Comparative Study of Soft-scape Element Significance in Improving the Walkability of Urban Corridor

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Abstract. The walkability of urban corridors determines the success of a Transit-Oriented Development (TOD) area. Aside from affecting people's propensity to walk, the walkability of urban corridors affects decision making in choosing a walking route(s). Variables of the walkability score of a route are the path profile, the route anatomy, building(s) development along the route(s), hardscape, and soft-scape elements. This study is focused on soft-scape elements. Studies showed that soft-scape elements can humanize the scale of the outdoor space, add attractiveness to the urban corridor, and control the micro-climate by creating ample shades and reducing exterior temperature. Soft-scape elements are applied differently depending on how it interacts with other natural and existing environmental elements such as the climate, building height, and traffic volume. Countries with hot-humid climate have the benefit of solar radiation and rainwater, the key elements which made the hot-humid climate uniquely differs from other climate zones. Previous researches are collected to gather the essential information about soft-scape elements and walkability of the urban corridor. The collected information is compared, analysed, and synthesized, to seek certain soft-scape design recommendation which could be applied for the walkability of urban corridors near the equator.

1. Introduction
Representing the name, Transit-Oriented Development (TOD) is a practice of planning which revolves in transit-facility and promotes transit ridership [1]. Renne (2009), on his study about several development areas around a transit station in the Bay Area, USA, mentioned several characteristics of a TOD area. While some characteristics are related to the density and compact land use, the others are grid street pattern, smaller block sizes which have more linkages and intersections, and less use of motorized vehicles. This led to greater pedestrian and non-motorized vehicle accessibility at the neighbourhood level [2].

From the afore-mentioned study, we can derive that the presence of pedestrian is important in TOD. Therefore, its most dominant way of pedestrian transport, which is mainly walking, is highly important too. More recent studies come up with discourse about why people walk, what encourage or discourage them to walk, and also about the walkability of a place.

Walkability can be defined as the attractiveness and suitability of the built environment for walking [3], and also as a concept to measure the score of pedestrian-friendliness of an area [4,5]. In some researches, walkability can be measured by several means, such as observation and scoring audit, physical survey (questionnaire, interview, video review, or an online review), audit through GIS and PC tools, and simulation. All of these means of measurements usually depend on the presence of physical
features in the area; for example, the presence of sidewalks, traffic signs or traffic lights, pedestrian crossing, soft-scape elements, and street furniture.

In this study, we are going to find out how soft-scape elements, as one of the physical features of urban corridors can have significant contribution in improving the walkability of urban corridors within the local climate context. Softscape elements, which are plants and vegetation, are highly dependent on the climate while vice versa the elements could also affect the microclimate of an area. It means that the inclusion of soft-scape elements in an intense artificial-built-environment such as TOD area is a part of the solution for micro-climatology problem, but on the other hand, it can meet certain challenges. The challenges might include, and not limited to the availability of the ground area for plantings, limited sunlight, intense wind, and high concentration of aerosol particle or hazardous pollutant. Furthermore, in places with tropical rainforest climate such as Indonesia, where the natural existing condition is abundantly flourished with soft-scape, the position of this element is highly important.

2. Methodology
This study consists of a literature review limited to publications of researches with case studies and assessment of soft-scape significance in the urban corridors. The literature is divided into three groups. First, a group of papers which contain at least one case study and critical assessment upon the correlation between the walkability and the soft-scape elements. Second, a group of papers which provide the specification of soft-scape type and design suggestion for the soft-scape element in a prominent TOD area. Third, a group of papers which mention the relationship between local climate and soft-scape element in urban context—especially hot-humid climate—and paper which provides any insight on soft-scape impact toward the microclimate.

These group of literature then compiled and the result is narrowed down into a group that are suitable to be applied in a hot humid climate. The final list should be able to be used as a recommendation for applying soft-scape elements in urban corridors in Indonesia.

