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Saad Thaibaoui[1*], Boudjamea Khalfallah[**], Hafid Layeb[*]

** Faculty of Earth Science, Geography and Urban Planning, University of Constantine, Constantine, Algeria*

*** Institute of Urban Management and Techniques (GTU), Mohamed Boudiaf University, M'sila, Algeria*

MEASURING INTER-NEIGHBORHOOD DISPARITIES BY TRIBAL ORIGIN AND ACADEMIC ACHIEVEMENT. CASE OF BOUSAÂDA, ALGERIA

Abstract: The phenomenon of inter-neighbourhood disparities is taking on worrying proportions in the city of Boussaâda. The quantitative study of disparities provides us with alarming figures on the social and spatial dimensions. Our research has shown a negative correlation between the indices of residential segregation and school success rates, specifically with a strong residential segregation through the overcrowded peripheral neighbourhoods, and a low level of school facilities. The study of inter-neighbourhood disparities in the city of Boussaâda, affirmed a strong residential segregation with 0.780 as the value of the segregation index and ghettos evaluated at 6 on the scale of Poulssen. The other result at the level of school facilities with indices of zonal aptitude varying between 0.41 and 1.02 on the neighbourhoods of "Maitar and Sidi Slimane" on a scale of 0 to 5. These figures are alarming for local authorities and require a search for social diversity and a re-evaluation of the methods of decision making for the allocation of school facilities based on socio-economic data and a level of facilities comparable to a national average. Its objectives are the result of combining social and spatial indicators in a square matrix by Saaty's AHP (Analytic Hierarchy Process) method. It is in this complex urban context that geographic information systems (GIS) can be used as a decision support tool, with a dashboard that displays in real time the situation of the different districts of the city, by means of disparity indices.

Key words: Boussaâda, inter-neighbourhood disparities, school facilities, zonal suitability index, AHP method, spatial and residential segregation, multicriteria decision

[1] saad.taibaoui@univ-msila.dz (corresponding author)

Introduction

In order to deal with the diversity of problems facing the city today, the latter is calling on new concepts, such as sustainable development and good governance. It is often confronted with socio-spatial disparities, which are synonymous with inequalities between the different districts of the city, but the main question, according to Amartya (1992), is what kind of inequalities are involved. It is in fact a two-dimensional theme, encompassing on the one hand, the spatial dimension, measured by the unequal distribution of income, wealth, power, facilities and resources, and on the other hand, the social dimension, which refers to the categories of populations according to their age, gender, socio-professional class, and ethnic origin (Stillwell et al., 2010). The observation is that these social disparities often become an obstacle to the populations of the neighbourhoods, preventing them from benefiting equally from the same facilities, resources, opportunities or any other right common to the citizens of the city.

Recent analyses of Lazar et al. (2021) and Wilkinson and Pickett (2009) have respectively provided preliminary empirical findings of a growing dependence between social and economic development, and a causal relationship between poverty and chronic disease.

Quantitative analysis of spatial disparities can conclude on the status of neighbourhoods with a series of indicators, such as the number of students per class or the travel time from the city centre to the neighbourhood; but social disparities are more ambiguous.

The Chicago School was a pioneer in the study of ethnic concentrations in the United States in the 1920s (Grafmeyer & Joseph, 1984). It measured this phenomenon through a series of indicators of residential segregation, such as the Dissimilarity Indices of Duncan and Duncan (1988), or Bell's Indices (1980). Other American researchers such as Jacubs (1981), Morgan (1983) and Wong (1993) develop various spatial indices to measure similar phenomena.

Massey and Denton (1988) classify the spatial forms and manifestations of residential segregation into five dimensions (Equality, Concentration, Exposure, Clustering, and Centralization), each of which is defined by single-group, intergroup, and multi-group indices.

This presentation of the phenomenon of disparity reinforces the idea of the study project, as it is a concept that varies between disparity synonymous with inequality and diversity; it encompasses several situations, from the identification and measurement of disparities to the decision to allocate wealth across city neighbourhoods. We believe that particular attention should be paid to the different social concentrations and levels of services offered to the population of the districts in difficulty.

The city of Boussaâda displays a tribal concentration in the dense, illicit and precarious peripheral neighbourhoods. Their population is estimated at 60% of the total population of the entire city. This imbalance in the demographic distribution of the neighbourhoods of Bousaâda, combined with the low level of school equipment, implicitly reflects school failure. This paper is limited only to this type of educational equipment because we have noted a near absence of other services. The extent of the failures and disproportions affects all other socio-economic facilities such as health, leisure, cultural, public transport facilities, etc.

