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An evaluation of visual aesthetic quality of pedestrian pathways based on ecological network corridor within campus landscape

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Abstract. Campus landscape reflects the identity and character of a college. The need of public accessibility in the form of pedestrian pathway in campus should be provided particularly to realize a campus life that is environmentally friendly and sustainable. In addition, the presence of a green way on the edge of the pedestrian track in the campus landscape can provide benefits as ecological network corridors that facilitate wildlife movement, linking wildlife habitats, and improve the aesthetic quality of pedestrian pathways. This study aimed to evaluate the visual aesthetic qualities of pedestrian pathways based on ecological network corridors within campus landscape. This study was conducted at campus of Bogor Agricultural University (IPB) Dramaga. The used method in this study was descriptive quantitative with analyses of Scenic Beauty Estimation (SBE), Shannon Wiener Index (H), and correlation analysis with Rank Spearman. The results showed that the aesthetic quality of pedestrian pathways based on ecological network corridors at IPB Dramaga campus overall showed good results which is characterized by the neatness of pedestrian characteristics and dominant of trees presence. This was indicated by a very high SBE value with a moderate H value. However, there were inadequate pedestrian pathways that have medium SBE value with low H value which is characterized by misused of pedestrian pathways, surrounding building appearance that were not neat, and minimum of trees presence. The correlation test showed positive correlation between SBE aspect and trees diversity aspect (0.335) though there is no significant correlation between the two aspects.

Keywords: campus landscape, corridor, ecological network, landscape aesthetic, pedestrian, scenic beauty estimation

1. Introduction

Campus landscape is a landscape that reflects the identity and character of a collage rather than just a left-overspace between buildings. Campus landscape can be as same as a small town because in it there are various activities such as work, study, and business with a high number of civitas academicians. A good campus environment is essential for educational missions as well as users' well-being. Therefore, the needs of accessibility for the community within the campus needs to be provided primarily to create a sustainable and environmentally friendly campus life [1]. One of the accessibility needs is pedestrian



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pathways to support the effectiveness of campus mobilization between buildings. The existence of pedestrian pathways is also useful to support the Green Campus concept, which is currently widely applied in several campuses in Indonesia to realize the environmentally friendly and sustainable campus. One campus that applies the Green Campus concept is Bogor Agricultural University (IPB) Dramaga which has an area of approximately 250 ha with wide green open space and high biodiversity that supports the life of various types of flora and fauna. The Green Campus concept that applied in Campus IPB has a high commitment on improvement of high energy efficiency, resource conservation, and environmental quality improvement to create a healthy life and a conducive learning environment on a sustainable basis [2]. In Green Campus concept there is a Green Transportation system that applied in IPB Dramaga campus that is developed to reduce environmental impact due to the use of fossil fuel. This system encourages people to return to the culture of walking and cycling and restrict the use of motor vehicles. Walking has an advantage that is low on speed, so pedestrians can observe the environment and objects in detail and can easily aware of the surrounding environment [3]. The convenience and safety pedestrian pathways can also be supported by the existence of green open space in the form of greenway along it.

The development of a greenway along the pedestrian track in a campus environment can enhance the user's comfort and safety, in addition in creating an environmental balance [4]. The vegetation on the greenway can provide aesthetic value, provide functions of visual control, physical barrier and climate control (temperature, sun, wind and humidity), and also provide ecological functions as animal habitat [3, 5, 6]. The existence of a green way along the pedestrian pathways can also be part of an ecological network corridor. Ecological networks are a concept derived from Europe that is useful for maintaining ecosystem functions, facilitating conservation of species and habitats, and preserving species and habitats in order to survive in human-dominated landscapes [7, 8]. Ecological corridors is one of ecological networks component that serve to provide connectivity in the form of linking habitats, increase the number of habitats, provide essential elements for animals such as food, shelter, and protection from predators [9, 8]. The existence of these ecological network corridors is important especially for wildlife movements which habitat is fragmented in the campus landscape as green open spaces within the campus landscape continue to decline due to infrastructure development such as buildings, roads, and parking areas to support and improve the learning process.

