MAPPING PEDESTRIAN ACCESSIBILITY AND THE QUALITY OF WALKING IN AN AFRICAN CITY: PRAIA, CAPE VERDE

Paulo Anciaes¹, Judite Nascimento² and Salif Silva³

Abstract

Urban areas in lower middle-income countries face specific challenges in mobility and accessibility. As cities expand in area and income grows, centres of attraction become dispersed and dependence on motorised transport increases. In this context, walking may be regarded as a residual activity, of lower priority to urban policy. However, insufficiencies in the walking environment in some neighbourhoods may reduce physical activity and restrict the accessibility of some groups to jobs and services. Planning for walking is then an important instrument for promoting public health and social equity. This paper analyses walking conditions in the capital of Cape Verde islands. It contributes to the literature on walkability by measuring indicators relevant to cities in developing countries and to fast-growing African cities in particular. The indicators measure the availability of destinations accessible on foot and the quality of walking trips in each neighbourhood. These types of measures are a useful tool for policy-makers to identify areas with particular problems of pedestrian mobility. When analysed alongside the income level and the degree of urban consolidation of each neighbourhood, the measures also provide insights into how mobility problems relate with social exclusion and with land use policies.

1. Introduction

Walking is a healthy activity, facilitates social interaction, and has a low environmental impact. The recognition of these benefits has lead policy-makers around the world to implement transport and urban policies that promote walking. The identification of the specific obstacles to walking in each location is an important component of those policies, because there is evidence that the propensity for walking is associated with the characteristics of the local built environment (Owen et al., 2004; Heath et al., 2006; Saelens and Handy, 2008). With that intent, researchers have been producing a large number of indicators of walkability, based on aspects such as accessibility to specific destinations (Kuzmyak et al., 2006; Iacono et al., 2010), land use mix (Frank et al., 2005) and street layout (Porta and Renne, 2005; Parks and Schofer, 2006; Neckerman et al., 2009).

¹. University College London, London, United Kingdom. p.anciaes@ucl.ac.uk
². University of Cape Verde, Praia, Cape Verde. judite.nascimento@adm.unicv.edu.cv
³. University of Cape Verde, Praia, Cape Verde. salif.silva@docente.unicv.edu.cv
To what extent are these aspects relevant to the case of a semi-arid, post-colonial, middle-income, fast growing African city? These are the characteristics of Praia, the capital of Cape Verde islands, which is the focus of the present study. The objective of the paper is to specify and estimate a set of indicators of walkability adapted to the specific context of this city and similar African cities. The paper contributes to the walkability literature by analysing a context that is considerably different from the one of North American cities, the object of the vast majority of the studies in this field.

Many African cities have grown from settlements established during the colonial period, in locations that benefited the colonial political and economical structure. As cities expanded, they started to cover nearby areas, where life in general, and mobility in particular, are in many cases limited by the relief and environmental risk. The areas with the most severe geographic limitations tend to be occupied informally by the poorer households.

Urban growth in developing countries also shows a tendency to be accompanied by rapid decentralization (Cervero, 2013). The widening of the distance between residential areas and centres of attraction reduces the opportunities for walking. At the same time, growing income leads to higher car ownership and usage rates. The growth in road traffic demand is accommodated in new road infrastructure where priority is given to motorised modes of transport (De Langen, 2005). The negative impact of road infrastructure and traffic on pedestrians in developing countries has long been identified (Vasconcellos, 2000) but a few recent studies have started to analyse the impacts on specific aspects such as pedestrian movement (Bradbury, 2014; Mfinanga, 2014) and safety (Tulu et al., 2013; Amoako 2014) in African countries.

