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Extracting Personal Preferences for Architectural Attributes: Examining the Reliability of Several Direct and Indirect Questioning Methods

Abstract: The personal satisfaction with the formal attributes of buildings has an underlying essence and needs some exploratory attempts to secure a set of attribute satisfactions. This paper aims to discover reliable methods for extracting the personal preferences for the formal attributes by examining the accuracy of several questioning methods. Focusing on building facades, the attributes are defined at first to cover a wide range of architectural forms. The study then introduces eight methods of extracting personal preferences: four attribute-based methods directly ask participants for their attribute preferences, and four building-based methods extract each attribute satisfaction from the analysis of appreciation of architectural forms. A survey then extracts individuals' satisfaction with the attributes via each method; the outcomes of each questioning method are examined by applying them into preference prediction of another set of building images integrated into the survey. The analysis shows that the most accurate results are achieved when participants directly express their opinions about the attributes illustrated in a building image. Among the building-based methods, considering all the visible attributes in the analysis of the building preferences can reveal the second-most accurate data. Finally, although the combination of both methods enhanced the result's accuracy, the former method is more efficacious while a lower number of attributes are considered and knowledgeable people are addressed; otherwise, the latter method is practically more valid for laypeople and scalable to a large number of people.

Keywords: architectural attributes; building preferences; attribute satisfaction; formal appreciation; building aesthetics.

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Introduction

The perceived visual features of architectural forms have important impacts on human experience and aesthetic appraisals.[1] According to Roger Scruton, a visual perception has a subjective and imaginative structure,[2] reminding the trace of symbols and representation discussed by Goodman[3] and Gombrich[4] respectively, rooted in our historical, social, and cultural background. Thus, many studies investigate the appraisals of visual attributes within a specific geographical, historical, and demographic classes, like the effects of political issues on signs and aesthetic perception of Chilean visual arts;[5] other studies confirm the positive impact of vernacular symbolic features on building façade preferences [6] and the effects of familiarity in the appraisals of storefronts.[7] Even the trace of urbanism, as a social transformation on the aesthetic experience of cinema and architecture, has been investigated.[8]

While these studies reflect the observer's background regarding aesthetic experience, other studies consider their preferences of the visual attributes beyond any limitation, from a general perspective. For example, it has been shown that people, in general, prefer curved over sharp objects,[9] large over small objects,[10] and buildings with visible entrances over those without.[11] Similarly, Milica Petrović discusses the significance of geometry as a universal language on the beauty of architecture,[12] and other researchers investigate the trace of complexity on buildings in general[13]

[1] Jack L. Nasar, "The Evaluative Image of Places.," in *Person-Environment Psychology: New Directions and Perspectives, 2nd Ed.* ed. by W. Bruce Walch, Kenneth H. Craik, Richard H. Price (Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers, 2000), 117–68.

[2] Roger Scruton, *The Aesthetics of Architecture* (Princeton University Press, 2013).

[3] Nelson Goodman, *Languages of Art: An Approach to a Theory of Symbols* (Hackett publishing, 1976).

[4] Ernst Hans Gombrich, *Art and Illusion: A Study in the Psychology of Pictorial Representation*, A.W. Mellon Lecture in the Fine Arts, 1956 National Gallery of Art, Washington (Princeton University Press, 1960).

[5] Miguel Zamorano Sanhueza, "Displacing Meanings: Hidden Signs of Aesthetics in the Chilean Context," *AM Journal of Art and Media Studies* 21 (2020): 101–8.

[6] Ebru Erdogan et al., "Urban Codes: Familiarity, Impressiveness, Complexity and Liking in Façades of Houses," *Gazi University Journal of Science* 26, 2 (2013): 319–30.

[7] Yasemin Burcu Çakırlar, "Factors Affecting Evaluations of Storefront Designs and Inference on Store Characteristics" (Bilkent University, 2010), http://hdl.handle.net/11693/15093.

[8] Sônia Campaner Miguel Ferrari, "Cinema, Architecture and Conditions of Artistic Experience in Big Cities," *AM Journal of Art and Media Studies* 21 (2020): 109–19.

[9] Paul J. Silvia and Christopher M. Barona, "Do People Prefer Curved Objects? Angularity, Expertise, and Aesthetic Preference," *Empirical Studies of the Arts* 27, 1 (2009): 25–42.

[10] David H. Silvera, Robert A. Josephs, and R. Brian Giesler, "Bigger Is Better: The Influence of Physical Size on Aesthetic Preference Judgments," *Journal of Behavioral Decision Making* 15, (2002): 189–202.

[11] Thomas R. Herzog and Ronda L. Shier, "Complexity, Age, and Building Preference," *Environment and Behavior* 32, 4 (July 1, 2000): 557–75.

[12] Milica Petrović, "Universal Language of Geometry: Geometrical Grid–The Nature of Space," *AM Journal of Art and Media Studies* 16 (2018): 69–84.

[13] Herzog and Shier, "Complexity, Age, and Building Preference."

or specifically on residential building facades appraisals.[14] Finally, regardless of the reason for the preference, whether rooted in the observer's background or not, some architectural attributes are more preferred over others.