The existence of pedestrian pathways and ecological network corridors along the pedestrian track within the campus landscape can link the human and animal movement, and also can provide recreational opportunities for the community. IPB Dramaga campus is one of the campus that can support the concept of pedestrian pathways based on ecological network corridor. This can be seen from the high biodiversity within the campus that needs to be preserved. This study aims to evaluate the visual aesthetic qualities of pedestrian pathways based on ecological network corridor within campus landscape at IPB Dramaga Bogor Campus. The basis of this research is the lack of concern about the visual aesthetic element in the development of campus landscape on pedestrian path ways by paying attention on ecological network corridor. The results of this study are expected to be useful as an input for planners and landscape designers in order to give more attention on aesthetic qualities in designing campus landscapes, such as improving the quality of life, maintaining biodiversity, facilitating the interaction between nature and humans, and support sustainable development.

2. Methods

This research was conducted at Bogor Agricultural University (IPB) Dramaga, Bogor, precisely on the Main Academic Road, IPB Dramaga Campus, with the total length is 6.3 km. The research was conducted in September–December 2016. The study sites were divided into 14 pedestrian pathways segments (Figure 1) and the condition of every pathways segments can be seen in Figure 2. The pathways segment is divided based on the name of the road, and each segment is subdivided according to the conditions and characteristics of pedestrian and trees [5] (Table 1). The method used in this research is descriptive quantitative.

