Exploring the neighborhood walkability aspects and their interaction with the urban environment. The case of a residential neighborhood in Athens city centre

Abstract

This paper has a two-fold focus. Firstly, to map and assess the basic pedestrian accessibility infrastructure in a larger residential neighborhood and secondly to investigate the factors influencing the human movement patterns that occur in these areas. The study area is Koukaki, a neighborhood in Athens’ municipality, mainly because of its considerable land use mix and its proximity to the Athens’ central core. Furthermore, this area has shown a rapid urban transformation during the recent years. The methodology framework consists of four stages: a) Evaluation of the pedestrian accessibility of the neighborhood giving emphasis on vulnerable users, b) Selection of a centrality meaning a place of dense human activity, c) collection of qualitative and quantitative data of pedestrian flow and d) interpretation of the results. The specification of the main study area is based on the existing land use pattern (high values of non-residential uses). The records of the pedestrians’ flow concern the streets of the main study area for different times of day and for different days of the week. This decision contributes to the revelation of the multiple identities of the city and its different users. Finally, the interpretation of measurements takes into consideration the land-use pattern and the pedestrian infrastructure. The results showed that human flows have positive correlation with commercial, though negative with residential activities. In addition, they present positive correlation with network centrality (space syntax), sidewalk width and functional density (land-use density). Regarding accessibility, it should be mentioned that pedestrian movement cannot be adequately sustained in Koukaki. This research is considered as an important step for analyzing central areas, pedestrian flows attracted and the interaction between them.

Keywords: Walkability, Network Centrality, Spatial Analysis, Public Space, Pedestrian Flow, Centralities

1. Introduction

City is the spatial setting of society and "the place where all kinds and classes of people are mixed so as to produce a common, though constantly changing and ephemeral life" (Harvey, 2012), forcing this heterogeneous ensemble to interact (Sennet, 1977). It constitutes a place of exchanges, activities, communication and a place of collective and organized life. The essential feature of the city is therefore concentration and coexistence (Lefebvre, 2007). Cities, as complex entities, consist of many different urban processes and one of the most notable is the everyday urban mobility which is strongly related to human activity. An average daily routine consists of a multitude of different activities and in order to be carried out, movement is a necessity in contemporary urban environments.

Walking is a fundamental aspect of this process since it’s the most basic, almost primitive, way of urban mobility, is free of charge, allows you to interact in the surrounding urban and social
environment and enables practices of encounter and exchange (economic, social etc.) in public space. That is the reason why, infrastructure that ensures pedestrian accessibility to every citizen - including persons with reduced mobility- is of utmost importance for a city. Especially in the car-driven Athenian urban environment which pedestrian movement is defined and constrained, to say the least, by the intense vehicular traffic. In other words, the ability to walk safely and comfortably is at the core of a socially and spatially just city. However, as Speck indicated in his book “Walkable City” (2013), “walk has to satisfy four main conditions: it must be useful, safe, comfortable, and interesting” and while walkability infrastructure address two of these conditions (comfort and safety), additional walkability aspects come into play when we are considering recreational and utilitarian walking. In this context, this paper has a two-fold focus. Firstly, to map and assess the basic pedestrian accessibility infrastructure in a larger residential area, and secondly to investigate the factors influencing pedestrian movement that occur in places crucial for pedestrian activity and specifically in a centrality cluster with dense human activity.

Regarding the structure, the paper consists of five sections, which are then sub-divided into individual entities. The second section contains all the theoretical background of the research. In the third section, we describe the dataset used in the research analysis and the methodological steps followed. The next section contains the various characteristics of the study area, the accessibility investigation and the analysis of the various walkability aspects and their relation to pedestrian movement in the selected centrality cluster. In the last section, we present the conclusions of the research as well as some thoughts beyond the findings.

2. Literature review

Walking is the most elemental mean of people getting around and reaching destinations, experiencing the urban space (Millan, 2009) and accomplishing essential physical activity. Walking is convenient, it needs no special equipment, is self-organized and is inherently safe.

In this context, walkability, which can be described as the quality of urban environment to support and promote safe and pleasant walking for all street users - including people with reduced mobility, women, young children and elderly (Forsyth and Southworth, 2008), has emerged as a fundamental aspect of accessibility and has been investigated in different ways by many scholars (e.g. Axelson et al., 1999; Alfonzo et al., 2008). Walkability is fundamentally a basic human right since is at the core of what is called accessibility and ensures the most basic and almost primitive aspect of mobility, walking, to all citizens. Thus, the necessary infrastructure that supports safe and comfortable walking to all street users is the most fundamental element of the walkable city.