Architectural features and building appearance are coherently related to the ubiquitous term of *composition*. Composition rules and composition elements, recalling words and grammar in a sentence, are considered the roots of architectural composition features and visual qualities. Some practitioners and scholars believe in the timeless underlying composition principles include Peng, who explains the six governing rules of composition,[15] and Hanlon, who discusses the five composition properties of composition including number, geometry, proportion, hierarchy, and orientation.[16] In contrast, others rely upon the epochal essence of principles; as Gargus put it, "the emphasis on specific principles can shift"[17] over time. This refers to the importance of axis-based symmetrical forms in the early 19th century, shifting toward balance in the late 19th century, the emergence of the unbalanced and asymmetrical plan in the early 20th century,[18] and recently, as Schumacher noted, the ontological shift from "rigid geometrical figure with straight-line toward the dynamic and adaptive geometrical entities."[19]

Nowadays, composition rules and principles are no longer valid unconditionally. As Wright in the 20th century said, "Composition [as a method] in architecture is, I hope, dead"[20]; instead, "non-composition" that attempts to escape compositional modes emerges.[21] Architects now move beyond the limitation of rules. Besides, technological advancement has eliminated the barrier of the composition elements. Accordingly, unlike the limited composition features of previous buildings, any formal qualities and visual features are visible and practically possible.

Consequently, on the one hand, the robust effect of visual qualities on aesthetic judgment and building preferences confirms the significance of introducing a reliable method to discover the visual attributes satisfactions. On the other hand, moving

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[14] Aysu Akalin et al., "Architecture and Engineering Students' Evaluations of House Façades: Preference, Complexity and Impressiveness," *Journal of Environmental Psychology* 29, 1 (2009): 124–32; Çagri Imamoglu, "Complexity, Liking and Familiarity: Architecture and Non-Architecture Turkish Students' Assessments of Traditional and Modern House Facades," *Journal of Environmental Psychology* 20, 1 (2000): 5–16.

[15] Hua Li, "'Composition' and Regularisation of Architectural Production in Contemporary China," *Frontiers of Architecture and Civil Engineering in China* 4, 4 (2010): 465–73.

[16] Don Hanlon, *Compositions in Architecture* (Hobokem, New Jersey: Wiley, 2009).

[17] Jacqueline Gargus, *Ideas of Order: A Formal Approach to Architecture* (Virginia: Kendall Hunt Publishing Company, 1994).

[18] Jacques Lucan, *Composition, Non-Composition: Architecture and Theory in the Nineteenth and Twentieth Centuries* (Lausanne, Switzerland: Routledge, 2012), 221.

[19] Patrik Schumacher, "Design Parameters to Parametric Design," in *The Routledge Companion for Architecture Design and Practice: Established and Emerging Trends*, ed. Mitra Kanaani and Dak Kopec (New York: Taylor & Francis, 2015), 11.

[20] Frank Lloyd Wright, *In the Cause of Architecture: Essays by Frank Lloyd Wright for Architectural Record, 1908–1952*, ed. Bruce Brooks Pfeiffer (New York: Random House Incorporated, 1928), 259.

[21] Lucan, *Composition, Non-Composition: Architecture and Theory in the Nineteenth and Twentieth Centuries*.

beyond the limits of composition, enabling architects to freely select from a wider range of visual attributes, shows that extracting the preferences for visual attributes is getting progressively significant. Although researchers have mostly explored the preferences for some attributes via rating a set of building images sharing the questioned attributes, the method of extracting the individual preferences is indeed questionable. Is it better to directly ask if an individual likes an attribute, or would it be more accurate to indirectly extract the individual preferences from a set of building images? Accordingly, this study aims to discover a reliable method for extracting personal preferences for the formal attributes. Regarding the complex essence of composition, different methods for exploring individual taste for formal attributes are introduced and then examined to consequently propose a reliable method for discovering the personal preference of the attributes.

Methodology

The goal was to introduce a reliable method to extract the individual preferences for formal attributes by defining some methods and examining their accuracies. As figure 1 shows the procedure flowchart, at first, a set of building attributes, and their value ranges are defined. Four directly and four indirectly questioning methods are then proposed to explore the individual preferences of the attributes; and, this paper examines the accuracy of the outcomes deriving from these eight methods. Lastly, a survey is designed to scrutinize the methods' outcomes. That is, the last part examines the accuracy as well as the validity of the eight acquired sets of preference values reflecting the precision of the raw data and, accordingly, the extracting method. The subsequent sections explain the four-step procedure (see Figure 1).

Defining composition attributes

Despite addressing the identification of formal attributes in another paper,[22] a predefined set of attributes are focused upon in this study. Worth mentioning, the countless possible numbers of attributes and their values are limited precisely in a way to cover a wide range of architectural forms, as well as keeping the study feasible. Altogether 16 attributes with 54 values are considered in this study, expressed in three groups concerning material, element, and building. To appreciate the attributes, they are exemplified with some building images, referred to by the number placed in parenthesis next to each value. To illustrate all the attribute values with a more manageable number of images, the samples are presented in three sets and numbered to be referred to accordingly in either group.

