

Sustainable development of streetscape in the desert city of Riyadh-Saudi Arabia

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Abstract: Trees have been associated with human settlements since the dawn of time. In modern time, trees play a major role in shaping healthy and beautiful cities. They scatter among the urban fabric mostly along public streets. Cities all over the world gave serious attention to street trees in order to overcome the decline of the natural environment as a result of the new industrialized urban growth. Riyadh City, as one of the fastest growing cities in the world with harsh arid environment, face the challenge of developing its streetscape in a hostile environment. A sustainable approach is important to be adapted in order to carry on development that saves energy, protect resources and fulfill the needs. This study is trying to assess the existing situation of planting, the proper techniques for planting and designing streetscape in desert city. The study will identify appropriate designing ideas for existing and future applications. In order to address this research, different techniques were applied to answer the research concerns.

Keywords: Planting patterns, Streetscape, , Paved sides, pedestrian, street patterns.

1. Introduction

Many civilizations, starting with the Assyrians of Mesopotamia to the Egyptians, planned their urban settlements to include open urban spaces. Romans who were an extension to Greek civilization produced elegant cities in the desert region of Syria and Jordan [1]. Arabs successfully introduced new plant materials and transferred irrigation techniques utilized for the urban forms and design into Western Europe through Spain [1].

The use of trees in landscaped public open spaces continued in many cities during the booming civilization of the Middle East and was significant in the Circular City of Baghdad built in the 8th-century AD [2] with its central public gardens and in the Turkish City of Bursa in the 15th-century AD where a group of public buildings were built in a green landscaped area. Because of the intensive use of trees, the facility was called the "green group" [2].

The Baroque gardens of France were the first to introduce the use of trees in public spaces in cities in the west [3]. These gardens consisted of wide pathways radiating from clearing the forest for the purpose of shooting game during the hunt. This concept inspired the radial street pattern of Paris and Washington D.C. [3]. The new boulevards of these cities were lined up with trees on their sides.

A real effort to introduce trees to streets began in the early and mid 19th century as a reaction of the negative impacts of industrialization in Europe and America. Classic examples of such efforts were the work of Ebenezer Howard in 1898 that originated the "Garden City" concept [4] and Olmsted's urban park projects in several American cities [4].

There are many factors challenging the spread of public trees in the city of Riyadh. The major factors are mainly related to water issues, climatic condition, and design and planning situations.

1.1 Objective and scope

Riyadh has gone through extensive planting stages in the last few decades to spread public trees in the city [5]. Priority has been given to trees because of their characteristics in influence in shaping streetscape in the city. However, after almost 40 years of planting and spreading greenery in the city's streets, the primary objective in this research is to assess the existing situation of planting public trees, the proper techniques for designing and spreading streetscape in desert city. The case study will be applied to the city of Riyadh in Saudi Arabia.

Desert cities face primary and secondary challenges. Primary challenges are the climatic conditions and scarcity of water and high level of evaporation. Climatic conditions can be specified as the sun

influence (high temperature and Glare) and the wind influence (intensity, heat, and dust blow).

The scarcity of water can be considered either because of the climatic situation or because of the absence of surface water bodies (lakes or rivers). Secondary challenges are the unavailability of enough spaces in the cities to accommodate public trees. To address this objective a fieldwork survey was used to know the situation of streetscaping in the city of Riyadh and assess the influence of challenges facing the city of Riyadh as an example of the desert cities and what are the techniques that are used to overcome those challenges.

1.2 Background information

The name Riyadh was derived from the extensive greenery of the area. William Palgrave, the British traveler who reached the city in 1863, tried to draw a picture of the urban landscape and surrounding areas:

Before us stretched a wide open valley, and in its foreground, immediately below the pebbly slope on whose summit we stood, lay the capital, large and square, crowned by high towers and strong walls of defense... All around for three miles over the surrounding plain, but more especially to the west and south, waved a sea of palm-trees above green fields and well-watered gardens [6].

