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THE SELECTION OF STREET TREES FOR SUSTAINABLE RESIDENTIAL NEIGHBORHOODS

Allu Revathi Devi[1], Vijayalaxmi J[2]. Ramesh Srikonda[3].

Department of Architecture, School of Planning and Architecture, Vijayawada, Andhra Pradesh India.

Email: allurevathidevi@yahoo.com, vijayalaxmij@spav.ac.in, ramesh.srikonda@spav.ac.in

Abstract: The street trees play a key role for the urban neighborhoods. Given the harsh urban conditions its necessary to select trees and maximize their benefits. Many urban areas have a poor understanding of the importance of street trees and their sustainability, which presents a gap in our knowledge of selection of street trees. The tree species selection process defines the steps necessary to select a tree species that is appropriate for a given location. Investigations on urban tree species selection have confirmed the use of environmental, social, and economic criteria. This study presents the methodological aspects of a proposed selection process for the key urban street tree species. This enables us to have a better understanding of selection of tree species in urban areas from the literature study to build up suggestions for decision-makers about possible new approaches for urban arboriculture and planning of the street vegetation.

Key words: street tree, sustainability, neighborhood

Traditionally urban tree selection focused on aesthetics and ornamentation as the primary objective. But evolving trends in modern context prioritizes tree as a critical infrastructure as they provide numerous benefits through which the cities can benefit. (City of Sydney,2013). The subject of street tree selection would seem to be an uncomplicated matter consisting of aesthetic planting preferences. However, street trees in residential neighborhoods offer many sustainability benefits, like ecological, environmental, health, and economic, to name a few. Trees can perfectly complement areas providing communities with pollution minimization, a reduction in ground temperature helping to subset global warming, and even positive effects on the human gut microbiome. However, improper, or careless selection of trees can lead to financial losses in terms of money spent on trees, damage to surrounding infrastructures, and harm to humans. Therefore, the right trees need to be selected for planting in the right areas to minimize loss and harm. While there are many decision aids available, acknowledging and exploring the intricacies of tree selection will ultimately be widely beneficial for any residential neighborhood.

As per Silvera Seamans (2013), sustainability has traditionally been defined as the balancing of environmental health, economic development, and equity or fair access to environmental and economic benefits. Nicholas in his study trees across various cities have consistently defined that 'Street trees are trees located in the public right of way.' (S Nicholas et.al 2020). When considering street trees in residential neighborhoods, sustainability is yielded in many ways. However, the purpose of including street trees has changed significantly over the last several decades. They used to be placed for beautification purposes. Today, they provide stormwater reduction, the

conservation of energy, an improvement in air quality, and other sustainability benefits (Mullaney et al., 2015).

Multiple studies mention various sustainability benefits categorized as environmental, economic, social, and health benefits. According to Mullaney et al. (2015), street trees play a vital role in supporting healthy urban communities and have a significant social impact by improving people's health, reducing crime, increasing community interaction, and increasing property values. Trees also provide shade, reducing the ground temperature, which is good when considering climate change issues. In neighborhoods and geographical areas that experience high temperatures, urban residents are at an increased risk of heat-related illnesses. For example, a 20 percent increase in trees has caused a 7.18 percent decrease in average temperatures in Phoenix, Arizona, reducing heat-related emergencies in the area by 11 percent (Salmond et al., 2016). Street trees can also influence indoor temperatures by providing shade over homes and places of business.

The health benefits of trees in residential neighborhoods are also mentioned in many studies. For example, some studies have concluded that creating more green areas in neighborhoods improves moods, deters depression-like illnesses, and encourages residents to engage in outdoor activities. In addition, as per Astell-Burt and Feng (2022), there is evidence emerging concerning the effect sleep, biodiversity, and microbial exposures of trees have on modulating the human gut microbiome and other internal mechanisms of the human body.

One of the greatest effects of street trees in residential neighborhoods is reducing harmful pollutants. At times, though, they contribute to pollution, which should be a careful consideration for tree selection. As per Salmond et al. (2016), the characteristics of the tree canopy, tree density, and proximity to other urban structures influence the ability of plants to remove pollutants. However, a tree's speed of removing pollutants highly depends on the tree's species. Generally speaking, the larger the leaf on the tree, the faster it can remove pollutants from the air. For example, when stressed, trees emit biogenic volatile organic compounds (bVOCs). However, one study has demonstrated that planting one million low bVOC-emitting trees, as compared to one million English oak trees, which are high bVOC-emitting trees, is the equivalent of blocking the emissions from as many as 490,000 vehicles (Salmond et al., 2016).

