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# Visual Landscape Quality Relationship towards Students' Well-Being

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**Abstract**
Plants are identified as a valuable element in visual landscape assessment. This study examines the visual landscape quality (VLQ) relationship to students' well-being. This study identifies the preferences for planting composition scenes through the photo-based survey method. The survey employs 51 scenes with 5-points Likert-scale rating. The PLS-SEM was used to interpret the findings. The findings show the preferred scenes are complex and coherent arrangement, moderate density, and natural plants, compared to openness and mysterious characteristics. These characteristics support students' engagement and positive emotions. This finding will assist the campus designers in improving the VLQ towards students' well-being.

Keywords: Visual landscape quality; planting composition; students' well-being; landscape preference


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## 1.0 Introduction

Plants are generally viewed as valuable green elements due to their ability to manipulate the landscape's aesthetic quality in green spaces (Liu & Schroth, 2019). As supported by Yılmaz et al., (2018), plants have become an influential factor in human perceiving visual landscape quality (VLQ) compared to other variables in landscape studies. On that basis, planting plays an important role in the human environment and has evolved into an aesthetic component of landscape design. In landscape design, planting composition is the main component to coordinate with the overall look of the landscape. The planting composition can enhance the condition of the surrounding environment (Othman et al., 2015) and stimulate therapeutic function, release stress, and develop better well-being. Besides that, many studies show the association of planting design with human well-being (Southon et al., 2018; Wang, R. et al., 2016; Zhang et al., 2014). In the campus context, stress, anxiety and depression are common situations due to the challenging tasks and stressful nature (Hipp et al., 2015; Speake et al., 2013). Therefore, planting design is an integral part of the university environment. It needs to provide multiple forms of planting design to meet the demands of a wide range of students (Speake et al., 2013). Previous studies have found that planting in campus landscape can generate more advantages to students' life and well-being (Gulwadi et al., 2019; Han, 2017; Scholl & Gulwadi, 2018), academic performance (Hodson & Sander, 2019) and develop healthy mental and physical performance (Puhakka, 2021; Scholl &

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Gulwadi, 2018). Previous research also has demonstrated that viewing plants can improve students' attention, performance, and recovery from stress and mental illness (Kweon et al., 2017; Li & Sullivan, 2016). Therefore, this study examines the visual landscape quality (VLQ) of planting composition and its relationship with students' well-being. Hence, the study objectives firstly to identify the preferences of planting composition scenes through the photo-based survey method and to determine the characteristics of preferred planting and students' well-being. This study uses the campus landscape to assess the planting composition visually. Therefore, the visibility of planting composition is an important component that allows students, even when they are indoors, to interact with the landscape planting visually and, as a result, improve their performance and well-being.

## 2.0 Literature Review

Well-being has a wide definition. In this context, students' well-being refers to students' overall development and quality of life (OECD, 2017). Nevertheless, there is a lack of a direct measurement model of well-being that investigates the ways that a built environment can influence well-being outcomes (Watson, 2018). This study employed the concept of flourish and happiness which was outlined by Seligman in his PERMA model. PERMA is identified as Positive emotions, Engagement, Relationships, Meaning, and Accomplishment. These five components purportedly give rise to human flourishing (Goodman et al., 2017). Knowing that life on campus can be stressful and one of the most sensitive situations for students due to the pressures of varied learning activities, continual homework, tests, and high expectations to attain good grades. Students may feel exhausted and burned out due to the pressure, which can sadly contribute to students developing mental health and well-being issues. University students' well-being has received a lot of attention in a variety of fields of study all over the world (Saravanan & Wilks, 2014).

In addition, the COVID-19 pandemic has shaken the world, with an unimaginable number of lives lost, families and communities forced apart. These consequences of the pandemic have exacted a significant toll on the mental health and well-being of the population (WHO Regional Office for Europe, 2021). More than one year into the COVID-19 pandemic, the lowest level of mental well-being reported in 2021 was among women aged 18–24 years. The largest reduction in mental well-being observed between 2020 and 2021 was among men aged 18–24 years (WHO Regional Office for Europe, 2021). This population has been demonstrated to be the most vulnerable to depression (Saravanan & Wilks, 2014) and affects well-being. It might be due to various factors, including a lack of connection to nature (Crump, 2015).