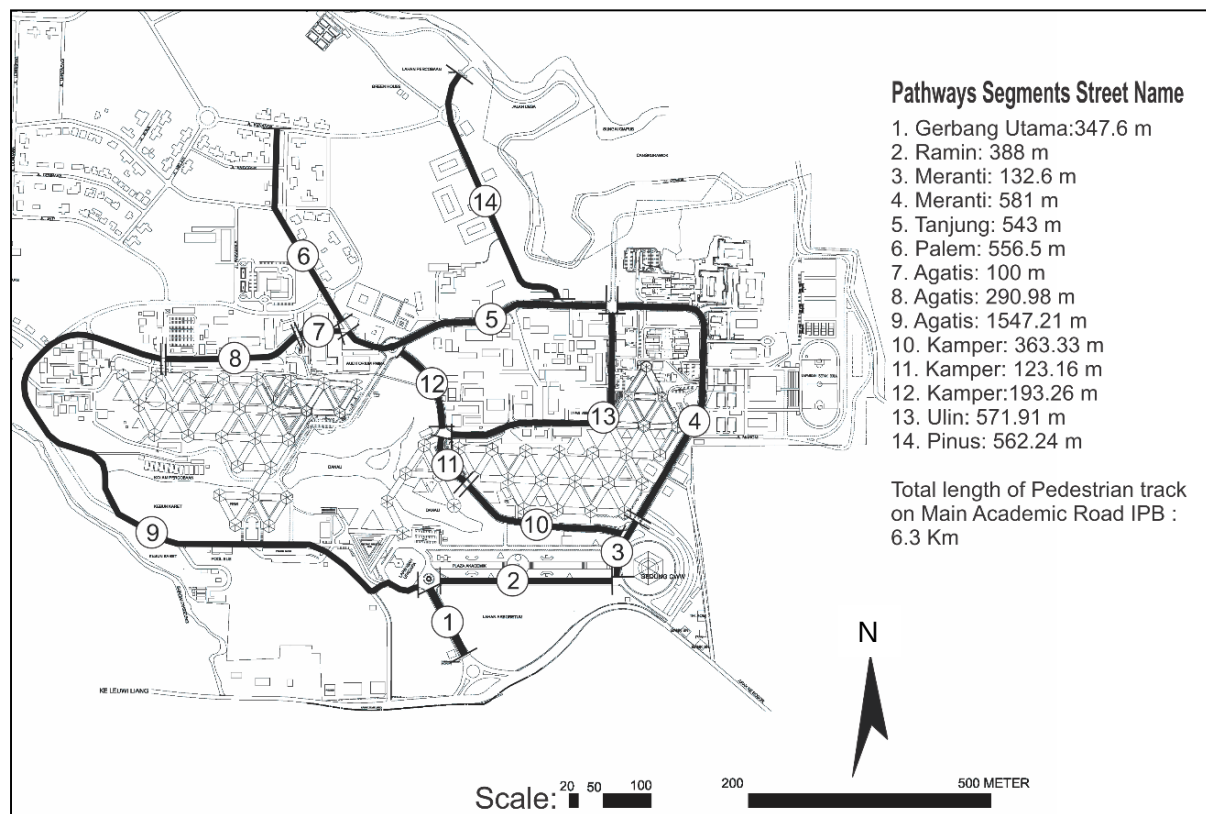


Figure 1. Map of the study area, showing the pedestrian pathways segments in the Main Academic Road in IPB Dramaga Campus Bogor.

2.1. Visual aesthetic analysis

Visual aesthetic qualities were analyzed using Scenic Beauty Estimation (SBE) which consist of three main stage [10]. The first stage of SBE is site visit and observe the study area to determinate the vantage points for landscape photograph. In every 14 pathways segments were defined several vantage points that represents the various landscape characters presented in Table 1. The total number of vantage points is 96 photos which represents the dominant landscape characters that is spread over the 14 pathways segments. The photos are selected based on the quality of the picture, the suitability on the purpose of the study, and the representation of landscape elements [5]. The landscape setting in the SBE analysis perceives the pedestrian conditions alongside the greenway as ecological network corridors, so the analysis is limited by looking at the character of the pedestrian pathways and the trees character alongside the pedestrian.

The second stage is the visual aesthetic quality assessment by 34 respondents. The respondents are students from Landscape Architecture, Bogor Agricultural University, because they have environmental knowledge [10]. Landscapes photos are prepared in the form of slides in Microsoft Power Point, which then presented in front of the respondent for 8 seconds per slide. Respondents were asked to rate each slide on a scale of 1 to 10, where point 1 shows the lowest landscape quality, while the rating scale of point 10 indicates the highest landscape quality [10].

The third stage is the visual aesthetic quality analysis that is assessed using normal Z distribution average. The formulation used in the SBE data processing is as follows.

$$SBE_x = [Z_{Lx} - Z_{Ls}] \times 100$$

Where SBE shows the aesthetic quality value toward x-landscape ($x = 1, 2, 3, \dots, 96$), Z_{Lx} shows the average Z value of landscape x, and Z_{Ls} shows the average Z value of the landscape used as standard (Z

= 0) [10]. Then the results of SBE are classified into four category where the SBE value < -20 is low, the SBE value between -20 to 20 is moderate, the SBE value above 20 is high [10]. However, the value of $SBE > 60$ is considered as a value of sanction so it categorized as very high.

