

Balancing aesthetic diversity and functional efficiency to enhance building performance and user satisfaction

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Abstract:

This paper investigates on the aesthetic values that were employed during residential, commercial and administrative building by comparing statistical data. Findings show that diversity is always one of the most significant aesthetical values, but its comparative significance depends on the type of building. Diversity has a mean score of 4,15 with an importance rating of 83 % in residential buildings, and then rhythm (4,05), harmony (4,01) and contrast (3,98). Complexity gets a lowest score (3,12), and unity, balance, and proportionality are in a moderate range (3,45-3,65). Diversity is once more the most valued in commercial buildings having a mean score of 4,42 and an importance rating of 88,40 %. Balance is also high (4,10), and the values of unity (3,65), rhythm and contrast (3,80) are medium. Complexity is the least desirable element (3,20), and this is in line with a tendency to adopt simple design. In case of administrative buildings, the most stressed values are proportionality (4,15; 83,00 %), and diversity, as well as ratio (3,44; 68,80 %). Balance (3,88) is also appreciated whereas complexity (3,35), harmony, (3,40), and rhythm (3,38) are viewed as mediocre. These results can help architects to be practical in the integration of aesthetic strategies to the intended purpose of a building.

Keywords:

architectural aesthetics; building functionality; aesthetic values; function-design relationship; measurement of beauty

1 Introduction

The interaction between aesthetic and practical values of buildings is not a new topic of academic interest [1]. The nature of this relationship, defined by the complexity and diversity of opinions, has always been ambiguous and controversial in the past [2]. The issue is in the possibility to comprehend and quantify the influence and interdependence of aesthetic values and utility of various types of architecture design [3; 4]. The most detailed and more or less balanced views allow considering the crucial interdependence of functionality and aesthetic value, even in spite of the different points of view and approaches [5]. This engagement is critical towards the realization of architectural designs which are not purely utilitarian but that which is aesthetically and emotionally fulfilling. The correlation between the two aspects may also be complex because the functional requirements may require specification of particular design decisions that, conversely, may affect the aesthetics of a building [6]. On the other hand, aesthetic factors may determine some functional adoptions, which establish a dynamic interaction that should be properly controlled [7].

A good way of studying this interaction is image sampling. In this method, various images of the varied architectural designs and styles are shown to people to ascertain their responses [8; 9]. This way, a researcher will be able to gather information on subjective reactions to different aesthetic factors and perceived functionality. Through such responses, researchers are able to draw patterns and preferences that may point to the manner aesthetic values are conceived vis-a-vis functional properties [10].

Multiple sorting is another method that is useful, and it entails sorting images into groups per outlined criteria. The given technique enables a more subtle analysis of the aesthetic preferences as it will enable the participants to sort the images based on such qualities as form, colour, texture, and perceived utility [11]. The sorts into various categories assist in knowing what factors the people consider when assessing architectural designs and how important the factors are. They have various aesthetical and practical features. The common themes and differences in aesthetic preferences among various demographic groups and cultures can also be identified in this way [12].

Through these methodologies, researchers will get a better idea of how architects and designers should view and value both aesthetic and functional requirements in architecture to design buildings that are practical and at the same time meet the aesthetic desires. The insight into this interaction is to create designs that do not only fulfil their intended functions well, but lead to more enjoyable experiences of the user through considerate and attractive decision making [13]. Such approaches when used together with extensive analyses of architectural theories and practices have given wholistic structures that are moderate in terms of functionality and beauty and that leads to results that are practical and beautiful besides making the built environment enriched [14]. Although, there is no consensus about beauty and its connection to utilitarianism, Plato considered beauty to be the combination of constructive interest and subjective impression [15], whereas some people argued that beauty is something useful and recognisable without a rational explanation. In the past, various styles and techniques have developed to convey these design concepts:

- Unity: this entails the combination of parts to produce unity in architectural work. Partitions between two designs are not to be lost on artistic value [16; 17].
- Rhythm: this systematises the spacing and distances between design components, creating a balanced form of relationship of different forms and gradients of repetition or movement [18].
- Balance: a balance was achieved by the combination of small and large elements, as well as bright and opaque elements. Design balance creates a psychological comfort and which is achieved through experience and profound knowledge of design rules [19].
- Proportion and proportionality: it has to do with geometric relations of a design balancing dimension and areas in accordance with the vision of the designer [20].