With modernity, the city spread over the traditional surrounding palm tree gardens. The new urban areas of the city represent a completely different land subdivision and street layout from the compact traditional one. This new pattern of streets was based on the grid pattern, which is usually comprised of equally spaced streets at right angles. Dwellings are lined up equally along these streets. To define the function between streets that were designed for automobiles and the dwellings on their sides, narrow sidewalks were built on the edges of most streets.

In order to overcome the negative image of the city as a result of the dramatic spread of city's neighborhoods, the municipality committed to increase the presence of trees in the city. The easiest and most logical way to do that, in a city like Riyadh, was to use the remaining public domains of streets (side-walks and middle-islands). From the beginning of the planting process, three technical problems can certainly

be pointed out to have faced public street trees. These problems were:

- 1) scarcity and water problems,
- 2) harsh climatic conditions, and
- 3) existing design and planning situations.

In the mid 1980s, more attention was given to increasing greenery in the city, which led to the establishment of the Beautification and Gardening Department in the Municipality of Riyadh. The new department took the responsibility from many administrations in the municipality to manage the planting process in the city. The department, unfortunately, had not kept detailed records of the planting projects conducted by the municipality crews nor by the field contractors. Little information regarding date of planting for each street, areas of the city covered in the planting process, exact number of planted streets, and selected planted species. All this related information and many more were not sufficiently available in the Beautification and Gardening Department in the municipality of Riyadh.

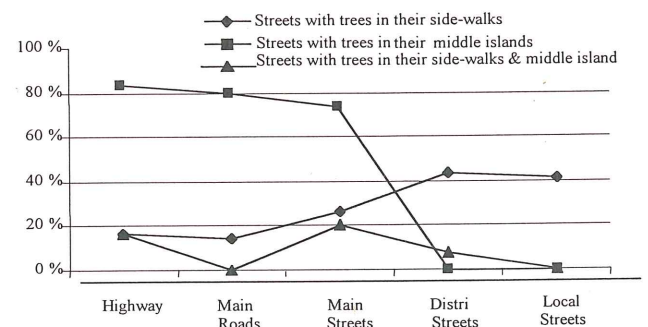


Fig.1 Streets with trees in their side-walks, middle island(s) and in both side-walks and middle island(s).

1.3 Physical patterns of streetscape

Despite the variety in street sizes and shapes and the differences in planting techniques and species from a planting stage to another and the uneven distribution of tree planting from one neighborhood to another, there have been some street planting patterns detected from the field study that can be highlighted. The following discussion will illustrate these patterns in relation to tree distribution, tree selection and street sizes, shapes and functions. In contemporary streets, field observation showed that there are four main patterns of streetscapes. These patterns are as follows.

1.3.1 Streetscape pattern no. 1: local and distributed street

Streetscape of local and distributor streets consist of

simply of trees planted in the paved sidewalks adjacent to the private property's external walls. The outcome of full growth trees on the sidewalks of streets defines the space and gives it a third dimensional limit (see Fig.2).

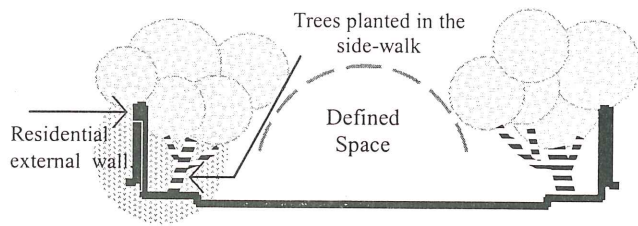


Fig. 2: Conceptual illustration of the detected planting pattern of the local and distributed streets.

The study found that about 47% of the local streets and 34% of the distributor streets in the city have trees in their side-walks while less than 17% of the combined three larger categories of the streets (highways, main road and main streets) have trees on their side-walks.

The majority of sidewalks, in Local and Distributor streets, vary from 1.20 meter to 2.00 meters in width. Study found that 52% of these sidewalks have trees in them (see Table 1).