The type of destinations people access on foot is also different from the case of developed countries. For example, (Oyeyemi et al., 2013) included access to building materials shops, food canteens, and wells in his study of perceived walkability in Nigeria. However, we argue that in cities in developing countries and hot climates, where large parts of the urban space is informal, the object of analysis should go beyond the activity of walking as movement and consider outdoor life in general. This perspective accounts for the large proportion of people in those cities who work outdoors (such as street vendors), and for the relevance of social interactions in public spaces near homes and workplaces. There is also evidence that the propensity for walking and spending time outdoors are related to social aspects such as safety from crime (Rech et al., 2012; Villaveces et al., 2012; Oyeyemi et al., 2012).

Restrictions to walking are especially relevant in African cities, due to the overreliance on walking and the limitations of the public transport supply. Those restrictions may limit access to employment and services for woman (Porter, 2008) and poorer households (Olvera et al., 2013) and have an impact on the quality of life of the elderly (Olawole and Aloba, 2014). However, concepts used in developed countries in the discussion of transport disadvantages may need to be adapted. Lucas (2011) argues that concept of social exclusion discussed during the last decade in developing
countries, needs to take into account that transport poverty in developing countries is a problem of the majority, rather than a minority of the population. The concept of environmental justice, understood as the fair distribution of the negative effects of transport, also needs to be translated to the African context, as documented in a case study in Nairobi by Becker (2012).

This paper studies walkability taking into account the specific circumstances of fast-growing African cities and the need to produce evidence about walkability dimensions and policy concepts that have previously been applied developed countries. The analysis consists in the estimation of indicators at the level of the neighbourhood, considering aspects related with the availability of destinations for pedestrians (people, jobs, shops, services, leisure areas, and bus stops) and the quality of the walking trips (availability of public space, formal public space, safety from crime and motorised traffic, relief and flood risk). The indicators are analysed in relation with the average income and the degree of urban consolidation of each neighbourhood.

The next section is a brief overview of the case study area. Section 3 describes the methods used to estimate the indicators and Section 4 analyse their distribution across the different neighbourhoods. Section 5 reviews the lessons learnt.

2. Praia

Praia is the largest city in Cape Verde, with 130,271 inhabitants at the time of the 2010 census, representing 26.5% of the country's population. The city has been growing fast, increasing 2.5 times since 1980. This growth has lead to the urbanization of the plateaus and hills surrounding the original settlement in a plateau near the port (Figure 1). Due to geographic restrictions and to the fast and haphazard growth, the urban space is now fragmented and centres of attraction are no longer concentrated in the original settlement but dispersed throughout the city. However, some neighbourhoods have virtually no jobs or local services.

Transport is a pressing issue in the city. According to the 2010 population census, only 19% of the households have a private vehicle. However, the figure varies between 2% and 89% - unsurprisingly, in the least and most affluent neighbourhood of the city respectively. The bus network is limited and does not reach some of the poorest areas of the city. Some neighbourhoods are at a distance of several km of the nearest bus stop. The role of shared taxis for intra-urban travel is relatively small, unlike in cities in low-income countries. Walking is therefore the main means of transport available in some areas.
Walking is restricted by the hot, dry climate and by the location of the neighbourhoods in hills and plateaus. There is also a general lack of formal public space in the city. Outside the historical centre, public squares and green spaces are rare. Urban parks make up only 1.4% of the urban space (CMP, 2013, Part B-01). Despite these limitations, walking is an important leisure activity, shared by different age and socio-economic groups, especially in the areas near the waterfront in the early morning and evening.

The local government has started to implement policies to improve pedestrian mobility during the last decade. Priority was first given to formal neighbourhoods, with projects to repave or pedestrianise parts of the historical centre. Recent policies have also covered informal areas, including street pavement, addition of pedestrian pavements and crossings and provision of equipment such as outdoor sports grounds and fitness parks. Despite the improvements, the tendency for the formalization of urban space has led to some tensions, as it impacts on the livelihoods of groups such as informal traders (Pólvora, 2013).

