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Evaluation of Pedestrian Pathways on The UKSW Blotongan Campus Landscape on An Ecological Base

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A B S T R A C T

Pedestrian paths in the campus environment should ensure safety, comfort, and efficient mobility for campus users. At the UKSW Blotongan Campus, several deficiencies in the pedestrian paths need to be repaired, primarily related to the needs of people with disabilities and the lack of facilities such as traffic signs, lighting, and special bicycle lanes. Not only that, pedestrian paths must also be able to improve the surrounding environment. Therefore, this research aims to evaluate the condition of pedestrian paths on campus and provide practical recommendations for improvement and development. The research method uses a purposive method, with the number of trees obtained being 20 trees with a diameter of >50 cm. This research method involves an inventory of the existing conditions of pedestrian paths, an analysis of carbon uptake and plant dust sorption along the paths, and a comparison of the results with applicable technical standards. The analysis results show that several tree species, such as Sesbania grandiflora (Kembang Turi), have a significant ability to absorb carbon and dust, positively contributing to maintaining air quality and the surrounding environment. By considering this data, practical recommendations can be given for improving pedestrian paths, including increasing accessibility for people with disabilities, adding facilities such as traffic signs and seating, and planting more trees that are effective in absorbing carbon and maintaining air quality. The results obtained from the analysis can provide a strong foundation for the development of sustainable and environmentally friendly pedestrian paths on the UKSW Blotongan campus and contribute to future sustainable urban development policies.

Jalur pedestrian di lingkungan kampus memberikan peran penting dalam memastikan keselamatan, kenyamanan, dan mobilitas efisien bagi pengguna kampus. Pada Kampus UKSW Blotongan, terdapat sejumlah kekurangan pada jalur pedestrian yang perlu diperbaiki, terutama terkait dengan kebutuhan penyandang disabilitas dan kurangnya fasilitas seperti rambu lalu lintas, penerangan, dan jalur khusus sepeda. Tidak hanya itu, jalur pedestrian juga harus dapat memperbaiki lingkungan di sekitarnya. Oleh karena itu, penelitian ini bertujuan untuk mengevaluasi kondisi jalur pedestrian di kampus dan memberikan rekomendasi praktis untuk perbaikan dan pengembangannya. Metode penelitian menggunakan metode purposive dengan jumlah pohon yang didapatkan yaitu 20 pohon dengan diameter >50 cm. Metode penelitian ini melibatkan inventarisasi kondisi eksisting jalur pedestrian, analisis serapan karbon dan jerapan debu tanaman di sepanjang jalur, serta perbandingan hasil dengan standar teknis yang berlaku. Hasil analisis menunjukkan bahwa beberapa jenis pohon, seperti Sesbania grandiflora (Kembang Turi), memiliki kemampuan yang signifikan dalam menyerap karbon dan menjerap debu, memberikan kontribusi positif dalam menjaga kualitas udara dan lingkungan sekitarnya. Dengan mempertimbangkan data tersebut, rekomendasi praktis dapat diberikan untuk peningkatan jalur pedestrian, termasuk peningkatan aksesibilitas bagi penyandang disabilitas, penambahan fasilitas seperti rambu lalu lintas dan tempat duduk, serta penanaman lebih banyak pohon yang efektif dalam menyerap karbon dan menjaga kualitas udara. Hasil analisis yang didapatkan dapat memberikan landasan yang kuat bagi pengembangan jalur pedestrian yang berkelanjutan dan ramah lingkungan di kampus UKSW Blotongan, serta memberikan kontribusi pada kebijakan pengembangan perkotaan yang lebih berkelanjutan di masa depan.

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1. Introduction

Pedestrian paths are exclusively used by pedestrians (A. I. C. Sari, 2014). Pedestrian paths can include sidewalks, intersections, special pedestrian paths, and other supporting facilities (The Ministry of Public Works and Housing, 2014, 2018). Pedestrians need separate lanes to support safety and can help separate vehicle traffic lanes from pedestrian lanes (Ambarwati et al., 2018). One aspect that can impact is that the pedestrian path becomes a safe zone for pedestrians to go somewhere (Rezky et al., 2023).

