates on getting ready before the questionnaire round is conducted. The primary stages of the Delphi method's implementation, data collecting, and analysis, are referred to as the distillation stage. As for the usage stage, it's the last one after reaching a consensus on findings.

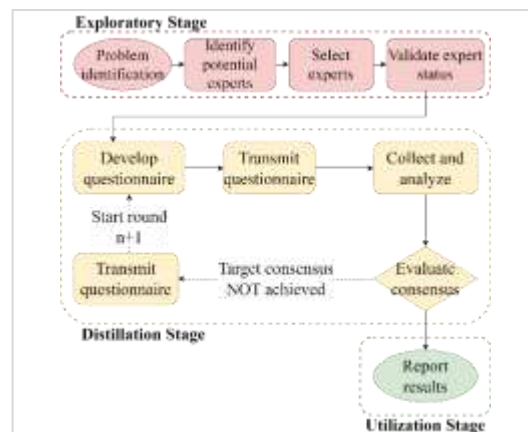


Figure 1. Delphi method process flow diagram

Exploratory stage

The first phase of the Delphi method, referred to as the preparatory stage, is the exploratory stage. Understanding the research topic and the procedure for selecting the panelists who will participate are the primary objectives of this step (figure 2). At this point, it is essential as well to consider the data-gathering procedures that will be employed, such as sending out questionnaires and scheduling interviews (Hasson, Keeney, and McKenna 2000). This is now easier to accomplish in the digital age since you may benefit from information technology advancements. However, researchers also need to get an idea of the characteristics of potential panelists (Hafiz 2016; Tamošaitienė et al. 2021), so they can adjust data collection methods at the next stage. Researchers need to ensure that they are familiar with digital technology as mentioned above.

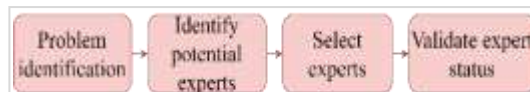


Figure 2. Exploratory stage process flow diagram

The process at this exploratory stage can be divided into several activities as follows: (1) Identify the problem; (2) Identify potential panelists (experts); (3) Selection of panelists (experts); (4) Validate panelist (expert) status.

Distillation stage

The distillation stage is the core stage of the Delphi method, which starts with developing a questionnaire and distributing it to the panelists, followed by analyzing the results (figure 3). These duties typically require repeated execution; they cannot be completed in a single round (Meijering et al. 2015). Until a consensus develops, the results of one round will serve as the foundation for the following round.

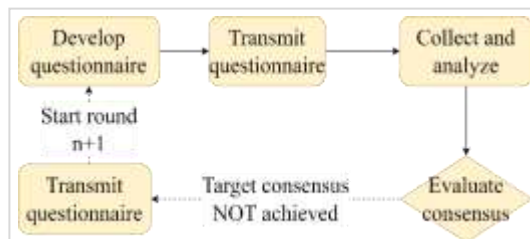


Figure 3. Flow diagram of the distillation stage process

The panelists anonymously completed the questionnaire that enabled them to express their

thoughts and respond to those of other panelists. The responses from each questionnaire are fed back concisely to the panelists as information about the status of their collective opinion (Goodman 1987). Researchers may be able to find items in this stage that they may have missed or dismissed as insignificant. Following such comments, participants are given the chance to modify or revise their opinions.

Utilization stage

The Delphi method ends with the usage step, which requires obtaining a consensus report prepared for publishing. Informing the panelists of the findings is equally crucial as an opportunity to express gratitude for their time and knowledge in support of the study. Panelists who are excited about applying the Delphi procedure will also be interested in its results (Skinner et al. 2015).

A research report using the Delphi method needs to include several details, such as the number of issues in each round, the number of panelists for each round, the response rate, the length of the study, the strategy employed to address bias matters, the consensus approach, the degree of consensus, and other measures on hypotheses, in addition to information about statistical computations.

Methods

This study incorporates various design research antecedents that employ the Delphi technique. The investigations were classified into two groups according to the way the Delphi method was applied: as the primary method and as a supplementary method. Using this information, we will examine the factors that caused these researchers to select the Delphi method for their architectural research. The advantages and disadvantages of employing the Delphi method as the primary approach as well as a supplementary method in architectural research will next be examined to further explore it.

