The Validity of Beauty in the Functionality of the Vertical Greenery Systems (VGS) in Interior Surfaces of Buildings

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Abstract

The study aims to reach the rationale and comprehensive understanding of the notion of aesthetic value and functionality in the vertical greenery system (VGS) in the interior walls of the buildings. VGS plays a key role in improving building functionality and aesthetic value. The paper tries to assess the beauty of inner surfaces depending on the functionality of these surfaces, and the pleasing level of these surfaces for the beholders. The methodology focused on evaluating the aesthetic value and functionality based on the performance of these types of walls. The influence of the functionality on the aesthetic judgment has been investigated to evaluated human perception to assess the aesthetic value of the VGS in the building based on aesthetic cognition process. Case studies have been selected to be analyzed for this purpose. Theoretical analysis proceeded in accordance with the examination model and supported by comparing the obtained outcomes with the attained findings through the opinions of experts. The findings revealed the significant influence of the functionality performance on the aesthetic judgment of VGS among professional people. The results give useful evidence for the promotion of our understanding regarding the aesthetic value of VGS of a building, objectively and subjectively.

Keyword: Aesthetic value; Beauty; Functionality; Vertical Greenery System, Cognition process.

1. Introduction

Vertical Greenery System (VGS) can make an alteration between building and environment. This alteration improves thermal comfort in internal spaces and decreases heating or cooling load on the building. Thermal comfort in the building can be improved through these walls and the indoor environment can be developed, because of the reduction in heat exchange through the building's envelope (Stec et al., 2005). It is a time to remove any ambiguity hinders a taste of obvious aesthetic merit of buildings' inner surfaces. Inner surfaces inspired many designers to don't see the inner surfaces in building as a rigid element. The inner surface is an essential element in the building's aesthetic; enrich inner spaces and showing its visual influence on the occupants and beholders. VGS

is always played an important role in the improvement of indoor air quality. The nature or (eventual nature) of VGS are perceived, and the brain processes and judges what it perceives on an objective and subjective basis. According to Muhy Al-din, and Ahmead Nia (2017), there is a significant relationship between the functionality and 'Beauty'. Architects, interior architects, and designers should have more awareness about the implementation of the functionality in the vertical greenery system of inner space surfaces as part of aesthetic value to reach a more successful design. The inner surfaces are considered the most effective element in the building design. The paper tries to come out with answers for the following questions; 1) what are the main factors to evaluate the performance of VGS in interior surfaces?; 2) Whether or not the level of the performance for VGS in interior surfaces are influencing the aesthetic value? And how much the functionality and aesthetic value can be incorporated into the design process?

The paper aims to explore the relationship between aesthetic judgment and the functionality in the VGS of interior surfaces in buildings. The current study hypothesized that the more functional the design, the greater the aesthetic value. This is through evaluating the performance rate of VGS and the perception of the professionals based on this performance. The paper tries to find indicators for aesthetic judgment based on the performance of VGS in. In other words, the paper tries to assess the beauty of VGS in inner surfaces depending on the functionality of these surfaces, and how it is influencing the pleasing level for the beholders.

2. Literature Review

2.1 Aesthetics & Beauty

'Aesthetic' is a concern with beauty, appreciation of beauty, artistic impact and appearance (Kumar and Garg, 2010). The aesthetics' field is falling into two interrelated but different zones: 'primary aesthetics', which consists of philosophical activity whose object is the beautiful and the experience of beauty; and 'aesthetics' in the modern and specialized sense which is both a practical and a theoretical knowledge of artistic creation (Gonzalez, 2001).

Beauty for George Santayana (1863-1952) is a type of experience which originates from the essential emotional interest in perception and is not a derivative quality from the perceptual process. Hence, he believes that beauty is an emotional element, a pleasure of ours, which nevertheless we regard as a quality of things. The conditions of beauty come through the material (sensation), shape or form (measure), or expression. In sum, Santayana describes beauty as "pleasure objectified", he says beauty is "pleasure regarded as the quality of a thing." (Archie and Archie, 2006). Regarding "Beauty", the philosophers gave many definitions to the meaning of the beauty. Plato (427-347 BC) divided beauty