Due to the growing awareness about issues of spatial equity and the role of walking in well-being, there is a need to identify the areas of the city at disadvantage in terms of walking conditions. This assessment is particularly important in Praia due to the diversity of land use patterns and socio-economic characteristics in the various neighbourhoods, with differences between the more and less urbanized areas and between the affluent and economically-deprived areas. The approach of this paper is then to analyse indicators of walkability in relation to two variables: average income and degree of urban consolidation of each neighbourhood.
The left part of Figure 2 shows average income per neighbourhood, using data from the 2010 census. The neighbourhoods with higher income are the historical centre and surrounding areas and the waterfront districts in the southwest part of the city. The neighbourhoods with the lowest income are the ones in the west and east fringes of the city. Income levels are highly variable: the income in the richest neighbourhood is 4.4 times higher than the income in the poorest neighbourhood.

Figure 2: Income and degree of urban consolidation

The degree of consolidation of a neighbourhood is defined as the ratio between the urbanized area and the area considered feasible for urbanization. Figure 3 illustrates the distinctions between those areas. The unfeasible area was extracted from the map of the Praia Municipal Master Plan and includes for example areas with ecological

Figure 3: Feasible space and urbanized space
value or with severe environmental restrictions to man-made uses. The urbanized area includes buildings and other types of man-made land uses. These land uses were classified into private and public space. Buildings were identified in a geographic dataset containing all the buildings in the city, provided by the Praia Municipal Government. Other land uses were identified in a variety of official maps and in orthophotos such as the one in Figure 3, also provided by the municipal government.

The map with the estimated degrees of consolidation in the right side of Fig.2 shows that the historical city centre and the geographic centre of the city have the highest values. The values become lower as we move towards the fringes of the city.

3. Methods

The unit of analysis is the neighbourhood ("bairro") as defined by the Cape Verde National Statistics Office. Neighbourhoods with less than 50 people were excluded. The remaining set includes 42 neighbourhoods. The indicators are divided into two groups, measuring the availability of destinations for pedestrians and the quality of walking trips.

3.1 Availability of destinations

The first indicator measures access to people. This indicator is included in the analysis as walking and outdoor life in general have an important role in the vitality of local social networks (Du Toit et al., 2007). Theoretically, areas with lower population density are less attractive to walking trips to meet people. In this paper, the indicator of access to people is the ratio between the resident population and the area occupied with man-made land uses.

Access to jobs is the ratio between the total number of jobs and the area with manmade land uses. The calculation of the number of jobs was based on the information in a dataset listing all the private companies in the city, provided by the National Statistics Office. The data does not include the number of people employed in each company. A second dataset provided the total number of employees in each sector of activity in the city. In a first stage, this number was divided equally by the number of companies in that sector. Corrections were then made to account for large companies, using local knowledge. The address of each company was linked to a neighbourhood and the jobs in each sector were summed up. Jobs in public services were then added, using information collected from each institution and a variety of other sources.

Access to shops is the ratio between the number of retail shops and the area with man-made land uses. The number of shops was calculated from the private companies dataset, considering companies in the retail sector. Branches of the largest supermarket chain in the city were assigned a factor of 3; other supermarkets were assigned a factor of 2. Other shops were assigned a factor of 1.
Access to services is a composite index measuring access to three types of services: administrative services, health and education. The locations of these services was identified in a variety of official sources. The density of the three types of services in each neighbourhood was first calculated. The values obtained were then used to rank the neighbourhoods in an ordered scale. Neighbourhoods with no services were ranked according to the decreasing order of the distance from the area with the centroid of its built-up area and the nearest service. The positions in the three ranks were then combined to derive an overall rank of access to services.

Access to leisure is ratio between the area of recreation places and the total area with man-made land uses. The recreation places considered were pedestrianized streets, squares and public gardens, green spaces, promenades along the waterfront, beaches and outdoor sports grounds and fitness parks. The identification of these places was based on local knowledge. Fieldwork was necessary to identify the exact areas available to pedestrians when it was not clear from the observation of orthophotos. This was especially the case of areas on the waterfront. Areas where pedestrians share the same space with motorised vehicles in formal roads were excluded. Neighbourhoods with no leisure areas were ranked according to the decreasing order of the distance to the nearest area.