Previously, Pulte, (2016) research stated that the improvement of performance and reduced stress results from viewing plants and green spaces through windows. However, previous research has not addressed the arrangement or design of its green spaces. Most people like green, but how the green is composed will impact preferences and visual quality. Sanders (2020) mentioned that when planting with people in mind, the spatial arrangement of planting indicated the composition keywords. In Information Processing Theory (Kaplan et al., 1998), the preference matrix predictors of preference such as coherence, complexity, mystery, and legibility reflect the characteristics of the composition. Parallel to this study, the preference predictors in this theory are adapted to planting design principles. Common planting design principles were classified into the four predictors of the preference matrix to understand better how planting design can affect preference. Table 1 displays the planting preference matrix assigned to relevant preference predictors in Kaplans' theory.

Table 1. Planting design principles assigned to preference matrix works and affect preference

| Planting Preference Matrix | | | |
|---|---|---|---|
| Coherence | Legibility | Complexity | Mystery |
| Unity | Visual weight | Variety | Visual connection |
| Balance | Scale & proportion | Contrast | Visual enclosure |
| Order | Colour | Density | Layers |

*(Source: Adapted from Kaplan's preference matrix; Sanders, 2020)*

These planting design principles do not always fit perfectly in one single category, but this matrix was developed to show the best fit in this research context. Therefore, other planting design principles may not be listed in this matrix. Still, careful consideration was given to what principles should be included to best understand preferences related to the campus environment.

Landscape planting should satisfy ecological functions and meet the preference of people (Du et al., 2016). However, it is difficult for landscape designers to learn the preference for planting design in the landscape of different users and what attributes of plants can achieve high VLQ (Du et al., 2016). Many scholars proved that the individual physical properties of plants, such as scale, texture, shape, colour, and density, can influence the preference of people (Kaplan & Kaplan, 1989; Polat & Akay, 2015; Tveit et al., 2012; Yılmaz et al., 2018). A high density of plants is known to negatively influence visual preference, while a low density has a positive influence (Ulrich, 1986). Density is related to limited short-range vision and reducing the ability to pass through the landscape (Othman, 2004). That is why high density often correlates with negative results such as feelings of insecurity. However, it is dependent on the type of landscape being researched. The degree of naturalness may impact the amount of plant density. Naturalness also defined the unmanaged appearance in which the plants grow naturally without human intervention. Naturalness is also the opposite of ornamental features (Kaplan & Kaplan, 1989). Therefore, this study seems to identify planting composition preference factors that impact well-being.

## 3.0 Methodology

A psychophysical paradigm was typically employed to analyse the visual landscape quality of planting composition (Polat & Akay, 2015). In the study context, this paradigm combines physical evaluation of campus planting composition characteristics with a perception-based

method that relies on student ratings and results in a well-being evaluation. This study involved 319 students in total. The participants ranged in age from 18 to 49 years old with the majority of undergraduate students from the University Putra Malaysia (UPM). All participants were also involved from all faculties in UPM. UPM was chosen as the study location due to the amount of green space available. This criterion is also one of the indicators measured in UI Greenmetric, and UPM, as a participant, is consistently ranked as the top university in Malaysia, with a high indication of green space provided. The photo-based questionnaire method was used as a surrogate item for the assessment. A photo-based questionnaire survey employs 51 planting composition images that have been selected by ten experts. The experts choose these images based on the content of principles of planting and the appropriate angle of the images. This photo-based questionnaire design used five points Likert-scale format to analyze the preference rating (Gerstenberg & Hofmann, 2016; Polat & Akay, 2015). For the visual landscape quality assessment, students ranked 51 photos from 'strongly dislike' to 'strongly like'. The photo-based questionnaires were applied within the situation of the face-to-face survey. Participants were also verbally instructed to focus on the landscape planting scene rather than other elements in the images given. Once participants had rated all of the images, they were asked to rate planting composition criteria they had previously preferred when assessing images. They also should answer how they feel when viewing the highly preferred landscape planting scene in the next part. The purpose of this section was to look into the degree of satisfaction and well-being score associated with planting composition sceneries. The data was then used to analyze the relationship between variables, and the PLS-SEM used the analysis of the Hierarchical Component Model (HCM) to interpret the findings. The descriptive and Relative Importance Index (RII) was also used to quantify the mean results and identify the ranking of preferred planting composition criteria. The level of ranking refers to the value as stated in Table 2.