into two types: the first is the beauty in nature and in living objects and, the second is the beauty in geometry, straight lines, and circles. He introduced the natural beauty as proportional, and what is created by human as absolute (Mahdavinejada et al., 2013). Beauty, for Thomas Aquinas (1225-1275) that inexistent things is objectively or really perceived by a cognitive process of seeing or hearing. Beauty in his view has three essential conditions: integrity, proportion, and clarity. He believes that beauty is not completely sensuous, despite beauty acquires through cognitive senses, Eyes, and Ears. Talks about beautiful sights and sounds are more general and comprehensive, whereas, beautiful tastes and beautiful odors are not very comprehensive. Thomas recognizes between the beauty of the form (proportion and clarity) and the beauty of the soul 'virtue or honesty' (Aquinas, 2006). Immanuel Kant (1724-1804) stated that our potential of judgment let us experience the beauty. Also argues that aesthetic judgments are prior to pleasure and are both universal and necessary. They have the purposive appearance despite they are not conceptually final. The judgment of taste, therefore, is not a cognitive judgment (Ward, 2012; Archie and Archie, 2006). The beauty is a part of aesthetics philosophy, which is the experience of the pleasure.

The object cannot be beautiful if it couldn't give pleasure to the beholder. It is generally projected the things that are giving pleasure, to the senses, to the imagination, or to the understanding, with the respect of time, place, and the environment. The mind response to 'beauty' has two ways, subjective and objective. Subjective means that beauty is in the eye of the beholder, as a matter of pure personal preference, objective means that beauty is something independent of individuals or cultures and it is universal (Allesch, 2001). The history witnessed controversy among the philosophers regarding the definition of 'Beauty' based on the objective view and subjective view, in different periods.

2.2 The relation between Beauty and functionality

Between utility and beauty, it holds a confusing dialectic. Sometimes we understand that the utility is the essence of beauty by achieving perfection, based on our consciousness of the practical advantages, which is the ground of our aesthetic appraisal. The chameleon skin is considered beautiful because it is safeguarding the body, in the same context the beauty of buildings came from its comfort and safety to the tenant, 'Socrates' states that the utility is creating beauty (Santayana, 2007, pp. 94-97). In one hand the theory that shows things ought to be beautiful is not rigorous and vain. In other hands, the beautiful does not depend on the useful but it is not independent of the necessary. There is, in our aesthetic judgment, the knowledge of performance and utility enters into our sense of beauty. The utility and performance affect us in an ordinary way negatively; the useless and the fictitious objects, the uncomfortable sense of waste and imperfection affect enjoyment negatively, hence deny a beauty.

(Santayana, 2007; Rolston, 2002, pp.132-133). Figure '1', shows the relation between 'Aesthetic value' and 'functionality', based on Santayana view.

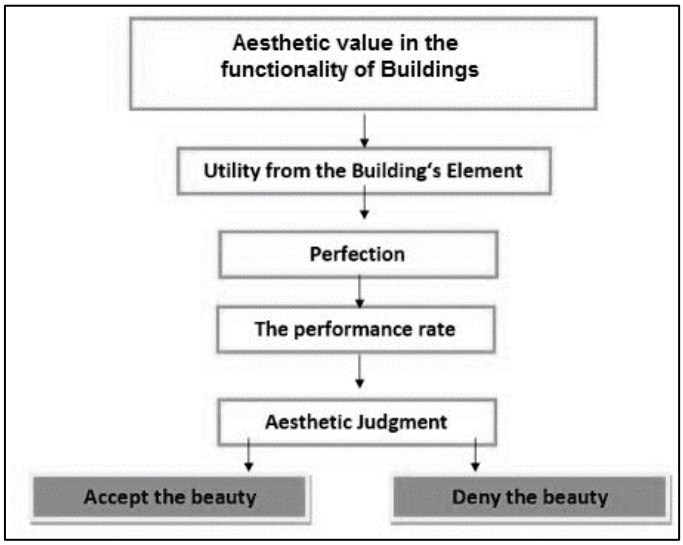

Figure 1. **The relation between Aesthetic value and the functionality (Performance) in buildings based on (Santayana, 2007)**

Kant in section 16 of his book 'The Critique of Judgment 1790' mentioned that there are two kinds of beauty, dependent and free beauty. The dependent is the beauty it has a specific kind with a certain function. To realize dependent beauty, it should first classify it within a kind and then consider the range of achievement of the function (Davies, 2006). The basic state of beauty for functionalists who follow the principle 'form follow function', is the range of utility of the architectural element (Bueno, 2009, P.48). The functionalist basic guiding principle of design is adapting 'form to the purpose' which considers the main scale to measure the excellence or the beauty of architecture (Sauchelli, 2011, P.2; Parsons, 2011). The functionality could be objective or subjective, where the functional expression of structure and its harmony with nature can be categorized as an objective function (Muhy Al-din, and Ahmad Nia (2017). The most utilitarian functions of a building are to supply shelter, services, and comfort to the occupants or the users (Lang and Moleski, 2010, P.111). Hence, the functionality here depend on the cognition of the people to reach aesthetic judgment, therefore it is subjective function. See figure '2'.