Access to bus stops is the ratio between the number of bus stops and the area with man-made land uses. The location of bus stops was identified by fieldwork and refers to the situation in December 2013. The ongoing re-organization of bus services may lead to changes in the location of bus stops, as some bus lines may be added or removed from the network. Pairs of bus stops on both sides of the road in the same location were treated as one bus stop. Neighbourhoods with no bus stop were ranked according to the decreasing order of the distance to the nearest bus stop.

2.2 Quality of walking

The assessment of the quality of walking includes indicators derived from the classification of public spaces and other indicators based on data on the social and natural environment.

Pedestrian space is defined as the share of public space that can be used as a link for pedestrian movement or as a place for social interaction. The need to recognize these two functions of public space has been increasingly recognised by researchers (Jones et al., 2007). The space available to pedestrians in fast-growing cities in developing countries is considerably higher than in cities in developed countries, as the space occupied by unpaved streets in informal areas is shared by pedestrians and motorised vehicles. Figure 4 illustrates the distinction between informal (unpaved) streets and formal (paved) roads and streets, where pedestrian space is limited to pedestrian pavements. The set of pedestrian spaces considered in the construction of the indicator then contains streets and open spaces in informal areas and pedestrian pavements and public squares and gardens in formal areas. The carriageway of formal roads and streets is not considered pedestrian space. The indicator of pedestrian space is the ratio
between the area of this space and the area with man-made land uses in the neighbourhood.

Figure 4: Pedestrian space

*Formal* pedestrian space is the proportion of the areas occupied by pedestrian pavements and public squares in the total (formal and informal) pedestrian space, as defined in the previous paragraph.

The indicator of *traffic safety* is the ratio between the area of carriageways in formal roads and area with all man-made land uses in each neighbourhood. The assumptions are that roads create a barrier to the movement of pedestrians and that this effect depends on the total length of the roads crossing the neighbourhood and on the width of these roads. The barrier effect of road infrastructure and motorised traffic on pedestrians has long been recognised (Appleyard and Lintell, 1972). A recent article by Bradbury (2014) suggests that the effect is also relevant in the African context and should be the object of further research and policy interventions. In the current paper, the width of the road is treated as an indicator of the level of motorised traffic. The widths of all roads in Levels 1 and 2 of the hierarchy defined by the municipal government were measured individually. The widths of roads in Level 3 were measured in a sample of roads, and the average used for all roads in this level. Only the road sections crossing the space with man-made land uses are considered, as defined in Section 2, as it is assumed that pedestrians do not need to cross roads in natural areas.

The indicator of *personal safety* uses published crime data (CMP, 2013). The number of crimes is divided by the residential area of the neighbourhood. The indicator is included in the analysis because crime is an increasing concern in the city (Zoettl,
2014) and its incidence is highly variable among neighbourhoods (Pina et al., 2011). The set of 20 neighbourhoods with data also covers a mix of values for the two reference variables (income levels and degrees of urban consolidation).

Terrain is an indicator of the relief, calculated as the average slope in the pedestrian spaces of each neighbourhood. The data on slopes was provided by the municipal government.

Safety from environmental risk is the ratio of the area of all pedestrian spaces that are located inside regions considered as prone to flooding or landslides. These regions were identified in the Praia municipal master plan (CMP, 2011).

4. Results

The results are analysed based on the positions of the neighbourhoods in the ranks of the two reference variables and of the twelve indicators of walkability. The bubble charts in Fig. 5 and Fig. 6 represent respectively the indicators of availability of destinations for pedestrians and of quality of walking trips. In each chart, the two axes measure the position of the neighbourhoods in the ranks of average income and degree of consolidation. The further to the right a data point is, the higher the income; and the further up, the higher the degree of urban consolidation. The size of the bubbles is inversely proportional to the position of the neighbourhood in the rank of the indicator represented. Bigger bubbles mean better conditions for walking, as measured by that indicator.