As a busy and dynamic academic environment, the campus is a place of intense interaction between students, lecturers, staff, and visitors around the environment (Hipp et al., 2016). Usually, two- or four-wheeled vehicles do not give way to pedestrians (Kamal et al., 2019). Campus residents and local visitors will find it difficult to move around and can pose a danger if they are not provided with facilities. The 2006 Directorate General of Land Transportation regulations explains that there is a need for facilities that can support safety in school areas. Therefore, planning and developing pedestrian paths in campus areas is becoming increasingly important to ensure safety, comfort, and efficient mobility for campus users (Prihanto, 2014; Sasmita & Marwati, 2023). However, pedestrian paths not only serve pedestrians and vehicles but must also significantly impact the environment (Nahdatunnisa, 2023).

The Universitas Kristen Satya Wacana (UKSW) Blotongan campus has a pedestrian path which, if viewed from a security or safety perspective, it can be said that the pedestrian path does not meet existing standards, especially the needs of people with disabilities. These shortcomings can be seen in the lack of facilities such as passing places and guide routes. Apart from that, the pedestrian route has other shortcomings, such as the lack of traffic signs and markings, crossing facilities, speed checks, waiting areas, pedestrian lighting, safety barriers, seating, stops, and traffic lights. These are problems that need urgent action. Then, the pedestrian path does not yet have a special lane for bicycles. The width of sidewalks that do not comply with standards is another deficiency that needs to be corrected to increase the safety of pedestrian path users on the UKSW Blotongan campus. A good pedestrian path must meet with regulations regarding pedestrian path standards (Ambarwati et al., 2018). Apart from ensuring easy and safe access for users, pedestrian paths must be environmentally friendly and can reduce air pollution and vehicle traffic on campus (Nursanty, 2023).

The UKSW Blotongan campus pedestrian path has drawbacks when viewed from a comfort perspective. These deficiencies include a lack of shade trees, as well as a lack of plants that can absorb carbon and dust. These trees or plants are needed because pollutants can cause problems for pedestrians if the pollutants become active (Siburian, 2020). Trees that can absorb dust, for example, are the *Spathodea* Tree, which has a dust absorption capacity of 0.041-0.043 g/m^2 per day, and the Nyamplung Tree, which has a dust absorption capacity of 0,023-0,025 g/m^2 per day (Sutrisno et al., 2020). Apart from that, several other trees can also absorb dust, such as the Trembesi Tree (0.443 mg/cm^2), the Jabon Tree (0.059 mg/cm^2), and the Acacia Tree (0.127 mg/cm^2) (Pratama & Sutrisno, 2022). Apart from functioning to absorb dust, trees can also absorb carbon. If a plot measuring 20x20 m contains 71 trees with 11 different tree species, it can absorb carbon at 5319.55 tons/ha (Ananda & Sutrisno, 2022). Therefore, pedestrian paths require several trees or plants to reduce pollution that occurs on pedestrian paths (Hakim et al., 2017).

Considering several factors above, the UKSW Blotongan campus needs adequate pedestrian paths that meet its user needs. The factors above not only provide safety, comfort, and accessibility for pedestrians but also make it easier for people with disabilities who want to use the pedestrian route to get to the lecture building. In this research, to produce recommendations for pedestrian paths that meet user needs, it is necessary to compare existing conditions with technical guidelines, determine the carbon absorption and dust absorption values of plants on the site in the laboratory, and recommend plants with the highest values for these issues. Therefore, research regarding the evaluation of pedestrian paths on campus is relevant and needs to be carried out to provide practical recommendations for developing and improving pedestrian paths on campus.

2. Material and Methods

This research was conducted at Campus III of Universitas Kristen Satya Wacana (UKSW) in Jl. Dr. O. Notohamidjojo, Blotongan Village, Sidorejo District, Salatiga City, and UKSW Plant Physiology Laboratory. The UKSW Blotongan campus pedestrian path is ±450 meters long with a width of ±4.6 meters (Figure 1). This research was carried out in three stages, namely inventory, analysis and synthesis.