3. Softscape Elements in Urban Corridors
Incorporation of soft-scape elements in urban corridors is not a novel concept. In research about urban design qualities, Ewing and Handy (2009) mentioning soft-scape elements such as trees, plants in small planters and other landscape elements as an example of physical features that influence all 5 qualities: imageability, enclosure, human scale, transparency, and complexity. All of these design qualities are used to measure the overall walkability in an area along with physical features and individual reactions to both features and the qualities [5].

It is important to narrow down what are the benefits of soft-scape elements in urban corridors and what factors that need to be considered before a planner can start to use soft-scape elements in their design of urban corridors, especially urban corridors in TOD area.

3.1. Methods of walkability assessment which include soft-scape in the variables
Researchers have utilized several methods of walkability assessment such as observation and scoring audit, physical survey, onsite interview, online reviews, audit through GIS and PC tools, and simulation. Depending on the method and the purpose of the assessment, the variables might be different from one another. It is necessary to collect the literature, in which soft-scape elements are included as variables to assess walkability in the case study, to know about how soft-scape elements are actually affecting the walkability.

| No | Reference | Context | Method | Result |
|----|-----------|---------|--------|--------|
| 1  | Agrawal et al, 2008 [6] | Japantown, USA | Questionnaire and walkability audit using GIS and PC Tools | - 35% and 44% respondents vote strongly-agree and agree that presence of the attractive building, trees and landscaping influence people to choose the route (number 5 after shortest route, presence of traffic |
| No | Reference                           | Context                | Method                                                                 | Result                                                                                                                                                                                                 |
|----|-------------------------------------|------------------------|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2  | Galingan et al, 2009 [7]            | Makati CBD, Philippine | Survey and assessment from several criteria of pedestrian-friendly street | devices, traffic drives at safe speeds and good sidewalk)                                                                                                                                         |
|    |                                     |                        |                                                                        | - Low presence of greenery in Julian Street (Japantown) affect the pedestrian’s perception of the street as an unsafe route which should be avoided if possible                                                   |
|    |                                     |                        |                                                                        | - One of the characters of the pedestrian-friendly street is to be comfortable for users to walk in; have enough shade and cover                                                              |
|    |                                     |                        |                                                                        | - In Makati CBD, planting plants are done to provide connections of covered walks along with areas where the pedestrian often pass. This, along with other treatments resulted in increased pedestrian traffic volume in a 2000 survey |
| 3  | Zayed, 2016 [8]                     | Egypt                  | Quantitative survey                                                   |                                                                                                                                                                                                      |
|    |                                     |                        |                                                                        | - The number of trees and palms are proven to be one of the strongest components that affect walkability. The trees and palms are considered as fresh air generators, improving the image of the path and may be used to create shaded areas along the path |
| 4  | Shaaban, 2019 [9]                   | Qatar                  | Observation and scoring audit                                         |                                                                                                                                                                                                      |
|    |                                     |                        |                                                                        | - One of the indicators is that the presence of shade trees increase the comfort level of the pedestrian. The role of the trees are to keep pedestrian cool, protect them from the sun, and present itself as a nice aesthetic elements |
|    |                                     |                        |                                                                        | - There is no conclusive result since the purpose of the study is to create an assessment indicator, but a sidewalk with more trees have a better score than the sidewalk with fewer trees                          |
| 5  | Erna et al, 2015 [10]               | Malang, Indonesia      | Observation and scoring audit                                         |                                                                                                                                                                                                      |
|    |                                     |                        |                                                                        | - The presence of trees enhances the ambience of the observation site. The score for walkability convenience is higher at the site with trees than without.                                               |
|    |                                     |                        |                                                                        | - Shades provided by tree canopies reduce about 80% of the solar radiation, control the wind flow resulting in a lower temperature, and in this case, enrich the site with more activities (ie. parking, sitting, walking, buying and selling) |
|    |                                     |                        |                                                                        | - It is concluded that thermal comfort was prioritized rather than other variables (cleanliness, quality of the path, etc.) in a tropical humid climate place like Malang                                                               |
| 6  | Lwin & Murayama, 2011 [11]          | Tsukuba, Japan         | Remote sensing, GIS, and online scoring application                   |                                                                                                                                                                                                      |
|    |                                     |                        |                                                                        | - The paper examines the relationship between green-score and the actual walkability in the regional scope of Tsukuba City, Japan; using Remote Sensing, GIS, and Spatial Web Technology. The project aims to create The Walk Score, which indicates how friendly a path is to walking. |
| 7  | Phillips et al, 2017 [12]           | Arizona and California, USA | Online scoring and onsite interview                        | Research shows a high agreement between online scoring (or online reviewing) and onsite interview as two alternative methods of assessing the quality of a corridor. The total of 120 corridors is surveyed with a near-perfect agreement (97%) on soft-scape assessment. |