[22] Seyed Farhad Tayyebi and Yüksel Demir, "Architectural Composition: A Systematic Method to Define a List of Visual Attributes," *Art and Design Review* 7, 3 (2019): 131–44. *

The first group exclusively considers attributes related to materials, whereby the building is mainly constructed. It considers material properties related to its quality, color, texture, solidity, reflectivity, and the relation between the applied materials. Please consider, the aluminum in the material quality indicates aluminum alloy cladding panels; material solidity refers to the solidity-transparency level of the material either by having a transparent material essence or by net-shaped or porous materials structure. Material relation summarizes both the number and relation between the applied materials in a building.

Material quality: Stone (B2) – Brick (A3) – Wood (C5) – Plaster/concrete (A1, C1) – Aluminum (B4, C3)

Material Color: White (C1) – Gray (B4) – Black (C3) – Light Warm Color (A3, C2) – Dark Warm Color (C4) – Cold Color (A4)

Material Texture: Without Texture (A1, C1) – With some texture (A3, B1) – Full of texture (A4)

Material Solidity: Solid (A1, A3) – Almost Solid (C2) – Net shaped (A2)

Material Reflectivity: Matte (A1, A3) – Reflective (B4) – Very reflective (A4)

Materials Relations: Single Material (A3, A4, C1, C3) – 2, 3 Different Material (B1) – 2, 3 Contrast Material (B2) – Many Materials (B3) (see Figure 2).

The second set of attributes focuses exclusively on the elements of composition, which are essentially distinguishable as formal components, especially in abstract formal representations. Although limited in numbers, the values can change the entire structure of the building's composition. In the geometry attribute, basic geometry refers to Pythagorean volumes; compound geometry refers to the unification, subtraction, or combinations of primary geometrical forms; smooth geometry indicates circular and curvilinear structure of the building elements; and fragment geometry refers to some distorted elements or an element with no apparent geometrical form. Apart from the number of elements, identification of the elements forms another composition attribute. If we can distinguish the parts, analogously like a Lego block, it will be considered as Distinctive and Separable. If the building parts are distinguishable but having overlapped parts prevents being separable, they are considered as Distinctive and Inseparable. If the building has no clear constituents, it is considered as Indistinctive and Inseparable.

Geometry: Basic Geometry (B1, C1, C2, C5) – Compound Geometry (B2, A2) – Fragmented Geometry (B4, A4) – Smooth Geometry (B3)

Quantity: Low (1-3) (B4, A4, C3) – Medium (4-7) (C2) – High (7+) (B1, B3)

Identification: Distinctive and Separable (C1, C2) – Distinctive and Inseparable (B1, B2) – Indistinctive and Inseparable (B4) (see Figure 3).

The last set of attributes mostly reflects the overall building properties, which are visible in a glance view of the façade images. Among the attributes, partial symmetry refers to building forms in which some parts are symmetrical, while the whole building does not have a symmetrical axis. The rhythm concerns the existence of any pattern or order in the arrangement of the formal components. The indentation reflects the amount of back and forth, emptiness, or porosity in architectural forms, as opposed to vertical growths of buildings with flat façades.

Symmetricity: Symmetry (C1) – Partial Symmetry (A1) – Asymmetry (C3)

Rhythm: Regular Rhythm (C1) – Irregular Rhythm (A3) – Partial Rhythmic (B2, B3) – No Rhythm (B1)

Stress: Horizontality (C2, B2) – Neutrality (C1) – Verticality (C4, C3)

Indentation (back-forth): No Indent (C5) – Almost Indented (C1, C2) – Fully Indented (B1)

Complexity: Simple (C2, C5) – Moderately Complicated (C3) – Complicated (B1)

Decoration: No Decoration (C1, C3) – Moderately Decorated (A1) – Fully Decorated (C4, C5)

Openness: Almost Open (B2, A2) – Moderately Open (C1, B1) – Almost Solid (C5, A4) (see Figure 4).

Proposing eight methods of preference extraction

Exploration of several questioning strategies to extract the attribute preferences results in distinguishing two main methods: attribute-based and building-based. The attribute-based method directly questions participants about their satisfaction with each parameter value. While, in the building-based method, participants' opinions about each building attribute are extracted based on their opinion about building forms; that is, participants rate building forms, then the internal composition attributes of the building will indirectly reflect their satisfaction with the formal attributes. In this study, eight different questioning methods are proposed. Four directly-questioning modes among the attribute-based methods and four different analyzing strategies indirectly acquiring the preferences within the building-based methods extract the personal preferences of each attribute. The name of all eight data-generating methods refers to their main points and is used consistently throughout the study.

Attribute-based methods

Method 1: Text-based questions

As 'text-based' suggests, no building images are illustrated in this method. Participants judge the attribute values explained by descriptive words. Understood via a pilot-based survey, a very limited number of parameters might be unperceivable for laypeople; accordingly, a simulated abstract image accompanied some text-based questions to facilitate the attribute perception. Participants select their preference range out of seven values.

Method 2: Image-based questions

In this method, each question accompanied by a set of three to five building images sharing the questioned attribute value; participants observe the samples of the attribute value, then rate the attribute value. For instance, while participants are asked to rate black material, images of some buildings with black material on their façades are presented as samples. In this method, samples are selected from different building forms to reduce the influence of the formal structure of the buildings on participants' opinions.

Method 3: Building-based questions

In this method of questioning, a building image is presented, and its formal attributes are asked. Compared to Method 2, rather than having a group of building images sharing the same attribute value, just one building image is illustrated, and participants rate its attributes directly. In Methods 2 and 3, the illustrated buildings not only present the parameter value but also demonstrate the probable influence of the attribute values on building forms.