A neighbourhood is rarely independent of its neighbourhood (Caloz & Collet, 2011). Therefore, our approach to the issue starts from the identification of social disparities on a

tribal basis by the Geo-segregation Analyser tool (Apparicio, 2008), in order to calculate the distribution of the different ethnic groups across the city's neighbourhoods, through a series of Moran (1988) indicators, including segregation indexes, the Gini index, or the Poulssen typology. Next, the level of educational facilities in each neighbourhood is analysed by evaluating the Zonal Aptitude Index.

The process of Hierarchical Analysis AHP (Saaty, 2008), summarizes the situation of multidimensional disparities between the neighbourhoods of the city of Boussaâda, by the Index of overall zonal ability weighted according to the constraints and factors previously established. The latter is of great help in the decision to establish educational facilities, currently taken on a mainly qualitative basis, so we will go beyond the phase of observation of inter-neighbourhood disparities towards expertise, measurement and decision on a scientific basis.

This article is organised as follows: first, the introduction of the case study and the method used to manipulate the data collected. Secondly, the presentations of the empirical results of the situation of socio-spatial disparities between the districts of the city of Boussaâda, introducing the zonal suitability index. Finally, the conclusions and research perspectives.

Material and Methods

Data Collection

Our database is built on the nominal list of beneficiaries of the RHP program (rehabilitation of precarious housing), distributed through the different districts of the city of Boussaâda, with one hundred beneficiaries per district. The sample is statistically acceptable, the calculation of chi-square with 80 as dll and a significance level of 0.05 is significantly higher than the chi-square of the theoretical table. These data are processed (with the help of the city's civil status department), to bring out the tribal origin of each beneficiary, with its geographical location. This research is limited to the evaluation of the level of service of the school facilities since the peripheral districts of the city of Boussaâda only offer this type of equipment.

Multi-criteria analysis of inter-neighbourhood disparities using the AHP method		
Dimensions	*Social dimension*	*Spatial Dimension*
First step	*Construction of a database on the districts of the city of Bousaada, in a vector layer (polygons) with the districts in rows and the population groups in columns according to their ethnic origins.* *Source: architecture and urban planning firms.*	
Second step	*Calculation of Residential Segregation Indices by geo-segregation analysis:* *- Entropy Indices.* *- Poulsen's typology indices*	*Levels of educational facilities:* *- Number of students/classrooms* *- Success rate in BEM* *- Success rate in the BAC*
Third step	*Import of the database of the six indices on the attribute table of a vector layer*	
Fourth step	*Calculation of the relative weights of the six factors by the AHP method. Inter-factor weighting.*	*Calculation of scores for each neighbourhood/factor Intra factor weighting.*
Last step	*Classification of neighbourhoods according to the calculation of overall zonal* *Decision-making on the priority location of educational facilities.*	

Fig. 1. Data processing steps to display inter-district (Source: Authors, 2022)

Methodology

Our approach to inter-district disparities in the city of Boussaâda is two-dimensional (spatial and social) and follow five steps (Figure 1). The social dimension is analysed by the geo-segregation tool (Apparicio et al., 2008) which consists of measuring the distribution of the different categories of neighbourhood population with a set of residential segregation indexes (Massey & Denton, 1988), to qualify and compare the distribution of population groups across the city's neighbourhoods, differentiated on the basis of their tribal origin. The spatial dimension is measured by the number of pupils per class, the success rate for the BEM (brevet de l'enseignement moyen), the success rate for the BAC (bac) and finally the duration of the journey from the neighbourhood to the city centre. The weighted summation method (Chakroun, 1998) allowed us to calculate weighted zonal aptitude indices (Ben Mena, 2000; Maystre et al., 1994; Roy, 1997). The multi-criteria analysis of inter-neighbourhood disparities by the Zonal Ability Index (Caloz & Collet, 2011), is carried out on the six thematic properties of the neighbourhoods of the city of Boussaâda in object mode. The six factors are not equal in terms of appreciation, hence the use of weighting according to the AHP method (Saaty, 2008), this evaluation was carried out in two stages: an intra-factor weighting and then an inter-factor weighting, after standardization of the factors given the variety of units of measurement (in minutes, percentages, or without unit).

Evaluation of the Weighted Zonal Fitness Indices

The zonal suitability of a neighbourhood is defined by an overall index of the level of service available to meet the multiple needs of the inhabitants and which can be positive or negative depending on the objectives sought (Caloz & Collet, 2011). It is a decision-

making tool that opens up multiple research perspectives on the management and development of urban space.