Table 1. Existence of plants on different sidewalk widths

Width of Side-walks	Percentage of Planted
< 1.2 m	2.7 %
1.2 m to 2.0 m	52.0 %
2.4 m to 2.8 m	13.3 %
> 2.8 m	6.7 %
No defined side walks	25.3%

Tree pits are aliened in these sidewalks every 6 meters apart. These pits are usually $1.2 \times 1.2 \text{ m}^2$ (see Fig.3). The existing situation of sidewalks, as it has been described, caused many problems. First, the remaining of the sidewalk on both sides of planted pits is not enough for comfortable pedestrian movement which in turn force them to walk on the vehicular asphalt part of street (Fig. 4A). Second, the sizes of tree pits in these sidewalks are much smaller than the minimum practical pit sizes, which is about 1.5 m [7]. Accordingly; root behavior of planted trees usually have their dramatic negative effects on the pavement structure (Fig. 4B). Third, due to the narrow strips of the side-walks that is usually much smaller in width than the canopy size of an average grown tree and because of the tendency of a tree to lean toward the source of light away from the adjacent property walls causing a severe bending of the trunk over the years, a gradual damage of pavement structure, and finally blocking pedestrian movement and adjacent traffic lane

(see Fig. 5).

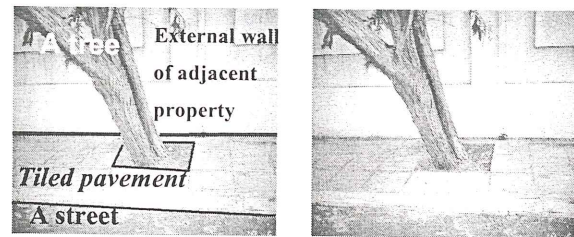
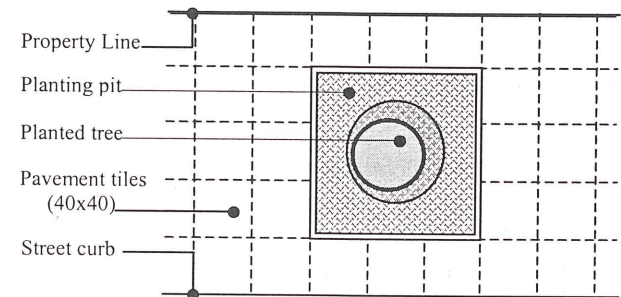


Fig. 3: Layout of the pavement and tree pits in the majority of sidewalks in Local and Distributor Streets.

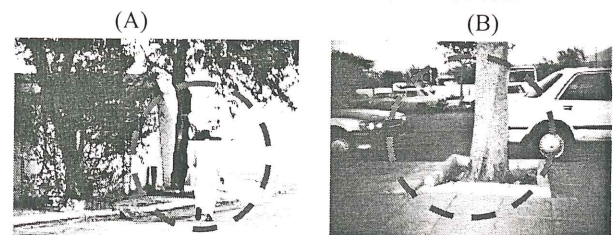


Fig. 4 Zizyphus spina usually fills up the space on the side-walks preventing pedestrians from using them (A), they also have their dramatic remark on pavement and structures (B).

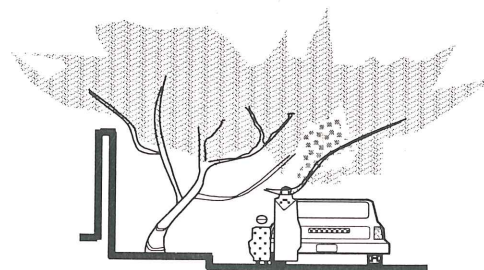


Fig. 5 Because of the narrow space available for trees in the sidewalks and because of the pit size, average size trees usually lean towards the streets, which led to blocking pedestrian ways and sometimes-adjacent traffic lanes.

Prosopis spp., *Pithecellobium dulce* and *Zizyphus spina* are the most common trees planted in sidewalks in Local and Distributor Street patterns. The characteristics of these trees are worth mentioning to know the immediate effects of the outcome on this pattern.

1.3.2 Streetscape pattern no. 2: main street

Main streets were among the first to be streetscaped in Riyadh. The widths of the majority of sidewalks in Main Streets are between 2.40 m to 2.80 m (about 29.4%) and between 1.20 m to 2.00 m (about 26.5%). Also, middle island's widths fell in the range of above 2.80 m (about 41.2%) and between 2.40 m to 2.80 m (about 32.4) (see Table 2).

