

Combinatorial locational analysis of public services in metropolitan areas. Case study in the city of Volos, Greece.

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Abstract

Social prosperity largely depends on spatial structure, a relation which becomes stronger in urban areas where the quality of life is menaced by several factors. Traffic, over-building, lack of open space and deficient location of services come to the fore. The latter reflects access inequality and is one of the main reasons for everyday movement difficulties of citizens. Particularly, public services, as part of the public sector, are considered to be driven by the principle of social well-fare. Therefore the study of their location gives rise to the question: how can access of city blocks to public services be evaluated and how can the results of this evaluation be combined with the monetary values assigned by the state?

In this respect, the main aim of this paper is the determination of a synthetic methodological framework for the locational analysis and evaluation of public services in urban areas. The proposed approach is based on spatial analysis methods and techniques as well as on the analytical capabilities of Geographic Information Systems (GIS) and finally leads to the definition of the locational value for each city block. Public services are classified according to population served age groups and to their yearly utilization levels. Minimum and average Manhattan distances to the services of each classification group are calculated along with the percentages of services that are closer than a critical radius to each city block. At the final step, city blocks are classified through the use of cluster analysis as of calculated distances and percentages and then ranked according to their overall accessibility to public services. Their score is utilized in the definition of their locational value and the formulation of a combinatorial index which compares locational and land values throughout the study area. The methodological framework is applied in the city of Volos where according to the results of the analytical process, 60,7% of its city blocks indicate a comparatively lower locational than monetary land value.

Keywords: locational evaluation, public services, urban areas, spatial analysis, GIS, index

Introduction

The study of space and particularly of phenomena related to its optimal organization according to predefined standards and criteria constitutes an intriguing research goal. Especially when this study focuses on aspects of quality of life attains

much more importance since results can form a set of effective actions aimed to its improvement. With respect to urban areas, these issues become crucial since the quality of life in these areas is menaced by several factors. Traffic, pollution, over-building and lack of green areas along with inefficient location of services define some of the major problems mainly affecting life in modern metropolitan areas.

The research interest increases in the case of public service systems which should be designed aiming to social welfare. In this respect, access “defined as the quality of having interaction with, or passage to, a particular good service or facility” (Talen, 2002: 259) emerges as a central priority in the planning process by improving citizen’s daily mobility and providing equity in access.

Furthermore, the study of their location gives rise to a critical question: how can access of city blocks to public services be evaluated and how can the results of this evaluation be combined with other measures such as the institutional (monetary) values assigned by the state? This brings up the issue of assessing the relationship between the spatial distribution of public services and economic characteristics of urban space which is “particularly absent from the literature on planning” (Talen, 1998: 24). As a response to the above question the main aim of the proposed methodological framework is the locational analysis and evaluation of public service systems in urban areas by comparing the locational and the institutional value of building blocks. The locational value is defined by a set of parameters dealing with access to services and bus stations, while the institutional value coincides with the land value assigned by the state. Cross-examination of these values is achieved by the use of an index called **Locational Convergence Index** (LCI) calculated for every block in the study area and representing the degree of their “similarity”.

Previous studies focusing on public services accessibility measures are reported by Ikporukpo (1987) dealing with citizen’s accessibility in Nigeria, Talen (1998) analyzing services location according to a need-based distributional standard with regard to socioeconomic status and Jahan and Oda (1999) assessing their spatial distribution in Dhaka, the capital of Bangladesh.

The proposed methodological framework is applied to the larger area of Volos, a Greek city with special traits and potentials whose profile rapidly changed during the latest decade due to various reasons. Among them the growth of tourism and the enlargement of the University of Thessaly mainly affected the image of the city and generated new demand regarding its services organization.

The next section of the paper deals with locational planning and location analysis issues. Methods and tools are presented from Spatial Analysis, Location-Allocation Models, spatial indices and Geographic Information Systems (GIS). In the second section the proposed methodological framework is analyzed through the definition of its constituting steps. Namely, data acquisition and input, public services categorization, GIS implementation, distance matrix and distance counts percentages calculation, distance and distance counts percentages clustering, LCI calculation and results mapping. The third section describes in detail the application while in section four, conclusions and prospects regarding future evolution of the proposed methodological framework are included.