Table 2. Mean and RII ranking value

| RII Importance Level | | Mean Value | |
|---|---|---|---|
| High | $0.8 \leq RII \leq 1$ | Low | 1.00 – 2.33 |
| High-medium | $0.6 \leq RII \leq 0.8$ | Moderate | 2.34 – 3.67 |
| Medium | $0.4 \leq RII \leq 0.6$ | High | 3.68 – 5.00 |
| Medium-Low | $0.2 \leq RII \leq 0.4$ | | |
| Low | $0 \leq RII \leq 0.2$ | | |

*(Source: Muniandy, 2019; Adnan et al., 2017)*

## 4.0 Findings

A pool of 51 images were analysed with factor analysis to group the criteria of the planting composition into several similar factors. This analysis formed a cluster of ten components with similar factors of planting composition. The ten components are named Factor 1 (A01) as "Complexity – Variety of plant properties", Factor 2 (A02) as "Coherence – Balance and symmetry", Factor 3 (A03) as "Mystery – Layer", Factor 4 (A04) as "Legibility – Visual weight", Factor 5 (A05) as "Legibility – Scale and proportion", Factor 6 (A06) as "Complexity – Contrast of texture", Factor 7 (A07) as "Complexity – Density of mixture plants", Factor 8 (A08) as "Mystery – Visual enclosure", Factor 9 (A09) as "Coherence – Orderly and openness" and lastly Factor 10 (A10) as "Mystery – Visual connection". The characteristics of each factor will assist the findings of the relationship between the variables. The average participant ranking scores of the visual landscape quality of each planting composition factor were calculated. It is almost significantly similar in preferences between students' selection. The ranking of preference scores is provided together with the value for the highest rating of planting composition scenes in Table 3. An examination of Table 3 reveals that the visual landscape quality of planting composition was higher for Factor 7 (A07), Factor 2 (A02), and Factor 4 (A04).

Table 3. Mean comparison and relative index of visual landscape quality of planting composition

