EVALUATING THE QUALITY OF LIFE IN URBAN AREA BY USING THE DELPHI METHOD. A CASE STUDY OF M'SILA CITY/ALGERIA

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Key-words: M'Sila; quality of life; Delphi Method; Hierarchical Analysis Process; GIS; Multi-Criterion Analysis for Decision-Making.

Abstract. Studies and research on the quality of urban life are witnessing a renewed interest not only of the research community, but also through policies and attention in urban management and planning for the search of how to make cities more competitive and maintain the development and promotion of the population well-being. In this manuscript, we discuss how to assess the quality of urban life by integrating the Delphi method with one of the multi-criteria analysis techniques in decision-making, the process of hierarchical analysis is sequential (AHP). The city of M'Sila, Algeria, was selected as a case-study, where we proposed a set of criteria for assessing the quality of life in the city, engaging its actors using the Delphi method and selecting six factors (public services, education, environment, culture, recreation, health, security, and protection). The first stage, in the second phase, I use a sequential method of the AHP pyramid analysis, the third stage came to translate the results obtained in a GIS environment, to derive the quality of the life map. One of the most important results follows: (7%) of the study-area achieves: high-quality of life with space (3.77 km²), (9%) average quality of life with an area (4.70 km²) and (14%) moderate quality of life with an area (6.98 km²) and (19%) low quality of life with space (9.75 km²) and (51%). It achieved the least quality of life with an area (26.02 km²). Map results can be used to identify areas that need to be upgraded or to choose the best areas for accommodation.

1. INTRODUCTION

For many years, researchers in all sciences have argued that the quality of any entity has a subjective dimension that is perceptual, as well as an objective reality. An essential element of this assertion is the notion that the environment can be defined as having a natural and socio-cultural dimension (Marans, 2005).

In the light of population increase, rural exodus and the uncontrolled expansion of cities due to the events of the "Black Decade" that took place in Algeria from 1990 to 2000 (the Algerians passed through a decade of instability and terrorism) made all inhabitants of isolated and insecure areas flee to urban areas close to them to provide security. This applies to all Algerian cities, and the city of M'sila was a place of displacement of the inhabitants of the neighboring areas. This fact led to a rapid and indiscriminate expansion of the city, which caused a decline in the quality of life Current, cities in the competition to provide the best quality of life for their inhabitants. In order to understand the quality of urban life in a city, we need to measure the conditions in this place by using sets of indicators, but the quality of life indicators began to emerge through the evolution of the social indicators in the 1960s (Kladivo & Halás, 2012), but they have roots in the economic means of measurement during The 18th, 19th and early 20th century rings (Mostafa, 2012). These innovative indicators are divided into quantity and quality, there are two basic ways of researching the quality of life: a personal and objective approach and a subjective (or internal) attitude focus on the feelings, perceptions, opinions and mental situations of individuals or groups Studied. An objective (or external) approach attempts to conduct research on the quality of life based on a wide range of measurable or observed indicators in the individual and environmental dimensions (Kladivo & Halás, 2012).

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The residential area is one of the main components of quality of life. Furthermore, we need to monitor changes in this area in these circumstances over time in order to assess or determine whether or not these circumstances have changed. If they change, we need to determine whether they have improved or deteriorated, and this effort may include assessing the impact of various public or private interventions that seek to improve conditions. To better understand the meaning of the studies that focus on the quality of urban life that enables us to better understand this meaning and how it can be measured (Marans, 2003). The quality of the place or location at different levels of the range (the area, the city as a whole, the neighborhood, the dwelling) is certainly a subjective phenomenon and everyone in this situation may differ in their views on the subject.

The main objective of the study is to evaluate the quality of life in M'sila city and to identify the areas where they are necessary to raise the standard of living for the welfare of all inhabitants of the city.

2. MATERIALS AND METHODS

2.1. Study-Area

The city of M'sila is one of the inner Algerian cities located within the following geographical coordinates: Between two viewing circles: '35.48°, '35.67° north of the equator. Between linear length: '4.57°, '4.48° east of Greenwich line the north-south link is the seat of the state. The city is characterized by economic diversification. Municipality of M'sila. Estimated Area B: (232) km^2 operated by (214,661) inhabitants, with a population density of (925) inhabitants according to the municipal Bureau of Statistics 2014, an estimated area of study field Urban center of the City B (50.01) km^2 (Fig. 1).