1. LOCATIONAL PLANNING – LOCATION ANALYSIS

Services and facilities location is a primary issue in every initiative of human-centered planning. Especially when this issue concerns exclusively the public sector and the location of its services, **locational planning** is seeking the best solution which in principle should also have a positive impact in the society. Furthermore, suitable location of public services and sufficient accessibility constitutes one of the fundamental parts of the environment which determine and affect quality of life (in the sense of surroundings) (Van Kamp et al., 2003:13) (**Figure 1**):

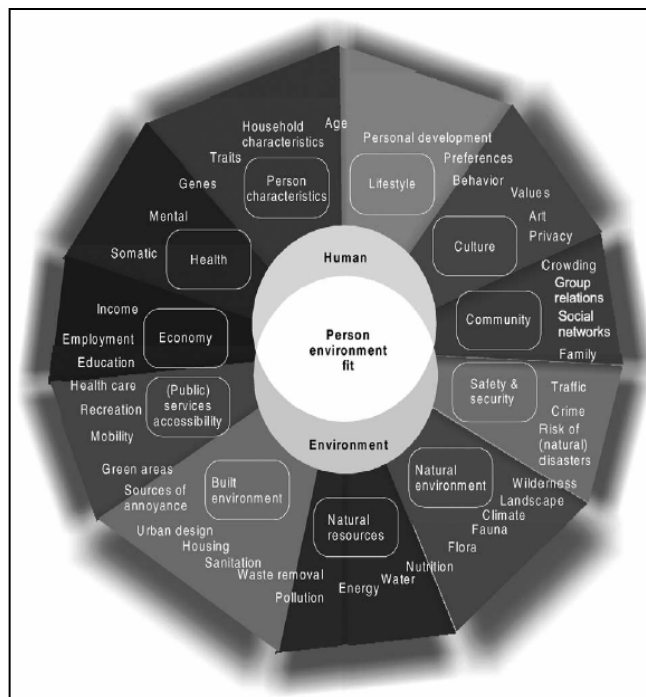


Figure 1. Domains of (human) liveability and (environmental) quality-of-life (Source: Van Kamp et al., 2003)

In Figure 1 it is obvious that the degree of human adjustment to his environment (person environment fit) depends on his surroundings (environment). Especially, the influence of space seems to affect human adjustment through a set of parameters among which is accessibility to public places related with health care, recreation, mobility and leisure. As afore-mentioned, it is clear that sufficient location of public services reflects a well-organized space with direct impact on quality of life.

In a locational planning framework of services, the critical problem parameters are **geographical proximity**, **spatial coverage** and **diachronic efficiency**. The term geographical proximity refers to the distance between services and total population served. In parallel, the issue of spatial coverage is particularly important in the case of public sector services which are supposed to function beyond profit and have equity as their central network design principle. The terms of geographical proximity and spatial coverage are two of the basic parameters forming the concept of accessibility since “accessibility is determined by the spatial distribution of potential destinations, the ease of reaching each destination...” (Handy et al., 1997: 1175). The diachronic efficiency of proposed solutions remains a key point to the process since it is often translated to the spatial restructuring of the system.

1.1. SPATIAL ANALYSIS

Spatial analysis focuses on the study of spatial phenomena and processes seeking the cause-effect relation behind every change or stagnancy in space. In this respect, the main issues studied in spatial analysis are **Location** and **Spatial Organization**. Location is basically related to the existing geographical distribution of phenomena, activities, facilities or populations while spatial organization constitutes the relational study of more than one objects seeking the explanation of spatial structure. Thus “Spatial Analysis focuses on location and distribution, relations between people and goods, the supply-function between regions, the spatial arrangements, the spatial structure and organization as well as the evolution of space” (Koutsopoulos, 1990:7).

Different spatial analysis methods are focusing on different stages of the process. One of these is the exploitation of information from a set of statistical characteristics by multivariable methods such as **factor** and **cluster analysis**. Their basic difference lays on the fact that “whereas factor analysis works by searching for similar

variables, cluster analysis has as its objective the grouping together of similar *observations*” (Rogerson, 2001:197).

Cluster analysis comprises methods attempting to group observations with minimum within-group variance and maximum between-group variation. These methods are furthermore discriminated in agglomerative or hierarchical and nonagglomerative or nonhierarchical (Rogerson, 2001:200). In this paper, **K-Means cluster analysis**, a nonhierarchical method, is used to group observations on accessibility. This method is also known as “nearest centroid sorting pass” or “reassignment pass” (Aldenderfer et al, 1984:47).