Method 4: Influential-attribute Questions

This set of questions focuses on significant attributes from the participant's perspective. While viewing a building image, participants' opinions about several visible attributes are questioned, and they are asked to answer those that caught their attention; participants express their opinion about the attributes they find influential. This method is proposed with the hope of acquiring more limited but more accurate outcomes, discerning attributes that participants find unimportant.

Building-based Methods

In the building-based methods, the researchers strive to realize the personal satisfaction with each attribute based on participants' opinions about buildings. Accordingly, there is only one mode of questioning, accompanied by various analyzing methods to extract each attribute preference. Generally, the participant's opinion about each building is assigned to the building attributes, then the average of each attribute satisfaction rates is the participant's opinion about the attribute. Despite sharing the underlying analysis mode, four analyzing methods result in four outcomes, explained below:

Method 5: Analyzing *all visible attributes of the whole buildings*

As the title shows, the buildings' rates are assumed as preference range of all visible parameters existing in the buildings. In this method, the researcher identifies five to fifteen easily perceived attributes (average 9.25) for each building; the buildings' rates allocate to all the visible attributes; then, the average of the attributes' rates reflect the participant's opinion.

Method 6: Analyzing *significant attributes of the whole buildings*

One may claim that participants may not be able to consider all the existing attributes of a building while expressing their opinion. Accordingly, as an alternative analysis method, the building satisfaction levels are allocated only to the very obvious, strong, and influential building attributes. In this case, two to seven attributes (average 4.2) are considered significant for each building. The preference ranges of the buildings are assigned only to the significant building attributes.

Method 7: Analyzing *all visible attributes of the extreme buildings*

Concerning the general analysis method, having buildings with a neutral preference range can moderate the satisfaction level of the attributes. Thus, buildings with a neutral level of preference are disregarded in the last two analyzing methods. Building preferences are via a Likert scale out of nine, and the building rates located in the middle third are omitted (rates 4, 5, and 6); only buildings with a high level of like/dislike is considered in the analysis (1, 2, 3, 7, 8, and 9). Finally, as Method 7, the satisfaction level of the remaining buildings is equated with all the visible attributes in the buildings, like in Method 5. In other words, method 7 can be regarded as method 5 limited to the extreme liked/disliked buildings.

Method 8: Analyzing significant attributes of the extreme buildings

In a similar vein, the moderately satisfactory buildings are discarded in this method. The building satisfaction levels of the remaining buildings are equated only with the identified significant attributes of the buildings, like in method 6. That is, method 8 assigns the preference rates of the extreme liked/disliked buildings to only significant attributes; accordingly, this method has the most limited number of rates in attribute preference analysis.

Preparing and distributing survey

In the next step, a survey is prepared to extract the personal preferences of the attributes via the eight introduced methods. The *text-based* and the *image-based* questions (methods 1 and 2) form the first and second sections of the questionnaire. The questions of the *building-based* (method 3) and *influential attributes* (method 4) concern the attributes illustrated in building images; in addition, general preferences for some building images are the only requirements for methods 5–8. Therefore, the third and fourth parts of the survey respectively focus on the *building-based* questions (method 3) and *influential attributes* questions (method 4), while integrated with the general preference of the image, to be later used for the analysis of methods 5–8. The four parts of the survey thus cover the raw data of the eight methods.

Many factors require careful consideration in preparing the survey and selecting the samples. A few failed trials in pilot studies show that for the *attribute-based* methods, the questions must be proposed in an understandable way for laypeople, and for the *building-based* methods, it was fundamental to select the images from a wide range of building forms covering diverse individual tastes. They all demonstrate the essential need for a database to provide a diverse range of building forms. Therefore, a database with more than 200 building images with all their parameter values is prepared in Microsoft Excel, to provide the best samples from diverse building forms. (The applied building samples and their designated attributes are attached as an appendix.) Apart from the first section (text-based questions) which do not present any building images, the second part of the survey presents three to five building images out of the buildings presented in appendices1 and 2. The third and fourth part of the survey presents every building image respectively, presented in appendixes 1 and 2.

The general preferences for the building images are utilized as the raw data for the last four analysis methods. Consequently, the utilized samples and their assigned attributes are all presented succinctly in the appendices.

Finally, the first four sections of the survey provide the attribute preferences of the eight methods. Eight sets of preference rates, as the outcome of each method, require further examination to discover their accuracy and reliability. As an examination method, the outcome of each method is applied to predict the preferences for another set of building images, which will be discussed in the subsequent parts. Regarding the fact that the examination of the accuracy cannot be applied to the previously-asked building preferences, which were the source of the raw data, a new set of the building preferences is required. Thus, from a wide range of architectural forms, 45 building images are selected in a way to cover all the questioned attributes, to be applied in the analysis part, and to examine the accuracy of the eight methods' results; the samples are attached as Appendix 3. Accordingly, these building images integrated into the survey and formed the fifth part, and participants are simply asked to rate the buildings. Consequently, a five-sectioned survey is distributed to gather the raw data and examine the accuracy of the eight method outcomes.