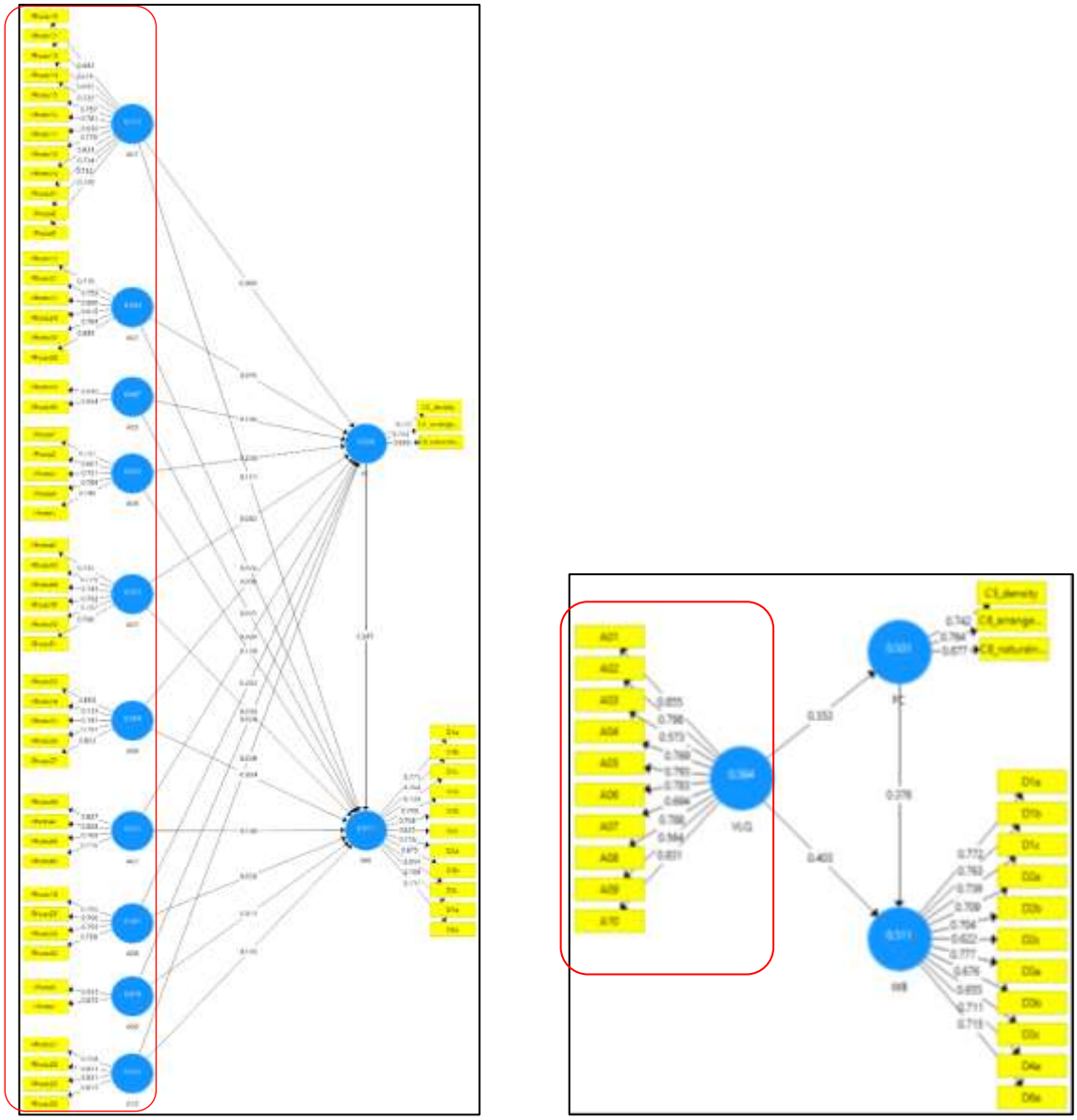
| Component | Mean Value | Tendency level | RII | Ranking | Importance Level |
|---|---|---|---|---|---|
| **Factor 1 (A01)** | **3.613** | | | | |
| Photo8 | 3.815 | High | 0.763 | 18 | High-medium |
| Photo9 | 3.931 | High | 0.786 | 10 | High-medium |
| Photo10 | 3.364 | Moderate | 0.673 | 41 | High-medium |
| Photo11 | 3.524 | Moderate | 0.705 | 31 | High-medium |
| Photo13 | 3.455 | Moderate | 0.691 | 36 | High-medium |
| Photo14 | 3.875 | High | 0.775 | 15 | High-medium |
| Photo15 | 3.639 | Moderate | 0.728 | 28 | High-medium |
| Photo16 | 3.492 | Moderate | 0.698 | 34 | High-medium |
| Photo17 | 3.339 | Moderate | 0.668 | 42 | High-medium |
| Photo19 | 3.411 | Moderate | 0.682 | 38 | High-medium |
| Photo20 | 3.815 | High | 0.763 | 18 | High-medium |
| Photo31 | 3.696 | High | 0.739 | 24 | High-medium |
| **Factor 2 (A02)** | **3.833** | | | | |
| Photo12 | 3.502 | Moderate | 0.700 | 33 | High-medium |
| Photo21 | 3.897 | High | 0.779 | 11 | High-medium |
| Photo22 | 4.132 | High | 0.826 | 3 | High |
| Photo23 | 3.317 | Moderate | 0.663 | 44 | High-medium |