Street trees and other green plants can help communities meet sustainability goals by providing equal access to green communal spaces (Turner-Skoff & Cavender, 2019). However, several studies have established that these communal spaces and their benefits are not always equitable. For instance, trees inresidential neighborhoods are more often found in areas with higher incomes. According to Lynch(2022), educational attainment, household income, race, and family or household size have been identified as significant in residential tree cover studies. In other studies, though, creating green spaces in poorer, urban areas has conflicting results. For example, in one study, wooded areas were weakly associated with increased violent acts committed by adolescents (Culyba et al., 2016). However, in another study, creating green spaces around dilapidated, abandoned homes and buildings resulted in lower crime rates and larger buy-in among residents (Xue et al., 2022). In addition, one study found that tree survival increased substantially when the community participated. Furthermore, the breadth and depth of trees' health and environmental

benefits in residential neighborhoods are just beginning to receive the proper research attention they deserve in understanding these complex plant and human symbiotic relationships related to sustainability. This guides us to address the residents' preferences and attitudes towards choice of sustainability of street trees.

Tree Selection

According to Gilman & Sadowski (2017), a thorough site evaluation can ensure that the chosen tree or trees will survive the area's conditions so that costly maintenance can be avoided. For example, if the area is prone to hurricanes and other strong winds, a tree that establishes a deep root system is preferable to withstand storms. It has been suggested that such an evaluation starts with gaining a good understanding of what types of trees are native to the area. Also, a consideration should be the temperature distribution for the given area. Soil and ground conditions should match the trees' optimal growing requirements. Laboratory testing of the soil's pH is strongly recommended as most trees can only grow in dirt that has a pH level between 4.8 and 7.2 (Gilman & Sadowski, 2017).

Environmental factors should also be considered, such as light exposure, the slope of the earth, overhead wires and other infrastructures, lighting, buildings in the area, and local regulations (Gilman & Sadowski, 2017). If there is a surplus of concrete or asphalt in the area, large trees with extensive root systems will either destroy the infrastructure or a strong root system will be inhibited, leading to an early death of the tree (Gilman & Sadowski, 2017). Underground utilities such as drainage and sewage systems are also of great concern. However, infrastructure interference is often unavoidable when selecting trees for an already well-established neighborhood. Modifications can be made, such as moving lights and wires, altering the pH levels of the soil, and improving drainage (Gilman & Sadowski, 2017).

According to Mullaney et al. (2015), parks and street tree plantings create interesting and dynamic public spaces within the urban environment. However, tree growth may be limited when tree plots are not properly designed. Therefore, per Salmond et al. (2016), careful thought needs to be put into considering tree placement, their beneficiaries, viable alternatives, who is responsible for ongoing costs and maintenance, and potential co-benefits with urban planning objectives at multiple scales. Furthermore, when choosing appropriate street trees, microclimate, air quality, noise regulation, pollution concentration, the emission of volatile biogenic compounds, noise attenuation, pollen, and cultural values should be considered (Salmond et al., 2016).

Achieving diversity in the type of trees planted is good for balancing the ecology of the particular area and increases the diversity of birds, insects, and other creatures. In this sense, a wide range of tree species is available for neighborhood streets. According to one study, the most important aspect is the balance of tree species by considering the ratio of species, native trees, planting density, and the ratio of evergreens (Choi & Lee, 2022). Other factors to consider when selecting trees for residential neighborhoods include biotic factors, insect populations, and bacteria/fungi/viruses that interfere with tree growth and management (Beecham & Lucke, 2018). In addition, mites, invasive insects or plants, weeds, and large animals such as deer can adversely affect street trees. Among other concerns are soil volumes and conditions, water availability, the

potential for fire, and extreme weather conditions (Beecham & Lucke, 2018). Furthermore, desired functions of the tree should be a strong consideration as these requirements would dictate the size, shape, life span capabilities, canopy, growth rate, and other attributes of the selection of the trees (Gilman & Sadowski, 2017).

In a sustainable neighborhood, trees with fruit should be avoided as they can cause walking or falling hazards for the community. This would be highly applicable in areas adjacent to streets and sidewalks. In these same spaces, how quickly a tree removes pollutants from the air and whether or not they are low bVOC-emitting trees should be factored in. PM-tolerant species, those that filter PM pollutants from the air, are optimal and include species such as silver birch (Salmond et al., 2016). Other low bVOC-emitting species include pine and larch.