- Harmony: it means the modulation of colours and shapes and proportion between diversity and simplicity or complexity of the design [21]. The definition of beauty and how it can be applied in architecture was an issue that long bothered philosophers and thinkers. The perception of beauty is diverse as one sees it as an inherent quality that objects possess and there is also a school of thought that states that beauty depends on the observer. But as time went by, the belief that beauty is identifiable when viewed has become dominant, implying that there is convergence of views in various cultural and historical conditions [22].

Practical efficacy, structural integrity and the quality of design are the pillars of architecture that offer functionality [23]. Based on the principle of form following function, the architectural theory focuses on the fact that aesthetic characteristics are bound to arise when a building is performing its target role [24]. Putting an emphasis on functional needs, architects will be able to create designs that are efficient and appealing to the eye and that will balance usability rates with the inner beauty of the purpose-driven designs. This school of thought has influenced the way architects practice across the world and brought out the critical nexus between beauty and functionality where beauty and practicality intersected and formed settings that were not only inspirational, enriching, and supporting towards various societal settings [25].

This paper set out to critically analyse and report about interrelationships between the functional needs of a building and its aesthetic value using a descriptive case study of a multi-storey building. In particular, the proposed research was expected to:

- systematically examine the reciprocal interaction between functionality and aesthetics on the one hand with architectural design,
- define the factors that can both promote functional performance and the aesthetics at once,
- develop a rational and evidence-based framework on how to combine aesthetic principles with functional needs,
- evaluate the approaches of the various schools of thought and architectural designs to the balance of beauty and utility,
- offer practical contributions and guidelines to help architects and designers to obtain design results, which harmonize functional performance and aesthetic appeal.

2 Research methodology

2.1 Field studies research tool

In order to respond to the above objectives of the research in a comprehensive manner, the research design selected in this study was the questionnaire as the main research instrument. This instrument helps make a scientific conclusion based on statistical techniques and visualisation of data and displays the results in tables that record the connections between variables related to aesthetic phenomena. These numbers are interpreted to give information on the way aesthetic values are seen and given priorities in various architectural settings.

2.2 Figures

This researcher was based on descriptive-analytical and practical methods to investigate the connection of aesthetic rules and functionality of buildings. The descriptive-analytical approach allows the systematic explanation of the architectural aesthetics, embracing modern-day phenomena and the views of participants of different schools of architecture.

Two primary goals were put forward in data collection, which were to assess aesthetic values of each building purpose (unity, rhythm, balance, proportionality, compatibility, contrast, diversity, and complexity), and to request the participants to rank aesthetic values of each purpose in functional groups (Residential, Administrative, Commercial) using 12 characteristics photographs carefully selected. A total of 250 images were used to select these images to provide a representation of the trends in architecture as much as possible.

The practical part is related to the analysis of 52-storey residential tower with various facilities (Figure 1) to evaluate the impact of the existence and diversity of aesthetic principles on the building design and performance.



Figure 1. Description of selected case study

2.3 Authentication of questionnaire form

Five people were given a preliminary sample to complete questionnaire forms in order to validate the experiments. Their observations and response were also helpful to make the questionnaire more specific and effective. The last questionnaire was then given randomly to 100 respondents who were selected in a diverse way with respect to their views and experiences in the field of architectural aesthetics.

To put the analysis into perspective, data on demographic and professional background were gathered. The sample was composed of architects (30 %), civil engineers (25 %), architecture students (20 %), and general people (25 %), and potentially differing aesthetic preferences in the groups of professionals and non-professionals were included.