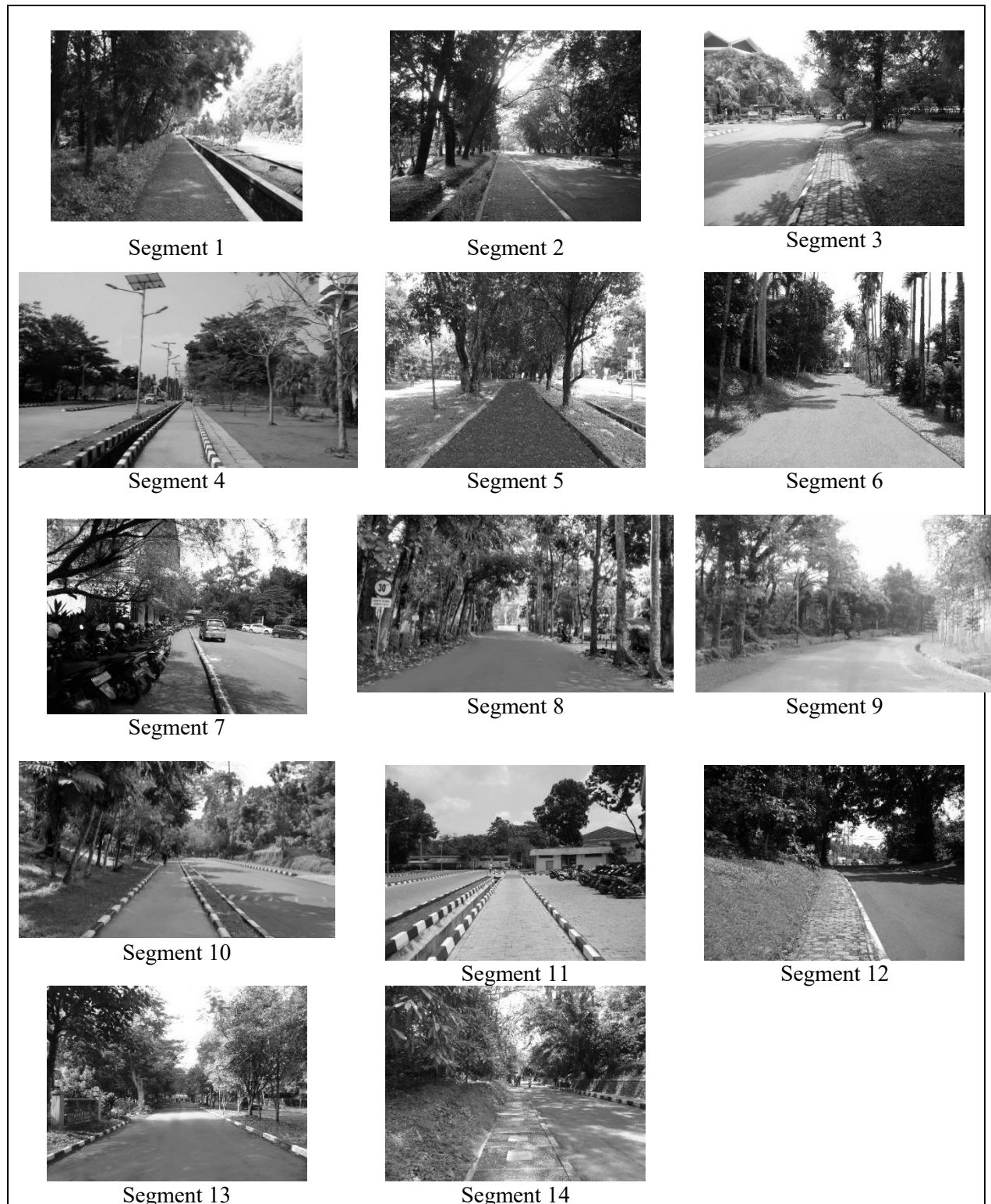


Figure 2. The condition of every pathway segment.

Table 1. Pedestrian pathways characteristic in every segment.

Pathways Segment	Pedestrian Characteristic										Trees Characteristic						
	Pedestrian Materials					Drainage		Greenway between Pedestrian and Road		Pedestrian and Bicycle Lane		Main Greenway		Trees Planting		Trees Canopy	
	Concrete	Asphalt	Paving block	Split Stone	Coral Stone	Open	Closed	Available	Not Available	Joined	Separate	Available	Not Available	Adjacent	Apart	Dense	loose
1			●			●		●			●	●		●		●	
2			●			●			●		●	●		●		●	
3			●				●		●		●	●		●		●	
4	●					●		●		●		●			●		●
5	●			●			●	●			●	●		●		●	
6		●				●			●	●		●		●		●	
7		●				●	●		●		●		●		●		●
8		●				●			●	●		●		●	●	●	
9		●				●			●	●		●		●		●	
10	●					●	●	●		●		●		●		●	
11	●					●		●		●		●		●	●	●	
12			●			●	●		●		●	●			●		●
13		●				●		●		●		●		●		●	
14				●			●		●		●	●		●		●	

2.2. Trees diversity analysis

The analysis of trees diversity was done by using Shannon Wiener's Diversity Index [11] to determine the ecological network corridor conditions. The initial phase of the trees diversity analysis is done by collecting trees data in the main greenways alongside the pedestrian pathways. The data collection is done by using Line Transect method with plot sample size is 20 x 20 m and skip with a distance of 10 m in path and then make another plot sample so that along the observation line has the same spacing distance [12]. The data collection is done by recording all existing tree data including the species name and number of individuals contained in the plot. After that, we analyze the diversity of trees using Shannon Wiener's diversity index. The higher value of the diversity in a corridor shows a diverse trees composition that can provide far greater benefits for more animal species who use the ecological network corridors [9, 13].