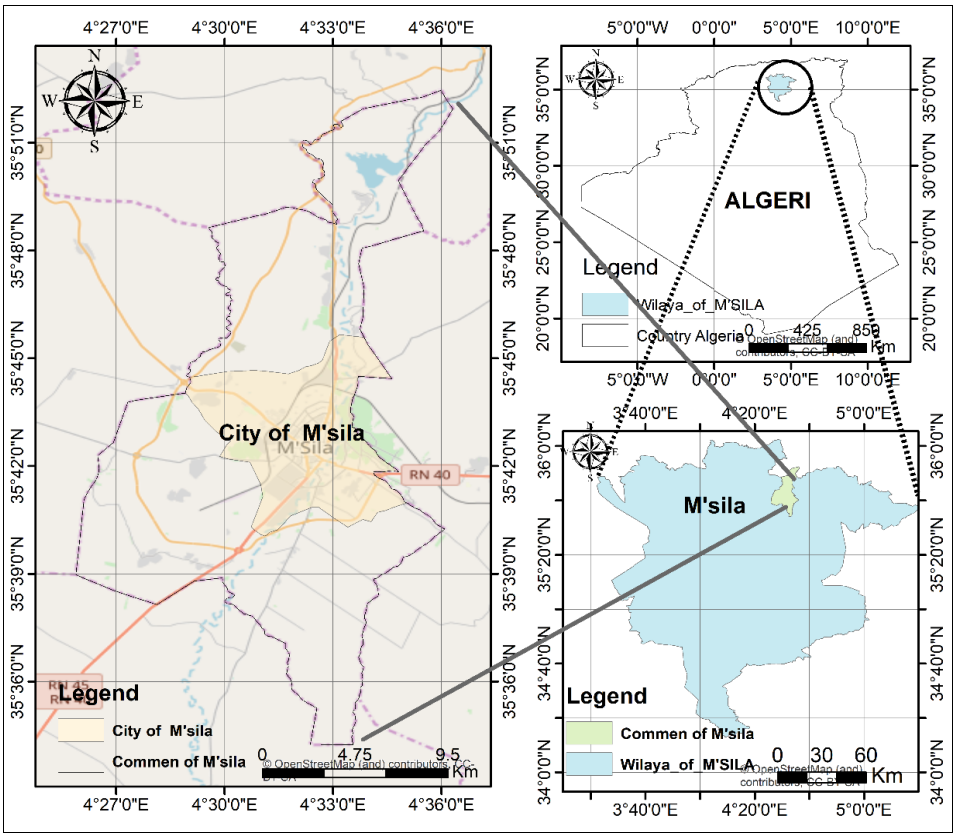

Fig. 1 – Location of the Study-Area City of M'Sila.

2.2. Data Collection

2.2.1. Factors for Evaluating the Quality of Life in the City

As mentioned previously, criteria were determined using the Delphi method to evaluate the quality of life by applying a multi-criterion analysis to decision-making through the analytical hierarchy process. After collecting the geographical data, layers of the main factors and sub-factors were set in the open source programme Q GIS.

2.2.1.1. Security and Civil Protection

In this factor, information was collected by field survey and the identification of all police stations and fire departments and the creation of a layer for the latter in the QGIS programme. Police stations and fire departments were chosen based the opinions of experts and field surveys in determining the range of service: (less than 2,000 m); (2,000 m to 3,000 m); (more than 3,000 m) (Fig. 2).