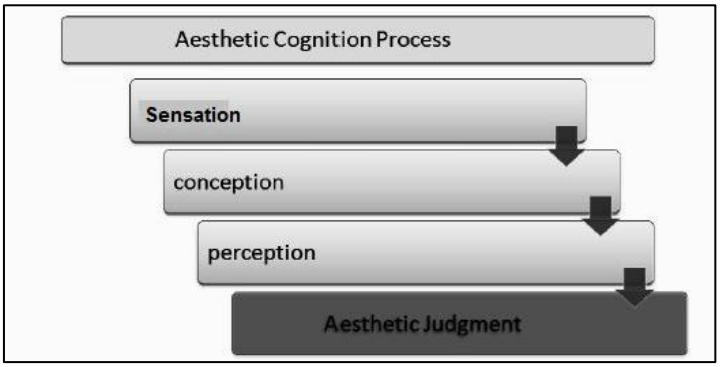

Figure 2. **The process of Aesthetic judgment through cognition. (Ahmad Nia and Atun, 2015)**

2.3 Vertical Greenery System (VGS)

The ideas of vertical greenery system is a very old, with examples in architectural history going back to the Babylonians, to 600 BC with the hanging gardens of Babylon, which is one of the world's seven ancient wonders (Jain and Janakiram, 2016). Vertical greenery was bearing a divergence of opinions. Pérez et al., (2011) and Bass & Baskaran (2003) defined vertical greenery system as the way in that the plants can be grown on, above, or in the walls of the building. See figure '3'.

Figure 3. **Vertical Greenery System in Interior design. URL1**

According to Chiang and Tan (2009), vertical greenery system can be divided into two categories (Support and carrier). The support system prepared for laying plants on vertical surfaces, whereas, carrier systems are referred to create the media for planting on the vertical walls. The support systems, also commonly termed as green wall allowing climb of plants and cascading ground-covers to grow up the vertical surfaces on specially designed support frames. While, carrier systems are able to involve more categories of plants, including shrubs, ground-covers, sedges, ferns, grasses, and even mosses. See figure '4'.

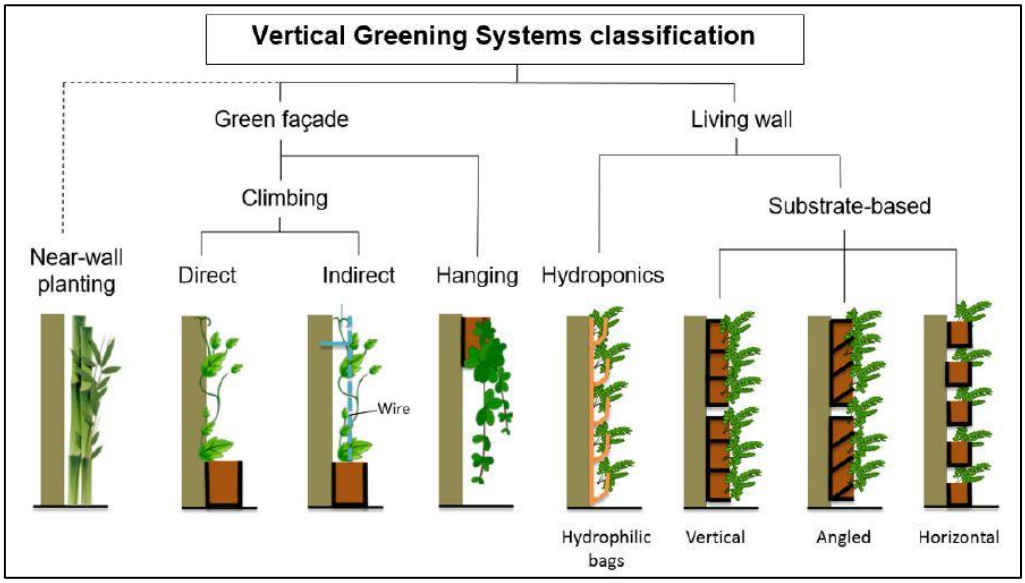

Figure 4. **Vertical Greenery Systems classification. (Ottelle, 2011)**

2.3.1 Thermal effect of VGS

Pérez, et al. (2011) address that the ambient around according to the surrounding ecology of the green walls characterized by low temperature and high humidity. Sunakorn and Yimprayoon, (2011) studied plants covering the apertures as vertical shading devices for naturally ventilated building and found that the indoor air temperature of the green wall room remains less than the control room during daytime. In addition to this, the VGS improves ventilation for a naturally ventilated room.