| | | | | | |
|---|---|---|---|---|---|
| Photo24 | 4.194 | High | 0.839 | 2 | High |
| Photo30 | 4.000 | High | 0.800 | 6 | High |
| Photo38 | 3.793 | High | 0.759 | 19 | High-medium |
| **Factor 3 (A03)** | **3.752** | | | | |
| Photo39 | 3.627 | Moderate | 0.725 | 29 | High-medium |
| Photo40 | 3.878 | High | 0.776 | 14 | High-medium |
| **Factor 4 (A04)** | **3.847** | | | | |
| Photo1 | 3.953 | High | 0.791 | 8 | High-medium |
| Photo2 | 3.959 | High | 0.792 | 7 | High-medium |
| Photo3 | 4.066 | High | 0.813 | 5 | High |
| Photo4 | 3.674 | Moderate | 0.735 | 26 | High-medium |
| Photo5 | 3.583 | Moderate | 0.717 | 30 | High-medium |
| **Factor 5 (A05)** | **3.673** | | | | |
| Photo41 | 3.721 | High | 0.744 | 22 | High-medium |
| Photo43 | 3.404 | Moderate | 0.681 | 39 | High-medium |
| Photo44 | 3.890 | High | 0.778 | 12 | High-medium |
| Photo45 | 3.856 | High | 0.771 | 16 | High-medium |
| Photo50 | 3.461 | Moderate | 0.692 | 35 | High-medium |
| Photo51 | 3.708 | High | 0.742 | 23 | High-medium |
| **Factor 6 (A06)** | **3.576** | | | | |
| Photo33 | 3.254 | Moderate | 0.651 | 46 | High-medium |
| Photo34 | 3.455 | Moderate | 0.691 | 37 | High-medium |
| Photo35 | 3.831 | High | 0.766 | 17 | High-medium |
| Photo36 | 3.696 | High | 0.739 | 24 | High-medium |
| Photo37 | 3.646 | Moderate | 0.729 | 27 | High-medium |
| **Factor 7 (A07)** | **4.156** | | | | |
| Photo46 | 4.194 | High | 0.839 | 2 | High |
| Photo47 | 4.370 | High | 0.874 | 1 | High |
| Photo48 | 4.122 | High | 0.824 | 4 | High |
| Photo49 | 3.937 | High | 0.787 | 9 | High-medium |
| **Factor 8 (A08)** | **3.453** | | | | |
| Photo18 | 3.752 | High | 0.750 | 20 | High-medium |
| Photo25 | 3.047 | Moderate | 0.609 | 48 | High-medium |
| Photo26 | 3.326 | Moderate | 0.665 | 43 | High-medium |
| Photo42 | 3.687 | High | 0.737 | 25 | High-medium |
| **Factor 9 (A09)** | **3.212** | | | | |
| Photo6 | 3.307 | Moderate | 0.661 | 45 | High-medium |
| Photo7 | 3.116 | Moderate | 0.623 | 47 | High-medium |
| **Factor 10 (A10)** | **3.629** | | | | |
| Photo27 | 3.887 | High | 0.777 | 13 | High-medium |
| Photo28 | 3.382 | Moderate | 0.676 | 40 | High-medium |
| Photo29 | 3.511 | Moderate | 0.702 | 32 | High-medium |
| Photo32 | 3.734 | High | 0.747 | 21 | High-medium |

*(Source: Authors, 2021)*

HCM allows researchers to reduce the number of relationships in the structural model, making the PLS-SEM path model more parsimonious and easier to apprehend (Hair et al., 2018). Figure 1 illustrates the aspect of the complex model: there are ten Lower Order Component (LOC) of VLQ relationships with planting composition factors and students' well-being. By including Higher Order Component (HOC), the number of path coefficients can be reduced, yielding a more parsimonious model in terms of structural model relationships. HCM has several approaches and one of them is the two-stage approach. The two-stage approach in this study employed the disjoint two-stage measurement. The score of LOC for VLQ was used in stage two to measure the HOC of VLQ, and multi-items measured the relationship between variables as in stage one (Figure 1).

Furthermore, this study discovered that plants' spatial arrangement, density, and naturalness are preference rating consideration factors. In addition, these factors are most closely associated with positive emotions like ease, pleasantness, and engagement, such as a make-up mindset.



(a) (b)

Fig. 1. (a) LOC measurement; (b) HOC measurement.
*(Source: Authors, 2021)*

## 5.0 Discussion

Participants' highly preferred planting composition scenes resulted in seven photographs with a high RII importance level. There are photos 47, 46, 48 (Factor 7), photos 24, 22, 30 (Factor 2), and photo 3 (Factor 4). When examining each picture individually, the commonalities in planting composition factors for these top-ranked landscape planting sceneries appear to be in a balanced arrangement. Indeed the plant species have a similar appearance, dominated by palms and appealing shrubberies. However, the density of the plants is observed differently. Photos of Factor 7 visibly display the variety of plants which consists of *Licuala grandis* (Ruffled Fan Palm) with broad palmate leaf palm, a mixture of shrubs and groundcover such as *Hymenocallis speciosa (*Spider lily*), Alpinia purpurata (*Red ginger*), Asplenium nidus (*Bird nest's fern*), Ipomea batatas "Margarita' (*Ornamental Sweet potato*)* and *Pandanus amaryllifolius (*Pandan*)*. A possible explanation for this highly preferred landscape planting scene might be related to the density of leaf structure. The solitary trunk of palms arranged in an orderly manner surrounded the courtyard and the shape of the plants is in contrast to others. The composition of shrubs and palms enhanced the aesthetic values, creating various shapes, forms and textures besides adding colours to the planting.

