Navigating Urban Space: Unveiling Patterns in Walking Routes through Space Syntax in Kypseli Neighborhood (Athens)

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Abstract: This paper explores pedestrian mobility patterns in Kypseli, a dense and socio-economically diverse neighborhood in Athens, Greece, that it is considered as a typical Greek residential area, in terms of its built environment and road network characteristics. The research method included crowdsourced geospatial data overlaid on cadastral maps, and semi-structured interviews with residents and visitors to understand the routes they usually take, the routes they could take, and the routes they would like to take. The study also applied space syntax analysis, using angular integration and choice tools, to assess how the urban layout impacts the pedestrian flow. Findings showed that the walking routes are primarily influenced by safety, accessibility, and pavement width, with well-connected streets and streets with intense mixed land-use. The study highlights the importance of urban design and land management in promoting the perceived walkability. It also recommends enhancing pedestrian spaces to create more sustainable, livable, and socially inclusive cities to support the implementation of the Sustainable Development Agenda 2030 SDG 11.

Keywords: Athens; crowdsourcing; SDGs; semi-structured interviews; space syntax; sustainable mobility planning

1 INTRODUCTION

Since urban mobility has grown during the last decades [1], integrated strategic planning -that combines traffic planning with urban policies - consists of a topical issue at the global level and seems to be one of the main pillars of modern spatial planning policy [2]. Through the Agenda 2030, which promotes sustainable economic development by reducing negative impacts on the environment and society, the importance of integrated sustainable planning, good land administration and management is even more evident. Two of the seventeen goals are mainly related to this topic: Goal 11 about sustainable cities and communities and Goal 13 about climate action [3].

Apart from the global policy through the United Nations, the European Union adopts sustainable urban mobility planning [4] to create environmentally friendly and "compact" cities that will encourage alternative means of transport such as walking [5]; this is the reason why planners do not focus only in making cities more walkable, in terms of infrastructure, but also urge people walking by making public spaces safer and more comfortable for citizens. To achieve this goal, planners consider multiple factors and parameters that affect walking, as it came into the fore through research. Such a series of factors include not only the mere provision of pavements [6] and pedestrian crossings but also the ideal geometric characteristics of the pavements that should be preserved in a good situation [7] without obstacles (i.e., illegally parked cars), adequate street lighting, planting [8] and clear signage [9]. Along with the above, mixed land-use [8], pedestrian networks continuity, geometric characteristics of streets [10] and social characteristics of public spaces [6] may also be considered as crucial parameters affecting people to feel comfortable while they walk and, thus, they act as factors enhancing walking.

All of these parameters contribute in creating a secure environment, particularly for vulnerable groups like children and elders. Additionally, the inclusion of green spaces, shaded pathways, and street furniture enhances the physical comfort of walking, making the walking experience more enjoyable [8] and urging people to remain in public space.

With all the above in mind, it could be understood that some public spaces that have been designed based on specific criteria that respond to the aforementioned parameters may be more walkable and, thus, more popular. When such design standards are not followed, public spaces = fall behind in terms of walkability, although there may be spots with architectural interests and good social characteristics.

This topic has not been extensively studied. Despite the fact that in Greece a lot of research has been conducted during the last ten years for promoting urban walkability in the context of sustainable mobility, no sufficient research has been implemented on this specific topic. In response, this study aims to address this challenge through a comprehensive analysis of mobility patterns in typical residential areas in Greek cities. Kypseli, a residential area of Athens, Greece close to the historic centre, was selected to be examined in the context of a case study analysis. The research question was focused on the criteria affecting people to select the routes they usually follow within the neighborhood. Moreover, it was crucial to identify whether the routes people follow differ from the ones they would prefer to follow or even those they could follow. The methodology applied, is presented in Section 3, and is focused on map-based surveys implemented during interviewing, in the field. Based on the results, explained in Section 4, conclusions (Section 5) came to the fore not only for Kypseli but also for typical Greek cities, through generalization of the research outcomes. These conclusions are discussed in light of the literature review that is briefly pointed out in Section 2.