(a) (b)

Figure 1. Research Map (a) and Pedestrian path (b) on the UKS W Blotongan Campus

2.1. Inventory

Inventory activities are the process of collecting data or information. The data obtained was obtained through a literature study and a survey of the existing conditions of the UKSW pedestrian path. The inventory data was collected by measuring and comparing pedestrian path facilities with standards, recording the names of plants along the pedestrian path to find out what plants are there, stem diameter at chest height to calculate carbon uptake, and taking leaf samples closest to the road (front canopy) to analyze dust absorption.

Methods for measuring trees in forest ecology, biomass research, or forest potential data collection usually use DBH (*Diameter at Breast Height*) (Sutaryo, 2009). To measure the DBH (Figure 2), it is 1.3 m from the ground surface. The DBH height measurement is placed perpendicular to the ground surface near the measured tree, then a mark is placed on the tree trunk (Rahmattin & Hidayah, 2020). If the ground surface and tree shape are uneven, then this can be done as shown:

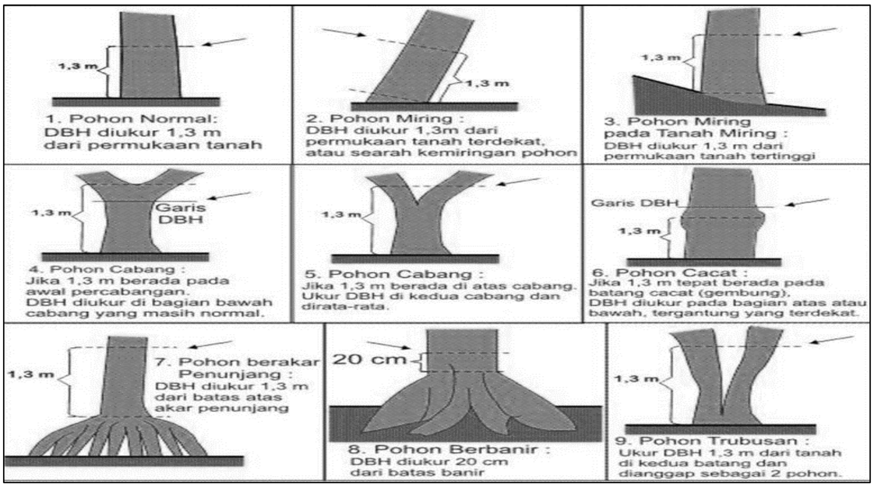
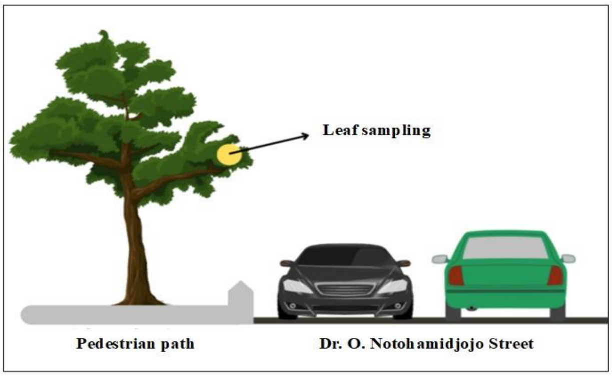
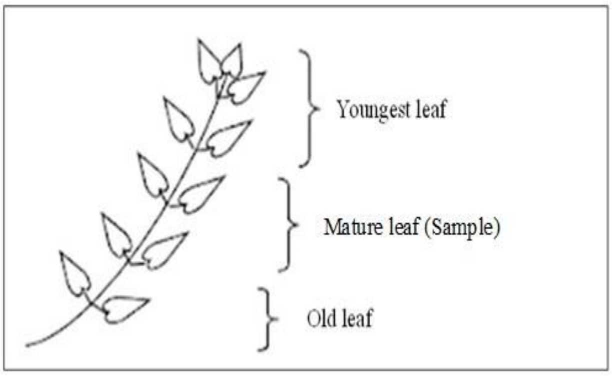


Figure 2. Measurement of the DBH of irregularly shaped tree trunks (Source: Akbar & Sosilawati, 2019)



(a)



(b)

Figure 3. Leaf sampling point (a); The part as a sample (Source: Hermawan et al., 2011)

Leaf samples (Figure 3a) were taken from the leaves closest to the road (front canopy), and sampling was carried out on the same day once (Afrizal et al., 2022). For repetition or as a comparison, samples were taken on different days, namely several days after the first sample was taken. The leaf samples (Figure 3b) were taken when leaves that had opened completely were green in color and were positioned at the base of the tree branch (Wirah Krisnawati & Sumarya, 2022). The leaf samples that have been obtained are then put into a plastic bag and labeled.