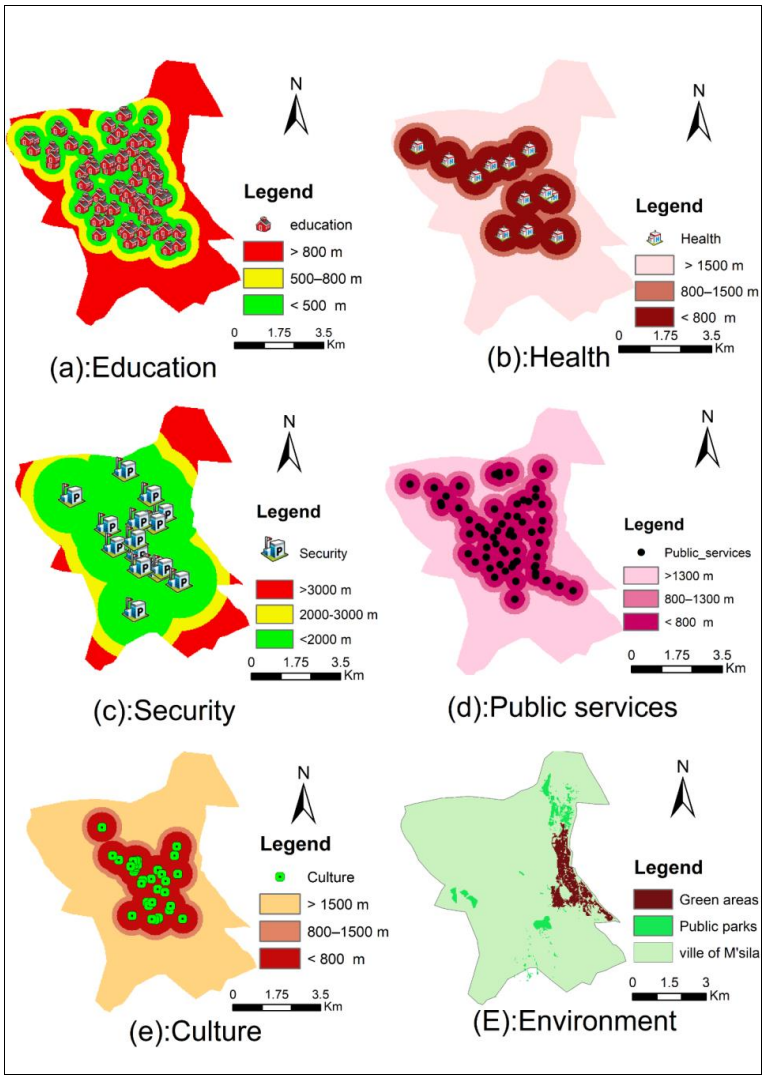

Fig. 2 – Factors studied in the analysis of the Quality of Life in the City of M'Sila.

2.2.1.2. Education

For this factor, we collected all the descriptive data from the Directorate of Education in M'sila and all the spatial data from the blueprints of the planning and reconstruction of M'sila with field survey to update all the collected data. For the range of service, the experts determined: (less than 500 m); (500 m to 800 m); (more than 800 m) (Fig. 2).

2.2.1.3. Culture and Entertainment

For this factor, we relied on all entertainment centers, including public parks, sports centers, football stadiums, swimming pools, theatre houses, cinemas, youth centers, culture houses and all the centers related to social aspects. The ranges of service were based on expert opinions, but the data were collected from the Directorate of Youth and Sports and the Directorate of Culture of M'sila. The range of service were determined as (less than 800 m); (800 m to 1,500 m); (more than 1,500 m) (Fig. 2).

2.2.1.4. Health

For this factor, information was collected on the basis of the blueprints of the planning and reconstruction of M'sila with field surveys to update all the collected data. A layer was then established for all health centers and hospitals. The ranges of service were determined by the experts' opinions as follows: (less than 800 m); (800 m to 1,500 m); (more than 1,500 m) (Fig. 2).

2.2.1.5. Public Services

For this factor we relied on all necessary public services distributed alongside the city, including post-offices, municipal branches, telephone service offices, water supply service, religious facilities, and urban transport service. Data were collected from the blueprints of the planning and reconstruction of M'sila in 2012 with field surveys to update the data. The range of services was determined by the experts as (less than 800 m); (800 m to 1,300 m); (more than 1300 m) (Fig. 2).

2.2.1.6. Environment

For this factor, the forest, agricultural fields, water basins, residential areas, green zones, arid zones, and diverse areas were determined and classified (Fig. 2).

2.3. Methods

Assessing the quality of urban life is a complex process, so a number of possible alternatives must be taken, as well as multifaceted and often conflicting evaluation criteria, such as economic, environmental, social, etc.; here, the Delphi method can be used to define evaluation criteria as a means of structuring the process of collective communication to deal with the complex problem of extracting and studying the influential criteria to find the preferred sites for the quality of life, by calculating the degree of importance of the percentage of significance value (Seyyed *et al.*, 2016) s,. This method has the ability to overcome the deficiencies in common methods such as brainstorming (that may influence collective thinking on the final results) by providing an opportunity for experts to respond anonymously (Kim *et al.*, 2013).

After the Delphi method, we use multi-criteria decision-making methods, which rely primarily on accurate measurement concepts and rigorous evaluation, to assist decision-makers by presenting suitable candidates to assess the quality of life in the city, including the analytical hierarchy process (AHP) (Aalianvari *et al.*, 2012). This style is developed by a world of mathematics Thomas (Wind & Saaty, 1980). "It is a quantitative method of evaluating and arranging alternatives relative to the goal" (Cheah *et al.*, 2018). Thomas has defined an integrated framework that combines subjective objective criteria, based on comparisons based on a relative scale (Wind & Saaty, 1980). This method could provide a methodology for determining weights and evaluating the different criteria used to assess the quality of life. Using AHP, the decision-making process can be divided in several hierarchical levels

so that a decision can be made based on the knowledge and experience of the experts involved through the binary comparison in each level (Yilmaz Kaya & Dağdeviren, 2016) (Fig. 3).