From the table, we can conclude that even though the climate context of each site in the paper is different, most of the research results agree that soft-scape elements are highly beneficial for improving the quality of urban context. It improves pedestrian perception toward the route(s) and provides better...
micro-climates which, based on several pieces of research, are more important than an aesthetically good urban corridor.

3.2. **Significance of various soft-scape type toward the walkability in the urban corridor.**

While the significance of soft-scape elements in the urban corridor has been proved by several researchers in the previous section, there is still a question about which kind of soft-scape elements to use in a specific urban corridor. Ewing (1996) had mentioned that “if the ‘right’ trees are planted at the ‘right’ locations, they contribute to nearly all pedestrian-friendly design objectives” [13], implying that while soft-scape elements have a significant effect to walkability, if it’s added the wrong way, it may also give less to no effect to the urban corridors. However, the ‘right’ trees and the ‘right’ location should be elaborated further and backed with empirical assessment and adequate studies.

**Table 2. List of literature which includes types of soft-scape and its impact on the urban corridor.**

| No | Reference | Context                                      | Softscape Type                                      | Result |
|----|-----------|----------------------------------------------|----------------------------------------------------|--------|
|    |           |                                              |                                                     | MC     |
|    |           |                                              |                                                    | AS     |
|    |           |                                              |                                                    | RC     |
|    |           |                                              |                                                    | BF     |
|    |           |                                              |                                                    | WP     |
| 1  | Rehan, 2013 [14] | Chapel Hill, North Carolina, USA | Shade trees or canopy trees | ✓   |
|    |           |                                              | Sidewalk rain garden                                | ✓   |
|    |           | Chicago, USA                                 | Various type (unspecified)                          | ✓   |
|    |           | El Ahram Street, Giza, Egypt                 | Shade trees or canopy trees                         | ✓   |
|    |           |                                              | Planters                                           | x     |
|    |           |                                              | Palm trees                                         | ✓   |
| 2  | Agrawal et al, 2008 [6] | Japantown, USA | Various type                                      | ✓   |
| 3  | Galingan et al, 2009 [7] | Makati CBD, Philippine | Shade trees and other treatment                   | ✓   |
| 4  | Ariffin & Zahari, 2013 [15] | Malaysia | Various type                                      | ✓   |
| 5  | Centre for Liveable Cities Singapore and The Seoul Institute (2016) [16] | Orchard Road, Singapore | Angsana trees (specific)                          | ✓   |
|    |           | Civic District, Singapore                    | Various type                                       | ✓   |
|    |           | Development of North-South Corridor and Bencoolen Street, Singapore | Shade trees or canopy trees | ✓   |
| 6  | Adkins et al 2012 [17] | Portland, USA | Green street installations                       | ✓   |
| 7  | Zayed, 2016 [8] | Egypt                                        | Shade trees or canopy trees                         | ✓   |
|    |           |                                              | Ground cover and planter box                        | x     |
| 8  | Lwin & Murayama, 2011 [11] | Tsukuba, Japan | Various type (unspecified)                       | ✓   |
Most of the sources mentioned the impact of soft-scape elements in creating a better microclimate. A study by Rehan (2013), also stated that different soft-scape elements could affect microclimate differently. In his research, while shade or canopy trees had a positive impact on microclimate, the planters and palm trees were not [14]. This result shows that the inclusion of soft-scape elements should also consider types of soft-scape elements to get the most optimum climate benefit.