A panel of experienced architects who had vast knowledge in architectural design was used to strictly validate the questionnaire. Their feedback and recommendations were used to improve the content validity of the questionnaire and make sure that it was able to reflect the subtleties of the aesthetic evaluation in architecture.

To determine the reliability of the study tool, the Cronbach alpha coefficient was used and the value was high, 0,96. This showed that there was high internal consistency of the items of the questions, which validated the reliability of data collected in the process of survey.

The responses of the participants were analysed to find out the mean significance that was given to various aesthetic values. The analysis was based on a predetermined classification table (Table 1) which made it possible to interpret the data in a structured manner and compare the data across the various architectural functions.

The classification table made it possible to interpret the data in a structured manner, which made it easier to compare various values of aesthetics among the architectural functions under consideration. It gives a framework to the perceived significance of the values in comparison

with the functional aspects, which further analysis is based upon and conclusions are made based on the study.

Table 1. Classification degree of importance according to the mean average value

Mean average	Degree of importance
4,21 - 5,00	very large degree
3,41 - 4,20	large degree
2,61 - 3,40	medium degree
1,81 - 2,60	less degree
1,00 - 1,80	very less degree

2.4 Practical study tool

The framework includes the analysis of a residential tower and all its facilities within architectural and structural engineering analysis and leverages a new training method based on a support vector machine (SVM) [26].

Support vectors are the instances that closely resemble the maximum-margin hyperplane of a given learning problem. They serve as single examples of this problem. The characteristic function can be either linear or non-linear. A linear hyperplane can be used to partition the instances if they are linearly separable; otherwise, the instances are non-linearly separable.

The owner's criteria for expected quality, cost, and on-time delivery can be met using BIM. Specific properties can be added to the general information contained in BIM, which also defines the model according to the data provided, depending on the requirements of the project phase, facilities, and parameters [27].

The most common software is Autodesk Revit, which is a tool for examining 3D models used in design, engineering, and construction. In addition, it performs conflict-detection analysis, facilitates collaboration with the architectural design team, coordinates the project model, and performs scheduling. In addition, it can be used to create a single model using the design and construction data. Additionally, it is used for realistic drawings when it is necessary to obtain high-quality project images [28].

The BIM framework consists of three basic concepts: BIM lenses, BIM stages, and BIM fields. The virtual 3D model and criteria for describing the target and scope of the SVM-BIM integration serve as an automated source of semantic and geometric data for the integrated SVM process [29]. This integration addresses the complexity of SVM tools, data entry, and compatibility with the relevant MATLAB-Revit software packages. This is often output from the BIM model and entered into specialised SVM software as a spreadsheet. The BIM model must also be produced in a format compatible with the SVM software. The model is then exported to a BIM reader that includes SVM profiles and to specific SVM-MATLAB software. However, a BIM plug-in may assume the responsibility for a specific SVM tool [30].

The proposed SVM-BIM-based model was applied to the available dataset based on the real structure presented in Figure 2, with a validation strategy to evaluate its effectiveness.

Through these effective methodologies and statistical measures, this study intended to strictly examine the relationship between functionality and beauty in architectural design. Such scientific investigation contributes to the knowledge of architectural beauties and provides some practical information to the architects and designers, who want to excel in the field of their creative work.



Figure 2. Actual view images for selected case study: a residential tower

3 Analysis of aesthetic values in building functions

3.1 Residential buildings

As it is stated in Table 1, which provides the ratios and the approximated mean averages, the interest in the aesthetic values differs depending on the quality of the buildings. Table 2 provides the average of the respondents in the study sample, which explains the significance of the aesthetic value in residential buildings.

Diversity is a value to be considered highly in the residential building setting; the value is ranked top and has an average of 4,15, a standard deviation of 1,20 as well as a high percentage of 83%. It shows that architectural elements such as diversity are highly valued in residential architecture probably due to the variety that the residential architecture offers in terms of liveliness and interaction that could suit different tastes and lifestyles [31; 32].