The analysis process is based on the first phase of evaluation whose result is the zonal suitability index on each factor, then the combination of individual indices for an overall index with a weighting of variables (Ben Mena, 2000; Mayster et al, 1994; Roy, 1997), this phase is critical, but the hierarchical analysis procedure AHP (Saaty, 1977), guarantees the logic and transitivity by comparing the factors two by two.

Normalization of Indices

The scoring of the six factors (entropy indices, Poulssen typology, number of pupils/classrooms, BEM success rate, BAC success rate, travel time from the neighbourhood to the city centre) is based on a scale ranging from 0 to 5, i.e., six classes, and each neighbourhood score is normalized in relation to the minimum and maximum recorded in the city, using the formula in the equation 1:

$$\text{I. Apt. Z} = \frac{A \quad d\ q \quad -A \quad M}{A \quad M \quad -A \quad M}, \qquad (1)$$

where I. Apt. Z: Zonal Aptitude Index.

Weighted Summation Method

This method goes through two stages, the first is the identification of the factors and then the attribution of the weighting weights of each factor, the latter also goes through two levels (Chakroun, 1998), an intra-variable weighting by attributing weights or a note to each category (nominal case) and an inter-variable weighting.

Intra-variable weighting

This operation consists of assigning weights to each value according to the equation 1 following a scale in whole numbers from 0 to 5, then we normalize these values between 0 and 1. Figure 2 summarizes the zonal suitability of the different districts according to a single factor.