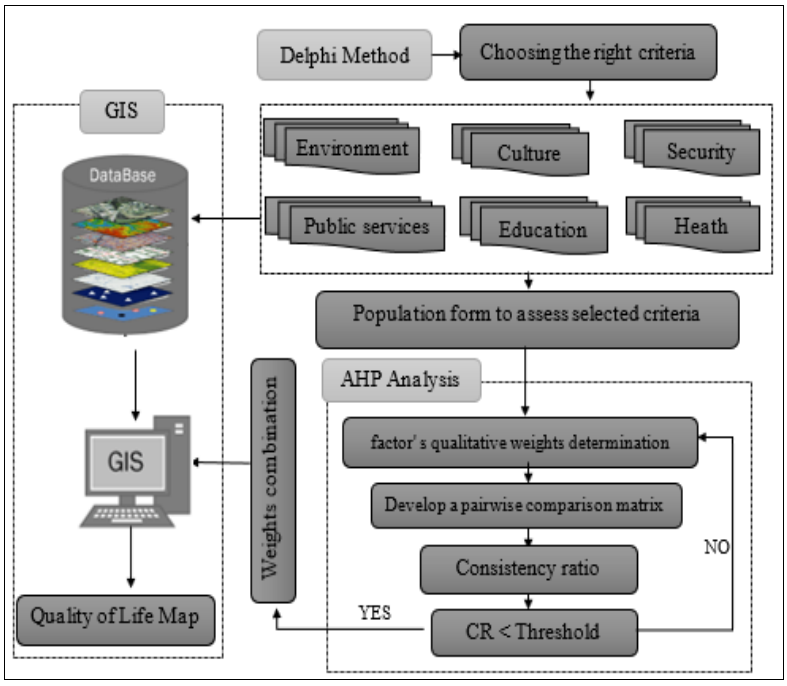

Fig. 3 – The analysis procedure followed for this research.

2.4. Delphi method

Is a systematic and interactive prediction method that relies on a Committee of Experts (Dalkey & Olaf, 1963), as an organized communication technique (Sackman, 1974), for interactive decision-making based on the term "collective intelligence of Experts" (Rowe & George, 2001), and experts to respond to questionnaires on the subject in two or more stages (Turoff & Scher, 2002).

In our research, four stages have been worked out with a group of (30) experts from different disciplines (environment, urbanism, economics, sociology) in various leadership positions and close to the decision-making authority, and after each of the previous phases, we send an anonymous summary containing the Outlook Feed of Experts from the previous stage and the reasons on which their judgments were based, and therefore experts are encouraged to review their previous responses in the light of replies from other members of the Committee of Experts (Linstone *et al.*, 1975). During this process, the range of responses is shrinking and the views of the Expert Group will converge towards the right answer. Finally, a process was discontinued following the fourth and final phase, after which the questionnaire results were determined (Qureshi *et al.*, 2014).

Six different and varied criteria were established, depending on the majority opinion: (health, public services, education, environment, culture and recreation, security and protection), and each of these main criteria has a set of sub-criteria, after the Delphi process the local people were involved in a random sample. In the evaluation of these standards through a closed Questionnaire to assess the quality of life in the city, where they were directed (385) Questionnaires retrieved (370) Questionnaire and loss (15) Questionnaire or White return, among the questions of the questionnaire what service is necessary for you among the proposed criteria? What is the appropriate distance between the house and the services among the suggested distances? Do these variables contribute to your welfare and that of the residents of the city, as you think? Is the distance related to the quality of service?

The degree of preference between the various main and sub-criteria was examined according to the opinion of the population using the scale Thomas watchmaker (Table 1), for the comparison of variables and the majority opinion of the population was taken in comparison AHP. Then go to the AHP serial pyramid analysis process to determine the weights of the main criteria and Sub-criteria.

2.5. Hierarchical Analysis Process (AHP)

AHP relies on the following factors:

2.5.1. Analysis

Decompose a complex problem in a hierarchical hierarchy of interrelated decision elements. A hierarchical structure is created for the thread and sequence of all decision elements in the top-level hierarchy (Pawattana & Tripathi, 2008). The global target is placed at the top of the pyramid structure. The lower level of the hierarchy consists of more detailed elements, which are associated with the criteria at the next top-level (Saaty, 1990).