2 LITERATURE REVIEW

Over the years, urban land managers and planners have seen cities through different lens; either through a visual-aesthetic tradition, or through a social-usage one, while now, the place-making tradition seems to be the most popular approach [11]. But even among researchers whose perception seems to be the same, differences are found in terms of their objectives and the methodologies applied. A typical example

is the different approaches of Lynch, Jacobs, and Alexander (social-usage tradition). Jacobs mainly focuses on social factors that create sense of safety, while Lynch examined urban space with the use of environmental images and Alexander focused on structural elements that produce specific patterns [12]. In Lynch and Alexander's approaches, urban space is understood through descriptions of its form that are classified into typologies [13]. Such approaches may be included into typo-morphology that was evolved by a more qualitative logic into a more quantitative one, over the years and through the evolution of research - even in the case of terminology applied [14] - across different countries.

However, nowadays, quantitative analytical methods tend to dominate in this field. The work of Wang et al. [15], who developed a method of feature analysis in order to quantitatively generate applicable design schemes, is one of such typical cases. Stojanovski [16] also combined typo - morphological analysis and statistics to show the various urban form factors affecting neighbourhood typology. Furthermore, another quantitative perception is the research work conducted by Bobkova, et al. [17] about the plot types across different European cities.

However, space syntax was one of the methodologies that arose a new perception in understanding cities. It provides a mathematical framework to integrate and re-evaluate both social and structural dimensions. In his work, Hillier [18] differentiates intrinsic and extrinsic spatial properties. The latter govern the relationships among spatial units, shaping the configurative rules of space [19]. From this perspective, topological considerations become particularly significant. These extrinsic properties not only influence the physical form of the built environment but also its potential function. While extrinsic spatial properties are concerned with underlying, invisible structural connections, intrinsic properties pertain to visible characteristics, such as geometry, patterns, and textures. These intrinsic attributes play a crucial role in expressing social meaning through the physical form of the built environment [6].

According to Hillier [20], extrinsic spatial properties are found in all built environments; the same happens in activities taking place in these spaces that characterize its functions. As a result, he supported that the spatial structure of a city affects shaping economic and social life in cities [6]. This is more evident in case of economic activities that are primarily driven by the implicit goal of profit maximization. In case of social activities, this relationship seems to be sicker, as cultural and societal contexts affect them. However, space syntax is considered as a tool of prediction of human activity [21] it gives the opportunity to esteem urban spaces with high - not only current but also potential-pedestrian flows [22] and, as a result, the areas that are characterized by centrality [6, 21].

As space syntax has a strong empirical validation and a high level of accuracy in predictions, it is applied to a broad spectrum of built environments, thereby enhancing and advancing the formulation of descriptive theories related to urban space. In this research, space syntax has been applied in order to correlate physical attributes with the degree of walkability. In Section 3, a description of the steps followed to answer the research question set in Section 1.

3 METHODOLOGY

3.1 Aims and Objectives

The primary focus of this study is to identify the components of urban space and the pedestrian flows expressed in it. It is essential to emphasize that the study specifically examines the walkability of pedestrians, as walking is essential for fulfilling daily needs and is a fundamental aspect of sustainable mobility. Our approach to study walking routes in Kypseli combines interviews with the analytical tools of space syntax. This method allows us to gain both qualitative insights from the interviewees and quantitative spatial analysis to better understand movement patterns in the study area.

3.2 Study Area

As it was mentioned above, Kypseli has been selected to be examined as it is a central area (built according to the Athenian modernistic architecture patterns and it is characterized by building density, socio-economic diversity [23] and touristification [24]. The coexistence of various population groups is important as it affects the character of the area and consequently, the way residents travel across Kypseli.

Figure 1 Width of Sidewalks in Kypseli

The scales of the policies applied in Kypseli are multiple. There are policies that focus on Kypseli as a neighbourhood, and policies that perceive Kypseli as a sector of the Municipality of Athens. As a result, Kypseli is influenced by strategic directions for the centre of Athens, which have a metropolitan character.

In terms of urban environment, a key characteristic and potential mobility problem in Kypseli is the existence of pavements of a very narrow width. This fact creates a strong disproportion between buildings and pavements.