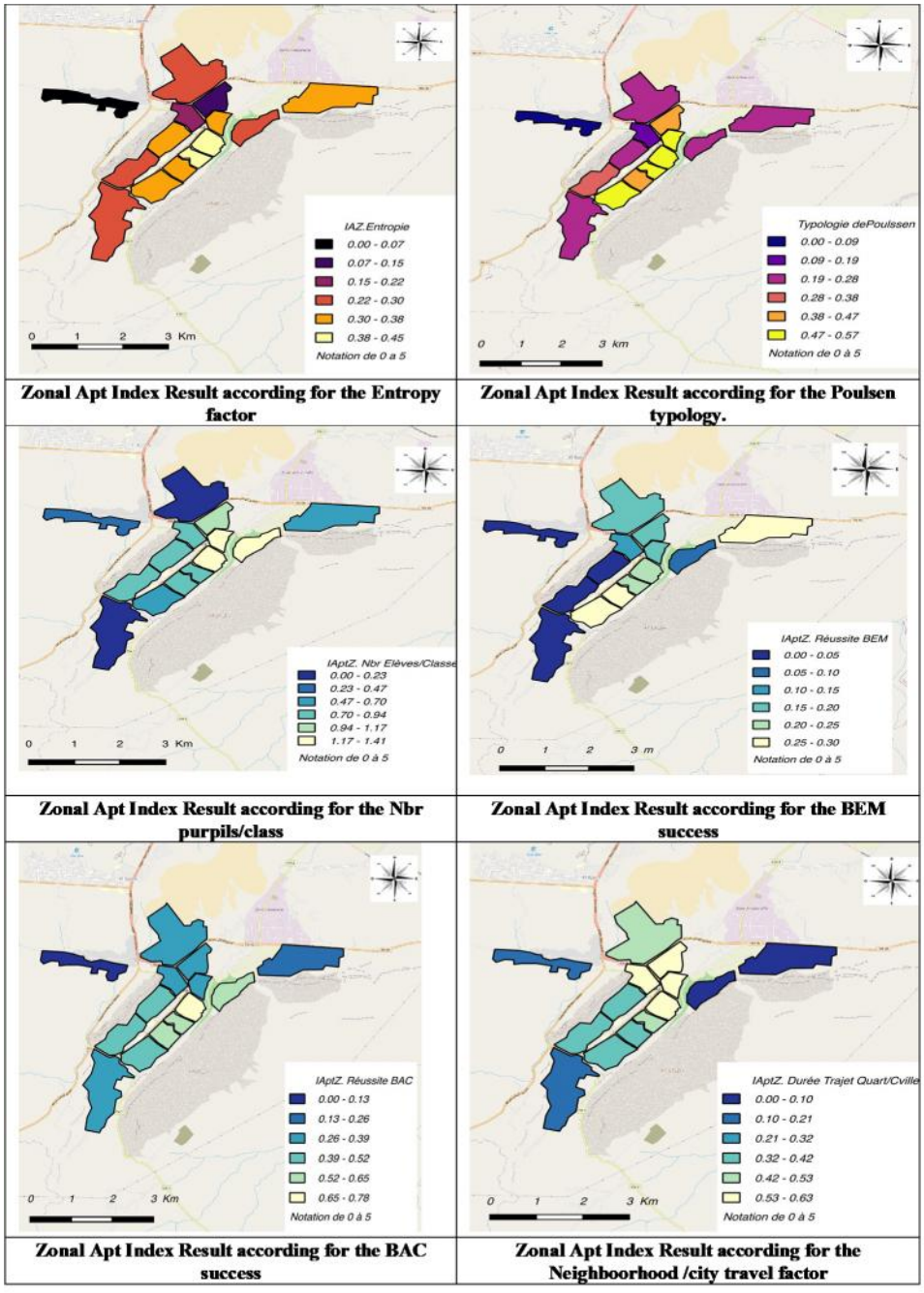

Fig.2. Results of Zonal Aptitude indices by Factor. Established by the author

Inter-factor weighting

This is a weight given to each factor involved in the calculation of the overall Zonal Aptitude index, according to the equation 2:

$$Z \quad = \sum_1^n \omega \quad , \qquad (2)$$

where ωn: weight given to the factor; λnk: k. factor score for the neighbourhood.

There are many scales of weighting, linear, exponential, arbitrary or reciprocal; the latter is applied for the Saaty method with a formula of appreciation from the least important to the most important.

The Saaty Method

Often the decision in the city is made after studying several scenarios, but the final choice of one of the best options remains dependent on the conditions of decision making. On the basis of a multi-criteria analysis, the method (Saaty, 1977) with the relative and reciprocal weighting scale supports the best possibility on a scientific basis. The method requires when assigning the relative weights to each factor, the independence of the factors and the consistency.

The latter, called the degree of consistency CR of the weighting matrix, checks the transitivity rule between the weighted factors. It follows the rule of pairwise comparison of the weighted factors summarized in a reciprocal square matrix on the basis of a table of weights in reciprocal scale:

For the calculation this table is transformed into a reciprocal square matrix:

$$M = \begin{bmatrix} \frac{\omega 1}{\omega 1} & \cdots & \frac{\omega 1}{\omega} \\ \vdots & \ddots & \vdots \\ \frac{\omega}{\omega 1} & \cdots & \frac{\omega}{\omega} \end{bmatrix}$$

Once the weights are given, the matrix can hide inconsistencies, the analysis of this matrix by the Saaty method rectifies these inconsistencies. The demonstration element (Caloz & Collet, 2011) starts from the assumption that the sum of the weights is known, consistent and standardized.

The method defines a consistency index CI.

$$C \quad = \frac{\lambda \quad - n}{n-1}$$

In the table 1 N is number of factors, while RI is random coherence index according to Saaty.

Tab. 1. Saaty's random coherence index.

N	1	2	4	5	6	7	8	9	10	11
RI	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51

Source: Caloz & Collet, 2011

Hence the proposal of a ratio of the coherence index CR:

CR=CI/RI the coherence is established in our case with CR=0.07 which verifies CR< 0.10, because in the contrary case it is necessary to re-assign other weights which will verify this rule.

Results and Discussion

This multidimensional study of inter-neighbourhood results on the distribution of tribal population groups and levels of school equipment revealed strong residential segregation, associated with a low level of school equipment apparent on the number of students/class, the success rate for BEM and BAC. The rating of all the factors is displayed in the table 2 for each district, by the Saaty method using the AHP hierarchical analysis process.

Measurement of weighted zonal suitability

The measure of weighted zonal suitability in the table 2 is the projection of the different weights given to each criterion by the AHP method verifying Saaty's conditions (Table 3 and Table 4), following the scoring of each neighbourhood according to a scale from 0 to 5. The total result in the table 5 is the weighted sum of all criteria on the respective neighbourhoods.

Table 2. Scoring of decision factors from 0 to 5.