Besides that, the species richness also may influence preferences, as supported by Southon et al. (2018). They identified that the richness of plant species was important to improve VLQ. Furthermore, perceived richness was positively associated with vegetation height, evenness, and colourfulness suggesting that these are cues for estimating species richness and contribute to psychological well-being (Southon et al., 2018). Indeed, this factor is parallel to the previously mentioned psychophysical paradigms whereby the physical landscape with a variety of species may offer students well-being dynamic emotions when viewing this planting composition.


Fig. 2. Planting composition factors with high important index
*(Source: Authors, 2021)*

Participants rated arrangement factors with a mean value of 4.339 and an importance index of 0.868, indicating that this variable should be considered first because the arrangement is the first impression to be reviewed. Perhaps this finding was also caused by highly rated planting scenes that were arranged in an organised manner. The second-ranking of factor consideration is density with a mean value of 4.188 and an importance index of 0.838. Landscapes with minimal density, get a low rating for urban living. This campus can be classified as a suburban area. Plants with a moderate density are more hypothetical to be considered than those with a high or low density. Therefore, photos in Factor 7 (Complexity – Density of Mixture Plants) have the greatest mean value due to the fact that the plant characteristics in the scenes are not too dense and not too open. The third-ranking is naturalness with a mean value of 4.185 and an importance index of 0.837. This value is just slightly lesser than the density result. It demonstrates that the naturalness factor and density are interrelated. Respondents may consider the original features of plants rather than decorative features. According to (Cengiz, 2014), other studies found that plants and natural areas positively affect visual quality. This factor is supported by Hami & Abdi, (2019) in which the amount of naturalness could affect the visual beauty of the landscape, and most people like normal nature and complexity in the landscape.

Many studies have demonstrated the effectiveness of visual preference studies in improving the landscape and individual quality. Consequently, the relationship between VLQ and students' well-being has been studied by some scholars (Gerstenberg & Hofmann, 2016; Hami & Maruthaveeran, 2018). The results have shown significant relationships between VLQ and students' well-being. The findings above show that VLQ is represented by ten factors of landscape planting which have been analysed through factor analysis to determine the significant difference between groups of plantings. This measurement demonstrates that all dimensions were suitable for reflecting the VLQ when assessing students' well-being. Previous research has proven that plants are powerful aspects of visual quality assessment and well-being (Gerstenberg & Hofmann, 2016; Wang, X. et al., 2016). This result is consistent with earlier research that has revealed a significant relationship between complexity and dense vegetation (Harris et al., 2017; Liu & Schroth, 2019). Therefore, one could suggest that a diversity of plants should be naturally composed in order to produce complexity, as densely arranged at a moderate level.

The measured items of well-being mostly reflected positive emotions with strongly agree. The statement "the preferred scene makes me feel at ease and positive," arrangement and density have been correlated with positive emotion. While naturalness provides engagement in well-being items with the highly agreed-upon statement of "this scene is capable of making up my mind." The statement agrees with other researchers that being exposed to a more natural environment may improve people's performance (Li & Sullivan, 2016; Scholl & Gulwadi, 2018). While positive emotion also reflects the feeling of security, happiness, and excitement which completely supports

the previous research that the level of density and arrangement of vegetation will positively or negatively influence people's preferences (Gerstenberg & Hofmann, 2016; 2017; Liu & Schroth, 2019)

## 6.0 Conclusion and Recommendation

This research makes a contribution to the body of knowledge by determining specific criteria for assessing the desired planting spaces in the campus landscape. However, the limitation of this research the evaluation is not able to grasp as much as postgraduate students. This situation is possible because most of the students available around green spaces in the faculties are largely undergraduate students. Therefore, in future research, the authors must diversify and explore the region where the postgraduate students are most likely seated. Generally, this research extends the literature on VLQ of planting composition and provides a new perspective in analysing the relationship assessment in this field of research. The new contribution to this research is the advanced application of PLS-SEM which employed HCM analysis with the method of a disjoint two-stage approach. This method is new in the landscape preferences research field. Therefore, it is suggested to use HCM analysis for other comparable studies since this type of analysis model has a diverse potential that needs to be explored and conducted. Besides that, this study can also facilitate preferable plant features with a particular arrangement, density, andnaturalness as an indicator to observe students' performance and wellness. Thus, the results are expected to provide evidence forcampus landscape planting, which needs highly consideration towards managing visual landscape quality and students' well-being on campus.

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