3.3 Data Collection

The methodology applied to answer the research question posed is divided into two parts. In the first one, geospatial information (land uses, road space geometry,

pavement width, plantings, and urban equipment) was collected by local residents and undergraduate students in the School of Rural, Surveying and Geoinformatics Engineering of National Technical University of Athens, who participated in the project as volunteers. The geospatial data collection methodology that was followed has been developed in a previously published research and its accuracy has been tested and proved as adequate [3]. In addition to the collection of the footprint of the buildings, relevant information is also collected about the prevailing use of each building. All necessary data was collected remotely online using Google Earth and StreetView, as well as open data derived from the Hellenic Cadastre. However, in cases where it was difficult to distinguish these features, fieldwork was also useful.

Concerning the data collection process, it should be clarified that, at an initial stage, the recordings were made individually by each volunteer in a predetermined area and after proper editing they were combined into a unified database.

Next, 188 semi-structured personal interviews were conducted (Tab. 1), during late January - early March 2022. Totally, 142 residents and 46 visitors participated in this activity as they agreed to be interviewed; the snowball method has been used in order for the interviewees to be found.

Table 1 Interviewers' demography

Relation to the area		Biological sex		Age Groups	
Residents	76%	Female	43%	18-29	55%
Visitors	24%	Male	57%	30-44	45%

The main topics of the interview were about (a) the routes they usually walk, (b) the routes to which they can walk and (c) the preferable routes (Fig. 3). Due to the fact that interviews have been scheduled to take place on-street, it was not easy to last too much. Most of them lasted less than 8 minutes and only 9 exceeded 20 minutes. Subsequently, the appropriate maps were created where the results of the interviews were illustrated.
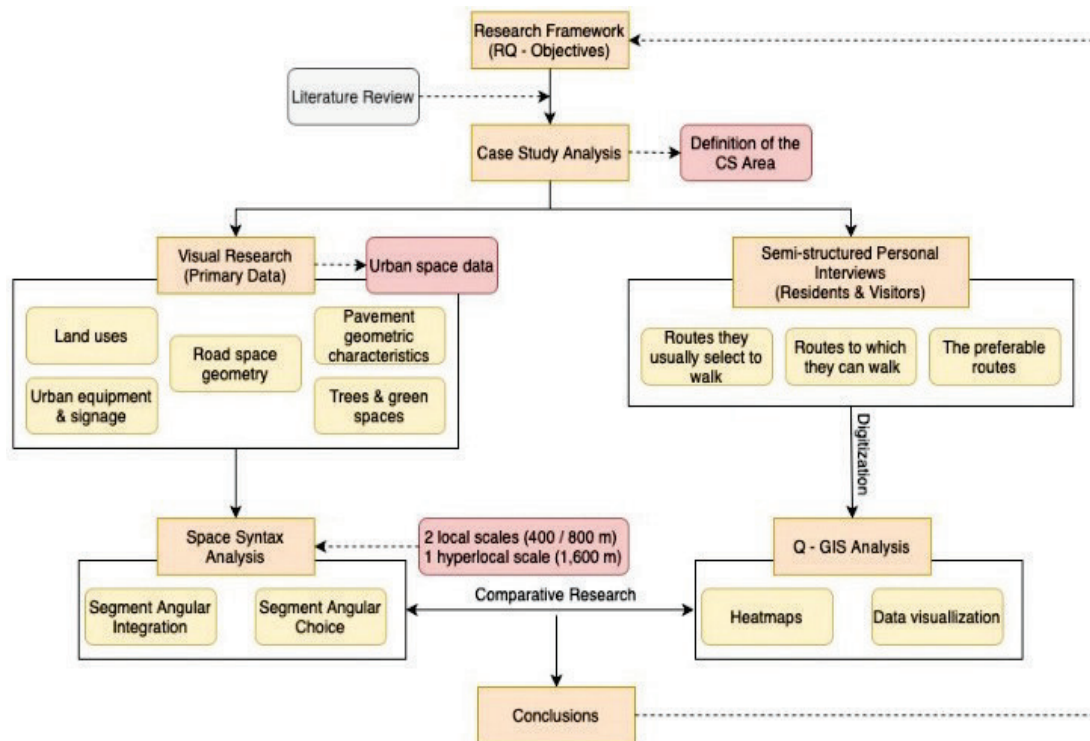

Figure 2 Methods applied

Then, analysis through space syntax methodology was applied [13]. As it was noted, space syntax analysis focuses on how the geometry and topology (connectivity) of the urban network affects the movement flows, land use and ultimately human activity in a city [25]. In the space syntax analysis the most important tools for identifying potential movements and important routes in the urban network, are segment angular integration (the quantification of the accessibility of a site in relation to the urban system to which it belongs) and segment angular choice (the quantification of the possibility of unfettered movement through a site in relation to the urban system to which it belong) [26].