2.3.2 The effect of VGS on Thermo-physical properties of walls

According to Hanna (2018), illustrated that VGS improve U-values of the walls provided this system by comparing with bare walls in the Mediterranean climate (. In the same contexts, other studies carried out such as Chen et al., (2013) and Susorova at al., (2013) asserts that the insulation potential and impact of VGS improve indoor temperatures. See Table '1'.

Table 1. The influence of VGS in walls on the U-value development. (Hanna, 2018)

U- Value for Wall without VGS (W/m²K)	U- Value for Wall with VGS (W/m²K)	Improvement of Insulation capability (By %)
1.5	1.0	33%
1.0	0.75	25%
0.6	0.5	17%
0.3	0.27	10

2.3.3 Reduction of energy consumption through VGS

Wong et al. (2009) carried out simulation research and found that VGS is able to reduce the mean radiant temperature values and with 50% green cover and a shading coefficient of 0.041 it could

decrease the heat loss/gain through the envelope by 40.68%. This means the reduction of energy usage for heating and cooling in the building through VGS. Furthermore, it has the ability to decrease the demands on energy for air-conditioning by up to 40-60% in a Mediterranean climate (Alexandri, and Jones, 2008; Perini and Rosasco, 2013).

2.3.4 Indoor air quality through VGS

According to Jaafar, et al., (2013), Plants absorb a significant amount of carbon dioxide for their growth and biological functions and through oxygen to the atmosphere. VGS works as a filter that improves indoor air quality, it helps in saving energy consumption for air conditioning (Ottelle, 2011).

3. Methodology

Through literature review and theoretical framework, the author tried to identify initial factors that could help in identifying the functionality in VGS in interior surfaces, based on their performance. Aesthetic judgment by the people is subjective because it depends on their perception. The methodology will emphasize on aesthetic judgment based on the functionality to assess the aesthetic value through performance rate in VGS on interior surfaces in the buildings (see figure '1'). This is through evaluating the initial factors formulated from theoretical analysis. Moreover, the aesthetic value will be obtained based on the subjective way depends on experts' judgment (personal mind) about the performance of these surfaces (see figure '2'). A comparative analysis between both results will be carried out in order to assess the validity of aesthetic value in the functionality of VGS, in inner surfaces of buildings.

Several case study buildings have been selected from different places around the world and have been analyzed and tested. VGS performance in interior surfaces has been identified, functionally, based on initial factors formulated from literature (see table '2'). In terms of aesthetic judgment, ten of academic people, architects, and interior architects have been interviewed to evaluate aesthetic value for the case studies. Likert's scale has been applied to evaluate their aesthetic judgment. The scale developed by 5 points (5. V. Beautiful, 4. Beautiful, 3. Normal, 2. Ugly, 1. V. Ugly. Aesthetic judgment about these case studies before and after introducing the participants to the performance rate of these green surfaces had been carried out to examine the aesthetic evaluation according to Santayana, (see figure '1'). The comparison between both aesthetic judgments has been analysed to see the effect of the functionality (performance) of the vertical greenery system in the selected case studies on their aesthetic judgment to reach to the conclusion. See figure '5'.