Despite efforts to gather the raw data in a shorter survey, it has more than 400 questions. The limitation of online-based survey platforms leads to having the survey prepared as a runnable file through Microsoft PowerPoint. The file has been sent to a network of friends. Finally, 25 voluntary respondents cooperated in the study by spending around an hour to complete the survey and sending back their replies. Worth-noting: personal opinions can be influenced by some secondary factors. For example, the presence of other people influence musical preferences[23] and being under time pressure can influence one's satisfaction with figurative and abstract paintings.[24] Despite not being well-discussed in architectural taste studies, there are some factors that can influence building preferences and participants' opinions, such as architectural familiarity,[25] functional issues, construction expenses, and even building maintenance.[26] To reduce the impacts of the secondary factors, participants are asked to assume the questions are related to the buildings they may prefer to observe from their house window, or just pass by. In addition, they are asked to complete the survey when they find themselves in a normal condition, neither under time pressure nor while having particularly strong feelings.

Examining the outcomes in the last step, the accuracy and credibility of the outcomes are examined by two main methods: general analysis and building preferences

[23] Andrei C. Miu, Simina Pițur, and Aurora Szentágotai-Tătar, "Aesthetic Emotions Across Arts: A Comparison Between Painting and Music," *Frontiers in Psychology* 6 (2016): 1951.

[24] Daphne V. Wiersema, Job Van Der Schalk, and Gerben A. van Kleef, "Who's Afraid of Red, Yellow, and Blue? Need for Cognitive Closure Predicts Aesthetic Preferences," *Psychology of Aesthetics, Creativity, and the Arts* 6, 2 (2012): 168.

[25] Richard Cook and Adrian Furnham, "Aesthetic Preferences for Architectural Styles Vary as a Function of Personality," *Imagination, Cognition and Personality* 32, 2 (October 1, 2012): 103–14.

[26] Herzog and Shier, "Complexity, Age, and Building Preference."

anticipation. The first method evaluates the general outcomes of the eight data and compares the results. The second method examines the outcomes by means of building preference predictions. In this method, the visual attributes of some building images first are defined. By assigning the preference rates of each method to the parameters, the average preference range of the existing attributes in the buildings echoes a preference rate expectation in an adverse way of extracting the attribute preference in the last four methods. In other words, the outcomes of each method provide a set of building preference anticipation; the more accurate prediction shows more valid data and a more reliable extraction method. Thus, the discrepancy between the preference prediction and the preference rates, which are provided by the fifth section of the survey, is the root of the second method analysis.

The internal validity of the study outcome and the reliability of the methods are further explored by both one-way chi-square and Cronbach's Alpha analysis. Chi-square analysis, is mainly based on the distance between the expected and observed values in a hypothesis; since this study concerns the distances between the expected and the observed building preference values, chi-square analysis can examine the internal validity of the study. Lastly, Cronbach analysis as the most significant reliability analysis shows the consistency of the outcome among various participants. Noticeable that all the analysis, from providing the personal attribute preferences to examining the internal validity of the outcomes, is performed by scripting in Microsoft Excel developer.

Analysis of outcomes

Without placing any limitations on the participants, 25 ordinary people from different fields of study cooperated with the study, 14 females and 11 males. Participants were between 21 to 45 years old: six people (24%) aged 21–25 years, nine people (36%) 26–30 years, seven people (28%) 31–35 years, and three people (12%) 36–41 years. The questionnaire *was not* sent to any more recipients after the analysis outcome reached a steady level. As discussed earlier, the outcomes were examined by two main methods.

The first method of analysis, general analysis, created an overview of the attribute preferences. Participants rate the attribute out of 7; accordingly, their preference range is numbered from 1–7, reflecting responses from "dislike a lot" to "like a lot", respectively. The averages and the standard deviation (SD) of all attribute preferences for all participants, as well as for the attribute-based and building-based strategies in general, are illustrated in Table 1 (see Table 1).

As the table shows, Data 2 has the highest preference average (5.3), meaning that participants express a higher preference while being asked about the attributes that exist in a set of building images. Sharing some attributes among the illustrated buildings increases the attributes preferences. By contrast, Data 4 has the lowest average (3.55); when people are asked about their preference ranges for an attribute catching their attention, they mostly express their disliked attributes, or they moderate their satisfaction ranges. Since participants in this data answer the extreme like/dislike attributes, it expectedly has the highest standard deviations (SD = 1.84). Although the average preferences of the attribute-based methods have some fluctuations, the average of the attribute preferences among the building-based methods are identical. Rather the SD of the rates differ among the methods. Method 5 concerning the highest number of attributes in analysis has the lowest SD, and Method 8 concerning the significant attributes of the extreme liked/disliked buildings has the highest level of SD for the attribute rates.

Interestingly, the average attribute preferences of the attribute-based and building-based methods are similar, 4.71, and 4.52 respectively; otherwise, the attribute-based methods have a higher SD. Several times indirectly-questioning attribute preferences in the essence of building-based methods somehow moderate the attribute preferences; while, directly questioning an attribute satisfaction with a limited number of questioning, acquire higher preference ranges with a higher level of SD.