### Table 3. List of literature which explains the effect of soft-scape elements on microclimate.

| No | Reference | Context | Types of soft-scape elements | Effect on microclimate |
|----|-----------|---------|------------------------------|------------------------|
| 9  | 9 Spangenberg, et al., 2007 [18] | Sao Paulo, Brazil | Observation and simulation using ENVI-met | ✓ |

**MC:** Improving microclimate  
**AS:** Aesthetics and design quality (including 5 qualities of urban corridors by Ewing and Handy (1996); *imageability, enclosure, human scale, transparency, and complexity*).

**RC:** Route choice  
**BS:** Buffer/virtual boundary for safety  
**WP:** Walking propensity

3.3. Climate-awareness in soft-scape design and how soft-scape affect the microclimate.

Al Saeed and Furlan (2017) mentioned that any urban-development designed in this ‘climate-change’ era must take a fresh view of climatic considerations [19]. As a country with hot-humid climate, Indonesia’s all year long solar radiation and abundant rainfall can be a challenge for pedestrian mobility, along with pollution from a motorized vehicle. Therefore, the comfort level of pedestrian regarding the climate and temperature of an urban corridor is more important to be considered rather than the aesthetic factor.
| No | Reference | Context | Types of soft-scape elements | Effect on microclimate |
|----|-----------|---------|-------------------------------|------------------------|
| 6  | Ma et al., 2019 [23] | Fo Shan City, China | Tree | reaching 35°C. Simulation with leaf cover shows maximum indoor temperature 4 K lower than without leaf cover, while the night temperature is slightly raised. Based on the simulated result, the increase of tree coverage ratio can significantly increase human's thermal comfort. This result can be attributed to transpiration and shading during the daytime. Grass coverage reduces reflected radiation. Though the effect is limited in the open space. |
| 7  | Rashid and Al Junid, 2014 [24] | Shah Alam, Malaysia | Grass cover | If planted in groups can give proper shading and effective cooling up to 8°C. can create thermal reduction effect up to 7.6°C Soft landscape can contribute to a healthy environment by cooling air, increasing relative humidity, giving fresh air supply, etc. Creates a long shadow on the pedestrian path and wall surface |
| 8  | Ramesh, 2016 [25] | Small-sized canopy tree Medium-sized tree | Long-oval shaped tree (7.5 – 10 m) Shorter trees (6 – 9 m) Sphere shaded tree (9 – 15 m) Grass | Directing breeze to a particular direction Use for roof shading Grass reduce the incidence of heat and glare, which is useful for the pedestrian. |

![Figure 1](image1.png)

**Figure 1** Type of canopy and suitable height for different microclimate purpose based on Ramesh (2016)

The effect of soft-scape elements is not limited to provide a proper shading which further reduces the air temperature of the area. It also performs as an air-purifier by taking gaseous pollutants [24, 25] and trapping dust [22] in the urban area. The tree is one among soft-scape elements type that is often mentioned in the discussion where the soft-scape elements are creating a better microclimate. Ramesh
(2016) and Rashid and Al Junid (2014), further explain in their study that it is also important to consider the morphology of the tree. This includes the size of the canopy and the height of the tree [24, 25].

3.4. Discussion

3.4.1. Challenge for Soft-scape Inclusion in the TOD Area. Soft-scape inclusion in the TOD area is different from soft-scape inclusion in the greener area in the city such as city parks or housing areas. Several challenges that needed to be considered before implementing soft-scape elements are:

a. Poor urban soil condition [26]. Due to rapid land development, soil in a TOD area might come from different sources. Therefore, the substances are unpredictable and the texture is also changed due to the compaction process. This problem might prevent the root from penetrating the soil and render difficult the absorption of water and nutrients. Furthermore, this condition will cause a growth problem to the soft-scape elements.

b. Extremely limited ground-level space [26]. Construction of under-ground infrastructure will limit not only the space for soft-scape elements to be planted but also the depth of the soil available for root growth. This condition may lead to poor vertical root systems which weaken the tree growth and increasing the risk of windthrow.