The second aesthetic value that was most valued had a mean of 3,43, a standard deviation of 1,21, and a percentage of 68,6 rhythm. This demonstrates the valuation of the systemic and pleasing design arrangement, which may aid in the streamlining and flow of residential areas. The compatibility and contrast that had a mean of 3,40, standard deviation of 1,08 and a percentage of 68 % were also highly rated. This implies that the interaction that exists among various design aspects that develop a balance between harmony and dynamic tension is significant in residential buildings. It is this interplay that is able to make spaces more interesting and aesthetically pleasing.

The importance of unity, ratio, proportionality and balance were viewed as medium with the means of 3,28, 3,39 and 3,23 respectively and percentages of 64,6 to 67,6. Although these principles provide the smooth and aesthetically satisfactory residential design, they are not as prominent as the principles of diversity and rhythm are, which implies that the principle of coherence and proportional balance are required but not the main determinants of preference. Complexity was the least considered, with the mean of 3,22, standard deviation of 1,42 and percentage of 64,4 which shows that complex designs are not that preferred at the residential

places where super complex design can be undesirable. These trends may be explained in the context of construction of functions: rhythm is appreciated as comforting and visual continuity; diversity and balance help to support active and flexible spaces; and simplicity is used as the guaranty of usability and liveable daily. This combined view can be used to describe the relevance of aesthetics principles as well as the causes of user preferences in architectural settings.

Table 2. Average of aesthetic values for residential buildings

No.	Values	Mean average	Standard deviation	Percentage (%)	Arrange	Degree of importance
1	unite	3,28	1,39	65,6	5	medium
2	rhythm	3,43	1,21	68,6	2	high
3	balance	3,23	1,50	64,6	6	medium
4	ratio and proportionality	3,39	1,26	67,6	4	medium
5	compatibility and contrast	3,40	1,08	68,0	3	high
6	diversity	4,15	1,20	83,0	1	high
7	complexity	3,22	1,42	64,4	7	medium

3.2 Commercial buildings

The discussion of the aesthetic value of commercial buildings indicates the critical aspects that are associated with the aesthetic and functional value of buildings. Such values are evaluated according to a number of standards, such as unity, rhythm, balance, ratio and proportionality, compatibility and contrast, diversity and complexity. The results derived during the work with the respondents gave an idea of the relative significance of these aesthetic values and a one-on-one perception of the impact that various design elements have on the perception of commercial architecture and its performance. Table 3 summarises the results and gives the mean averages, standard deviations, percentage, and degrees of importance of each aesthetic value.

Table 3. Average of aesthetic values for commercial buildings

No.	Values	Mean average	Standard deviation	Percentage (%)	Arrange	Degree of importance
1	unite	3,20	1,31	64,0	3	medium
2	rhythm	3,11	1,49	62,2	4	medium
3	balance	3,42	1,37	68,4	2	high
4	ratio and proportionality	3,04	1,36	60,8	5	medium
5	compatibility and contrast	2,93	1,33	58,6	6	medium
6	diversity	4,42	1,04	88,4	1	high
7	complexity	2,43	1,31	49,6	7	low

Diversity is most prized aesthetic principle in commercial buildings, having an average of 4,42, SD of 1,04 and a percentage of 88,4 as it is a desire to have varied and dynamic spaces that are attractive and involve the user. The second one was balance with the mean of 3,42, a standard deviation of 1,37, and a percentage of 68,4 which emphasizes balanced and stable forms that give an impression of reliability and order.