Neighborhoods/Factors	F1 Entropy	F2 Poulsen Typologie	F3 Student/Classrooms	F4 Successful completion of BEM	F5 Successful completion of BAC	F6 TripQ/CV
Results of the weights of each Factor	0.091	0.115	0.283	0.06	0.156	0.127
Maitar	0	0	1	0	0	1
Kaissa	2	1	3	2	2	5
El Koucha	4	2	3	0	3	3
El Moudjahid	3	3	3	0	3	3
Sidi Slimane	3	2	0	0	2	1
Nouvelle Cadat	4	5	2	5	3	3
Cadat	4	4	3	5	4	3
Staih	5	5	3	4	4	4
Plateau	5	5	5	4	5	5
Dechra Gueblia	3	2	5	1	4	0
Med Chaabani	4	2	2	5	1	0
Ksar	4	5	5	3	2	5
El Mouamine	1	4	4	3	2	5
20 Aout	3	2	0	3	2	4
Centre Ville	5	5	4	3	5	5
El Nasr	5	5	3	5	4	5

After having evaluated the respective districts on each factor it is necessary to multiply them by the respective weights and making the sum obtaining the index of Global Zonal Aptitude weighted (Table 5).

Tab. 3. Normalization of factor weights

	Entropy	Poulsen typ	Std/Cl	Succs BEM	Succs BAC	Trip Cv/Neib	Wght.	Ranks	PEV (λ)
Entropy	0.15	0.32	0.15	0.14	0.09	0.14	0.168	3	6.3979
Poulsen Typologie	0.05	0.11	0.08	0.14	0.27	0.14	0.127	4	6.3979
Stu-dent/Clas rooms	0.07	0.11	0.08	0.05	0.09	0.09	0.083	6	6.3979
Successful comple-tion of BEM	0.29	0.21	0.38	0.27	0.18	0.27	0.269	1	6.3979
Successful comple-tion of BAC	0.15	0.04	0.08	0.14	0.09	0.09	0.095	5	6.3979
TripQ/CV	0.29	0.21	0.23	0.27	0.27	0.27	0.258	2	6.3979
Somme	1.00	1.00	1.00	1.00	1.00	1.00			

Tab. 4. Results of CI, CR, ROI

CI=0,07 < 0,1	RCI= 1,24	CR = 6,42%	PEV (λ)=6,397	n= 6

Tab. 5. Summary of zonal ability indices by neighbourhood and factor

	Entropy Index	Typology of Poulssen	St/Cla	Succes BEM	Succes BAC	Trip Quar/ Cv	Weight
Résults of the weights of each Factor	0.091	0.115	0.283	0.06	0.156	0.127	
Maitar	0	0	0.28	0	0	0.12	0.41
Kaissa	0.18	0.11	0.84	0.12	0.31	0.63	2.21
El Koucha	0,36	0.23	0.84	0	0.46	0.38	2.29
El Moudjahid	0.27	0.34	0.84	0	0.46	0.38	2.31
Sidi Slimane	0.27	0.23	0	0	0.31	0.12	0.94
Nouvelle Cadat	0.36	0.57	0.56	0.30	0.46	0.38	2.65
Cadat	0.36	0.46	0.84	0.30	0.62	0.38	2.97
Staih	0.45	0.57	0.84	0.24	0.62	0.50	3.25
Plateau	0.45	0.57	1.41	0.24	0.78	0.63	4.10
Dechra Gueblia	0.27	0.23	1.41	0.06	0.62	0	2.60
Med Chaabani	0.36	0.23	0.56	0.30	0.15	0	1.61
Ksar	0.36	0.57	1.41	0.18	0.31	0.63	3.48
El Mouamine	0.09	0.46	1.13	0.18	0.31	0.63	2.81
20 Aout	0.27	0.23	0	0.18	0.31	0.50	1.50
Centre Ville	0.45	0.57	1.13	0.18	0.78	0.63	3.75
El Nasr	0.45	0.57	0.84	0.30	0.62	0.63	3.43

With values close to 1 of the various indices of residential geosegregation and the analysis of socio-spatial disparities between the neighbourhoods of the city of Boussaâda, by the method of weighted summations has proven the inability almost characterized precarious peripheral neighbourhoods, to provide for the basic needs of their population largely segregated and sometimes ghettoized. On a scale of 0 to 5, the peripheral neighbourhoods cannot move away from the value of 1.