The Effects of Improper Tree Selection

When selecting street trees, most prioritize aesthetics over other essential components in decision-making. With this approach, biotic homogenization occurs, leading to ecological concerns (Mardiastuti, 2021). Biotic homogenization can interfere with establishing bird and insect species that form symbiotic relationships with the trees, keeping them healthy. They can also lead to neighborhood damage as biotic homogenization involves planting non-native trees in areas they do not necessarily belong to. Disadvantages in tree planting in residential neighborhoods can be minimized by carefully selecting the right tree species for the area in which they will be planted.
If not carefully considered upon planting, the growth of trees can become stunted in residential neighborhoods as they can have limited access to appropriate amounts of water and nutrients essential for tree health. In these circumstances, if the trees survive, their root systems seek suitable alternatives to fulfill their moisture and nutritional requirements. Unfortunately, this often leads to street trees in residential neighborhoods causing damage such as heaving sidewalks and street pavement and damage to sewer systems and other infrastructures.

As per Salmond et al. (2016), the current preference for male over female trees of the same species in many North American and European cities to reduce the mess from seeds and fruit can result in higher pollen loads in the atmosphere, affecting human allergy and asthmatic reactions. In this sense, street trees can have a more negative effect on human health. Some trees are inherently more allergenic than others, such as birch, olive, Japanese cedar, London Plane, and cypress trees. Even though trees positively affect air quality, one aspect of tree respiration can negatively affect local air quality. Increased BVOC(biogenic volatile organic compounds) react with nitrogen oxides to increase air pollution in the form of ozone, which is dangerous to human respiration (Turner-Skoff & Cavender, 2019).

Cost, Management and Governance

As per Choi and Lee (2022), planting costs are substantially high in residential park landscaping plans, including apartment complexes, because various species are required.
Despite movements to create more green spaces in residential neighborhoods, especially in urban locations, managing trees can be somewhat complicated, involving public, private, and nonprofit businesses. Even when they fall within public domain management, they involve administrative offices, public works, transportation offices, parks and recreation sectors,

and planning offices of both local and state departments (Eisenman et al., 2021). This causes an array of challenges, including miscommunication and confusion.

Per Turner-Skoff & Cavender (2019), few trees in urban locations fail to reach maturity due to the costs associated with planting and maintaining them. They are also likely to be the subject of harsh community criticism. For example, according to one study, Angasana, Akasia, Yellow flame, and Petai belalang trees are prone to heavy storm damage and frequently do not survive (Hasan et al., 2017). Trees such as these likely should be avoided in a residential neighborhood where they can cause damage to surrounding buildings or infrastructure and possibly injure people. They are also the most frequent types of trees complained about by residents. According to Hasan et al. (2017), another example of poor planning involves tree species such as Pelthophorum pterocarpum, and Tabebuat rosea are popular selections due to their visually appealing blooms. However, these species also have negative effects to consider, such as blooms and leaves clogging drainage systems and brittle branches. Other commonly planted trees that result in various issues are detailed below in Figure 1. In short, the wrong tree species in the wrong places will negatively affect public safety and cause property damage (Hasan et al., 2017).

Administration, development, and maintenance are necessary aspects of management of street trees. Trees to be pruned and maintained at regular intervals for the aspects of visibility and transparency to the urban fabric for reasons of safety and security. If not maintained the obstructing branches they develop branches in a bushy manner at lower levels which also hinders the movement at the street level. (R Hasan et.al 2016)

Selection Models

The trees in their places discuss about the relationship between human and non-human agencies. The tasks cape related to the ethical presumptions of generosity towards the individual trees in case of urbanscapes (cloke&Jones, 2003). This points towards developing awareness in individuals and various stakeholders in the qualities of trees which helps in aiding the choice. Presently, a variety of resources can aid in tree selection, such as the Northern Illinois Tree Selector (Turner-Skoff & Cavender, 2019). Other researchers have published their own models, such as the case with the optimization model for tree selection by Choi & Lee (2022). Their model factors in the tree species, prices, carbon dioxide absorption, canopy coverage of the tree species, size and quantity of existing trees, and the ratio of evergreen trees. Institutions also publish free tree information pertaining to the specificity of chosen sites (Gilman & Sadowski, 2017). Miller (1997) proposed a species selection model for urban tree selection, Key factors in the model include the site factors (include cultural and environmental constraints), economic factors (include establishment, maintenance, and removal cost) and social factors (include neighborhood, community values, functional utility, species aesthetics, public safety, and negative social externalities).

Conclusion

According to Gilman & Sadowski (2017), a proper site evaluation may ensure that the selected trees can thrive in the area's conditions, reducing costly maintenance (2017). While street tree plantings produce exciting and dynamic urban landscapes, badly built tree plots may inhibit tree

development. An inspection must begin with a thorough understanding of the local trees. Consider the temperature distribution in the region, ground, and soil conditions, surrounding infrastructure, drainage, and the overall purpose for planting the trees. Microclimate, air quality, noise management, pollutant concentration, biogenic volatile compound emission, noise attenuation, pollen, and cultural values should also be addressed (Salmond et al., 2016). Time and consideration taken to choose the correct trees for the area are worth the diverse benefits reaped in a sustainable residential neighborhood.