The basic infrastructure sustaining the minimum level of accessibility is the public space of the city, consisting mainly of the road network, sidewalks included, which crucially affects neighbourhood walkability. Thus, this network offers, or rather has to offer, the possibility of direct access and movement throughout the city for all people including people with reduced mobility, meaning sufficient unobstructed sidewalk width, existence of tactile paving and curb ramps, adequate lighting etc. (Mehta, 2007).

However, utilitarian and recreational walking has found to be significantly associated with various urban features, such as street connectivity, land-use diversity and proximity to walking attractors (e.g. transportation facilities, commercial and retail land uses) (Frank, et al., 2005; Cervero, 1996; Cervero & Kockelman, 1997; Owen et al, 2007; Bartzokas-Tsiompras & Photis, 2017. What is more, plethora of studies (e.g Waitt et al., 2019) highlights the crucial significance of walkable

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1 It should be mentioned that pedestrian activity formulates various typologies of pedestrian movement due to the different functional and morphological features of the urban environment (central areas, residential areas, industrial areas, etc.). We chose to focus on central areas as they constitute the most important part of a neighborhood.
accessibility to such destinations. Pedestrian studies has shown that people seek out concentration of other people (Alexander, et al., 1977, p. 164; Geddes & Vaughan, 2014; Marmot, et al., 2010) and are attracted to places that allows them to walk up and down, meet their friends, stroll and browse (Alexander, et al., 1977, pp. 168-173). Thus, a crucial aspect of walkability is walk-accessible place attractiveness (Bieli, et al., 2018; Kang, 2018), meaning the degree to which a place attracts pedestrian movement, and therefore is attractive to pedestrians. A more complete take on street connectivity is proposed by space syntax theory\(^2\), which quantifies the network-based accessibility and attractiveness (Hillier, B. & Iida, S., 2005; Hillier et al., 1993; Penn et al., 1998) of the urban grid and recently has been utilized in numerous walkability studies (Kooohsari et al., 2013; Jabbari et al., 2017; Kooohsari et al, 2016). As it is evident, there are various urban features that affect pedestrian movement, and there are several studies investigating this interaction. In this research we explore how the different features affecting pedestrian movement in a central residential neighborhood of Athens.

3. Methodology

The current methodological framework of the research consists of 8 steps, which are illustrated in the diagram below (Diagram 1). The first step is the selection of the study area. We selected a central neighborhood of Athens, in order to identify and highlight the walkability aspects as well as their interaction with the urban environment in such type of areas. The next step includes the thorough recording of the essential pedestrian infrastructure. Particularly, we examine the following features throughout the study area: (a) sidewalk width, (b) tactile paving and (c) curb ramps.

Then, we proceed to the third step in which we perform a combined evaluation of the basic walking infrastructure, aiming to gain an overall view for the potentials of pedestrian movement. The criteria used for this evaluation are divided into three categories, in order to demonstrate how the range of the network in which one can move as a pedestrian is reduced when correspondingly the person's physical difficulties in walking increases. More specifically, the first category requires the total width of the sidewalk to be equal or exceed 1,5m, since this value allows the smooth movement of a person on the sidewalk. Therefore, this category refers to the service of able-bodied people. The second category requires a) the total width to be at least 1,5m, b) the existence of tactile paving and c) the presence of two curb ramps per sidewalk section. Finally, the third category holds the criteria of tactile paving existence and curb ramps existence, but increases the least total sidewalk width to 2,1m, which constitutes according to the Greek urban planning legislation (Ministry of Environment, Regional Planning and Public Works, 1996) the minimum value for the service of any person and the installation of streetscape features (e.g. streetlamps, trees, etc).

After the evaluation of the pedestrian infrastructure, we proceed to the definition of the main study area. A basic prerequisite is the identification of the central clusters of our neighborhood. At next (step 5), we selected one of the generated central clusters, and the sample streets respectively, as the study area of the research. The criteria for this selection were the size and the shape of the cluster as well as the existence of public transport stop. The sixth step consists of two distinct components. The first component refers to the measurement of the pedestrian flows. In particular, pedestrians were recorded twice during the day (noon and afternoon), both on

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\(^2\) Rooted in graph theory and the idea of urban morphology, space syntax theory (Hillier & Hanson, 1984; Hanson & Hillier, 1987; Hillier et al., 1987; Penn, et al., 1998) describes and measures quantitatively the configurational properties of urban space (visibility, topology, geometry) and its potential to attract human activity and pedestrian movement specifically (Hillier, et al., 1996/2007; Hillier, 1999).
weekdays and on weekends and the measurements in each road segment lasted one quarter of an hour (15’). The second component relates to the examination of urban characteristics and specifically functional features and pedestrian infrastructure (from previous steps).