Results and discussion

Delphi method as the main method in architectural research

It is slightly challenging to locate architectural research that primarily employs the Delphi

method of analysis. A thesis with the title "The Challenges of Parametric Design in Architecture Today: Mapping the Design Practice" (Zarei 2012) can be used as an example of architectural research that uses the primary method is the Delphi method. This study examines parametric design's position, which is still regarded as relatively new in the field of architecture. Because parametric design is still primarily recognized in theoretical contexts, practical application still confronts challenges due to its relatively recent development. In addition, there are several connections between parametric design and other scientific disciplines outside of architecture. To determine its place in the real world of practice, professionals with knowledge of parametric design must be involved. For this reason, the Delphi method must be utilized for this research.

The Delphi method employed in this research underwent slight modifications. This is natural, considering that there are no universal guidelines that standardize the procedures for using the Delphi method as a whole (Hasson, Keeney, and McKenna 2000). This study used the Delphi method, which involved conducting interviews in addition to employing a questionnaire. As a result, there are phases in the Delphi method approach that are completed by questionnaires and stages that need interviews.

Panelists for this study included university lecturers who practice architecture as well as professionals with backgrounds in architecture. Three rounds of the Delphi process were conducted, and the final result was a consensus that served as the foundation for developing study conclusions. The study's final findings conclude the advantages and difficulties of adopting parametric design as well as how it differs from other design methodologies and procedures. Things that are considered to be novel can be positioned using the Delphi technique, particularly if they include multiple scientific fields. As a result of the study topic's direct relevance to the real world, panels consisting of academics and working architects must collaborate to reach an unequivocal consensus.

Delphi method as a supporting method in architectural research

In research entitled "A Study on Sustainable House Design in Lanyu" (R. Chen and Yang 2012), the Delphi method was utilized not as the main method, but as a supporting method in the finalization stage. This research aims to build a

framework for assessing sustainable house design in Lanyu by applying green architectural concepts and traditional architectural language. It can be seen that there are two concepts with different characteristics, encompassing green and traditional architecture. Green architecture is a concept that talks a lot about measurable and quantitative things. All aspects that are not actually measurable are then made measurable to make it easier to assess the fulfillment of green architecture criteria. In contrast, traditional architecture emphasizes solely qualitative topics. The research methodologies employed in this study represent the various attributes of these notions.

To create a draft assessment framework-which will be utilized as a tool to gather data for the development of an analytical framework-this research commenced with a review of the literature and expert interviews. The assessment framework was refined using the Delphi technique in the following step, and analysis was performed using the Analytic Hierarchical Process (AHP). This indicates that the Delphi method is not utilized as a comprehensive primary strategy, but rather merely in specific phases.

In this research, the Delphi method is applied more to elaborate the concept of green architecture compared to the concept of traditional architecture. This research involved 20 senior architects and professionals in the field of green architecture as panelists for the Delphi method. To obtain consensus results, the questionnaire was administered in three rounds. In this study, the Delphi method is being applied to verify the validity of an assessment framework's completeness and integrity. Literature research and interviews served as the foundation for the draft assessment framework's formulation, but because the findings are still too theoretical, expert validation is required to provide a more operational assessment framework. After the experts' approval, the assessment framework is utilized as a tool for collecting data that will subsequently be processed to produce the results of the study.

The second research used as an example is a journal with the title "Analysis of Accessibility of Green Spaces in Tehran for People with Limited Movement with an Emphasis on the Concept of Universal Design" (Rafizadeh 2021). The Delphi method in this research was also used as a supporting method. This research aims to evaluate the accessibility of parks in Tehran for people

with physical limitations. The Delphi method is focused on determining and assessing indicators of the availability of architectural parks and urban planning.

In this research, it is not explained in detail how the Delphi method was used. However, it is said that the initial method used was a literature review and direct collection of expert opinions. The results of the two initial methods were then analyzed with the help of the Delphi method. In this way, the function of the Delphi method in research is only as a supporting method.

The third research is a journal with the title "Analysis of Creativity in Architectural Design after the Islamic Revolution" (Ilka, Bazrafkan, and Soltanzadeh 2019). This research focuses on analyzing creativity in the process of architectural design work during the Islamic revolution in Iran. This research tries to evaluate the creativity index in the selected sample and see whether there is a significant relationship between the creativity index and the effectiveness of the work and the selection process as the superior sample. This research method begins with a theoretical literature review with a descriptive analytical approach, then content analysis is used at the empirical stage.

In this study, the Delphi method was applied to two groups with distinct objectives; however, it was not specified if the panelists in the two groups were the same. In the first Delphi method, ten professionals in art and architecture evaluated the creative derivative index derived from a theoretical study's results. At this point, the Delphi method is applied to validate how an assessment from the previous step was categorized. The second phase of the Delphi process comprised 15 architectural specialists narrowing down the 70 building's worth of architectural works to 4 that were thought to be most pertinent to the study topic.