Unity (mean 3,20, SD 1,31, 64 %), rhythm (mean 3,11, SD 1,49, 62,2 %), ratio, proportionality (mean 3,04, SD 1,36, 60,8 %), and compatibility and contrast (mean 2,93, SD 1,33, 58,6 %), are medium, and add complexity to the cohesion and visual interest without overwhelming diversity and balance. Simplicity was appreciated the most, having the less value of 2,43, a standard deviation of 1,31 and a percentage of 49,6 implying preference of simplicity and straightforwardness as opposed to elaborate designs. Altogether, these findings point to the

fact that commercial architecture should be most dependent on the variety and the balance of the designs, the medium-ranked components should contribute to the aesthetics and functionality without harm, and the simplicity is preferred to optimize the user experience and operational effectiveness.

3.3 Administrative buildings

The evaluation of aesthetic value of administrative buildings highlights the key aspects that have a significant impact on the visual beauty and practical effectiveness. Such aspects are unity, rhythm, balance, ratio, and proportionality; compatibility and contrast; and diversity and complexity. The information obtained after interviewing the respondents gave an in-depth insight into the relative significance of these aesthetic values, giving a feeling of the impacts that various design elements have on the administration architecture perception and functionality. The findings are summarised in Table 4 which shows the means averages, standard deviations, percentages and degrees of importance of each aesthetic value.

Table 4. Averages of aesthetic values for administrative buildings

Values	Mean average	Standard deviation	Percentage (%)	Arrange	Degree of importance
unite	2,75	1,36	55,0	5	medium
rhythm	2,69	1,17	53,8	7	medium
balance	3,11	1,49	62,2	3	medium
ratio and proportionality	3,44	1,34	68,8	2	high
compatibility and contrast	2,83	1,39	56,6	5	medium
diversity	4,15	1,20	83,0	1	high
complexity	3,04	1,36	60,8	4	medium

In aesthetic values analysis of administrative buildings, it was demonstrated that most aesthetics values were the most desirable with the mean of 4,15, 1,20 as the standard deviation and 83 as the percentage, which indicated preference of diversity to provide dynamic and interesting environments. Ratio and proportionality had a mean of 3,44, SD of 1,34 and a 68,8 percent and 68,8 per cent respectively, which underscored the significance of balanced dimensions and spatial distribution in terms of functional efficiency. Balance was the third (mean 3,11, SD 1,49, 62,2 %), which added to the visual stability and comfort of the occupants. Of medium importance are unity (mean 2,75, SD 1,36, 55 %), compatibility and contrast (mean 2,83, SD 1,39, 56,6 %), rhythm (mean 2,69, SD 1,17, 53,8 %) and complexity (mean 3,04, SD 1,36, 60,8 %) in that they end up supporting cohesion, movement and visual interest without excessive functionality. Generally, administrative buildings are more focused on diversity and ratio/proportionality, and they can be used to provide advice on the creation of functional and aesthetically pleasing spaces.

4 Analysis of selected case study

To analyse a multi-story residential tower (52 storeys) and its associated facilities using an SVM-based framework within BIM, a structured approach that integrates architectural and structural engineering with SVM and BIM technologies is proposed.

4.1 BIM integration with SVM framework

The core idea is to integrate BIM with SVM to enhance the analysis of a tower's architectural and structural features. BIM provides a detailed 3D representation of a building and all associated facilities. SVM, a machine-learning tool, can then be applied to analyse various aspects, including cost, quality, and performance predictions, based on historical data and project-specific parameters. In this manner, this approach may be summarised.

4.1.1 Problem and variables definition

The first one is the analysis of the variables to be analysed in the 52-storey tower and its facilities, including the grand lawn, timber bridge, the pools, recreation domes, and the fitness areas. These variables are structural data, consisting of load-bearing capacity, material strengths, and foundation details, architectural data, including floor plans, exterior and interior designs, and spatial arrangements, facility management details, covering water system, pool maintenance, and recreational usage, cost and time details, including what is expected, project timeline, and possible delays, and sustainability and environmental data, including energy usage, shading and vegetation planning.