2.2. Analysis

2.2.1. Carbon uptake

Data was collected using the census method, measuring all the trees along Jl. Dr. O. Notohamidjojo arrived at the UKSW Blotongan campus. The calculation uses allometric equations to measure existing tree biomass by Ketterings et al. (2001):

Tree Biomass (B)= $0{,}11 \times p \times D^{2.62}$ (1)

where: B= Tree Biomass (kg/tree); D=Diameter at chest height (cm); P= Specific gravity of wood (gr/cm^3) Penman et al. (2006).

Once the tree biomass is known, the carbon stock analysis using the biomass content approach developed by Penman et al. (2006):

Carbon Reserves (C)= $0.5 \times \mathrm{W}$ (2)

where: C= Carbon Reserves (Tc); W= Biomass (kg); 0.5= coefficient of carbon content in plants If carbon reserves are known, then carbon uptake analysis can be calculated using the formulation of Penman et al. (2006):

Carbon Uptake (EC)= $3.76 \times \mathrm{CLC} - \mathrm{D}$ (3)

where: EC= Carbon Uptake (tCO_2); 3.76= Ratio of atomic carbon dioxide to carbon; 44/12 (tCO_2 e /ton C); CLD-D= Carbon Stock

The carbon absorption values obtained can be compared with other plants to design pedestrian paths with plants that absorb better/higher carbon.

2.2.2. Dust capture

The sample leaves that have been obtained are then taken to the laboratory to be analyzed for their ability to absorb dust. The first analysis is measuring leaf area using the I-Daun application. Once the leaf area is found, the next step is to calculate the leaf's ability to absorb dust using the formula:

Dust capture (g)= $\frac{Dust\ weight}{Dry\ weight\ of\ leaves}$ (4)

If the values for leaf area and dust content have been obtained, then the ability of the leaves to absorb dust can be calculated using the equation:

The ability of leaves to absorb dust (g/cm) $= \frac{Dust\ level}{Leaf\ area}$ (5)

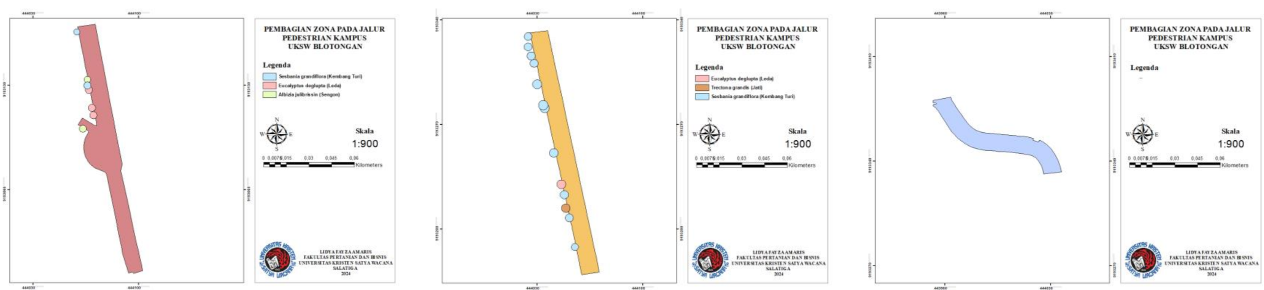
2.3. Synthesis

By combining the results of carbon absorption and dust absorption analysis, researchers can formulate recommendations for optimal plants (with high value) for use on the UKSW Blotongan campus pedestrian path.