There are some similarities between the three studies mentioned above in terms of how the Delphi technique is applied. All three follow essentially the same steps, beginning with a review of the literature and obtaining expert opinions to classify or categorize an assessment framework. They all use the Delphi method as a research support approach. The assessment framework validation procedure is required because there fails to be a reference that has been accepted as standard or because there is a reference that is already in place but has to be modified for the particular situation. For instance,

in the first study, there were already established criteria for rating green buildings; however, due to the distinctive features of the traditional architectural environment, these criteria had to be modified.

These three studies basically have a main topic whose discussion focuses more on qualitative matters, but in the process a measurable assessment is needed that involves the expertise of experts. For example, in the first research the emphasis was on traditional architecture, but the researchers wanted to also link it to the assessment of green architecture, which in principle is very measurable. Researchers cannot simply take an assessment system from the concept of green architecture, because it must first be adapted to the context of traditional architecture.

These three disciplines, in theory, deal with two or more fundamental ideas that need a connecting bridge to be understood. For instance, the first study examined the ideas of conventional and green buildings. The relationship between design and social behavior is examined in the second study, while creativity, history, and design are covered in the third study. These three studies employed the Delphi technique to identify relationships between data from different scientific disciplines or a range of concepts that are connected to the discussion topic (Linstone and Turoff 2002).

Significance and limitations of the Delphi method in architectural research

The Delphi method can be utilized as the main method or supporting method in architectural research (Gerosa, Argentin, and Spada 2023).

From several examples that use the Delphi method as a supporting method, it can be seen that its use is to validate categories or classifications which in the next stage will be used as measurement instruments (K. Chen 2015), especially in cross-disciplinary research areas that have different concepts and characteristics. The Delphi method pattern in this research begins with a literature review and direct networking of expert opinions to produce a classification or category that will be used as an assessment instrument, because there is no standard reference yet, or because adjustments are needed to existing references because the context faced is different. (Quantitative - qualitative, monodisciplinary - multidisciplinary differences).

The Delphi method can be effectively used to obtain consensus from experts through a simple process, namely a questionnaire (Pongruengkiat et al. 2023). Adopting the Delphi method is highly appropriate for architectural study including challenges that are yet fresh or unclear. Expert opinions in associated domains can be easily obtained by researchers through the use of information technology-supported questionnaires. Gathering information can be accomplished in a relatively short time compared to efforts to bring together specialists to talk in one spot. However, to allow professionals to express their thoughts in an unbiased manner, the anonymity that is inherent to this approach must be preserved (Goodman 1987).

The Delphi method has certain disadvantages in addition to its advantages. Firstly, the Delphi approach is applicable and useful only for certain research challenges requiring consensus among subject matter experts. It ought to come as no surprise that published research rarely uses the Delphi method. The Delphi method is rarely employed as the primary technique; instead, it generally serves as a supporting method in the case studies found in the literature. Second, the willingness of the panelists' experts to participate greatly influences how effective the Delphi approach is. It is difficult to ask panelists to regularly adhere to a study schedule and take part in each round. In particular, architects typically have demanding project schedules, which makes it challenging to allocate time for study. In addition, because architecture is such a large field, it might be challenging to identify the qualifications for reliable panelists. Third, the number of parties involved in the study has a significant impact on how long it takes to complete because panelists' responses are rarely received at the scheduled time, causing delays and frequent adjustments to the work schedule.

If the researcher can identify the problem, the Delphi technique can be utilized quite well. The clarity of the questions posed will have a significant effect on the panelists' responses. Sharply formulated questions will facilitate panelist's ability to offer pertinent answers. Furthermore, the data collection process will be conducted in multiple rounds, with each round being dictated by the results of the preceding round. As a result, a poorly formulated problem may affect panelists' responses in subsequent rounds, which could compromise the validity of the research's overall results.

Another crucial limitation of the Delphi method is the risk of panelists being absent or even dropping out for various reasons. The absence of panel members in a round will result in incomplete round result data. The withdrawal of panel members will cause the amount of data to decrease, thereby reducing the representativeness of the research results.

If these unforeseen events occur, the researcher is required to be prepared to make several adjustments to rebalance the Delphi method's architecture. To keep panel members engaged and dedicated to their duties as study participants, researchers need to remain in contact with them as well as cultivate personal connections.

Conclusions

The Delphi method can be applied in architectural research as a main method or supporting method. The Delphi method typically needs to be adjusted to correspond with the specific situation when employed as the primary method. The newest trends in architecture or technological advancements in the area are relevant subjects for architectural research. The Delphi method performs well as a supporting technique for validating categories or classes that will be utilized as measuring tools at a subsequent stage. Multidisciplinary and evaluative topics for study are pertinent.