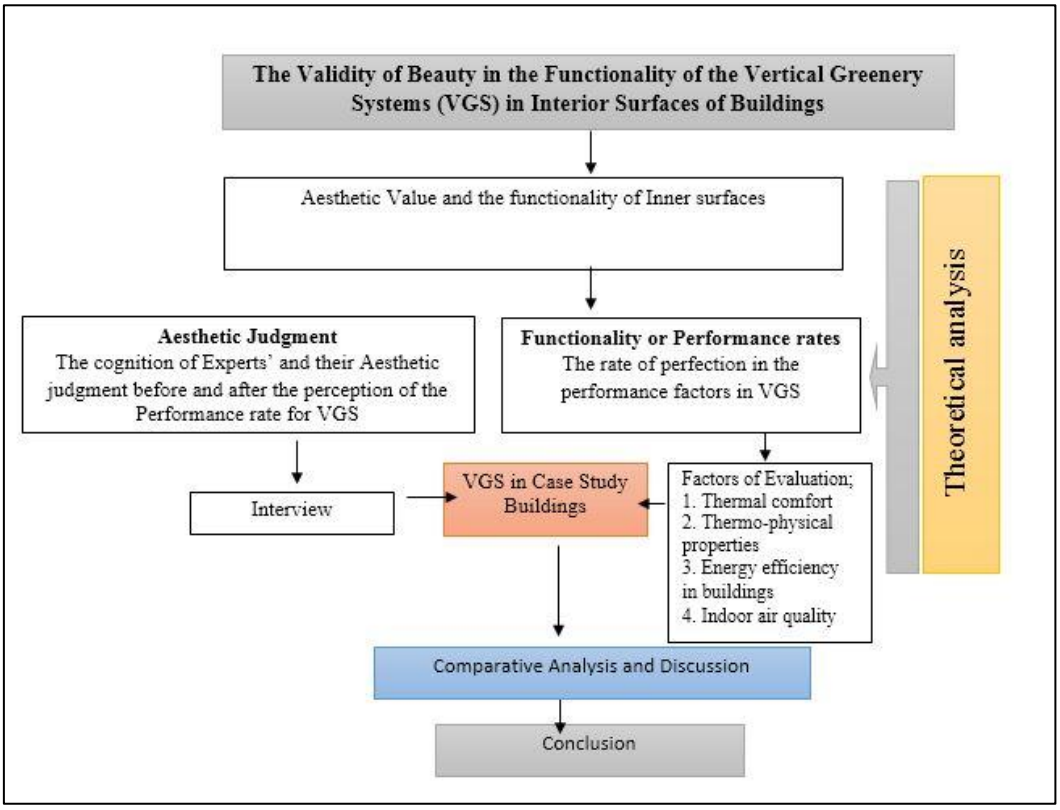

Figure 5. Methodology framework and the outline of the research. (By Author)

3.1 The Main Performance Factors for VGS to evaluate the Functionality

According to the literature and theoretical framework, several factors have been identified as the most effective factors to evaluate the performance of the VGS in interior walls, and these factors are; thermal comfort inside the building, thermo-physical properties for the walls, energy consumption, and inner air quality, as shown in Table '2'.

Table 2. Factors to evaluate VGS functionality inside the buildings.

No.	Factors of VGS to improve functionality in buildings indoor condition	References
1	Thermal comfort improvement	Pérez, et al., 2011; Stec et al., 2005; Sunakorn and Yimprayoon, 2011.
2	Improvement Thermo-physical properties of walls	Hanna, 2018; Chen et al., 2013; Susorova at al., 2013.
3	Reduction of energy consumption	Wong et al., 2009; Alexandri & Jones, 2008; Perini and Rosasco, 2013.
4	Improvement of Indoor air quality	Jaafar, et al., 2013; Ottelle, 2011.

The table above has illustrated the factors that the performance of the vertical greenery system inside the buildings should be rated in order to evaluate the functionality.

3.2 Case Studies

Five case studies have been selected from different regions around the world in order to find the validity of beauty and functionality in VGS of interior walls, as mentioned in the methodology. The application of the performance factor on them and find the perfection of these surfaces according to the functionality factors, which demonstrated in Table '2'. In the same time, the aesthetic value has been evaluated based on the opinion of the experts before and after introducing them the perfection rate of these surfaces to reach the decision through their aesthetic judgment based on their cognition process, as shown in figure '2'.

3.2.1 '171' Broadway Restaurant (Modular Living Wall), NYC- United States- Case Study '1'

The project is Located in NYC the date of implementation is Oct. 2007 the area is 29 sq. meter. The types of plants used in this wall are Pothos, Climbing jade, Philodendron, and Aglaonema. This high-end restaurant used this vertical green wall in order to create an ambiance for relaxing fine dining. The green wall was decided with a purely cosmetic intent. The green wall improved the inner air quality by increasing the humidity within the restaurant, and reduced acoustic discomfort, and intimacy (Introduction to Green Walls Technology, Benefits & Design, 2008). See figure '6'.