As the main method of analysis, the eight data are examined by anticipating some other building preferences. Here, the distance between the expected satisfaction level and the actual acquired preference level is the main root of the analysis. When the distance between the expectation and actual preference range is less than 1, it is assumed as an *acceptable range*; and less than 0.5 is considered as *exactly mentioned*. For example, if based on the attribute preferences, it is expected a participant likes a building 5.2 out of 7; if the selected range was 6, then it would be assumed as an *acceptable range* (the distance is 0.8), and if the participant selects 5, it will be considered "exactly mentioned" (the absolute distance is 0.2). The analysis outcomes of the eight data are illustrated in the table below, including the percentage of *the acceptable range* and the *exactly mentioned* columns, as well as the *sum of the distances,* the *average distance,* and the *SD* concerning the gap between the expected and actual preference rates of the 45 questioned buildings from 25 participants (see Table 2).

Among the attribute-based methods, Data 1, 2, and 3, have identical *acceptable ranges* percentage; otherwise, Data 3, the building based method, has by far the highest level of *exactly mentioned*. Among the building-based methods, despite similar outcomes, method 5 possesses the most accurate level of prediction, both in the *acceptable range* and *exactly mentioned*. Since these two columns reflect the accuracy of the expectations and show how precisely the attributes are extracted aright, thus data 3 and 5 provide the most accuracy, resulting in the best prediction for the building preferences.

In addition, the sum of the distances, their average, and SD also demonstrate the accuracy of the data attained by each method. As these columns show, the lowest distance between the expectation and actual preference is related to data 3 and 5, which is about half of data 4. On average, the distance between the expectation and actual preference of these two methods hits approximately 0.9. Although it directly reflects the accuracy of the prediction, it reflects the reliability of the raw data and confirms the validity of the attribute extraction method. Finally, as the table shows, data 3 and 5 have the least distance (average 0.92 and 0.94) with the lowest standard deviation (0.71 and 0.67) and accordingly reflect the most accurate data and the best methods for extracting the preference of the building composition attributes.

Among the aggregate data, method 3 as an attribute-based method results in the most accurate outcome. It means, the most reliable attribute preference rates acquire while participants express their opinion about the attributes of a building image. The second-most accurate data belongs to the fifth method; it is acquired while the building's rate assigned to all the visible attribute values of all buildings; this analysis method is the most reliable method of attribute preference extraction from the *building-based* methods.

As another further investigation, the average of the two accurate data is studied as another dataset. Considering the average of data 3 and 5 slightly improved all criteria. The acceptable range was enhanced by approximately 2 percent, and the average distance as an important parameter improved from 0.92 and 0.94 to 0.90. Consequently, not only do data 3 and 5 have the highest accuracy, but the average of them can also somehow enhance the outcome. Although this improvement can be ignorable in large-scale studies, concerning both methods provides a more robust method of extracting the personal preferences of the architectural attributes.

The validity and consistency of the study outcome and the reliability of the method are explored by both one-way Chi-square and Cronbach analysis. Chi-square analysis mostly tries to reject the invalid hypothesis and distinguishes the invalid methods. Since the p-value of data 4 was around 0 and far below the critical point, it directly rejects the possibility of any prediction from method 4. Otherwise, the p-value for the remained methods hit almost 1, which indirectly confirms the possibility of building preferences prediction, and somehow the accuracy of the method and raw data for the seven methods. Lastly, Cronbach analysis as the most significant reliability analysis shows the consistency of the outcomes among various participants. Although Cronbach's alpha, known as coefficient alpha, needs to be above 0.7 (in the special analysis above 0.9) to confirm the reliability of the outcome, the alpha in our analysis hits the 0.9459; it reflects an exceptional consistency of the data and reliability of the analysis. It confirms the internal validity of the outcomes, reflecting the presence of similar trends among different participants

Conclusion

This study introduces and examines extracting personal preference of architecture composition attributes via eight methods under two categories: *attribute-based methods* directly asking personal opinions about the attribute satisfactions, and *building-based methods* that an analysis extracts attribute preferences based upon participants' opinions about buildings' rates.

The general analysis shows that, despite a similar average rate of the attribute preferences, the building-based methods have a lower standard deviation. Several times questioning the attribute preference, which exists in the essence of building-based methods, moderated the preference rates and decreased preference rates oscillation; otherwise, asking the attribute preferences directly provides higher SD and potentially reflect a more accurate level of attribute satisfaction. Among the eight methods, participants expressed higher preference rates while being asked about the attributes that exist in a set of building images. In contrast, participants decrease their satisfaction rate if they are asked about the attributes catching their attention. Among the building-based methods, the more number times each attribute is questioned, the more the attribute preferences are moderated, and standard deviation is decreased.

The building preference anticipation part of the analysis with a very high level of validity and reliability shows that the building-based questioning method can extract the most accurate personal preference by directly questioning the pleasantness of each attribute illustrated in a building image. In other words, people can express their personal preferences best when their opinion about the attributes of a building image is asked. The fifth method attains the second most accurate outcome; in this method, participants rate some buildings and the preference range allocated to all the building composition attributes; the average of each attribute preferences reflects the participant's opinion about the attribute. This method, so-called visible attributes of all buildings, provides the most accurate level of attribute preferences in indirect questioning methods. Although applying both methods can slightly enhance the accuracy of the outcomes, both methods consequently extract the personal preferences of the building attributes reliably, within an acceptable range of accuracy.

