Modelling landscape aesthetic of planting composition influencing visual quality and well-being: PLS-SEM approach

N Mt Akhir1 S R Md Sakip1,2 M Y Abbas3,4 N Othman4
1Faculty of Architecture, Planning and Surveying, University Teknologi MARA, Perak Branch, Seri Iskandar Campus, 32610 Perak, Malaysia
2Green Safe Cities Research Group, Universiti Teknologi MARA, Shah Alam Campus, 40450 Selangor, Malaysia
3Head, Centre for Environment-Behaviour Studies (cE-Bs), Faculty of Architecture, Planning & Surveying, Universiti Teknologi MARA, Shah Alam Campus, 40450 Selangor, Malaysia
4Faculty of Architecture, Planning and Surveying, University Teknologi MARA, Selangor Branch, Puncak Alam Campus, 42300 Selangor, Malaysia

Email: noriz102@perak.uitm.edu.my

Abstract. Planting composition (PC) is designed to be aesthetically pleasing, functional utilizing and ecologically sustaining. In landscape research, a plant is a powerful element in assessing visual quality. Visual quality for each landscape depends on the visual composition of plants. The study on landscape assessment in a campus is commonly correlated with green space. However, the composition and design of planting in the green spaces on campus grounds have not been considered yet. Therefore, this study aims to explore the influence of PC towards visual quality and its relationships with the well-being of students. The conceptual model is composed of endogenous latent variables (LVs) according to the pattern of visual composition namely coherence, complexity, legibility and mystery. The exogenous LVs is PC and well-being. Positive emotion, engagement, relationships, meaning and accomplishment (PERMA) are the items used to test the relationship with the pattern of PC. This study applied confirmatory factor analysis (CFA) with pilot data to measure the relationship between LVs. The result validates that PC should consider 5 pillars of well-being which is PERMA to serve students with better visual access to landscape on campus.

1. Introduction
A beautiful and tranquil landscape is important. When people are surrounded by lush greenery it can stimulate more positive emotions Error! Reference source not found.. The psychological study of environmental aesthetic hypothesized that people tend to judge a scenically beautiful landscape with positive preference Error! Reference source not found.. The quality of landscape should be considered because low quality landscape can induce negative reactions, while, high quality landscape evoke positive responses Error! Reference source not found.. In the planting design, landscape properties like planting composition (PC) is important to secure the whole landscape as being unified in design. Indeed, the composition could enhance aesthetic value resemble of colour, texture, form, rhythm, order, emphasis and other related formal aesthetic principles. PC may consist of groundcovers, shrubs and trees which are truly important in reviving the condition of the surrounding environment Error! Reference source not found.. Among these group of plants, trees significantly act as a visual accent to the scenery while supported by other plant categories. Therefore, these group of plants should be managed carefully with a good composition to create better visual interest.
The primary objectives in this study are; (1) to explore the characteristics of PC related to visual quality; and (2) to examine the relationship between PC preferences and the well-being of students. The theoretical explanations for PC characteristics builds upon a data base from earlier research by Kaplan and expands the subject pool used in that theory to encompass a range of principles on PC.

1.1. Theory in landscape aesthetic
The perception of individuals towards a landscape is associated with certain variables of visual quality preferences. The different arrangement of plants, forms different spatial setting. Hence, the different spatial variables affect aesthetic and landscape preferences Error! Reference source not found.. The preference matrix Error! Reference source not found.. is an evolutionary theory that adopts the aesthetic appraisal to encourage the selection of habitat Error! Reference source not found.. The preference matrix in the Information Processing Theory have determined four visual response variables; coherence, complexity, legibility and mystery (see Table 1). According to the theory, a good understanding of the physical environment was crucial to human survival, but an exploration of a new habitat conveyed adaptive benefits as well Error! Reference source not found.. This support the hypothesis by Kaplans that the perceptual process involves extracting information from an individual's environment Error! Reference source not found..

| Understanding | Exploration |
|---------------|-------------|
| Making sense  | Being involved |
| COHERENCE     | COMPLEXITY  |
| Related with PC principles like order, balance, repetition and simplicity | Related with PC principles like complexity, harmony and contrast |
| LEGIBILITY    | MYSTERY     |
| Related with PC principles like emphasis, focalisation, scale and proportion | Related with PC principles like rhythm, sequential and chaotic |

Table 1. The preference matrix of Kaplans’ Information Processing theory

Based on the theory, this study addresses the following hypotheses:

**H1**: Perceived characteristics of planting composition is positively associated with coherence, complexity, mystery and legibility.