Architectural research using the Delphi method is more successful when the researcher has strong management and communication abilities. Managing a large amount of data from different panelists that needs to be processed based on their unique features requires managerial skills. Meanwhile, effective communication is required to establish a functional network and uphold positive connections with reliable, knowledgeable panelists, ensuring the continuity and efficiency of research.

There are still a lot of limitations with this research, prominent among them being the paucity of architectural research cases included. This is a result of the challenge encountered by academics in locating instances of architectural research that employ the Delphi method. There could be an absence of Delphi method adoption in the architectural studies domain, or a failure to

identify relevant keywords or methods for searching the literature.

The Delphi method could be employed in Indonesian architectural research in several circumstances, particularly when determining priority levels, strategic options, or phasing steps requiring for expert panel judgment.

If there is a reason why the Delphi method has yet to be extensively utilized in architectural research, it is crucial to investigate it further. Is using the Delphi method in architectural research genuinely too difficult? Does the Delphi method have any prerequisites that need to be fulfilled to be employed as a productive and successful alternative research approach in the field of architecture?

Suggestions

The Delphi Method should be taught alongside other methods that are already generally included in teaching curricula in master's and doctoral-level architectural research methodology courses as it offers an enormous amount of potential and benefits when applied rigorously in architectural research. In the beginning, research methodology lecturers and graduate students at architecture schools can receive socialization and training on the Delphi method through introductory lectures, discussion forums, and workshops. The body of information regarding the Delphi method and its strategies for application will progressively influence the degree of acceptance of the Delphi method by the academic architecture community, as well as the extent to which it is employed in architectural research projects including a wide range of problems.

References

- Barth, David, and Margaret Carr. 2014. 'Using a Delphi Method to Develop Criteria for High Performance Public Spaces That Contribute to Community Sustainability'. *Landscape Research Record* 2, 132–37.
- Brook, Alastair. 2020. 'Can We Virtually Model Architectural Patterns from Stories? Exploring Possibilities to Remotely Implement a Native Research Practice'. *IMADE: International Confrence on Multimedia, Architecture and Design* 1.
- Chan, Puthearath. 2022. 'An Empirical Study on Data Validation Methods of Delphi and General Consensus'. *Data* 7 (2): 18.
- Chen, Keyu. 2015. 'A Strategic Decision Making Framework for Organisational BIM Implementation'. Cardiff University.
- Chen, Ron, and Hsi Chi Yang. 2012. 'A Study on Sustainable House Design in Lanyu'. *Applied Mechanics and Materials* 209–211 (October): 449–54.
- Derendorf, Lisa, Stephanie Stock, Dusan Simic, and Clarissa Lemmen. 2023. 'Developing Quality Indicators for Cross-Sectoral Psycho-Oncology in Germany: Combining the RAND/UCLA Appropriateness Method with a Delphi Technique.' *BMC Health Services Research* 23 (559).
- Essam Khamis, Noha. 2022. 'The Delphi Method as a Morphological Catalyst for Foresight-Oriented Design Research'. *DIID*, no. 76 (May). <https://doi.org/10.30682/diid7622j>.
- Foth, Thomas, Nikolaos Efstathiou, Brandi Vanderspank-Wright, Lee-Anne Ufholz, Nadin Dütthorn, Manuel Zimansky, and Susan Humphrey-Murto. 2016. 'The Use of Delphi and Nominal Group Technique in Nursing Education: A Review'. *International Journal of Nursing Studies* 60 (August): 112–20.
- Gerosa, Tiziano, Gianluca Argentin, and Alice Spada. 2024. 'What Are Teacher Relational Skills? A Defining Study Using a Bottom-up Modified Delphi Method'. *Quality & Quantity* 58 (1): 581–602.
- Goodman, Claire M. 1987. 'The Delphi Technique: A Critique'. *Journal of Advanced Nursing* 12 (6): 729–34.
- Hafiz, Dalia O. 2016. *Improving Design Decision-Making through a Re-Representation Tool for Visual Comfort Consideration in Dynamic Daylit Spaces*. Virginia Tech.
- Hasson, Felicity, Sinead Keeney, and Hugh McKenna. 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>.
- Ilka, Shabab, Kaveh Bazrafkan, and Hossein Soltanzadeh. 2019. 'Analysis of Creativity in Architectural Design after the Islamic Revolution ; Case Study : The Selected Award