Table 2. Main streets middle islands' width

Width of Middle island	Existing Percentage/%
< 1.2 m	0.0
1.2 m to 2.0 m	11.8
2.4 m to 2.8 m	32.4
> 2.8 m	41.2
Missing or Not applicable	14.6
Total	100.0

Field study found that 73.5% of the planted streets have plants in their middle islands. On the other hand, there are some trees planted on the side-walks of this pattern (see Fig. 6). Survey showed that 26.5% of main streets have trees in their side-walks. The main reason for having low percentages of streets with trees in their side-walks is that because these streets are classified as commercial streets with commercial activities on their sides and trees are not planted to avoid blocking the view to those commercial activities.

Shrubs grasses are planted between palm trees in a planting ditches. Planting in sidewalks, when existed, is almost done in same planting pits sized $1.2 \times 1.2 \text{ m}^2$. Among the plant species, palm trees are the most popular in this pattern. This study found that 72 % of the streets in this pattern have palm trees in their middle islands. It became a tradition in the city to plant

palm trees in middle islands.

There are some advantages of planting palm trees in middle islands. Palm trees, because of their shapes, have ornamental landscape design values as large-scale vertical definers used repeatedly in courtyards, entry spaces and boulevards [8]. Because the main function of middle islands is to separate the two opposite traffic directions in streets, palm trees are used as physical definers, creating vertical dimension to space and adding aesthetic values to streets (see Fig. 6).

1.3.3 Streetscape pattern no. 3: main road

Simple anatomy of a Main Road can reveal the main components which include one main middle island separating the two different traffic directions of the road, two secondary middle islands separating the main traffic lanes from service lanes of each direction, and two side-walks (see Fig. 7). The Majority of main middle islands are wider than 3 meters (about 57%) while about (29%) fell in the range between 2 m to 3 m in width. Sub middle islands on the other hand fell in the range of 1-2 meters in width. Sidewalks also vary in width with the majority falls in the range of over 3 m (about 57%).

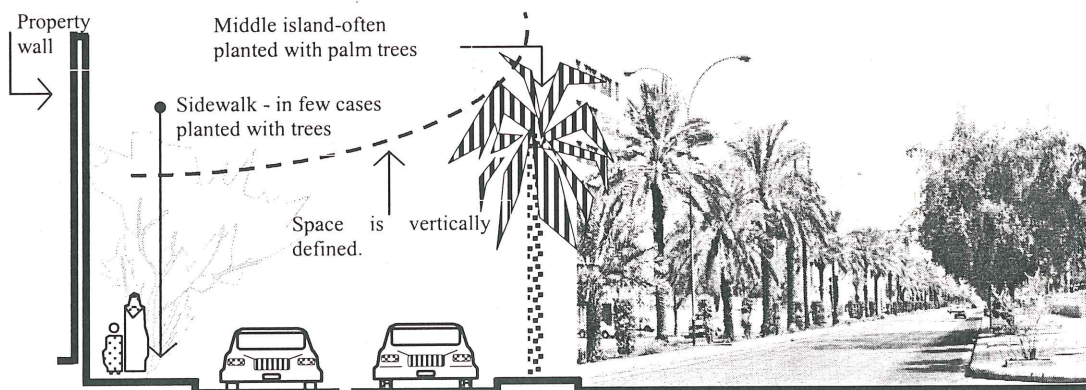


Fig. 6 Conceptual illustration of the detected planting pattern of the Main streets