**H2**: There are positive relationship between well-being and the preferences of students

1.2. Visual quality in planting composition
Plants properties are able to attract the attention of the viewers through colour, form, texture and line. In planting design practices, a real difference in landscape aesthetic is when visual properties and basic design principles are well accomplished Error! Reference source not found.. With assistance from planting design principles, designers can influence the perception of viewers and their aesthetic satisfaction Error! Reference source not found.. Findings from previous scholars show, the compositions of plants and their colours and plant species diversity are the main elements of the visual quality of landscape areas Error! Reference source not found..Error! Reference source not found.. In concurrence with the preference matrix stated above, it parallels with the complexity preference predictor which can be hypothesized as a significant factor in judging landscape visual quality.

1.3. Influencing pattern in well-being
Based on the pattern in landscape visual assessment, the natural setting has become a major concern of preference predictor. There are some studies which confirm that contact with nature is fundamental to health and well-being. However, in the context of study students are continuously connected with technology devices and crucially have less contact with nature. Spending more time indoors has predicted to lead to a negative impact on students. Therefore, this study is evocative to encourage outdoor connectedness. Before that, better planting design must be reviewed to ensure the effectiveness in visual preferences. The advantages of plant view have correlated with enhance positive emotions. The alternative scale was used in this study as well as students’ performance. As well as mental health, well-being are evoked by positive emotions. The PERMA model is derived from the psychology field, the meaning behind the model is aligned with the PERMA acronym used in this study. Although this PERMA model is derived from the psychology field, the meaning behind the model is aligned with the PERMA acronym used in this study. The question in PERMA has been adjusted according to a landscape scene to relate with the preferences pattern and psychology outcome.

2. Relationship between planting composition, visual quality and well-being
In parallel with the theoretical study and landscape properties, a similar relationship can be found between variables for PC pattern and well-being. According to Kaplans’ theory, coherence, complexity and mystery are among the significant variables in the context of nature, while legibility has less significance in landscape aesthetics. Previous studies have found that plant views are able to evoke positive emotions among people when engaging with the green environment. Furthermore, nature contact also affects as adaptive behaviour. which are able to motivate the students to nature connectedness. The well-being model by Seligman is known as positive emotion, engagement, relationship, meaning and accomplish hence the PERMA acronym used in this study. Although this PERMA model is derived from the psychology field, the meaning behind the model is allied with landscape preferences. The question in PERMA has been adjusted according to a landscape scene to relate with the preferences pattern and psychology outcome.

3. Methodology
Data collection was conducted through a pilot survey. In the first phase, the respondents were selected at random from different faculties with design based and non-design based students. This selection is necessary to generalise the questionnaire as well as to obtain diverse perception views. The total number of respondents involves 50 samples. In the pilot study, 10 to 30 samples are sufficient. Convenient sampling technique was used to meet the users of the campus with green spaces as respondents. The survey was divided into three sections. Part A includes personal information question in nominal scale, while part B and C were in the form of attitude rating scale. Many researchers used this scale to measure subjective phenomena such as satisfaction, perception, expectation and awareness. Part B consists of 38 numbers of PC images that represent faculties with green spaces. Part C comprises of well-being items which relate to the most preferred PC images in part B. Five point of the Likert scale was used for respondents to answer the question in part B and C. The five point scale was typically used by many researchers in various field such as management, business and social sciences. The alternative scale were assigned from 1 (strongly dislike) to 5 (strongly like) for part B and 5 (strongly agree) to 1 (strongly disagree) for part C. Then, the data was analysed using PLS-SEM 3.0 to test the relationship between preference pattern with PC and well-being. The path coefficients which beta value represent a strength of correlation between LVs were measured. The higher β value indicates the most influential relationship of exogenous LVs towards endogenous LVs which is close to 1, whereas if the β value that close to 0 indicate weak relationship.
4. Result, analysis and discussion
In order to investigate the relationship between PC and well-being in landscape visual quality, the reflective model of that relationship have been recorded. To validate the reflective measurement model, there are two types of validity that should be assessed which are convergent validity and discriminant validity Error! Reference source not found.. In the convergent validity, there are three components to be reported accordingly: 1) composite reliability (CR), 2) average variance extracted (AVE) and 3) factor loadings. Table 2 demonstrates the result of CR and AVE. Both results have achieved the minimum guidelines with CR > 0.70-0.90 and AVE > 0.50. The result for factor loadings are shown in Figure 1. The recommended result is 0.70, but for the loadings >0.70 to 0.40 is adequate if other items have high scores and complement to AVE and CR Error! Reference source not found..