2.3. Correlation analysis

Correlation analysis is done to analyze the relationship between the visual aesthetic qualities (SBE) variable and ecological network corridor variables (trees diversity). Correlation analysis was done by using Rank Spearman test [14].

3. Result and Discussion

3.1. Visual aesthetic quality

The result showed different levels of aesthetic quality of the pedestrian pathways in the campus landscape. The results of SBE value on every segment can be seen in Figure 3 with values ranging from

14.4 to 75.0 which indicates that the aesthetic quality of the pedestrian pathways in IPB Dramaga Campus landscape has medium to very high quality.

Landscape with a very high aesthetic quality is found in segment 1 and 2 with SBE value of 67.0 and 75.0 respectively. The very high quality of the landscape character can generally be seen in Table 1. The very high aesthetic quality is characterized by the neatness of pedestrian characteristics and the dominant of tree presence. Adjacent tree stands with dense tree canopies can improve the aesthetic quality of the landscape and provide character and identity to the campus environment. This is supported by the statement of Simonds and Starke [4] that the most interesting part of the tree is the tree canopy because it can provide an identity and character to the environment. Gunawan and Yoshida [15] and Gunawan [5] also stated that landscapes with dominant tree stands are the most preferred and highly esthetic landscapes.

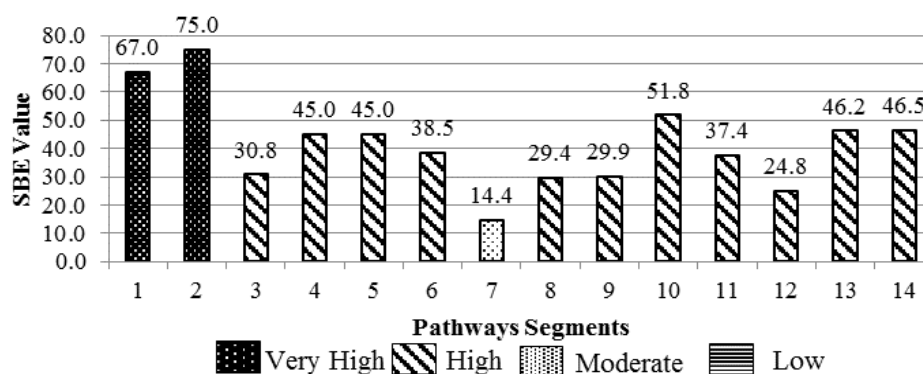


Figure 3. SBE value in every path way segment.

The high aesthetic landscape is found in 11 pathways segments shown in Figure 3 with SBE values ranging from 24.8 to 51.8. Seen as a whole in Table 1, the high aesthetic pathways segments have various differences in pedestrian characteristics and trees characteristics. In this case, the characteristics of the pedestrian and the characteristics of the trees are assessed aesthetically and the condition of each of these segments does not contain any disturbing human activity. This is in line with Yang *et al.* [16] statement that landscape values are related to landscape attributes and the intensity of human activity.

In contrast, landscapes that have the lowest aesthetic quality (moderate category) are in segment 7 with SBE value 14.4. Based on Table 1 this segment has characteristics such as unavailability of the main greenway, distant of trees planting distance, and the loose tree canopy. In addition, in this segment there are buildings on the side of the pedestrian pathways which causes arid, and the condition of this pedestrian pathways is used as a parking area of the motorcycle that can interfere the walking activities of the pedestrians and lowered the value of the aesthetic quality. According to Gunawan [5], the variety of size, shape, and tidiness of building architecture can make the aesthetic quality of the landscape low. No or least vegetation in the form of tree stands, shrubs, or soils is also the least favorable type of landscape, as buildings that dominate the landscape can give the impression of arid and intense heat.