4.1 Availability of destinations

The distribution of levels of access to people has a pattern different from the other indicators of availability of destinations for pedestrians, as the neighbourhoods with the best position are not the ones in the upper half of the income and urban consolidation ranks. In this case, the neighbourhoods with the best position are those with lower income located in more consolidated areas. This finding is consistent with the spatial patterns found in many cities in developing countries, where populations densities are high in low-income areas near the centre, but not in low-income areas at the fringes of the city. The neighbourhoods with the worst position are those with higher income in less consolidated areas. This finding reflects the low population densities in upper-end newly urbanized areas in the western extreme of Praia, which include some isolated gated communities.

The distribution of other pedestrian destinations follows a similar pattern. Access tends to be higher in areas with higher income and consolidation, and lower in areas with lower income and consolidation. The inequality between these two sets of areas is especially visible in the case of access to jobs and to services. The distribution of access to bus stops is the most equal, as the neighbourhoods with the best position appear near the centre of the chart.
The areas with higher income and lower degree of consolidation fare relatively well in terms of access to jobs, services, and bus stops, although a few of the neighbourhoods in these areas are near the bottom of the rank. The number of neighbourhoods near the bottom in these areas is higher in the case of access to shops and leisure areas. The areas with lower income and higher degree of consolidation tend to be in the middle of the rank for all types of access.

4.2 Quality of walking

The indicator of pedestrian space shows a clear pattern where neighbourhoods with lower income and lower degrees of consolidation come first in the rank. The rest of the districts are ranked according to a regular order: neighbourhoods with higher income and lower consolidation, with lower income and higher consolidation, and finally with higher income and lower consolidation.

As expected, the indicator of formal space is higher in neighbourhoods with higher degree of consolidation, especially the ones with higher income. A few of neighbourhoods with the best position in the rank are low income but almost all the neighbourhoods in the bottom of the rank are low-income.

The indicator of traffic safety shows the clearer pattern of all indicators, as the best positions in the rank are consistently located in the lower-bottom quadrant, representing neighbourhoods with lower income and located in areas with lower degrees of consolidation. This pattern contradicts the results obtained in most of the environmental justice analyses in cities in developed countries, where a link tends to be found between the incidence of risk and nuisances from transport and other urban activities and the levels of economic deprivation of the exposed populations (Braubach and Fairburn, 2010; Deguen and Zmirou-Navier, 2010). The areas with the second best position are still areas with lower-income, but located in more consolidated areas. The neighbourhoods with higher income in less consolidated areas come next and the areas with high income in more consolidated areas come at the bottom of the rank.

The chart for personal safety includes only the 20 neighbourhoods for which crime data was available. The bubbles were drawn at the same scale as the ones for other indicators, that is, the smaller and the bigger bubble have the same size as in other charts. The distribution of the indicator does not follow a clear pattern, although the highest positions occur in higher-income neighbourhoods.

The values of the terrain indicator also show a clear order, where higher-income areas have better positions, regardless of the degree of consolidation. Lower-income areas have positions near the bottom, especially in less consolidated areas. This finding is consistent with the usual pattern of residence location of poorer households in hilly areas in many fast-growing cities in developing countries.

On the other hand, areas with low income and lower urban consolidation have the best positions in terms of safety from environmental risk. The worst positions in this
ranking are nevertheless occupied by lower-income neighbourhoods located in areas with lower degrees of consolidation.