1.2. LOCATION – ALLOCATION MODELS

Location analysis determines the best location of a set of facilities considering predefined criteria. The two basic categories of location analysis methods are **Multiple Criteria Analysis** and **Location-Allocation Models**. Multiple Criteria Analysis refers to basic queries based on criteria values related with distance, time or density of service centers. On the other hand, Location-Allocation Models determine solutions for a set of facilities that will serve optimally demand. The assumption made in most of the location models is that «all individuals ... will always visit the closest centre or facility that provides the service they seek» (Bailey and Gatrell, 1996:369).

1.3. SPATIAL INDICES

One of the most important issues assessed in every study is the quantification and comparison of a phenomenon’s variations through time and space. One way to quantify and express such trends as measures of different forms built according to related variables are **indicators** and **indices**. In this framework, “indicators are a necessary part of the stream of information we use to understand the world, make decisions and plan our actions” (Meadows, 1998:1). **Index numbers** constitute “statistical measures, exempted from measurement units, which show the changes of a variable or a set of variables relative with each other, between two time periods or two regions” (Dimitriadis, 2002:277).

Particularly in spatial analysis, indices are a widely used tool. The benefits of their use are: **a.** the comparison of phenomena or measures, **b.** the derivation of conclusions for the variation of phenomena or measures which can be represented in thematic maps and **c.** the evaluation of regions according to their values.

1.4. GEOGRAPHIC INFORMATION SYSTEMS

Capabilities provided by Geographic Information Systems (GIS) are henceforth recognized by the majority of scientific sectors and particularly in the case of locational planning where the whole process has radically changed. The combination of a rich descriptive database with spatial entities constitutes one of the basic advantages of GIS. Particularly interesting is the ability to provide a “representation of certain aspects of the ‘real’ world by digital means... where it provides an environment for queries and experimentation which would be expensive or impractical to perform in reality” (Martin, 1991: 161).

Moreover, it is possible to perform complex spatial queries according to logical functions that combine more than one criterion. Also, very important is the function of **Geocoding**, a "process of connection of databases containing conventional location elements (address, kilometric place, etc) with map elements (points, arcs, polygons)" (Pappas, 1998: B-41). At the end of this process a digital coverage is created with points representing the geocoded facilities.

Furthermore, the role of GIS is catalytic in **mapping** spatial problems and processes which to a great extent increases the size of information included in a database and has rapidly changed the path on which cartography is moving. Despite that, the introduction of GIS in the sciences of space “does not necessarily eclipse the role of cartography in the visualization of spatial knowledge but, as a means of storing, managing and analyzing that knowledge, a GIS provides immense benefits when compared to the analogue technology of conventional maps” (Jones, 1997:4).

2. METHODOLOGY

In this chapter the proposed methodological framework and its phases are analyzed and schematically represented in the **Figure 2**:

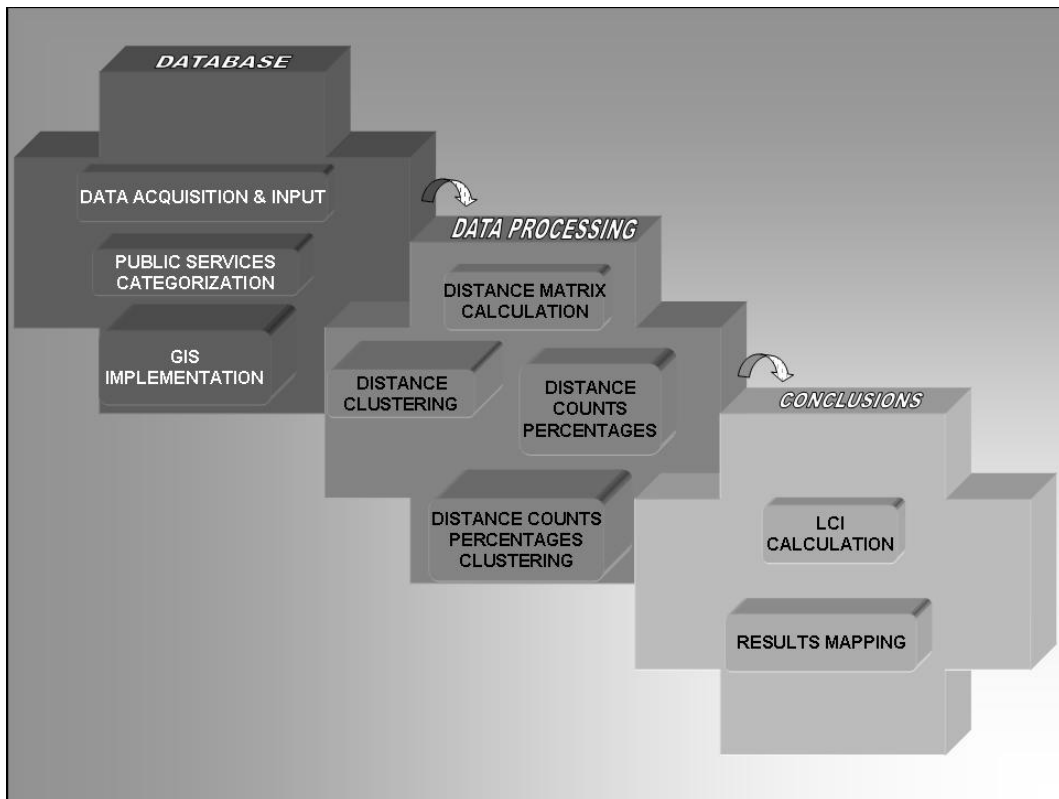


Figure 2. Methodological Framework

2.1. DATABASE

The **first phase** of the methodological framework includes three individual stages. Initially, data should be **acquired** and **registered** and since the objective of the study deals with public services, their address and precise name should be given in tables as well as population and land values per building block. The next stage includes the categorisation of services, according to served population age groups and to their yearly utilization levels as well as the categorisation of bus stations per number of served lines. The third stage includes the **implementation** of GIS involving the existence of a **street network** digital map, essential for the geocoding process, as well as the digital map of **building blocks**.

2.2. DATA PROCESSING

In the **second phase** of the methodological framework three individual stages are included. In the **first** stage the calculation of minimum and average distances (Euclidean, Manhattan block or network distance) from building blocks centroids to each service is performed and in the **second** stage the percentages of services found within a radius R are calculated for each categorisation of services. The **third** stage of this phase includes the clustering of distances and percentages through the application of **K-**

Means Cluster Analysis which results in groups of building blocks with attributes determining their accessibility to the public services (based on the minimum and average distance).

2.3. CONCLUSIONS

In the phase of conclusions, LCI an indicator comparing the locational value (resulting from the data clustering process) with the land value of building blocks is calculated. The LCI's mathematical formulation is:

$$LCI = \frac{V_L / \max V_L}{V_I / \max V_I} \quad (1)$$

where

V_L is the Locational Value per building block and

V_I is the Institutional Value per building block

Finally, the results from the clustering process and the LCI values are shown in thematic maps build in the GIS environment.

3. APPLICATION

The study area includes the Municipalities of Volos and Nea Ionia as well as the settlement of Nees Pagases and it was selected because of its rapidly transforming profile with respect to urban population increase as well as to tourism development observed during the last decade.

3.1. DATA ACQUISITION AND INPUT

The data acquired for the purposes of the current study are:

- a. **digital maps** of the area's street network and building blocks (ArcView shapefiles)
- b. **services data** and precisely public services data (Education, Healthcare-Provision, Athletics, General Services) as well as bus stations
- c. **population** per building block of 1991 census as reported by the Greek National Statistical Service (GNSS)
- d. **land values** per building block valid until 2004.

3.2. PUBLIC SERVICES CATEGORIZATION

The services were categorized (bus stations not included) according to: a. served population age groups (**Table 1**) and b. their yearly utilization levels (**Table 2**). Bus stations are categorized separately (**Table 3**) according to number of served lines since due to their nature they can't follow the previous.