3. Results and Discussion

1.1. Distribution of trees on pedestrian paths

The UKSW Blotongan campus pedestrian path is 450 meters long and is divided into three zones (Figure 4). The number of trees on the pedestrian path with a diameter of > 50 cm is 20. In the first zone, there are seven trees consisting of 2 Sengon trees (*Albizia falcata*), three Leda trees (*Eucalyptus deglupta*), and 2 Kembang Turi trees (*Sesbania grandiflora*). In the second zone, there are 13 trees dominated by Kembang Turi trees (*Sesbania grandiflora*), namely 11 trees, one Leda tree (*Eucalyptus deglupta*), and one Teak tree (*Tectona grandis*). Meanwhile, zone 3 has no trees with a diameter of > 50 cm.



(a) (b) (c)

Figure 4. Tree distribution legend, (a) Zone 1; (b) Zone 2; (c). Zone 3

1.2. Comparison of existing conditions with regulation

Based on the Minister of Public Works Regulation (The Ministry of Public Works and Housing, 2014, 2018), the general principles for pedestrian facilities must at least meet the aspects of the integration system (environmental planning, transportation systems, and accessibility between areas), continuity, safety, security, and comfort, as well as accessibility. Table 1 shows a comparison of the condition of existing pedestrian paths with regulations.

The most visible deficiency in the UKSW Blotongan campus pedestrian path is the lack of facilities for the needs of people with disabilities. According to The Ministry of Public Works and Housing (2018), campus pedestrian paths must have facilities for people with disabilities, namely space for crutches, blind people and wheelchair users.

Other shortcomings can also be seen in the lack of facilities such as passing places and guide routes. Because the width of the UKSW Blotongan campus pedestrian path is 1.35 m wide, it should require a passing area. According to Minister of Public Works Regulation and Housing, a passing place area is required if the sidewalk is less than 1.5 m wide. Apart from that, the UKSW Blotongan campus also needs traffic signs and markings, crossing facilities, speed checks, waiting areas, pedestrian lighting, safety barriers, seating, stops, and traffic lights are problems that need action.

The next drawback is that there are no special bicycle lanes available. According to the Regulation of the Minister of Public Works and Public Housing, the pedestrian path must be placed separately from other traffic lanes. Pedestrian facilities must prioritize security, safety, and comfort for pedestrians (Ambarwati et al., 2018). According to I. Y. Sari (2019) bicycle paths on sidewalks can be located on the right or left of the pedestrian path. Placement of bicycle lanes on sidewalks must provide a minimum width of 1.5 m for pedestrians.

Table 1. Comparison of existing conditions with Regulation

No	Regulation	Pedestrian Path Conditions	Documentation
1	The main facilities consist of pedestrian paths (sidewalks) and crossings.	Public facilities only have pedestrian paths.	
2	Pedestrian facilities for users with special needs.	It is not yet friendly for people with disabilities because necessities such as *passing places* and guidelines are not yet available.	
3	Supporting facilities consist of signs and markings, a speed controller, a waiting stall, lighting for pedestrian facilities, a safety fence, a protector/shade, a green lane, a seat, a rubbish bin, a stop, drainage, and a bolar.	There are no road signs and markings yet, no speed controller, waiting stall, lack of pedestrian lighting, safety fence, seat, stop, or bolar on the UKSW Blotongan campus pedestrian path. Facilities such as protection/shade and green lanes already exist, rubbish bins exist only at one point, and drainage is located side by side on the pedestrian path.	
4	Paths that are shared by pedestrians and bicycle users (placement of bicycle paths must provide a minimum width of 1.5 meters for pedestrians)	There is no special lane for cyclists along the UKSW Blotongan campus pedestrian route.	
5	Pedestrian paths (sidewalks) should be at least 150 cm wide so that two pedestrians can pass each other without touching.	The pedestrian path (sidewalk) is 135 cm wide and does not meet pedestrian path standards.	

1.3. Carbon uptake analysis results

Table 2 shows the results of the carbon uptake analysis, which is very important in this research because it provides an in-depth analysis of the carbon uptake of various types of trees growing along the pedestrian path. The data presented in this table shows significant variation in carbon uptake among different tree species. For example, the *Sesbania grandiflora* (Kembang Turi) tree shows very high carbon uptake, reaching 69.03 kg. In contrast, other tree species, such as *Eucalyptus deglupta* (Leda), show variations in carbon uptake depending on the size of the trunk diameter.