3.2. Ecological network corridor

Ecological network corridors can be functionally defined to show connectivity between areas and physical structures to indicate connectedness [8]. The condition of the ecological network corridors in each pathways segment can be determined from the results of the Shannon Wiener (H) diversity index on the greenway alongside the pedestrian pathways. Based on Figure 4 it can be seen that the value of H diversity ranges between 0 and 2.86 which indicate from low to moderate trees diversity. The highest value of H is in segment 5 with a value of 2.86 which show moderate trees diversity. While the lowest value of H is in segment 11 with a value of 0 which show low trees diversity. Low H values can lead to disconnection of animal connectivity and affect wildlife movement due to disconnected greenway [9].

The condition of the green way along the pedestrian pathways in the Main Academic Road, IPB Dramaga Campus, in most other segments have been connected continuously so it can facilitate the movement of animals. The existence of linear greenway into a network corridor located along the edge of a pedestrian pathways within the campus landscape can enhance the comfort and safety for the community and can serve as biodiversity conservation [9, 17].

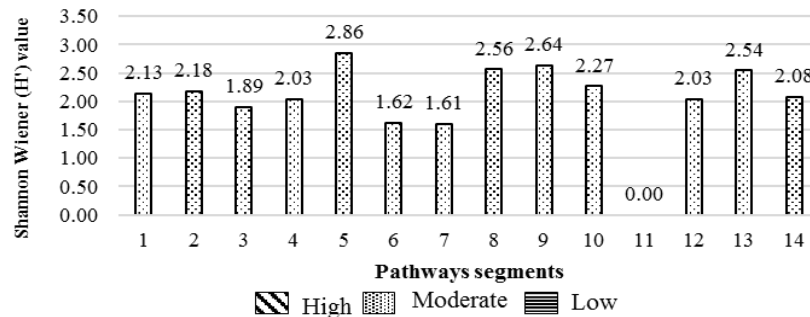


Figure 4. Shannon Wiener's diversity index value of tree on each pathway segment.

3.3. Correlation between visual aesthetic and ecological network corridor

The evaluation of visual aesthetic qualities of the pedestrian pathways based on ecological network corridors within the campus landscape can be seen by correlate the aesthetic value (SBE) variable with the ecological network corridor variables (trees diversity). Based on Rank Spearman test result between the SBE values and the trees diversity value (correlation significant at the 0.05 level) has Sig result. (2-tailed) of 0.279, this indicates that there is no significant correlation between the two aspects. However, correlation coefficient result is 0.335, this shows a positive number which indicates a positive correlation between aesthetic aspects and trees diversity aspects. It can be interpreted that the increasing of visual aesthetic value of pedestrian pathways can be influenced by the increasing of trees diversity value. In contrast, the lower aesthetic quality value of the pedestrian pathways, the lower value of trees diversity. This result is supported by the statement of Klein *et al.* [15] who found a statistically significant increase trend in visual aesthetic preferences for landscape structures that have larger amounts of vegetation diversity as well as indicated an increase in ecological function. Although from the results of this study the influence between the two aspects is very small.