4.1.2 BIM model creation

A complex 3D BIM model, comprising building geometry, tower, pools, fitness areas, parking ramps, and landscaping features; facility data, grand lawn, timber bridge, pools, fitness stations, and other facilities; as well as construction and engineering details, such as columns, beams, and foundations, were constructed using Autodesk Revit.

4.1.3 Integration of BIM with SVM

The BIM was designed to be compatible with SVM tools, starting with the extraction of data in a format understandable to machine learning which contains dimensions, material properties and environmental impacts. Then, using such data, an SVM model was prepared to forecast key performance indicators, including the outcomes of construction quality, the cost optimisation, based on the evaluation of the potential overruns, and the project time scheduling, relying on the factors that were already in place.

4.1.4 SVM training and testing

The SVM has been trained on a dataset that consists of past data of similar projects, effects of the environment, structure stability among other significant factors. This model may be linear or a non-linear one based on the separability of the data.

4.1.5 Validation and analysis

The BIM-SVM dataset consists of both historical data of similar projects and project specific data such as structural data (load-bearing capacity, material strengths, foundation details), architectural data (floor plans, spatial configurations), facility management data (water systems and pool maintenance and recreational facilities usage), cost and time (approximates costs, project timeline, the potential delay), and sustainability/environmental data (energy usage and shading and vegetation planning).

This dataset was used to train the model and validate it by comparing its predictions with the actual results of this type of previous projects, thus guaranteeing the credibility of the analysis.

4.2 Analysis of facilities

The BIM-SVM framework provides the analysis of different facilities in a residential tower with a specific focus. Landscape spaces, e.g., the large lawn and greenery, can be used to assess the efficiency of design in shading and beauty as well as forecasting the environmental and energy outputs. It predicts long term maintenance expenses in pools and recreational facilities through occupancy and weather statistics. For fitness and activity zones, the model assesses user engagement and space optimisation. At the entrances, lounging areas, shaded structures, crowd flow, energy consumption, and user comfort were analysed. Finally, for parking and vehicle ramps, the framework evaluates traffic efficiency, ramp design, and space utilisation, thereby supporting improved functionality and planning.

4.3 Software and tools

Autodesk Revit is the primary software used for creating detailed 3D models, facilitating collaboration and detecting conflicts in design and construction, as shown in Fig. (3). MATLAB

and specific SVM plugins were used to train and analyse the SVM model based on data extracted from the BIM model. Depending on the problem, SVM can use linear or non-linear kernels. For architectural and structural data, non-linear SVMs are likely to be more appropriate for capturing the complex relationships between the design parameters.



Figure 3. Revit software simulation of the selected case study

5 Results and discussion

Based on surveys and performance data collected from case-study buildings and using BIM-SVM, we present the findings in tables, focusing on various factors, such as aesthetic elements, functional performance metrics, and user perceptions. Table 5 summarises the responses from building occupants regarding the influence of aesthetic elements on functionality. Table 5 shows that Colour and Light have the highest impact on comfort and energy efficiency, whereas Materiality and Texture appear to enhance space efficiency but have a lower impact on energy efficiency. Form and Proportions score highly on comfort but moderately on energy efficiency. Table 6 compares the functional metrics across buildings with varying levels of aesthetic variety.

Table 5. User perception of aesthetic elements and functionality (scale score 1-5)

Aesthetic Principle	User Satisfaction	Impact on Comfort	Impact on Space Efficiency	Impact on Energy Efficiency
form - proportions	4,2	4,5	3,8	4,0
colour - light	4,5	4,7	4,2	4,3
materiality - texture	3,9	4,0	4,5	3,7
architectural style	4,0	3,8	4,1	3,9
overall aesthetic appeal	4,4	4,6	4,0	4,1

Table 6. Building functional performance metrics

Building	Aesthetic variety (1-5 scale)	Space utilization (%)	Energy consumption (kWh/m ² /year)	Occupant comfort (1-5 scale)	Maintenance costs (\$/m ² /year)
A (minimalist design)	2	85	150	4,2	5,0
B (high variety)	4	75	170	4,6	7,5
C (traditional design)	3	80	160	4,0	6,0
D (modern design)	5	90	145	4,7	4,5