Figure 5: Availability of pedestrian destinations, income and urban consolidation
Figure 6: Quality of walking, income and urban consolidation
4.3 Synthesis

The results of the twelve charts indicates that no type of neighbourhood is systematically at disadvantage in terms of all dimensions of pedestrian mobility. Lower-income neighbourhoods in less consolidated areas tend to occupy hilly areas and be at disadvantage in walking access to most pedestrian destinations (jobs, shops, services, bus stops and leisure areas). However, these areas have the highest availability of pedestrian space and are the least affected by risk posed by motorised traffic. Lower-income neighbourhoods in more consolidated areas are the most affected by environmental risks but have the best access to social networks. Higher income neighbourhoods in less consolidated areas have the worst access to social networks but the best geographic conditions for walking, both in terms of terrain and safety from environmental risk. Higher-income neighbourhoods in more consolidated areas have the least availability of pedestrian space and the highest exposure to motorised traffic, but also the best walking access to all types of destinations except social networks.

The two maps in Fig.7 illustrate the spatial dimension of the patterns found. The maps show the position of each neighbourhood in the combined ranks of the six indicators of availability of destinations and the six indicators of quality of walking trips. The availability of destinations is higher in the original settlement of the city, the geographic centre, and residential areas in the west and east. Suburban areas at the fringes tend to perform worse. In contrast, the quality of walking is better in the fringes of the city. Central areas are in the middle of the scale and the areas faring the worst are small neighbourhoods scattered across the city.

5. Conclusions

This paper assessed the availability of destinations for pedestrians and the quality of walking trips, measured by indicators take consideration the specific context of a fast-growing African city. The indicators were constructed based on variables of the natural and built environment and the analysis related the indicators with income levels and
degree of urban consolidation of the neighbourhood. The results show that walkability is highly variable and there are no areas of the city and social groups systematically at disadvantage. Walking access to jobs, shops, services, bus stops and leisure areas tend to be higher in higher-income neighbourhoods in more consolidated neighbourhoods. However, other neighbourhoods have advantages in terms of access to people, availability of pedestrian space, and exposure to motorised traffic.

These results have implications for public policy in Praia, which can be generalized for similar African cities. There is a clear split between the obstacles faced by pedestrians in areas with different incomes and degrees of consolidation. Policy interventions to remove those obstacles apply to all the neighbourhoods with similar characteristics in terms of those two variables. For example, in neighbourhoods with low income located in less consolidated areas, the priority is the application of economic and land use policies to increase the number of jobs and facilities within walking distance of residential areas. In neighbourhoods with low income located in more consolidated areas, transport, land use, and housing policies are needed to reduce the number of trips using routes that cross areas with environmental risk. High-income neighbourhoods in less consolidated areas require measures to reduce the dispersion of the population. In high-income neighbourhoods in more consolidated areas, the measures are similar to the ones applied in similar neighbourhoods in developed countries, such as the redesign of streets to increase the space available for walking and outdoor life, and traffic restriction measures to reduce the risks posed by motorised traffic.

However, the identification of the measures suitable to each place requires further information, calling for additional research. The analysis in this paper provided a general assessment of the relative positions of each neighbourhood in several dimensions of walkability. This approach allows for a characterization of the disadvantages of each neighbourhood in relation to the rest of the city. However, the definition of policy priorities should also take into account the conditions of each neighbourhood in relation to what society regards as minimum standards. Variations within each neighbourhood are also relevant, as obstacles to walking may be felt only in a small part of the neighbourhood. Finally, policy-makers must consider people’s perceptions about the different dimensions of walkability and how they relate with the objective values measured by methods such as those recommended in this paper.

6. Acknowledgements

The authors wish to thank José Carlos Borges (National Statistics Office) and José Constantino Veiga and (Praia Municipal Government) for providing access to some of the data used in this study.
7. References


Heath, G. W.; Brownson, R. C., Kruger, J., Miles, R., Powell, K. E., Ramsey, L. T., 2006. The effectiveness of urban design and land use transportation policies and practices to increase physical activity. Journal of Physical Activity and Health, 3(S1), pp.55-76.