Taking into account that real-world movement patterns have shown that citizens move in space by "reading" the angular geometry of the network rather than simply physical distances [27] and also that "angular resolution is highly responsive to spatial navigation and orientation, as users are more likely to minimize perceived distance when in an unfamiliar environment" [28], in this research, 3 different radius have been calculated (Figs. 4-9): 2 local ones (400 m, 800 m) and 1 hyperlocal one (1600 m). The choice of rays is based on the logic of the 15-minute city model. In particular, for a radius of 400 m, the angular deviations from each node to all others have been calculated (respectively for each

radius) only within this radius. Therefore, by applying the radius during structural analysis, it is possible to analyze the city at different scales for the local and supra-local relations that emerge in the urban network.

Through comparative research, the outcomes came from both methodological types are correlated in order for conclusions to be drawn, not only for the study area, but also for residential areas in Greek cities, as a generalization.

4 RESULTS

In the following images, the results of our research are presented. Firstly, the final map with all the routes derived from the interviewees (Fig. 3). Visualization is also seen under the light of statistics about the time spent, the reason for moving, and the time spent walking in the area (Tab. 2). As it is pointed out in Tab. 2, most of the participants tend to walk for more than an hour, in each autonomous trip. Their majority supported that, on a daily basis, just one or two trips are implemented; either for amusement and exercise or for work. Afternoon is the most popular time of the day for walking in Kypseli, as 33% of the interviewers prefer this time zone. Probably, 25% of the people who walk, in the morning times, on a daily basis, are those who go to their work, on foot (partly or totally). The majority of the afternoon walkers (8%) are probably urged to walk for leisure.

Initially, the results between the three types of routes revealed moderate differences (Fig. 3) – this was attributed to two key characteristics of a city that are indicators of road safety and the quality of road networks: lighting and pavement width. Therefore, the majority of the residents are choosing the best route, taking into account two main qualities: safety as well as accessibility.

Table 2 Statistics about each autonomous trip

Time Spent per Walk			
Variable prices	>1 hour	1-2 hours	2-3 hours	>3 hours
Percentage	10%	30%	40%	20%
Preferred Time to Walk			
Variable prices	Morning	Noon	Afternoon	Evening
Percentage	25%	25%	33%	17%
Reason for Moving				
Variable prices	Leisure	Work	Child at school / Walk with child / School	Sports	Shopping
Percentage	37%	30%	15%	8%	10%

Furthermore, by contrasting the routes derived from interviewing, it was noticed that a large part of them were identical. This was also expected from the interview stage as many of the participants reported that the routes they take are identical to the routes they could take and the routes they would like to take. This shows that most participants have inevitably adapted their routes in an optimal way, both in terms of meeting their needs (shopping, work, etc.) and in terms of the aesthetic choice of these routes. The already developed city, in terms of urban form, has indirectly defined its routes.
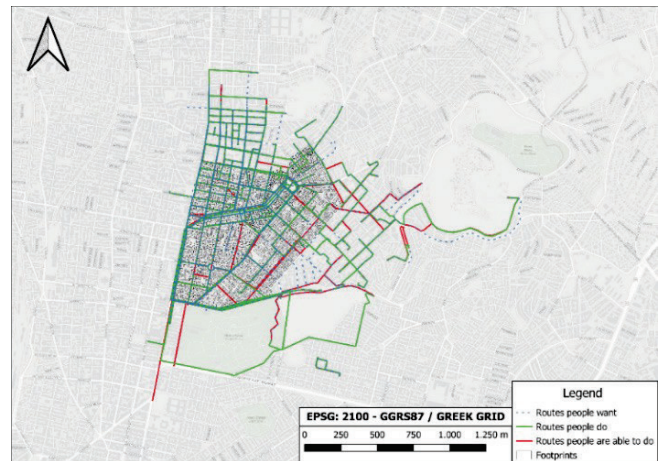