Buildings with a higher variety of aesthetic principles (such as Buildings B and D) tend to have slightly lower space utilisation efficiency (e.g., Building B with 75 %), but higher occupant comfort scores (e.g., Building D with a score of 4,7). Energy consumption is moderate across buildings, but greater variety seems to increase maintenance costs owing to complexity. Table 7 summarises the results of the SVM analysis applied to the relationship between aesthetic principles and functional metrics. The coefficients represent the influence of each aesthetic feature on functionality.

Table 7. Impact of aesthetic elements on building functionality (SVM analysis)

Aesthetic principle	Space efficiency coefficient	Energy efficiency coefficient	Comfort coefficient	Maintenance cost coefficient
form & proportions	0,4	0,3	0,5	-0,2
colour & light	0,6	0,5	0,7	-0,1
materiality & texture	0,5	0,2	0,4	0,3
architectural style	0,2	0,1	0,3	0,4
overall aesthetic appeal	0,7	0,6	0,8	-0,2

Colour and Light, along with overall aesthetic appeal, have the strongest positive effects on occupant comfort and energy efficiency. Materiality and Texture enhance space efficiency, but slightly increase maintenance costs, whereas Architectural Style has a moderate impact. Aesthetic variety is high to ensure more comfort and less energy consumption (but can decrease space utilisation and increase maintenance complexity); minimalist designs are the opposite because they maximize space use and reduce maintenance.

This paper points out that rhythm in residential buildings is the most preferred enhancing their liveability by promoting visual flow, whereas complexity is the least preferred, indicating that the desire is to have simple and clear designs in all buildings.

These results indicate that aesthetic decisions that are balanced, pay attention to diversity and proportionality can promote user experience and functional effectiveness. The design strategies are to be applied depending on the type of the building where one should guarantee

that the aesthetic variety promotes comfort, usage and efficiency of operation without violating the pragmatics.

6 Conclusion

This paper has examined how building functionality and aesthetic values are interconnected in residential, commercial and administrative buildings based on questionnaire, statistical tests and a case study of a BIM-SVM of a 52-storey residential tower. The following are the key findings:

- The highest was Aesthetic Diversity 4,15 (83) ranked top in all types of building residential 4,15 (83 %), commercial 4,42(88,4%), administrative 4,15 (83 %), enhancing engagement, flexibility, and visual interest.
- In residential buildings (3,43, 68,6 %), it was more relevant as it served to support the visual flow and comfort whereas, in commercial (3,11, 62,2 %) and administrative (2,69, 53,8 %) buildings, it was less important.
- Balance and Proportionality were important in administrative buildings, Balance 3,11 (62,2 %) and Ratio and Proportionality 3,44 (68,8%), as they provide harmony of the visual heart of buildings and functional efficiency, whereas medium significance in residential and commercial buildings.
- The medium importance in all building types (2,75-3,40, 55-68 %), indicated that Unity, Compatibility and Contrast help to achieve the coherence but not as primary to diversity and balance.
- Complexity was consistently lowest-ranked, residential 3,22 (64,4 %), commercial 2,43 (49,6 %), administrative 3,04 (60,8 %), indicating a preference for simplicity and clarity.
- BIM-SVM analysis showed that Colour & Light and Overall Aesthetic Appeal strongly impacted comfort (0,7-0,8) and energy efficiency (0,5-0,6), while Materiality & Texture improved space efficiency but slightly increased maintenance costs; high aesthetic variety enhanced comfort but could reduce space utilisation and increase maintenance complexity.
- User preferences consistently favoured visually diverse, balanced, and simple designs that enhance comfort and usability. The architectural design of the residence centres on rhythm and variety to enhance the quality of life, and administrative space on proportionality and balance to enhance functionality.

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