- Winning Architectural Works'. *Armanshahr Architecture & Urban Development* 12 (26): 31–49.
<https://doi.org/10.22034/AAUD.2019.89052>.
- Kumar, Parvesh. 2021. 'Building Materials & Thermal Comfort in Rural Habitat'. Indian Institute of Technology.
- Linstone, Harold A., and Murray Turoff. 2002. *The Delphi Method: Techniques and Applications*. New York: Addison-Wesley Pub. Co.
- Malkawi, Aminah Rezaqallah, Muhamad Shahbani Abu Bakar, and Zulkhairi Md Dahlin. 2023. 'Review of the Delphi Method in the Higher Educational Research'. *Kongzhi Yu Juece/Control and Decision*.
- Meijering, Jurian Vincent, Hilde Tobi, Adri van den Brink, Fiona Morris, and Diedrich Bruns. 2015. 'Exploring Research Priorities in Landscape Architecture: An International Delphi Study'. *Landscape and Urban Planning* 137 (May): 85–94.
<https://doi.org/10.1016/j.landurbplan.2015.01.002>.
- Mozuni, Mehdi, and Wolfgang Jonas. 2017. 'An Introduction to the Morphological Delphi Method for Design: A Tool for Future-Oriented Design Research'. *She Ji: The Journal of Design, Economics, and Innovation* 3 (4): 303–18.
<https://doi.org/10.1016/j.sheji.2018.02.004>.
- Naji, Khalid K., Murat Gunduz, and Ayman F. Naser. 2022. 'Construction Change Order Management Project Support System Utilizing Delphi Method'. *JOURNAL OF CIVIL ENGINEERING AND MANAGEMENT* 28 (7): 564–89.
<https://doi.org/10.3846/jcem.2022.17203>.
- Pongruengkiat, Wiwat, Korrakot Y. Tippayawong, Pruk Aggarangsi, Preda Pichayapan, Tossapon Katongtung, and Nakorn Tippayawong. 2023. 'Applying Delphi Method to Develop Sustainable City Indicators: A Case Study of Chiang Mai, Thailand'. *TeMa: Territorio Mobilità e Ambiente* 16 (1): 165.
<https://doi.org/10.6093/1970-9870/9813>.
- Przybylski, Liz. 2020. *Hybrid Ethnography: Online, Offline, and In Between*. California: SAGE Publications Inc.
- Rafizadeh, Neda. 2021. 'Analysis of Accessibility of Green Spaces in Tehran for People with Limited Movement with an Emphasis on the Concept of Universal Design.' *Bagh-e Nazar* 18 (94): 37–50.
- Sherriff, Graeme. 2012. 'CLUES to Urban Energy in the UK: Survey of Initiatives'. University of Manchester.
- Skinner, Richard, R. Ryan Nelson, Wynne W. Chin, and Lesley Land. 2015. 'The Delphi Method Research Strategy in Studies of Information Systems.' *Communications of the Association for Information Systems*.
- Subroto, Tarcicius Yoyok Wahyu. 2019. 'Natural Coexistence And Culture in Architecture'. *ARTEKS: Jurnal Teknik Arsitektur* 3 (2).
<https://doi.org/10.30822/arteks.v3i2.60>.
- Sudradjat, Iwan. 2020. 'Teori Dalam Penelitian Arsitektur'. *ARTEKS: Jurnal Teknik Arsitektur* 5 (1): i–vi.
<https://doi.org/10.30822/arteks.v5i1.378>.
- Sumsion, Thelma. 1998. 'The Delphi Technique: An Adaptive Research Tool'. *British Journal of Occupational Therapy* 61 (4): 153–56.
- Tamošaitienė, Jolanta, Hadi Sarvari, Matteo Cristofaro, and Daniel W. M. Chan. 2021. 'Identifying and Prioritizing the Selection Criteria of Appropriate Repair and Maintenance Methods for Commercial Buildings.' *International Journal of Strategic Property Management* 25 (5): 413–31.
<https://doi.org/10.3846/ijspm.2021.15225>.
- Widodo, Johannes. 2019. 'Human, Nature, And Architecture'. *ARTEKS: Jurnal Teknik Arsitektur* 3 (2): 145–48.
<https://doi.org/10.30822/arteks.v3i2.65>.
- Zarei, Yasser. 2012. *The Challenges of Parametric Design in Architecture Today: Mapping the Design Practice*. ProQuest LLC (2018).

Author(s) contribution

Arman Arisman contributed to the research concepts preparation, methodologies, investigations, data analysis, visualization, articles drafting and revisions.

Iwan Sudradjat contribute to the research concepts preparation and literature reviews, data analysis, of article drafts preparation and validation.

Indah Widiastuti contribute to methodology, supervision, and validation.