Consequently, although the attribute-based methods generally require a straightforward analysis to extract their personal opinions about each attribute, participants may not be able to distinguish the attributes properly; they can misunderstand the values, or they even may find themselves uncertain about an attribute satisfaction. On the other hand, building-based methods acquire more reliable raw data faster and easier, but they need a more sophisticated analysis to provide a clear list of attribute preferences. Worth noting, gathering the data via the third method is time-consuming, and the questions could be hard for laypeople; in contrast, the fifth method has more accessibility and much faster essence, especially when laypeople are addressed. Consequently, regarding the slight difference between the accuracy levels, the third method (building-based method) is more efficacious while a lower number of attributes are considered, and knowledgeable people are addressed; otherwise, the fifth method is by far the best method for examining the preference of a large number of participants, especially in case providing the analysis part systematically.

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List of figures, tables and appendices

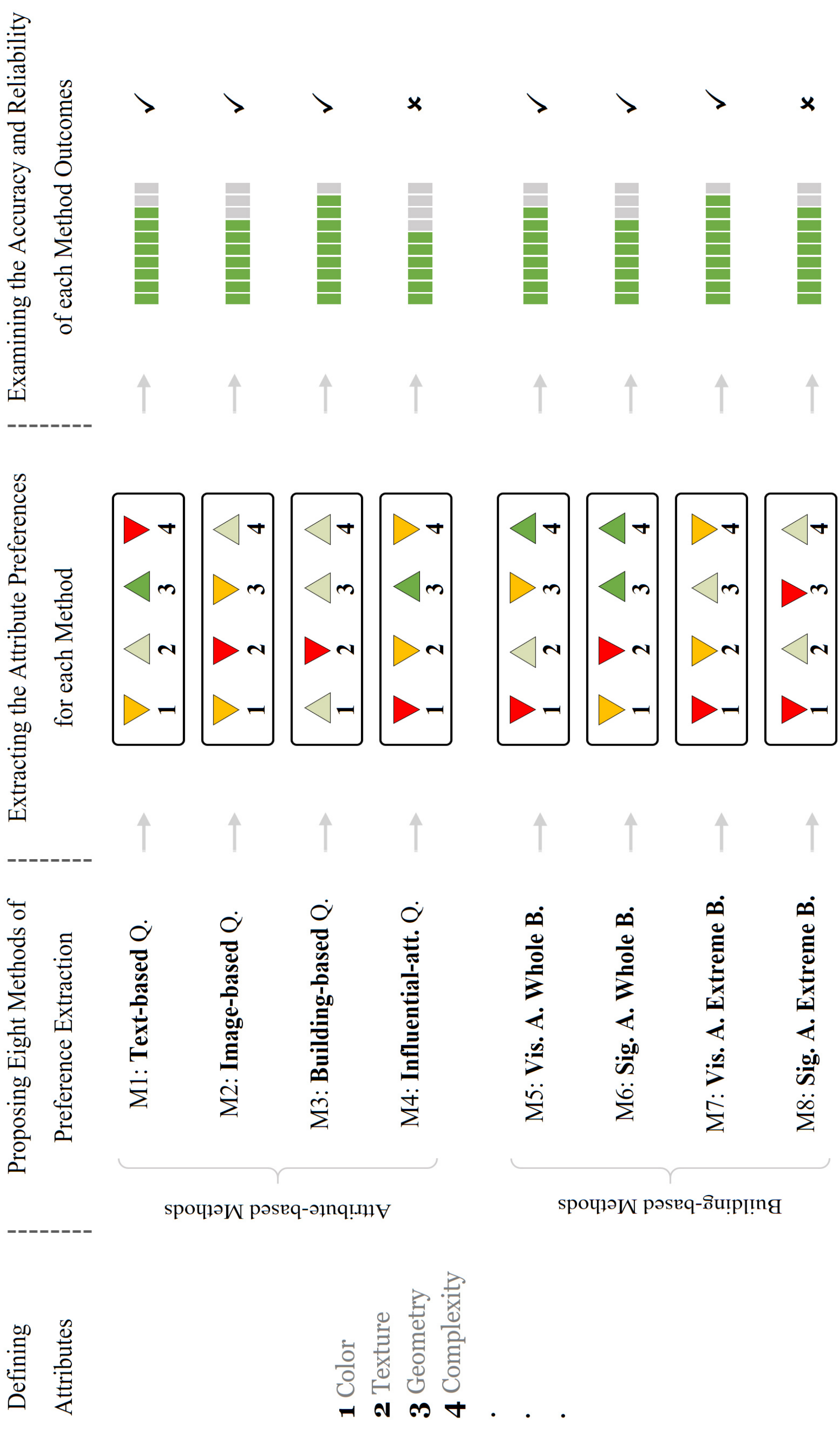

Figure 1: Methodology flowchart

Figure 2: The first set of samples for the composition attributes

Figure 3: The second set of samples for the composition attributes

Figure 4: The third set of samples for the composition attributes

Data	Data-generating Methods	Mean	SD	Altogether
1	**Text-based Questions**	5.12	1.55	**Attribute-based** Mean: 4.71 SD: 1.36
2	**Image-based Questions**	**5.30**	1.14	
3	**Building-based Questions**	4.88	0.98	
4	**Influential-attributes Questions**	**3.55**	**1.84**	
5	**VISIBLE Attributes of all Buildings**	4.61	**0.60**	**Building-based** Mean:4.52 SD: 0.97
6	**SIGNIFICANT Attributes of all Buildings**	4.46	0.85	
7	**VISIBLE Attributes of the Extreme Liked/Dislike Buildings**	4.43	1.15	
8	**SIGNIFICANT Attributes of the Extreme Liked/Dislike Buildings**	4.59	1.25	