Figure 3 Routes derived by the interviews

Small differences can be found in the routes they take and the routes they want to take. These differences are found on the narrow roads in the north-western part of the study area. In particular, interviewees seem to wish to follow these routes but do not choose them in their daily lives. This is most likely related to the limited width of the sidewalks, the high height of the surrounding buildings and the lack of lighting compared to other areas. For the selection of a route, it was observed that most routes are located on streets across which mixed land uses are developed, as well as on those in which the largest sidewalk widths is observed; urban equipment also plays a significant role. This observation was also expected, as the built environment has also been shown to have a significant effect on walkability and environmental quality for those who walk [29].
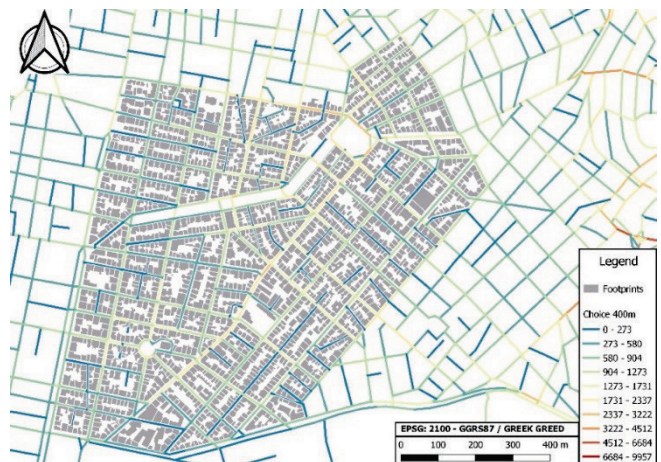

Figure 4 Angular Choice 400 m (Source: Research Team Elaboration)

In a second stage, when the routes were compared with the results of the space syntax analysis, it was not observed direct correlation between them, proving Pafka's claim [30], according to whom, integration, although it is a useful tool in terms of identifying morphogenetic tendencies in a large scale, however, it may be misleading as a means of measurement of walkable access, at a neighborhood scale. More specifically, greater emphasis is placed on the angular integration measure, which highlights the accessibility of a

space in relation to the urban system to which it belongs. Therefore, the roads on which interviewees move are not always as integrated as it may be expected, according to the editorial analysis of the local 400 and 800-meter radius (Fig. 10). In contrast, the roads they move are more closely converged with the 1600-meter radius integration; this is a hyper-local radius and is more associated with car travel than pedestrian travel. Finally, although they are not highlighted through the space syntax analysis but only through the routes, it is observed that the pedestrian streets, such as Fokionos Negri and Agias Zonis, are usually preferred by pedestrians for their movements either as a destination or for transit. This is probably because these streets combine the presence of urban amenities with a variety of land uses, such as commercial shops and residential. Finally, another street in which preferable routes were found is Patision Street. It is mainly preferred for commuting as many people move in there because of the existence of public transportation stops, the wide pavements, and the extensive commercial activity.

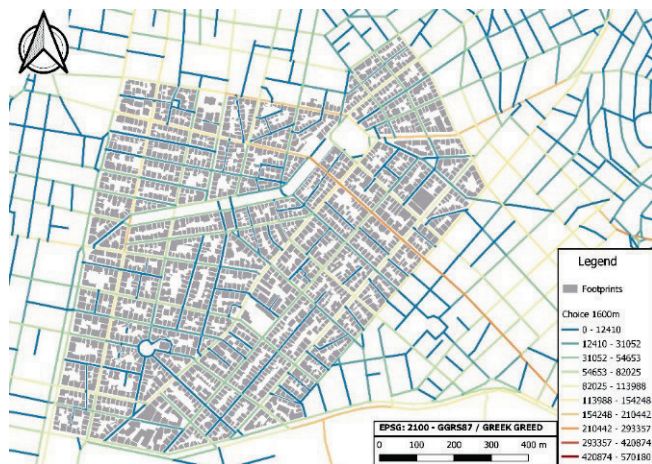**Figure 5** Angular Choice 800 m (Source: Research Team Elaboration)

Figure 6 Angular Choice 1600 m (Source: Research Team Elaboration)