Figure 6. Vertical green wall inside 171 Broadway restaurant in New York. Source: ((Introduction to Green Walls Technology, Benefits & Design, 2008).

3.2.2 St Leonards Mental Health Clinic (Sydney, Australia) - Case Study '2'

Two living walls were demanded the dining space in the clinic, where the designer used a combination of plants to create a vibrant space, bringing nature closer to the patients and allowing them to experience the benefits of biophillic design (Living wall case study, 2019). See figure '7'.

Figure 7. Inner space of Northside Clinic in Greenwich. Source: (living wall case study, 2019)

3.2.3 Furniture store, Yorkshire, United Kingdom- Case Study '3'

In a furniture store at Yorkshire in England, 100 sq. meter of the artificial vertical green wall was created. Fitted behind the staircase from behind from up to down. It is creating good aesthetic, and improve thermo-physical properties of the back wall (VistaGreen, 2019). See figure '8'.

Figure 8. Artificial vertical green wall in furniture store in Yorkshire, England. Source: (VistaGreen, 2019).

3.2.4 Vertical greenery systems in Terminal 3 of 'Changi' International Airport: Singapore- Case Study '4'

More than 50 species have been selected to be plants on this vertical Wall, to show different layers and textures to the wall. The overhaul on the five-story-high vertical garden, which spans 300 meters across the terminal (Terminal 3 green wall, 2011), it is completed in January 2018. See figure '9'.

Figure 9. Vertical Greenery System in Changi Airport in Singapore. URL2

3.2.5 Vertical greenery systems in H&M Head Quarters, London: UK- Case Study '5'

The Swedish fashion firm H&M has believed in making f sustainability fashionable. H&M in London decided to create green walls inside their renewed offices. The location of the case study is 25 Argyll Street- London in the United Kingdom. Three walls with 21.5m2 using 12 various interior plants including 'Maranta leuconeura' and 'Chlorophytum comosum' –Ocean plants. Two of the living walls installed in the entrance for greeting visitors at reception. A third one installed in a staff breakout area for further relaxing (Living Wall Case Study, 2014). See figure '10'.

Figure 10. Interior walls in H&M Head Quarters, London-UK. Source: (living wall case study, 2014)

4. Discussion

Based on the theoretical analysis the performance factors have been considered with the same weight to be applied to the case studies to find the performance percentage in each case. Each factor has been weighted by 25% of the total performing percentage. The results demonstrated the following; the first case study demonstrated performance by 100% because the restaurant has been covered by the big area of natural plants, which demonstrated significant influence on the ambiance of the inner space. The second and fifth case studies demonstrated less performance because of the VGS area are small. These areas if they have been compared with the total inner surface will have a very low influence on

thermal comfort performance, but relatively affecting other factors and obtained 75%. Regarding the third case study, it demonstrated only 50% of performance because it could not improve thermal comfort and indoor air quality, because of the artificial material of the green wall that has been used instead of natural plants. The fourth case study has demonstrated 75%, despite the VGS wall is covering big area but it is still not improving thermo-physical properties of the building's walls because it is partition wall, and not directly touched the outside environment. See Table '3'.

Table 3. The performance of the case studies based on the performance factors for interior VGS. (By Author).

Case study	Thermal comfort improvement	Improve Thermo-physical properties of walls	Reduction of energy consumption	Improvement of Indoor air quality	Performance rate
171 Broadway Restaurant	✓	✓	✓	✓	100%
St Leonards Mental Health Clinic	X	✓	✓	✓	75%
Furniture store, Yorkshire	X	✓	✓	X	50%
Terminal 3 - Changi International Airport- Singapore	✓	X	✓	✓	75%
H&M Head Quarters, London	✓	X	✓	✓	75%

The five case studies have been judged aesthetically by the professional people based on aesthetic cognition process, before introducing them the performance rate, as demonstrated in table '3'. The results demonstrated that first case study rated less by 3.9 (beautiful) based on Likert's scale and second case study rated by 4.5 (v. beautiful), while the third case study gets 4.2 (beautiful). Moreover, the fourth case study rated more than others by 4.6 (v. beautiful), and fifth was rated by 4.2 (beautiful) as the third case study. See table '4'.

Table 4. Aesthetic judgment of the professionals before introducing them the performance of each case. (By Author).