c. Fear or experienced vandalism, and low maintenance [27]. Being in a public area, it is easy for soft-scape elements to be the object of vandalism from the public. On the other hand, as soft-scape elements are also a natural element, it has its cycle when the leaves, fruits, or other parts of it might fall or becoming obstacles for the passer-by people.

d. A common or recurrent natural disaster or natural constraint specific to the area. Tian et al (2004), on their study in Hongkong, mention that frequent typhoons and difficult terrain (rugged and very steep), are not an ideal condition for soft-scape inclusion [28].

e. Selection of plant-based on appearance and not ecological function [29]. While it is true that soft-scape inclusion might add to aesthetic value to the area, choosing soft-scape types only based on this factor is not recommended because it only lessens the benefit of having soft-scape elements in the area.

As TOD area usually is a dense and heavily built structure, with limited ground level and poor urban soil condition, the growth of any soft-scape element will be the most common implementation challenge. Other than that, the dense built structure will lessen sunlight intake through the corridor and create faster wind speed. A gaseous pollutant and other hazardous particles are also a challenge since urban area usually generate more pollutant than other areas in the city. While soft-scape elements also have the ability to filter the air from its surrounding [22, 24, 25], their nativity should also be considered [29] in order to make it easier for the soft-scape elements to take on such harsh condition. The type of soft-scape elements can also be considered. While it is true that the tree might have the most significant effect on microclimate, the TOD area might not have what it takes to support its growth. The other type, such as green wall and grass as groundcover has also been proven to have such effect in microclimate [21, 23, 25] and therefore should be considered too.

3.4.2. Softscape Inclusion specific to Hot-Humid Climate Area. As a country with a hot-humid climate, urban corridor walkability in Indonesia should be treated according to the context. While it is true that imageability, attractiveness, and complexity of an urban corridor are important for the walkability, planners need to prioritize pedestrian’s comfort as a starting point to design urban corridors in Indonesia. Based on the researches that have been collected, soft-scape elements play an important role in creating the microclimate of its surrounding.

Softscape’s morphology has an important part in modifying the temperature and humidity. The height of the soft-scape elements decides where it is more suitable to be planted, and whether it is suitable to be planted individually or in groups [24, 25]. The canopy type, density of foliage and branches are also important to be noted since those are the elements which filter sunlight and wind from the urban environment [29].
Regarding the planting space and lack of sunlight which are the common challenges of soft-scape inclusion in an area, Hidayat (2010) also mention about the nativity of soft-scape elements which helps the element to survive in the area [29]. Other than that, it is also important to consider 'trending' or considering a case that has been succeeded in other areas with similar climate or urban condition [30].

4. Conclusion
Through this literature review, we can conclude that soft-scape elements have a significant impact on improving the walkability of the TOD area. Softscape in various form improve the microclimate of the area, enhance aesthetic and design quality, provide a virtual barrier for pedestrian safety from the vehicle, and also affecting route choice and propensity to walk. This impact can be assessed through three large methods, namely: direct observation and measurement, online or onsite scoring, and simulation. Therefore, the improvement effort in the future could be integrated not only in the small-scale area but also in a larger urban region.

Softscape inclusion in TOD meets at least 4 challenges: (1) limited root space hence also limited water and nutrients, (2) limited sunlight in a certain area, (3) high wind speed in high buildings and urban canyons, and (4) high concentration of aerosol particles and hazardous pollutant in the air. Specific for hot-humid climate, soft-scape installation should prevent the excessive heat emanated from building surface which could cause burn on the leaves. Self-cleaning leaves are most desired to reduce the maintenance effort caused by dust. Any supporting structure should require low maintenance, has humidity resilience, and has durability towards the wind. Most of all, the shade trees or canopy trees must be prioritized since the studies show that large trees provide more significant impact than the ground cover, green roof, green façade, palm trees, and planter box greeneries. The species of the plants for the green wall, green façade, and the leaf cover application are not affecting the ability of the plants in reducing the surface temperature of the exterior wall. Therefore, any wall climbers could be used. If urban cool island exists in an area, expansion of cool air seeping phenomenon should be conducted by extending the line of trees from the urban cool island into the built-environment with certain intervals.

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