Tree biomass based on trunk diameter can provide an idea of how big the tree is in terms of total mass. Similar to Haruna (2020), the biomass value can be influenced by the tree trunk diameter value, namely the larger the diameter, the greater the biomass. For example, a *Sesbania grandiflora* (Kembang Turi) tree with a diameter of 50 cm has a carbon uptake amount of 4.09 kg. In comparison, a *Sesbania grandiflora* (Kembang Turi) tree with a diameter of 147 cm has a higher carbon uptake amount, namely 69.03 kg. According to A. H. M. Putri & Wulandari (2015), differences in carbon uptake values can be caused by several factors, such as the number of trees/density and the type of tree.

Sesbania grandiflora (Kembang Turi) and *Eucalyptus deglupta* (Leda) trees have the same diameter, namely 100 cm, but the two trees have different amounts of carbon uptake. This can be caused by the difference in the density of the wood of the two trees. According to (Arsad, 2011), variations in specific gravity between various trees can be caused by differences in the composition of cell walls and the content of extractive substances per unit volume. *Sesbania grandiflora* (Kembang Turi) trees which have a diameter of 100 cm, can absorb 25.16 kg of carbon with a specific gravity of 0.70 gr/cm^3 (Idris et al., 2008), while *Eucalyptus deglupta* (Leda) which has a specific gravity of 0.57 gr/cm^3 (Idris et al., 2008) has a carbon uptake amount of 20.48 kg. The greater the specific gravity of the wood, the stronger and heavier the tree will be (Dahle et al., 2017; Groover, 2016; Hébert et al., 2016).

Table 2. Carbon uptake analysis results

No	Tree Name	Bar Diameter (cm)	Tree Biomass (kg)	Carbon Reserves (kg)	Carbon Uptake (kg)
1	*Albizia falcata* (Sengon)	75	3.15	1.57	5.92
2	*Eucalyptus deglupta* (Leda)	69	4.12	2.06	7.75
3	*Eucalyptus deglupta* (Leda)	66	3.67	1.83	6.90
4	*Eucalyptus deglupta* (Leda)	100	10.90	5.45	20.48
5	*Sesbania grandiflora* (Kembang Turi)	63	3.99	1.99	7.50
6	*Albizia falcata* (Sengon)	50	1.09	0.54	2.05
7	*Sesbania grandiflora* (Kembang Turi)	54	2.66	1.33	5.01
8	*Sesbania grandiflora* (Kembang Turi)	87	9.29	4.65	17.47
9	*Sesbania grandiflora* (Kembang Turi)	72	5.66	2.83	10.64
10	*Tectona grandis* (Jati)	86	8.63	4.31	16.22
11	*Sesbania grandiflora* (Kembang Turi)	67	4.69	2.34	8.81
12	*Eucalyptus deglupta* (Leda)	84	6.90	3.45	12.97
13	*Sesbania grandiflora* (Kembang Turi)	100	13.38	6.69	25.16
14	*Sesbania grandiflora* (Kembang Turi)	147	36.72	18.36	69.03
15	*Sesbania grandiflora* (Kembang Turi)	96	12.02	6.01	22.60
16	*Sesbania grandiflora* (Kembang Turi)	140	32.31	16.16	60.74
17	*Sesbania grandiflora* (Kembang Turi)	53	2.54	1.27	4.77
18	*Sesbania grandiflora* (Kembang Turi)	111	17.59	8.79	33.07
19	*Sesbania grandiflora* (Kembang Turi)	57	3.07	1.53	5.77
20	*Sesbania grandiflora* (Kembang Turi)	50	2.18	1.09	4.09

1.4. Dust adsorption analysis results

Table 3 provides analysis results showing the ability of trees growing along pedestrian paths to absorb dust, a significant factor in maintaining air quality in the surrounding environment. Dust levels are a factor affecting the respiratory tract and lung function disorders. The higher the concentration of dust particles in the air, the greater the number of particles that settle in the lungs (Rout et al., 2013). This data shows that the *Sesbania grandiflora* (Kembang Turi) tree stands out for its ability to absorb dust, with a relatively high amount of dust absorption compared to other tree types. For example, on October 24, 2023, the *Sesbania grandiflora* (Kembang Turi) tree managed to absorb 525,117 grams of dust with a leaf area of 0.09 cm^2, while on November 7, 2023, the amount of dust adsorption increased to 675.602 grams with an area the same leaf, namely 0.09 cm^2. From this, it can be seen that this tree consistently absorbs dust from the surrounding environment.