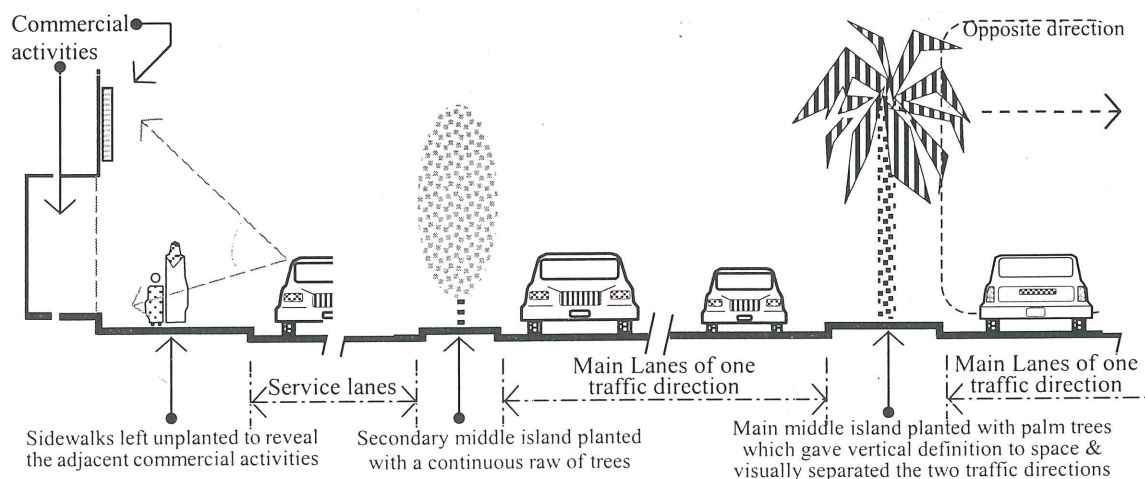


Fig. 7 Conceptual illustration of the detected streetscape pattern of the Main Roads

Streetscape in this street type consist mainly of planting trees on pavement. Trees in this pattern were mainly planted in the middle islands. Because these roads were classified as major commercial and traffic arteries in the city, sidewalks were purposely left unplanted to accommodate the commercial activities on the sides (see Fig. 7). In main middle islands, palm trees were the most common trees used. About 80% of the roads have palm trees in their main middle islands (see Table 3). Secondary middle islands, on the other hand, were planted mainly with *Pithecellobium dulce* and *Prosopis* spp. (see Table 3). Few other tree species were used with low percentage of occurrence. Both of these two most used trees species develop an awkward branch structure that grows straight from the main trunk which easily exceeds the width of the secondary islands (1.20 m to 2.00 m) to the adjacent traffic lanes on both sides of the islands.

Table 3. Occurrence of different tree species planted in Main Roads

Name of trees	Ratio of roads planted/%	Planting place
Palm trees-Phoenix dactylifera	80	Main middle island
<i>Pithecellobium dulce</i>	60	Secondary middle island
<i>Prosopis</i> spp.	40	Secondary middle island
<i>Delonix regia</i>	20	Secondary middle island
<i>Albizia lebbek</i>	20	Secondary middle island

The planting pattern of this street category has several advantage and disadvantages. Among the advantages are: the use of palm trees in main islands that gave vertical definitions to the wide open road and provided visual separation between the two traffic directions; Trees in both main and secondary islands created a visually controlled corridor in each of the main lane traffic directions as seen in Fig. 7; and finally, trees of the secondary islands create physical separation between the busy main traffic lanes in the middle of the road and the active service lanes on the sides. In fact, the trees of the secondary middle islands provided spatial and functional separation of the different sections of the road (see Fig. 7). The planting pattern of this street category has several advantage and disadvantages. Among the advantages are: the use of palm trees in main islands that gave vertical definitions to the wide open road and provided visual separation between the two traffic directions; Trees in both main

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1.3.4 Streetscape pattern no. 4: highway

This pattern could definitely be classified as the simplest street planting pattern in the city. The survey found that trees only planted in the middle island of the Highway (see Fig. 8). In some cases, trees are planted in the secondary islands around and under over-passed bridges and exits. There are no systematic pattern that can be detected. Planted middle island is a continuous concrete edge island higher than the road level with about 90 cm and filled with good planting soil.

The most common tree species used in this pattern is Palm trees-Phoenix dactylifera. Palm trees are planted in the middle of the island. Sometimes, other tree species can be seen planted between the palms with no specific pattern. Small shrubs were found to be planted on both sides of the palm trees.