Regarding functional features, it should be mentioned that we recorded every existing land use of the ground floor, based on the entrance of buildings. Then, we categorized these land uses into 6 categories: 'Residential', 'Open Public Space', 'Commercial', 'Community', 'Workplace' and 'Empty Space'. In more detail, 'Residential' refers to the residential activities found on the ground floor of the sample streets. 'Open Public Space' signifies open spaces such as parks, squares, school courtyards, etc. 'Commercial' refers to uses that meet the needs for commerce or recreation (e.g. commercial shops, cafes, cultural sites). 'Community' refers to the wide range of uses that serve the daily needs of citizens and go beyond the narrow context of commercial uses (e.g. places of worship, healthcare, public or municipal services, education, etc.), 'Workplace', which includes offices, crafts, etc. and 'Empty Space', which contains uses such as permanently closed shops, spaces for renting or abandoned buildings.

In addition to the data extracted from on-site observations, the present study utilizes space syntax analysis in order to obtain better findings for the area. This study focuses on walking accessibility; therefore we selected the syntactic measure of local integration. More specifically, angular integration (Normalized Angular Integration) with low metric radius (800 meters) is undertaken because is considered to be the most powerful tool for measuring accessibility in street networks (Al Sayed, et al., 2014). The 800-metres radius is being selected, as a typical walkable radius that corresponds well with walking patterns (Geddes & Vaughan, 2014).

After the recordings of the urban features, we proceed to the analysis and presentation of results (step 7) by implementing brief descriptive statistical analysis and making some maps in order to gain a view about the geography of the phenomenon. Finally, the last step combines the aforementioned data and investigates possible existing correlations between human flows and urban environment characteristics (utilize of Pearson correlation method). This step allows us to draw conclusions about factors that influence human flows in central neighborhoods area.

Regarding the data, we should note that pedestrian flows data and urban features are derived from on-site observations that took place at the year 2018. The only data obtained from external sources were the digital files of blocks that were retrieved from Hellenic Statistical Authority (ELSTAT).
4. Study area and Results

The study area of the research is the neighborhood of Koukaki, which is located at the western part of the Municipality of Athens and is adjacent to archaeological sites of international importance, such as the Acropolis and the Philopappou Hill. Koukaki is a place with diverse morphological and functional character. More specifically, the central and southwestern part of the area has numerous high-rise buildings (mainly apartments), constituting one of the most densely populated areas in the municipality of Athens. On the contrary, the northern part of the study area which neighbors with the Philopappou Hill, is characterized by an entirely different building morphology and real estate values (lower heights, high values, etc). Throughout the recent years Koukaki is facing a radical transformation from a residential neighborhood with small retail and craft shops into a central area with cultural and recreational activities, mainly during the nighttime. It should be noted that the skyrocketing of Airbnb services in the area and the construction of significant cultural centers in its surroundings such as the Acropolis Museum or the National Museum of Contemporary Art played considerable role towards the aforementioned direction.

4.1. Pedestrian accessibility

Regarding the evaluation of pedestrian infrastructure, we created a combinatorial map which
illustrates the three accessibility categories that were defined in the previous section.

Map 1: Evaluation of pedestrian infrastructure

From the map above, the majority (65.8%) of the sidewalks meet the first requirements, allowing a relatively comfortable movement of an able-bodied person. The percentage satisfying the conditions of the second classification appears to be greatly reduced (9.5% of the sidewalks), meaning that there is a significant absence of the minimum width, which makes walking difficult or even impossible. Finally, the sections of sidewalks that are fully accessible to each category of users are limited in number; they are only 504m (1.9%) in length and are located at the east edge of the study area. It is clear that the study area is unable to meet the requirements for equal and fair accessibility for all. Hence, this situation degrades the walkability of the area, sustaining vehicular movement.

4.2. Centrality clusters

By recording and then mapping the points of interest of Koukaki (Map 2), one can understand how the neighborhood's pedestrian activity articulates. The area is defined by the semi-permeable barrier of Sygrou Avenue, the archaeological site of Olympus Zeus Columns, Philopappos Hill and Kallirois Avenue. The neighborhood's points of interest formulate centrality clusters, either as linear or circular shaped entities of commercial and recreational activities. The first cluster is located along Veikou and Dimitrakopoulou streets in the northeast part of the area between the metro stations of Akropoli and Sygrou-Fix, in great proximity with Sygrou Avenue. On the other hand, the second cluster is located around Zini and Dimitrakopoulou streets in the southwestern part of the neighborhood, being considerably proximal to the National Museum of Contemporary Arts.
Map 2: Centrality clusters of Koukaki

We chose to focus on the southwestern cluster due to its size, its shape and the existence of public transport stop within its boundaries.