The leaf area of the observed tree species has different areas. This is because each tree has a different shape and surface If leaf area is related to the leaf's ability to absorb dust, then the value of the leaf area must be directly proportional to the amount of dust absorption produced/absorbed. So, the wider the leaves, the greater the number of dust particles that can be absorbed (He et al., 2019; Liu et al., 2018; Shao et al., 2019).

The leaves on each tree will be different and will cause differences in the ability to absorb dust. The leaves can be thin or wide, and the leaves also have a variety of rough to fine-haired surfaces (He et al., 2019; Liu et al., 2018; Shao et al., 2019). Leaves with a soft, hairy surface absorb dust more effectively. The hairy texture of the leaves will better absorb dust particles than trees with smooth surfaces (He et al., 2019; Shao et al., 2019). *Tectona grandis* (Jati) leaves have a surface with fine hairs, so dust particles are easier to stick to the surface of the leaves. This can be explained that the surface of leaves with dense hairs can absorb dust better than leaves with smooth surfaces (He et al., 2019; Shao et al., 2019; Tan et al., 2022; Zhang et al., 2018). Several studies have explained that the unique characteristics of plants that have a high ability to absorb dust, namely having soft hair, a rough surface, scaly leaves, serrated leaf edges, needle leaves, and leaves whose surfaces are sticky (He et al., 2019; Liu et al., 2018; Shao et al., 2019).

Table 3. Dust adsorption analysis results

No	Tree Name	Dust Level (g)		Leaf Area (cm2)		Dust Capture (g)		Ability to absorb dust (g/cm2)	
		S-1	S-2	S-1	S-2	S-1	S-2	S-1	S-2
1	*Albizia falcata* (Sengon)	0.02	0.01	429.255	478.926	0.002	0.001	5E-05	2E-05
2	*Eucalyptus deglupta* (Leda)	0.09	0.08	359.815	342.984	0.009	0.008	0.0003	0.0002
3	*Eucalyptus deglupta* (Leda)	0.13	0.24	368.008	331.297	0.013	0.024	0.0004	0.0007
4	*Eucalyptus deglupta* (Leda)	0.21	0.23	370.638	356.928	0.021	0.023	0.00057	0.00064
5	*Sesbania grandiflora* (Kembang Turi)	0.13	0.09	525.12	675.602	0.013	0.009	0.00025	0.00013
6	*Albizia falcata* (Sengon)	0.02	0.01	463.460	499.595	0.002	0.001	0.00004	0.00002
7	*Sesbania grandiflora* (Kembang Turi)	0.07	0.09	563.816	689.541	0.007	0.009	0.00012	0.00013
8	*Sesbania grandiflora* (Kembang Turi)	0.24	0.22	635.519	690.749	0.024	0.022	0.00038	0.00032
9	*Sesbania grandiflora* (Kembang Turi)	0.23	0.21	670.825	629.193	0.023	0.021	0.00034	0.00033
10	*Tectona grandis* (Jati)	0.18	0.19	368.105	481.311	0.018	0.019	0.00049	0.00039
11	*Sesbania grandiflora* (Kembang Turi)	0.03	0.01	578.139	512.765	0.003	0.001	0.00005	0.00002
12	*Eucalyptus deglupta* (Leda)	0.11	0.17	431.824	360.479	0.011	0.017	0.00025	0.00047
13	*Sesbania grandiflora* (Kembang Turi)	0.19	0.17	510.383	641.455	0.019	0.017	0.00037	0.00027
14	*Sesbania grandiflora* (Kembang Turi)	0.16	0.13	587.830	472.846	0.016	0.013	0.00027	0.00027
15	*Sesbania grandiflora* (Kembang Turi)	0.16	0.13	564.746	482.680	0.016	0.013	0.00028	0.00027
16	*Sesbania grandiflora* (Kembang Turi)	0.24	0.19	539.439	480.082	0.024	0.019	0.00044	0.00040
17	*Sesbania grandiflora* (Kembang Turi)	0.32	0.24	573.891	476.867	0.032	0.024	0.00056	0.00050
18	*Sesbania grandiflora* (Kembang Turi)	0.18	0.16	569.336	514.420	0.018	0.016	0.00032	0.00031
19	*Sesbania grandiflora* (Kembang Turi)	0.26	0.20	486.666	585.556	0.026	0.020	0.00053	0.00034
20	*Sesbania grandiflora* (Kembang Turi)	0.20	0.19	581.853	514.702	0.020	0.019	0.00034	0.00037