References

Astell-Burt, T., & Feng, X. (2022). Paths through the woods. International Journal of Epidemiology, 51(1), 1–5. https://doi.org/10.1093/ije/dyab233

Beecham, S., & Lucke, T. (2018). Street Trees in Paved Urban Environments – The Benefits and Challenges—Treenet. Treenet. https://treenet.org/resource/street-trees-in-paved-urban-environments-the-benefits-and-challenges/

Choi, J., & Lee, G. (2022). Optimization of tree planting for urban residential green spaces. Landscape and Ecological Engineering. https://doi.org/10.1007/s11355-022-00524-8

Culyba, A. J., Jacoby, S. F., Richmond, T. S., Fein, J. A., Hohl, B. C., & Branas, C. C. (2016). Modifiable Neighborhood Features Associated with Adolescent Homicide. JAMA Pediatrics, 170(5), 473. https://doi.org/10.1001/jamapediatrics.2015.4697

Eisenman, T. S., Coleman, A. F., & LaBombard, G. (2021). Street Trees for Bicyclists, Pedestrians, and Vehicle Drivers: A Systematic Multimodal Review. Urban Science, 5(3), Article 3. https://doi.org/10.3390/urbansci5030056

Gilman, E., & Sadowski, G. (2017). Choosing suitable trees for urban and suburban sites: Site evaluation and species selection. University of Florida IFAS Extension. https://hort.ifas.ufl.edu/woody/documents/ep310.pdf

Hasan, R., Othman, N., & Ismail, F. (2017). Tree Species Selection in Street Planting: It's relationship with issues in urban area. Environment-Behaviour Proceedings Journal, 2, 185. https://doi.org/10.21834/e-bpj.v2i6.951

Lynch, A. J. (2022). Predictors of tree cover in residential open space: A multi-scale analysis of suburban Philadelphia. Urban Ecosystems, 25(5), 1515–1526. https://doi.org/10.1007/s11252-022-01244-5

Mardiastuti, A. (2021). Urban trees to attract wild birds in a tropical urban residential complex in Sentul, West Java, Indonesia. IOP Conference Series: Earth and Environmental Science, 918(1), 012003. https://doi.org/10.1088/1755-1315/918/1/012003

ullaney, J., Lucke, T., & Trueman, S. J. (2015). A review of benefits and challenges in growing

Miller R. W. Urban Forestry: Planning and Managing Urban Greenspaces, 2nd ed. Prentice Hall, Englewood Cliffs, NJ, 1997 M street trees in paved urban environments. Landscape and Urban Planning, 134, 157–166. https://doi.org/10.1016/j.landurbplan.2014.10.013

Ramly Hasan, Noriah Othman, Faridah Ismail, (2016) Roadside Tree Management in Selected Local Authorities for Public Safety, Procedia - Social and Behavioral Sciences, Volume 234, Pages 218-227,

Smart Nicholas, Eisenman Theodore S., Karvonen Andrew (2020), Street Tree Density and Distribution: An International Analysis of Five Capital Cities, Frontiers in Ecology and Evolution Volume 8

Salmond, J. A., Tadaki, M., Vardoulakis, S., Arbuthnott, K., Coutts, A., Demuzere, M., Dirks, K. N., Heaviside, C., Lim, S., Macintyre, H., McInnes, R. N., & Wheeler, B. W. (2016). Health and climate related ecosystem services provided by street trees in the urban environment. *Environmental Health*, *15*(1), S36. https://doi.org/10.1186/s12940-016-0103-6

Silvera Seamans, G. (2013). Mainstreaming the environmental benefits of street trees. *Urban Forestry & Urban Greening*, *12*(1), 2–11. https://doi.org/10.1016/j.ufug.2012.08.004

Turner-Skoff, J. B., & Cavender, N. (2019). The benefits of trees for livable and sustainable communities. *PLANTS, PEOPLE, PLANET*, *1*(4), 323–335. https://doi.org/10.1002/ppp3.39

Xue, C., Jin, C., & Xu, J. (2022). Inequality in urban green space benefits: Combining Street greenery and park greenery. *PLOS ONE*, *17*(9), e0273191. https://doi.org/10.1371/journal.pone.0273191

https://www.cityofsydney.nsw.gov.au/-/media/corporate/files/2020-07-migrated/files_u/urban-forest-strategy-adopted-feb-201