Table 1: The general analysis of the eight data-generating methods

Data	Data-generating Methods	Acceptable Range	Exactly Mentioned	Sum of the Distances	Average Distance	Standard Deviation	Chi-square (p-value)
1	Text-based	**61.7%**	30.0%	49.96	1.11	0.81	✓(0.992)
2	Image-based	**62.2%**	31.1%	49.98	1.11	0.87	✓(0.996)
3	Building-based	**60.0%**	**38.9%**	**41.32**	**0.92**	**0.71**	✓**(0.994)**
4	Influential Attributes of the Buildings	*31.5%*	*16.8%*	*78.72*	*1.77*	*1.09*	✗*(0.001)*
5	Visible Att. – All Buildings	**59.4%**	**37.2%**	**42.19**	**0.94**	**0.67**	✓**(0.999)**
6	Significant Att. – All Buildings	57.2%	32.2%	44.20	0.98	0.66	✓(0.998)
7	Visible Att. – Extreme Liked/Disliked B.	58.3%	30.6%	46.70	1.04	0.75	✓(0.996)
8	Significant Att. – Extreme Liked/Disliked B.	58.3%	35.0%	45.70	1.02	0.78	✓(0.994)
Extra	Average Data 3 and Data 5	**62.2%**	37.8%	**40.60**	**0.90**	0.66	✓(0.998)

Table 2: The acceptance rate for the eight data analysis

	Material Related Attributes																								Elements Related Attributes										Building Related Attributes																				
	Quality					Color						Texture			Solidity			Reflection			Quantity				Geometry				quantity			Identification			Symmetricity			Rhythm			Stress		Indentation			Complexity			Decoration			Openness			
	Stone	Brick	Wood	Plaster	Aluminum	White	Grey	Black	Light Warm	Dark Warm	Cold	Little	Moderate	Full	Solid	Porous	Net	Matt	Reflective	Very Reflective	Single	2,3 Different	2,3 Contrast	Many	Basic	Compound	Fragmented	Smooth	Low	Medium	High	Distinctive & Separable	Distinctive & Inseparable	Indistinctive & Inseparable	Symmetrical	Partially Symmetrical	Asymmetrical	Regular Rhythm	Irregular Rhythm	Partially Rhythmic	Horizontality	Verticality	Almost Flat	Almost Indented	Fully Indented	Simple	Moderately Complicated	Complicated	No Decoration	Moderately Decorated	Fully Decorated	Almost Open	Moderately Open	Almost Solid	
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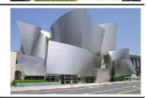
					✓		✓												✓̲		✓							✓			✓̲		✓̲												✓̲			✓̲						✓	
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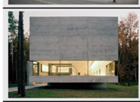				✓̲			✓̲						✓̲								✓				✓̲				✓̲						✓											✓			✓̲						
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* Appendix 1. Building samples and their designated attributes utilized in method 3; the ticked qualities = visible attributes, the underlined attributes: both visible and significant.

	Material Related Attributes																								Elements Related Attributes										Building Related Attributes																				
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* Appendix 2. Building samples and their designated attributes utilized in method 4.

	Material Related Attributes																								Elements Related Attributes										Building Related Attributes																				
	Quality					Color						Texture			Solidity			Reflection			Quantity				Geometry				quantity			Identification			Symmetricity			Rhythm			Stress		Indentation			Complexity			Decoration			Openness			
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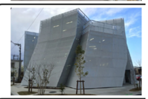
									✓				✓						✓			✓					✓		✓				✓												✓										
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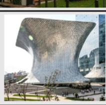																				✓	✓							✓																										✓	
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* Appendix 3. 45 building samples and their designated attributes, utilized in the examination part.

	Material Related Attributes																								Elements Related Attributes										Building Related Attributes																				
	Quality					Color						Texture			Solidity			Reflection			Quantity				Geometry				quantity			Identification			Symmetricity			Rhythm			Stress		Indentation			Complexity			Decoration			Openness			
	Stone	Brick	Wood	Plaster	Aluminum	White	Grey	Black	Light Warm	Dark Warm	Cold	Little	Moderate	Full	Solid	Porous	Net	Matt	Reflective	Very Reflective	Single	2,3 Different	2,3 Contrast	Many	Basic	Compound	Fragmented	Smooth	Low	Medium	High	Distinctive & Separable	Distinctive & Ineparable	indistinctive & Ineparable	Symmetrical	Partially Symmetrical	Asymmetrical	Regular Rhythm	Irregular Rhythm	Partially Rhythmic	Horizontality	Verticality	Almost Flat	Almost Indented	Fully Indented	Simple	Moderately Complicated	Complicated	No Decoration	Moderately Decorated	Fully Decorated	Almost Open	Moderately Open	Almost Solid	
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* Appendix 3. Continue

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