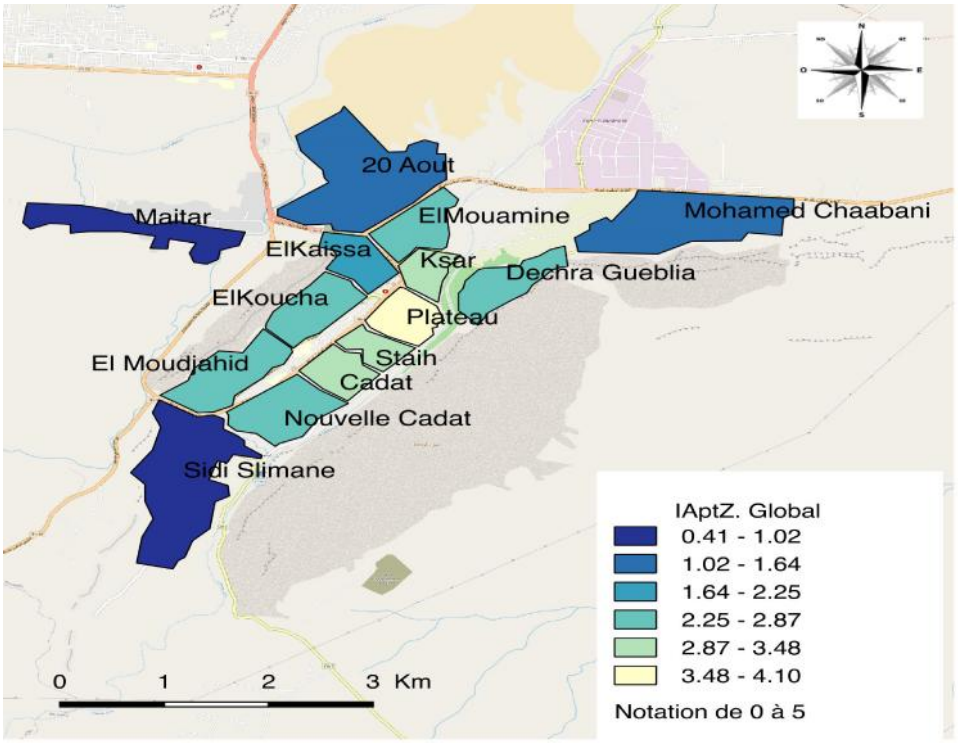

Fig.3. Weighted Global Zonal Aptitude Indices (Source: Authors, 2021)

Conclusion

The aim of this research is to propose a multi-criteria and multi-objective tool to help and monitor the decision to distribute equipment across the neighbourhoods of the city of Boussaâda and thus reduce inter-neighbourhood disparities, as local authorities are often confronted with the discontent of the populations of neighbourhoods that do not benefit from support equipment, especially those with an ethnic concentration. The studies conducted on territorial disparities, such as that by François Dugény (2003) present the situation of territorial disparities by manipulating only one or two criteria such as delinquency, unemployment and chronic diseases, but the phenomenon is more complex. We therefore believe that a tool for monitoring and correcting inter-neighbourhood disparities can be constructed on the basis of Zonal Ability Indices (Caloz & Collet, 2011). This will allow local authorities to measure the ability of city neighbourhoods to meet the needs of their populations and to correct inequalities related to service provision, equal

opportunities, and development. The main idea of this study is to use this concept of ability to identify and address inter-neighbourhood disparities. However, the term suitability is generally used in the assignment of a site according to the properties that make it suitable for the desired function.

The results of this study highlight the inability of the outlying neighbourhoods of the city of Boussaâda to provide for basic needs in terms of education, associated with residential segregation. The situation is critical and vulnerable. The city of Boussaâda can hope for an equitable development of all its neighbourhoods by strengthening services and enhancing social diversity.

The use of MCAD (Multi-Criteria Decision Analysis) makes the decision of the local urban system more participatory, transparent and efficient. It is with shared values and uncontested facts that the decision in the city will be successful. The construction of a decision support tool makes the management of the urban system more concrete and transparent. Usually, the various urban interventions through the precarious districts, are part of the project “City Policy Districts” for a fixed period (Decree of 06/06/2006) on the city's orientation project, with a priority objective, the reduction of inter-district disparities. But the reality is dynamic, a child who enrols in a school with 60 students per classroom and a BAC success rate of (16%) is more likely to fail. With a dynamic and updated decision support tool, local authorities, with the support of the Wilaya and the State or even international organizations (World Bank), will be able to provide for the pressing and priority needs of neighbourhoods in difficulty, especially with an ethnic concentration that may appear to cause disparities in the populations' point of view.

It should be noted that the results of this study should be considered with caution if the choice of indicators and their weightings are modified by other studies, even though the ethnic concentrations shown are relatively accurate.

Research perspectives on decision support tools, built on weighted zonal aptitude indices, can offer support to any urban decision with the help of a multidisciplinary expertise and which could develop into a local decision simulator. It is towards a diversity of territories that we must work by stimulating competition and variety in development with equal chances and opportunities.

Conflicts of Interest: The authors declare no conflict of interest.

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