| Construct | AVE   | CR     |
|-----------|-------|--------|
| PC        | 0.459 | 0.922  |
| WB        | 0.502 | 0.950  |
| Coherence | 0.519 | 0.842  |
| Complexity| 0.562 | 0.834  |
| Legibility| 0.566 | 0.935  |
| Mystery   | 0.585 | 0.848  |
**Figure 1.** Model relationship between planting composition, visual quality and well-being

| Construct | PC  | WB  | Coherence | Complexity | Legibility | Mystery |
|-----------|-----|-----|-----------|------------|------------|---------|
| PC        | 0.677 |     |           |            |            |         |
| WB        | 0.481 | 0.709 |           |            |            |         |
| Coherence | 0.446 | 0.402 | 0.721     |            |            |         |
| Complexity| 0.230 | 0.434 | 0.115     | 0.750      |            |         |
| Legibility| 0.361 | 0.369 | 0.487     | 0.431     | 0.753      |         |
| Mystery   | 0.256 | 0.266 | 0.253     | 0.195     | 0.358      | 0.765   |

The following Table 3 shows a result of discriminant validity. There are three methods to assess, Fornell-Lacker criterion, cross loading and Heterotrait-Monotrait Ratio (HTMT). Based on the criterion the indicators should load more strongly on their constructs rather than on other constructs in the model *Error! Reference source not found.* as well as cross loading. HTMT values close to 1 indicate a lack of discriminant validity *Error! Reference source not found.* The result show there is no discriminant issues between constructs. Table 3 indicate that all constructs exhibit sufficient discriminant validity. Table 4 depicts a method result of HTMT.

| Construct | PC  | WB  | Coherence | Complexity | Legibility | Mystery |
|-----------|-----|-----|-----------|------------|------------|---------|
| PC        |     |     |           |            |            |         |
| WB        | 0.509 |     |           |            |            |         |
| Coherence | 0.519 | 0.449 |           |            |            |         |
| Complexity| 0.277 | 0.448 | 0.337     |            |            |         |
| Legibility| 0.364 | 0.362 | 0.558     | 0.491     |            |         |
| Mystery   | 0.297 | 0.345 | 0.378     | 0.349     | 0.358      |         |

In determining the relationship between PC and well-being the path coefficient was assessed. Path coefficient value should exceed 0.10 to measure the impact of a certain model *Error! Reference source not found.*. However, if the value less than 0.10 also can be accepted for the different result of a weak relationship or negative relationship depending on the theory *Error! Reference source not found.*. The result shown in Figure 1 illustrates the relationship between LVs. The model illustrates the strong relationship between well-being, complexity and coherence pattern. With regard to Kaplans’ theory, the most preferable indicator in landscape aesthetic always highly correlated with complexity and coherence matrix. Table 5 shows the relationship between LVs and hypothesis remarks. For the relationship between PC and preference pattern, coherence shows the most strength than other constructs. This result detected that coherence is the significant and strongly accepted variable because people can easily cognitively understand a scene with an orderly arrangement. Legibility has a weak relationship with 0.093. As supported by Kaplans’ theory, legibility variable is difficult to assess and does not have a significant role in landscape preference. However, legibility can clearly be measured for urban setting.

**Table 4.** HTMT Result

In determining the relationship between PC and preference pattern, coherence shows the most strength than other constructs. This result detected that coherence is the significant and strongly accepted variable because people can easily cognitively understand a scene with an orderly arrangement. Legibility has a weak relationship with 0.093. As supported by Kaplans’ theory, legibility variable is difficult to assess and does not have a significant role in landscape preference. However, legibility can clearly be measured for urban setting.

| Hypothesis | Path coefficient | Remarks   |
|------------|------------------|-----------|
| H1: Perceived characteristics of planting composition is positively associated with: | | |
| a) Coherence | 0.359 | Strongly accepted |
| b) Complexity | 0.127 | Accepted |
| c) Legibility | 0.093 | Slightly accepted |
H2: There are positive relationship between well-being and students’ preferences on:

|   |   |   |   |
|---|---|---|---|
| d) | Mystery | 0.107 | Accepted |
| a) | Coherence | 0.402 | Accepted |
| b) | Complexity | 0.434 | Strongly accepted |
| c) | Legibility | 0.369 | Accepted |
| d) | Mystery | 0.266 | Accepted |

Overall, the research model in Figure 1 accounted that landscape aesthetic variables are able to influence the PC pattern and well-being. All of the hypothesis are accepted according to the path coefficient relationships. The relationship proves that coherence and complexity are the most significant indicators in evaluating landscape properties like the composition of plants in a campus setting.

5. Conclusion
Based on the findings discussed above, the evaluation of PC towards well-being are the areas that should receive careful attention from campus landscape management and campus community. The research is significant to enhance the quality of life of the campus community by viewing or exploring the good composition of plants. As supported by previous scholars research, viewing high quality landscape is able to evoke a positive response which increases the happiness index and reduce the level of stress. Therefore, the setting of PC should integrate the preference indicators to enhance the quality and impact of a green surrounding in a campus area. In conclusion, by identifying the relationship of PC for the well-being of students towards a high quality landscape, this study is beneficial to all universities in assisting the identification of green spaces that need improvement. Since the respondents of this study are only students, therefore it is recommended to extend the findings with various types of users in the future.

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