4.3. Walkability aspects

4.3.1 Pedestrian Flows

The spatial pattern of the measured pedestrian flows is depicted on the map below (Map 3).
It is clear that some streets in the study area tend to be more “attractive” than other street segments in the network. Precisely, parts A and B of Dimitrakopoulou street illustrate the highest pedestrian flows. After these segments, part C of Dimitrakopoulou street and all parts of Zinni street follow in the “attractiveness” rank. Finally, Androutsou and Falirou streets are less attractive than the aforementioned streets while Vyzantiou and Botsari are the least attractive streets of the cluster.

4.3.2 Urban features

Pedestrian flows are generated and take place inside the urban environment. Therefore, this research analyses the spatial pattern of the urban features and its relation to the pedestrian flow. The next map (Map 4), draws the sidewalks’ width and the spatial pattern of land uses.
Almost 69% of the research area has pavements with more than 1.5 meters which can be satisfactory towards the needs of pedestrians (Ministry of Environment, Regional Planning and Public Works, 1996). However, 5 parts of research area’s road network (Botsari A & B, Vyzantiou A & B & C) are less than 1.5 meters which make them inaccessible for pedestrian movement.

Dimitrakopoulou, Zinni which are attraction poles and part C of Androutsou streets have satisfactory pavement infrastructure with more than 2.1 meters of width (Ministry of Environment, Regional Planning and Public Works, 1996). Map of the spatial pattern of urban functions shows that the research area is mainly a commercial center and secondary a work center (Malizia & Song, 2018). Dimitrakopoulou and Zinni streets, part B of Botsari and part A of Falirou, concentrate commercial land use while Androutsou C and Falirou B have mainly workplaces. Additionally, Androutsou B and Vyzantiou B have mainly empty spaces due to abandoned buildings and the lack of rented shops. Vyzantiou A, seems to be the only mainly residential part of the research area but we have to keep in mind that only ground floors are examined. Moreover, the typology characteristic and functional fulfilment of the urban center (of the lack of it) show that none of the road network parts are directed towards community activities which brings out that the development of the cores is retail-centric. Finally, Androutsou C and Botsari A have the most mixed land uses consisted of Commercial Use or Workplaces and Workplaces and Empty spaces, respectively. The space syntax analysis of local scale space (800m) is depicted on Map 4, as well as the urban functional density.
Higher syntactic values appear in the local scale of the research area. All parts of Zinni street have the highest values, while Dimitrakopoulou, Androuotsou and Botsari have satisfactory syntactic values but Vyzantiou and Falirou streets are the most isolated streets. A radius of 2km from the research area is selected for the syntactic analysis in order to identify the syntactic pattern created inside the applied urban system. Functional density simulates the pattern created by the sidewalk width, the local syntactic centrality pattern and the pedestrian pattern. The reason behind this claim is that Dimitrakopoulou and Zinni are the densest functionally. Low dense functionality is located in Vyzantiou, part B of Androuotsou and part A of Botsari.

4.3.3 Interactions between pedestrian flows and urban environment

Particular parts of the urban environment have impact on sidewalks’ flow. However, features which belong to urban characteristics, urban morphology as well as pedestrian movement infrastructure are highly important factors that affect pedestrian flow intensity. Urban features and pedestrian flows are correlated in Tables 1 and 2 shown below. Scatter plots with high positive correlation are depicted in Graphs 3 and 4. Spearman’s Rho indicator is utilized since the datasets are not normally distributed.

Table 1: Correlation of (Spearman’s ρ) pedestrian flows and land uses

<table>
<thead>
<tr>
<th>Pedestrian flow</th>
<th>Residential (%)</th>
<th>Open public space (%)</th>
<th>Commercial (%)</th>
<th>Community (%)</th>
<th>Workplace (%)</th>
<th>Empty space (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian flow</td>
<td>-0.37</td>
<td>0.21</td>
<td>0.55</td>
<td>0.34</td>
<td>-0.16</td>
<td>-0.20</td>
</tr>
</tbody>
</table>
Table 2: Correlation of (Spearman’s ρ) pedestrian flows and urban features

<table>
<thead>
<tr>
<th>Functional Density (Uses/m)</th>
<th>Entropy</th>
<th>Sidewalk width (m)</th>
<th>Space syntax (NACH 800m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrian flow</td>
<td>0.72</td>
<td>0.21</td>
<td>0.88</td>
</tr>
</tbody>
</table>

As literature suggests, pedestrian flows are greatly correlated with commercial land uses, so this can be noticed as well in our research area where only Commercial land use has strong positive correlation. Pedestrians tend to visit more these land uses since they connect their daily routine with them. There is no correlation between other activities apart from Residential and Community land uses which have weak negative and weak positive correlation, respectively. The negative correlation calculated between residential use and pedestrian flow can prove that citizens choose to live in more quiet areas.