Based on the angular integration tool, which has been applied in the context of space syntax analysis and highlights the accessibility of a space in relation to the urban system to which it belongs, it was concluded that the study area, in total, is not well integrated with the neighboring ones. Such

an observation was obvious for the case that the analysis was conducted by using 1600 m as a measurement basis (Fig. 9). In the rest of the cases in which the angular integration tool was applied on a local scale, it was concluded that a big part of the area is integrated to the neighboring ones. This observation has to do with urban form not only of the study area but also of the wider one; Pedion of Areos Park seems to be the main reason why this observation takes place. According to Fig. 9, the eastern as well as the northern part of the area is less integrated in relation to the rest part. Another reason explaining this differentiation is the existence of important streets in the western part of the area that plays a crucial role in connecting city centre to the northern part of the Municipality of Athens: Pattison Ave. and 3rd of October Ave. In the same figure, Drosopoulou Street, which is a quite important road artery for the function of Kypseli, is also highlighted as a quite integrated axis.
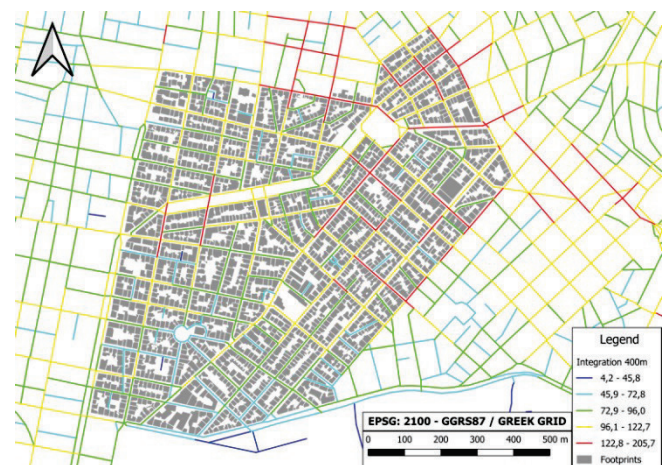

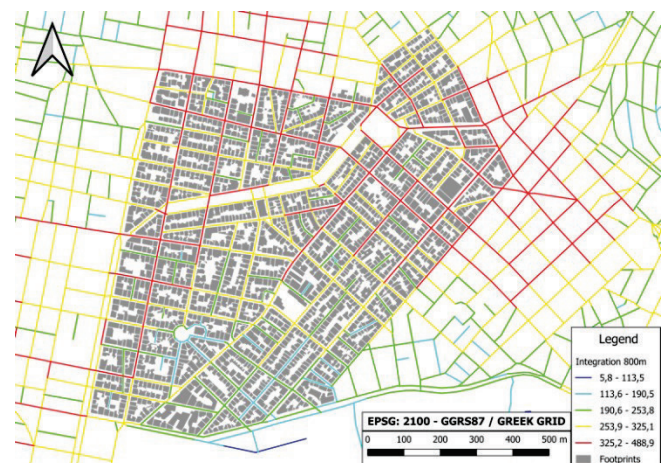**Figure 7** Angular Integration 400 m (Source: Research Team Elaboration)

Figure 8 Angular Integration 800 m (Source: Research Team Elaboration)

Based on the angular choice tool (Figs. 4-6), it is concluded that most of the streets located in the study area are local ones; that means that residents usually prefer moving across them only in case the move within Kypseli. In a different case, they usually prefer moving on streets like Pativision Ave., Kastalias Street, Kyprou Street and Kypselis Street. Contrary to that, in case of local scale journeys, people

tend to move across streets that are narrower or even of shorter length.

Although Kanaris's Square consists of a place which is quite livable, as the possibility for someone to move around it is high, in all case scenarios (local and hyperlocal), the same observation is not relevant to the case of Fokionos Negri's pedestrian street. The latter is mainly preferred by people who move in a local scale while people who move on longer distances do not prefer this route.
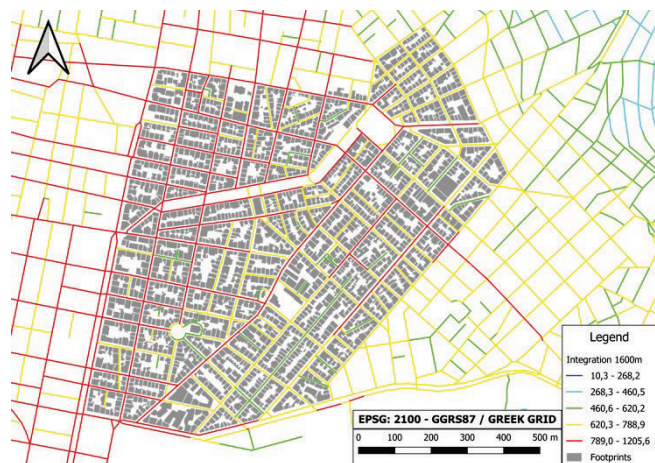