Sampling-1: October 24, 2023; Sampling-2: November 7, 2023

A comparison between the results on two measurement dates provides an idea of changes in the tree's ability to absorb dust over time. For example, *Eucalyptus deglupta* (Leda) trees showed variations in their dust absorption between October 24, 2023 and November 7, 2023 which may indicate instability in environmental conditions or other factors affecting the tree's ability to absorb dust. The weather conditions before the sampling on October 24, 2023 did not rain much, it only rained exactly one day before the sampling. Meanwhile, after taking the first sample until November 7, 2023, it constantly rained daily. In addition, the distance of each tree to pedestrian paths or emission sources varies. According to Judge *et al*. (2017), the differences in dust absorption for each tree can be different due to the distance from the emission source (location of the tree), canopy position, leaf density, and leaf area. The influence of position of the tree canopy will have a significant influence because the canopy closest to the emission source will absorb more dust than the canopy far from the emission source. This can be explained by Hermawan et al. (2011), namely that the front canopy will be first exposed to falling particles, and if there are particles that cannot be trapped, the rear canopy is thought to be the one that will trap the particles.

1.5. Synthesis

From the carbon uptake and dust absorption analysis, certain trees have a significant capacity to absorb and sequester carbon. The *Sesbania grandiflora* tree (Kembang Turi) stands out for its ability to absorb carbon and positively address carbon emissions, which are the main cause of climate change. Apart from that, dust absorption analysis also provides an interesting picture of the ability of trees along pedestrian paths to improve air quality. *Sesbania grandiflora* (Kembang Turi) trees have also demonstrated their effectiveness in capturing dust from the surrounding air, which is an important step in reducing air pollution and improving the health of local communities. Thus, planting *Sesbania grandiflora* (Kembang Turi) trees along the pedestrian path is very good, but it would be even better to impact the campus environment significantly.

Based on the results of this analysis, several trees or plants can be recommended that can absorb carbon and dust with a high capacity to support user comfort while still paying attention to the condition of pedestrian paths. The following are some trees or plants with high carbon uptake that can be recommended, namely Spider Plant (*Chlorophytum comosum*), Dracaena, Bamboo Palm (*Chamaedorea seifrizii*), Yellow Palm (*Chrysalidocarpus lutescens*), Bungur Leaf (*Lagerstroemia speciosa*), Mahogany (*Swietenia mahagoni*), Umbrella Sunshade (*Felicium decipiens*), and Pingku Tree (*Dysoxylum excelsum*). Meanwhile, several trees or plants with high dust absorption are Mahogany Tree (*Swietenia mahagoni*), Glodokan pole (*Polyalthia longifolia*), Ketapang Kencana (*Terminalia mantaly*), Umbrella Sunshade (*Filicium decipiens*), Angsana (*Pterocarpus indicus*), and Sri Rejeki (*Chinese evergreen*).

4. Conclusions

The pedestrian path on the UKSW Blotongan Campus does not meet the required existing standards. The analysis results show variations in the ability of trees along pedestrian paths to absorb carbon and dust. The *Sesbania grandiflora* tree (Kembang Turi) shows a high ability to absorb carbon and dust from the surrounding environment. Based on these results, a pedestrian route is recommended to take into account the existing standards. Planting trees with high carbon absorption and dust absorption capabilities is recommended to improve the quality of the environment and air around the pedestrian path area. Thus, pedestrian paths not only provide user safety and comfort benefits but also protect the environment and health of surrounding communities.

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