Thermal Sensation	1 V.Ugly	2 Ugly	3 Normal	4. Beautiful	5 V. Beautiful	Likert Formula	Result	Scale	Judgment
Case Study 1	0	0	2	7	1	39	3.9	4	Beautiful
Case Study 2	0	0	0	5	5	45	4.5	5	V.Beautiful
Case Study 3	0	0	2	4	4	42	4.2	4	Beautiful
Case Study 4	0	0	0	4	6	46	4.6	5	V.Beautiful
Case Study 5	0	0	1	6	3	42	4.2	4	Beautiful

After the introduction of the performance percentage for each case study according to the table '3' to the professional people, the aesthetic judgment has been changed. The first case study that has the best performance based on the performance factors ratings in table '3'. It has demonstrated the raising in its aesthetic value during the next judgment, where it has gained 4.5, and ranked (very beautiful). While the second case study obtained less aesthetic judgment than before because of its deficiency in the performance. Therefore, the aesthetic judgment of the second case study has been changed from 4.5 (very beautiful) to 4.4 (beautiful), based on the second aesthetic cognition process for the professional people. The third case study which had 4.2 before the introduction of performance ratings, became 3.8, and ranked (beautiful), which shows according to Likert's scale result lower than the first judgment results. Regarding the fourth case study which had 4.6 (v. beautiful) in the first judgment, it has gained less in the second judgment 4.4 (beautiful), also because it's a rating of performance. The same issue with the fifth case study, which its aesthetic judgment in the second time became less than first judgment, where it was 4.2 (beautiful), and became 3.9 (beautiful). The reason returns, as mentioned previously, to the deficiency in the performance of these case study compared with the first and second cases. See table '5'.

Table 5. Aesthetic judgment of the professionals after introducing them the performance of each case study. (By Author).

Thermal Sensation	1 V.Ugly	2 Ugly	3 Normal	4. Beautiful	5 V. Beautiful	Likert Formula	Result	Scale	Judgment
Case Study 1	0	0	0	5	5	45	4.5	5	V. Beautiful
Case Study 2	0	0	0	6	4	44	4.4	4	Beautiful
Case Study 3	0	0	4	4	2	38	3.8	4	Beautiful
Case Study 4	0	0	0	6	4	44	4.4	4	Beautiful
Case Study 5	0	0	2	7	1	39	3.9	4	Beautiful

Thus, the results have demonstrated that the rank of aesthetic judgment has been changed and raised based on the performance rates for the case studies through aesthetic cognition processes.

5. Conclusion and Recommendations

According to the obtained results in this paper, this part will try to answer the questions of the study, which have been arisen in this paper, which is; "1) What are the main factors to evaluate the performance of VGS in interior surfaces?; 2) Whether or not the level of the performance for VGS in

interior surfaces are influencing the aesthetic value? And how much the functionality and aesthetic value can be incorporated into the design process?"

The most effective factors on the functionality of VGS in inner spaces have been investigated based on secondary sources, through books, credible index journals, and net sources. The main factors have been selected to test the functionality of VGS were; thermal comfort, thermo-physical properties of the walls, energy consumption, and inner air quality. The results demonstrated that aesthetic judgment based on aesthetic cognition process is significantly influenced by performance rating. Where professionals' cognition process (starting with sensation, and conception, then perception) to reach aesthetic judgment have been changed significantly with their perception of the performance rate in VGS of the selected case studies, as seen in table '6'.

Table 6. The influence of the performance rates in VGS on the aesthetic judgment. (By Author)

Case study	Aesthetic judgment level **before** the perception of the Performance according to Likert's Scale	The rate of performance	Aesthetic judgment level **After** the perception of the Performance according to Likert's Scale
171 Broadway Restaurant	3.9	100%	4.5
St Leonards Mental Health Clinic	4.5	75%	4.4
Furniture store, Yorkshire	4.2	50%	3.8
Terminal 3 - Changi International Airport-Singapore	4.6	75%	4.4
H&M Head Quarters, London	4.2	75%	3.9

This result indicates that as much as functionality or the performance rates are increased, the aesthetic value will be increased. Thus, according to the previous findings, the questions of the study have been answered. Consequently, it is valid to say that the hypothesis of the study can be supported.

More accurate results can be acquired by increasing the numbers of the case studies, as well as the number of participants in the judgment process. Classify the main factors to secondary sub-factors are recommended for more accurate performance rates. The study can be part of other studies avenues, where, in a future studies, the aesthetic judgment for the occupants of the inner space could be engaged to compare it with the results of the current study.

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