2. Conclusion and findings

Although the city of Riyadh has a wide variety of street sizes and shapes and the differences in planting techniques and species from one planting stage to another, field study detected four patterns of streetscape existed in the city streets. Streetscape patterns were strongly related to street sizes, shapes and functions. As a result of the study, It could be said that streetscaping of the city streets were done for the purpose of beautifying the city and give it the green look with no or little considerations for the water problems, the climatic conditions, and or the available public spaces. Trees as the most important element in

streetscaping were used extensively in shaping streets and spatially define their spaces. Street planting also provided aesthetic value to streetscape and either enhance view field, creating corridors, or sometimes block views that are essentials for the safety of drivers.

The discussion will summaries the study findings and recommendations:

An urgent review of the planning and street design policy need to be done to consider creating a sensible public spaces that can accommodate functional and beautiful streetscaping. Among the disadvantages of this pattern are: shapes and forms of selected trees for the secondary island are

Considering heat and low water tolerant tree species in planting streets.

Utilize trees and other streetscape elements to serve as a tools to make streets more alive and full of functions.

Planting trees in streets must consider variety of tree species to give different characters and provide for different uses and advantages. Planting must not relay on one specie even in planting one street because such policy could represent a very critical risk for the planting program when a disease attacks or when climatic changes occur.

In selecting trees for street planting, it is very important to consider the root behavior of the selected species. Some trees species were found to have an invasive root system that damages the pavement and nearby structures.

Tree shapes play important roles in street planting. Lower branches of large and medium size trees, such as *Prosopis* and *Pithecellobium dulce*, must be removed to allow for pedestrians circulation and to provide shade. In narrow strips, such as side-walks in Local Streets and secondary middle islands in Main Roads, it is recommended to plant trees with upright oval shape crown not a shrubby or wide umbrella like crown trees.

The study took a step forward to highlight some of the streetscape issues in desert cities such as Riyadh. It is believed that the topic is worth the effort especially

when dealing with a multi profession issue such as planning streets in large and arid cities. Further studies need to be done to cover other related issues that this study could not cover in order to come out with a complete vision in regard to proper streetscaping for planning of city streets.

References

- 1 Abdul Rahman, Abdullah. . Altarweeh in the Arab Cities. In the sixth symposium of the Arab Cities Organization. Al Doha, Qatar: the Institute for Developing the Arab Cities, 1980.
- 2 Al Zagt, Mueen F. Dallel Zraet al Nabatat fi Mantagat al Riyadh. (in English: Guide to Planting in Riyadh Region). Riyadh: Saudi Arabia, King Saud University, 1989.
- 3 Bradshaw, A., Hunt, B. & Walmsley, T. Tree in the Urban Landscape: Principles and Practice. London & New York: E & FN Spon, 1995.
- 4 Ebenreck, Sara. "The Values of Trees." Shading Our Cities, Resource Guide for Urban and Community Forests, Edited by G. Moll and S. Ebenreck. Washington D.C. and Covelo, California: Island Press, 1989.
- 5 Krieg, John C., Sappington, Nancy R.H. and Sappington, Charles. Desert Landscape Architecture. New York: CRC Press, 1999.
- 6 Hough, Michael. City Form and Natural Process: Toward a New Urban Vernacular. London and New York: Routledge, 1989.
- 7 Miller, Robert W. "The History of Trees in City." Shading Our Cities, Resource Guide for Urban and Community Forests, Edited by G. Moll and S. Ebenreck. Washington D.C. and Covelo, California: Island Press, 1989.
- 8 Municipality of Riyadh. Al Tashjeer wa al Tajmeel fi Madinat al Riyadh. (in English: Greening and Beautification of the city of Riyadh) A municipality report. Riyadh: Saudi Arabia, Municipality of Riyadh, 1990.
- 9 Palgrave, William G. Personal Narrative of a Year's Journey through Central and Eastern Arabia. London: McMillan, 1868.
- 10 Pregill, Philip. and Volkman, Nancy. Landscapes in History, Design and Planning in the Western Tradition. New York: Van Nostrand Reinhold, 1993.
- 11 Zion, Robert L. Trees for Architecture and Landscape. New York and London: Van Nostrand Reinhold, 1995.
- 12 Zube, E. H. "Trees and Woodlands in the Design of the Urban Environment." Trees and Forest in an Urbanizing Environment. Planning. Research. Development. Service. No. 17. Amherst, Massachusetts: University of Massachusetts Press, 1971.