Services categorization according to served population age groups						
	Code	Service	0 - 14	15 - 29	30 - 59	60 - 85+
Education	101	Nursery school	⊗			
	102	Primary school	⊗			
	103	Lower secondary school	⊗			
	104	Upper secondary school		⊗		
	105	University		⊗		
Healthcare Provision	201	Hospital	⊗	⊗	⊗	⊗
	202	Municipal health centers	⊗	⊗	⊗	⊗
	203	Public day nurseries	⊗			
	204	Centers of elderly restitution				⊗
	205	Youth centers		⊗		
	206	Squares	⊗	⊗	⊗	⊗
	207	Public Playgrounds	⊗			
Athletics	301	National & Municipal Stadiums	⊗	⊗	⊗	
	302	Gymnasium	⊗	⊗	⊗	
	303	Swimming pools & relative	⊗	⊗	⊗	
	304	Athletic Centers	⊗	⊗	⊗	
	305	Fields	⊗	⊗	⊗	
General Services	401	Police Department		⊗	⊗	⊗
	402	Fire Department		⊗	⊗	⊗
	403	Courts		⊗	⊗	⊗
	404	Public Economic Service		⊗	⊗	⊗
	405	Port authorities		⊗	⊗	⊗
	406	Forest authorities		⊗	⊗	⊗
	407	Post offices		⊗	⊗	⊗

Table 1. Services categorization according to served population age groups

Services categorization according to their yearly utilization					
	Code	Service	More often	Often	Less often
Education	101	Nursery school	⊗		
	102	Primary school	⊗		
	103	Lower secondary school	⊗		
	104	Upper secondary school	⊗		
	105	University	⊗		
Healthcare Provision	201	Hospital		⊗	
	202	Municipal health centers		⊗	
	203	Public day nurseries	⊗		
	204	Centers of elderly restitution		⊗	
	205	Youth centers		⊗	
	206	Squares		⊗	
	207	Public Playgrounds		⊗	
Athletics	301	National & Municipal Stadiums			⊗
	302	Gymnasium		⊗	
	303	Swimming pools & relative			⊗
	304	Athletic Centers		⊗	
	305	Fields			⊗
General Services	401	Police Department		⊗	
	402	Fire Department		⊗	
	403	Courts			⊗
	404	Public Economic Service			⊗
	405	Port authorities			⊗
	406	Forest authorities			⊗
	407	Post offices			⊗

Table 2. Services categorization according to their yearly utilization levels

1 ⁿ category	Bus stations serving 1 line
2 ⁿ category	Bus stations serving 2-4 lines
3 ⁿ category	Bus stations serving 5-10 lines

Table 3. Bus stations categorization according to served lines

3.3. GIS IMPLEMENTATION

The creation of a GIS is. The GIS database construction realized in the **Arc View 3.1** and **Arc GIS 8.3** environment demands not only spatial information about studied entities but also descriptive information characterized as **geographic data** which refers to: the population per building square, institutional land values and services information. The **population** should be initially registered in a database file according to the GNSS code of each building block. The **services data** are transformed via Geocoding to points located on the street network (coverage) in the place that corresponds to their address.

3.4. DISTANCE MATRIX CALCULATION

The distance matrix calculation is necessary for the formation of the locational value (accessibility). The fact is that “the closer the opportunity, the more it contributes to accessibility” (Handy et al., 1997:1177). The distances are calculated by the use of the

Manhattan block distance r_m between two points 1 and 2 which is considered to give a good approximation of the network distance (Equation 2):

$$r_m = |x_1 - x_2| + |y_1 - y_2| \quad (2)$$

A critical issue is the measurement of distance from each building block (polygon) to the geocoded services (points) which requires the usage of the centre of gravity or the centroid of building blocks also performed in the GIS environment.

3.5. DISTANCE COUNTS PERCENTAGES

This phase is also essential for the definition of the locational value. The distance counts percentages method is a cumulative opportunities measure of accessibility since it counts “the number of opportunities reached within a given travel time (or distance)” (Handy et al., 1997:1177). The calculation of services percentages within a radius R from each building block arises from the previous process of distance matrix calculation. This process is realised for two different radiuses $R_A = 500\text{m.}$ and $R_B = 700\text{m.}$ The two radiuses resulted as follows: first the average maximum distance that every student should travel to his/her school (400m. and 800m) was calculated (600m.) and then 100m were added and subtracted in order to define a more pragmatic interval.

3.6. DISTANCE CLUSTERING

The minimum and average distance clustering is realised with the use of the non-hierarchical method K-Means Cluster Analysis. The analysis takes place for every categorisation of services (per served population age groups, per yearly utilization levels and per number of lines served for the bus stations).

The results of the clustering process give information on the values of variables in the cluster centres, the cluster membership of each building block as well as the distance of each building block from the cluster centre to which it belongs. Cluster grading is defined by the values of minimum distance of their respective centres.