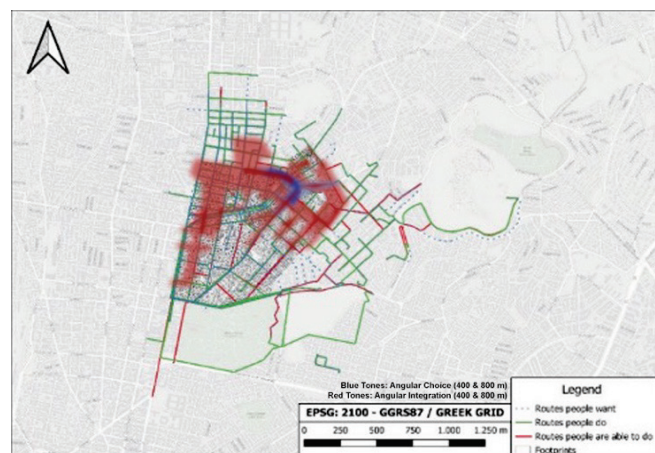Figure 9 Angular Integration 1,600 m (Source: Research Team Elaboration)

Figure 10 Results came from Space Syntax (Angular Choice and Integration (400 and 800 m)) Analysis contrary to the ones came from interviewing (Source: Research Team Elaboration)

5 DISCUSSION-CONCLUSIONS

This paper focuses on the way people walk within a typical residential area in Greek cities. More specifically, its goal is to identify the way they walk, the routes they would prefer to follow, and their preferable routes. The philosophy besides this differentiation is that people may select a walking route by taking into account criteria that differentiate from the ones that determine the routes they prefer or they could follow. These criteria are not always related to the geometric characteristics of pavements and the urban equipment elements, although they are quite important parameters affecting walkability and perceived walkability. The urban form seems to be another parameter that may define their behaviour.

The research was based on a comparative analysis, in which space syntax analysis and interviewing were the main methods applied. The outcome was, on the one hand, maps analysing the study area in terms of angular choice and integration, and, on the other hand, digitized data about routes people follow, want to follow and can follow. In the latter, it should be underlined that data about geometric characteristics of pavements and urban equipment was also recorded and digitized.

By comparing routes' footprints derived from interviewing with conclusions derived through space syntax analysis, it was found that streets that are well integrated into the wider area are the ones in which most people walk, as they are the easiest, simplest and - usually - the closest way to reach their destination that may be a public transport station. This case is modified in case of short distances where people prefer to "explore" their neighborhood by moving across less integrated streets. However, in the case of Kypseli, most of the interviewees tend to walk in order to move at an external point. This observation proves that although the urban centre in the case of Kypseli is defined in Kanaris's Square, however, in terms of function, the most central location seems to be around Patision Ave., which is mainly used on a daily basis. Taking into account that the streets which are better connected to the neighboring areas are the ones in which pavements are wider - this is the most important parameter when a pedestrian walk - there is no much differentiation among the routes people do with the ones people prefer.

Concerning the routes in which interviewees can walk, most of them indicated streets of the first category.

The in-depth analysis carried out in this study highlights the critical importance of urban space planning to promote walking and sustainable mobility. Space is not just a neutral environment for human activity, but is actively produced, shaped and defined by human actions and the social relations that support them. The findings obtained from the study provide a substantial understanding of the factors that influence commuting in urban areas. Implementation of the recommendations arising from this research can lead to the creation of cities that are more pedestrian-friendly and more ecologically and socially sustainable. At a long-term level, the adoption of the principles proposed can lead to more humane and sophisticated urban areas, promoting health, safety and social inclusion.

At this point, should be mentioned that a statistical analysis may be applied in order for future results to be derived through a quantitative approach. In that way, findings will be derived to be more accurate and give us the chance to generalize them for similar cases across Greece.

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