However, the rest of urban characteristics tend to have stronger positive correlations with pedestrian flow. The strongest positive correlation appears for pavement width and pedestrians flow by 88%. In addition, correlations between pedestrian flows and the characteristics of urban functional density and local syntactic centrality are strong positive. There is rich literature material which highlights the strong relation of the spatial centrality and the pedestrian movement (Hillier, et al., 1993; Geddes & Vaughan, 2014), and the creation of central areas (Scoppa & Peponis, 2015; Porta, et al., 2012; Penn & Turner, 2004) which also appear in Athenian urban environment in areas such as Koukaki.

Finally, urban functional density is the most important part of a vital and walkable urban centre (Jacobs, 1961) while it is further highlighted by the correlation with the pedestrian flows. Jacobs (1961) points out the secondary most important factor which is the diversity and can be expressed by land-use mix. However, there is no correlation of these two factors in our research area since it is 0.21. Thus, pedestrian flows are not connected to the diversity of our research area. It is worth mentioning again, that only ground floor land uses are recorded which may lead to less mixed land uses since Residential use and Workplaces are located in other floors of the buildings.

Diagram 2: Scatter plot. Pedestrian flow and Sidewalk width (Left) & Pedestrian flow and Space syntax-NACH(Right)
All aforementioned results show that urban features such as Pavement Width, Functional Density, Local Syntactic Centrality and Commercial activities have impact on pedestrian flows. Dimitrakopoulou and Zinni streets are the most significant streets of the study area based on pedestrian flows and syntactic centrality. Moreover, these streets have mainly commercial activities, high functional density and adequate sidewalk width. These characteristics are also necessary for areas which target towards encouraging walking and social interaction in the urban environment.

5. Conclusions

The present research led to various and considerable findings about the walking infrastructure and its interaction with the urban environment in central neighborhoods. Regarding pedestrian accessibility, it is profound that the existing conditions in Koukaki, cannot sustain safe and sufficient movement to all users in the city, and especially in vulnerable social groups, resulting undoubtedly in social exclusion and inequality, undermining the basic right of mobility. Moreover, the study area is characterized by serious spatial contrasts, as segments at the southern part of the area are in better condition than others. This existing situation strongly dictates the urgent implementation of policy measures and interventions concerning the improvement of accessibility conditions in the area.

As for the urban features, it should be noted that commercial activity is predominant in the area, as it occupies 30% of the uses in the sample street segments. It was also found that commercial and central streets in terms of space syntax have wider sidewalks. Focusing on the interaction between human flows and urban features, we identified the following: Pedestrian flows are positively related to commercial activity and negatively to the residential. Furthermore, they illustrate significant positive correlation with space syntax centrality, sidewalk width and the functional density (land uses per meter). Therefore, it is apparent that if the competent planning authorities decide to increase the presence of pedestrians in the streets, then they ought to improve pedestrian infrastructure, enhance the connectivity of the area (e.g. creation of blocks openings), but also to increase the density of commercial or community activities (taking of course into consideration the capacity and the identity of the area).

Concerning the extraction of more detailed findings about the reasons affecting pedestrian movement in particular neighborhoods and streets, as well as the investigation of the interactions between human flows and vehicular traffic throughout the day, it is essential to carry out
questionnaire surveys and enrich our measurements. It is striking that the findings of the research can greatly contribute to a cohesive view of the function and the identity of street public space and its users. Furthermore, they have potential to be used as an input into the planning process in order to promote the vitality and sociality of contemporary cities. The research contribution of the paper constitutes a small but at the same time a considerable step towards the efficient and just management of urban public spaces. Under these circumstances further research is definitely needed in order to enlighten more crucial issues in the public realm of urban areas such as combined evaluation of accessibility and attractiveness of public spaces. New research could either use features from our research highlighting other spatial and social issues of the city, or they apply the suggested methodological approach to other study areas with similar characteristic in order to enrich the existing findings. In any case, engaging with the public space, and in particular with street environment in cities, requires even more scientific and social dynamics to transform this kind of spaces into functional, social and sustainable entities.

References


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