3.7. DISTANCE COUNTS PERCENTAGES CLUSTERING

The procedure of clustering services percentages within radius R_A and R_B is similar with that of clustering distances and is repeated for each categorisation of services. The definition of clusters as of high, medium and low accessibility is based on the variable that has similar distribution with most of the other variables (**Table 4**):

Yearly services utilization	Clusters		
	1	2	3
More often	3,5%	3,2%	3,3%
Often	4,5%	2,6%	6,7%
Less often	11,1%	0,9%	26,1%

Table 4. Cluster centres resulting from the clustering of services percentages within a radius R_A

The gradation of cluster centres appears in **Table 5** (high percentages to low):

Yearly services utilization	Percentages gradation		
	High	Medium	Low
More often	1	3	2
Often	3	1	2
Less often	3	1	2

Table 5. Gradation of cluster centres for the clustering of services percentages within a radius R_A

According to the final cluster grading the high accessibility cluster is considered to be cluster 3, the medium accessibility cluster is cluster 1 and the low accessibility cluster is cluster 2.

3.8. LCI CALCULATION

The creation of the indicator resulted from the need of a comparison measure between spatial entities but also of an evaluation measure built according to its optimum value. The substances participating in the creation of the indicator are the **locational value** of each building block (V_L) quantified according to the results of preceding clustering procedures and the **institutional value** of each building block (V_I). More specifically, each building block's locational value was defined according to its cluster membership and the assigned weights (**Table 6.**):

Services Categorisation	Clustering of	Weight
per served population age groups	minimum and average distance	8/33
	services percentages in radius 500m.	2/33
	services percentages in radius 700m.	1/33
per yearly utilization levels	minimum and average distance	8/33
	services percentages in radius 500m.	2/33
	services percentages in radius 700m.	1/33
per count of served lines by the bus stations	minimum and average distance	8/33
	services percentages in radius 500m.	2/33
	services percentages in radius 700m.	1/33

Table 6. Gradation weighting for each clustering procedure

The cluster membership of a building block in the 1st cluster is marked with 3, in the 2nd cluster with 2 and in the 3rd cluster with 1 and then it is weighted with the corresponding weight from **Table 6**. The locational value of each building block results finally from the sum of the weighted marks attributed in each clustering procedure and the **maximum locational value** per building block results from the sum of the maximum marks that could appear for each clustering (3 marks per clustering procedure).

3.9. RESULTS MAPPING

The final data from the individual phases of application are represented cartographically with the help of ArcGIS 8.3 and ArcView 3.1. by mapping the: **1.** minimum and average distance clustering, **2.** clustering of services percentages within a radius R_A and R_B and **3.** LCI values which are in extenso described.

3.9.1. Conclusions from the mapping of the minimum and average distance clustering results

The clustering of minimum and average distance between building blocks and services, graded according to served population age groups and yearly utilization levels, as well as to the bus stations gave the following results (**Table 7**):

Cluster	Percentage of building blocks per cluster for each distance clustering procedure		
	clustering by served population age groups	clustering by yearly utilization levels	clustering by served lines count for each bus station
High accessibility	57,4%	57,3%	58,4%
Medium accessibility	34,9%	34,7%	36,1%
Low accessibility	7,7%	8,0%	5,5%

Table 7. Aggregated results of minimum and average distance clustering for the three categorisations

The results show that the cluster membership of the building blocks in the three clusters is similar for the two first categorisations (per age groups and utilization levels) while for the bus stations the count of building blocks is fairly differentiated in the three clusters.

3.9.2. Conclusions from the mapping of distance counts percentages clustering (in R_A and R_B) results

The second phase of clustering procedure includes basically the clustering of building blocks according to the percentages of services that are found within a radius $R_A = 500m.$ and $R_B = 700m.$ from each building block and for each categorisation of

services (per age groups and utilization levels) as well as for the bus stations (per count of served lines).