3.4. Design concept implementation for pedestrian pathways based on ecological network corridor within campus landscape

In general, to improve the visual aesthetic qualities of pedestrian pathways based on ecological networks corridor within the campus landscape can be done by taking into account the conditions of safety, convenient, easy and humane pedestrian pathways. Based on Regulation of Minister of Public Works Number 03/PRT/M/2014 [19], the ideal standard for pedestrian pathways planning for educational areas, the minimum width of the pedestrian pathway is 115 cm to 200 cm which is the minimum service standard B. The dimensions width of the pedestrian pathways which is combined with a bicycle lane without buildings on either side is 300 cm, with 150 cm for the pedestrian pathways and 150 cm for the bicycle lane. The dimensions width of the pedestrian pathways where one of the side is adjacent to the building is 325 cm, where the path that is adjacent to the building for the pedestrian pathway nor the bicycle lane is 175 cm and the other path is 150 cm. The dimensions width of the pedestrian pathways where both sides are adjacent to the building is 350 cm, where the pedestrian pathways and the bike lane is 175 cm wide. The standards to improve the quality of ecological network corridors can be done by (1) increasing vegetation diversity, (2) making variation of vegetation structures such as ground cover, shrubs, and tree layers to provide greater benefits for more species, (3) providing a continuous corridor form, although some other species have no effect on the cut-off corridors, and (4) planting random vegetation to make it more attractive for animals and humans [20, 13, 9, 21]. The

landscape visual aesthetic quality value will increase in line with the increase of diversity, the level of naturalness, and the presence of patches or leafy corridors [18]. In addition, it is also necessary to consider the tidiness of building architecture, as well as managing human activities that can interfere visually.

Specifically, for the IPB Dramaga Campus, almost every pathway segment already has a good visual aesthetic quality of pedestrian pathways based on ecological network corridors. Viewed from ecological network corridor side, the tree planting alongside the pedestrian pathways has various combinations of randomly arranged trees. The width of the existing pedestrian pathways has fulfilled the standard criteria of having a width of at least 115 cm to 200 cm. Where the current pedestrian pathways in IPB Dramaga Campus ranges from 120 cm to 230 cm. For pedestrian pathways that combined with bicycle lane in segments 4, 10, and 11 do not have minimum standards of 300 cm, where the existing width is only 210 cm wide in segments 4 and 200 cm wide in segments 10 and 11. In segments 6, 8, 9, and 13 have no pedestrian pathways, but these segments are visually assessed aesthetically and have a continuous greenways as ecological network corridor. The feedback for this pathway, it is better to make pedestrian pathways without interrupting existing trees with a width of at least 115 cm so that pedestrians are safe from motor vehicles and can facilitate movement between areas. The low quality of aesthetics in segment 7 is caused by poor management, causing pedestrian pathways is used as motorcycle parking, whereas in terms of trees diversity it is able to support as ecological network corridor. For that, it needs good parking management in segment 7 to improve the aesthetics quality. Segment 11 has moderate SBE quality, but low H diversity value, this has resulted in inability to provide continuous ecological network connectivity. Overall IPB Dramaga Campus landscape needs to add different types and species of trees in segments with low H diversity so that the value of trees diversity becomes higher and can connect the disconnected ecological network corridor and also add aesthetic value on pedestrian pathways. In addition, vegetation planting structures also needs to be combined from ground cover vegetation, shrubs, to trees. The existing trees in each segment of the pathways needs to be maintained and managed well. The selected trees diversity needs to be adjusted to the needs of animals that will use ecological network corridors. Considering aesthetic qualities can help anticipating in landscapes change and environmental impacts, while paying attention in ecological quality can also be affected by the aesthetic value that felt in the landscape [22]. If the pedestrian pathways facilities within the campus have a good condition, comfortable, and aesthetic it is expected to increase the desire of the community to walk. Thus, it can also support the implementation of Green Transportation system in IPB Dramaga Campus and encourage people to walk. According to Ignatieva *et al.* [17] the design features of ecological networks are by combining ecological features (species and biodiversity movement), provide recreational functions (bicycle and pedestrian pathways), provide aesthetic (beauty) elements, and become a cultural identity that can create a sustainable environment.

4. Conclusion

The good visual aesthetic qualities of the pedestrian pathways based on ecological network corridors within the campus landscape is the one that has very high SBE values with moderate to high trees diversity values. Inadequate pedestrian pathways based on ecological network corridors within the campus landscape are those with moderate SBE values and low trees diversity values. Implementation of the concept of pedestrian pathways should generally accommodate the simultaneous movement of people and animals, provide benefits as biodiversity conservation, provide community recreation functions, provide aesthetic elements, and become the identity and character of a campus landscape.

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