3.9.2.1. Distance counts percentages clustering procedure within radius R_A

The aggregated results of this phase are presented in **Table 8**:

	Percentage of building blocks per cluster for each services percentages (in radius R_A) clustering procedure		
Cluster	clustering by served population age groups	clustering by yearly utilization levels	clustering by served lines count for each bus station
High accessibility	8,9%	2,5%	10,2%
Medium accessibility	42,8%	16,4%	19,1%
Low accessibility	48,3%	81,1%	70,7%

Table 8. Aggregated results of the services percentages (within a radius R_A) clustering for each services categorization

Table 8 shows an intense differentiation of building blocks numbers in each cluster for the three procedures. Indeed, the clustering for the services categorization by served population age groups presents the maximum count of building blocks in the 2nd-cluster, the clustering by yearly utilization levels has the **minimum** count of building blocks in the 1st cluster but also the **maximum** count in the 3rd cluster and finally, the clustering by bus stations reaches the **maximum** count of building blocks in the 1st cluster.

3.9.2.2. Distance counts percentages clustering procedure within radius R_B

For the percentages clustering within a radius R_B , the cluster centres resulted in the corresponding categories for the radius R_A were used as initial cluster centres in order to maintain the criteria levels and therefore only one iteration of the clustering procedure was realized (**Table 9**).

	Percentage of building blocks per cluster for each services percentages (in radius R_B) clustering procedure		
Cluster	clustering by served population age groups	clustering by yearly utilization levels	clustering by served lines count for each bus station
High accessibility	11,6%	1,7%	6,2%
Medium accessibility	45,6%	11,7%	9,6%
Low accessibility	42,8%	86,6%	84,2%

Table 9. Aggregated results of the services percentages (within a radius R_B) clustering for each services categorization

These results show that the clustering by served population age groups has assigned the majority of building blocks to the high and medium accessibility clusters (11,6% and 45,6% respectively). Moreover, and focusing on the low accessibility cluster

its lowest percentage is for the clustering by served population age groups (42,8%) while its greatest percentage is for the clustering of services by utilization levels (86,6%).

3.9.3. LCI values mapping

The values of LCI are calculated for each building block of the study area which are then grouped depending whether its value is < 1 , ≈ 1 or > 1 (**Figure 3**).



Figure 3. Locational Convergence Index per building block of the study area

Building blocks in the group with **values** $< 0,98$ (relative locational value smaller than the relative land value) are located in the wider part of the study area. The LCI values between **0,98 and 1,019** imply that the relative locational value is almost equal with the relative land value and appear in a small part of the city centre and partly in the periphery of the study area. Finally, blocks with **values** $> 1,019$ (relative locational value greater than their relative land value) are mainly located in the central and north-eastern department of the study area. In the map of **Figure 4** LCI values are comparatively overlaid with population per building block in order to assist both the cartographic representation and the interpretation stage of the analysis. Accordingly, in **Table 10** the percentages of building blocks for each combination of LCI values and population are shown.



Figure 4. Locational Convergence Index and population per building block

Population per building block	LCI values		
	0,010 - 0,979	0,980 - 1,019	values > 1,019
0	6,3%	0,8%	3,0%
1 - 49	44,4%	9,9%	17,8%
50 - 98	9,0%	3,6%	3,7%
99 - 147	1,0%	0,3%	0,2%

Table 10. Percentages of building blocks by LCI values and population groups

The majority of building blocks has LCI values $< 0,98$ and also low population (1-49 habitants) while the minority of blocks has LCI values $> 1,019$ and high population (99-147 habitants). It should be clear at this point that for the three first groups of population, the lower percentages are detected in the LCI values ≈ 1 while the highest in values < 1 which means that the majority of blocks have different relative locational than institutional value.

4. CONCLUSION

The main aim of the suggested methodological framework is the analysis of citizen's accessibility to public services in urban areas as well as its convergence with institutional values. The interest in public sector is justified since the study of phenomena related with social prosperity is to a large extent related to quality of life. Indeed, the public sector is devoted to social welfare and proceeds with the planning and organisation of its services taking always into consideration effectiveness and efficiency.

The applied methodological framework led to the formulation of LCI, an index correlating the locational and the institutional value per building block. The locational value reflects the blocks' accessibility to public services and the institutional value substantially coincides with the land value attributed by the state. In this respect, LCI represents the degree that the locational value corresponds to the land value and the cartographic representation of his values as well as his comparison with the population distribution which sets the direction on which a correlation of the locational and institutional value can be realized.

In summary, it should be pointed that the results of this work can appear particularly useful in planning or re-designing of a public services network by providing an alternative view which with the increased capabilities of GIS can be further analyzed providing even richer conclusions when time series data are available. Moreover, the

approach could be strengthened if more detailed data (i.e. population per age group) for each building block and network distances were utilised.

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