2.5.2. Prioritization

After the hierarchy is created, the relative importance of all resolution elements is captured and detected through binary comparisons, which are used to create a ratio matrix. Binary comparisons are determined between the main criteria and sub-criteria within the same hierarchical level (Fagbohun & Aladejana, 2016). The digital scale was used as suggested by Saaty (Ouma & Tateishi, 2014), ranging from 1 to 9 (Table 1) in the pair comparison matrices (Saaty, 2008).

Table 1

Gradation scale for quantitative comparison of alternatives
Source: (Abediniangerabi *et al.*, 2014, p. 62)

VALUE	PREFERENCE LEVEL NUMERIC
1	EQUAL PREFERENCE
3	MODERATE PREFERENCE
5	STRONG PREFERENCE
7	VERY STRONG PREFERENCE
9	ABSOLUTE PREFERENCE
2, 4 , 6 , 8	INTER MEDIATE VALUES BETWEEN THEM

The judgment matrices were extracted (Eq. 1).

$$M = \begin{bmatrix} 1 & a1n & \cdots & a1n \\ 1/a12 & 1 & \cdots & a2n \\ \vdots & \vdots & \ddots & \vdots \\ 1/a1n & 1/a2n & \cdots & 1 \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots Eq\ (01)$$

In this matrix, aij = 1/aji. Thus, when i = j, it can be concluded that aij = 1. The normalization of the decision matrix was performed in such a way that each value was divided by the sum of values existing in each column and ultimately by calculating the row values average (Kamali *et al.*, 2017), the weights were obtained. To ensure consistency within the pairwise comparison matrix, a consistency index (CI) was defined according to **(Eq. 2)**.

$$CI = \frac{\lambda \max - n}{n-1} \ldots\ldots\ldots\ldots\ldots\ldots \boldsymbol{Eq.(02)}$$

where: λmax refers to the largest eigenvalue of the decision matrix, and n is the number of criteria. Accordingly, the final consistency ratio (CR) was obtained by (Eq. 3) to measure the degree of CI (Table 2)**.**

Table 2

Random indices from (Saaty, 1977)

n	3	4	5	6	7	8	9	10
RI	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

$$CR = \frac{CI}{RI} \ldots\ldots\ldots\ldots\ldots\ldots \boldsymbol{Eq.(03)}$$

In this equation, RI is a random consistency index. Its value related to the dimension of the matrix developed by Saaty (Saaty, 1982). If it exceeds CR 0.1, The Evaluation should be repeated to improve Consistency.

Then, we extracted the measures. The consistency Ratio (CR = 0.05) was less than (0.1) of the values of Saaty (Shokati & Feizizadeh, 2019) at the first hierarchical level of AHP, which meant that measure distribution between the factors was acceptable and showed good consistency (Abediniangerabi *et al.*, 2014).

2.6. Geographic Information Systems

The integration of MCDM methods (such as AHP) with the Geographic Information System (GIS) has enabled a strong decision support system (DSS) to be used for spatial planning purposes (Kazemi *et al.*, 2016). GIS is the process of mapping and integrating computer-based information with the ability of data layers management to make appropriate decisions by combining geographical information layers (Kazemi *et al.*, 2016). Accordingly, several studies have been conducted that emphasize the adoption of Delphi, AHP, or a combination of these methods ,with GIS for the analysis and modelling of spatial suitability (Mousavi *et al.*, 2015).

3. RESULTS AND DISCUSSION

This research adopted the multi-criteria analysis approach using sequential hierarchical analysis to assess the city's quality of life with the participation of the population in several stages. In the sequential hierarchical analysis process, the couple's comparison matrices were implemented for each of the major factors and sub-factors through a questionnaire that included local people and experts.

The questionnaire scores for each of these elements are applied in the degree of importance to Saaty in matrices to be translated into weights. Marital comparisons are made between the main criteria and then the marital comparison is made between the sub-criteria of the same level (Al-shabeeb, 2016), then the weights are extracted (Table 3).

Table 3

Compare AHP among Key Criteria

	Security	Education	Culture	Heath	Public	Environment	Weights	Rank
Security	1	2	2	1/2	1	1/2	0.151	3
Education	1/2	1	1	1/2	3	1/2	0.135	4
Culture	1/2	1	1	1/5	1	1/3	0.084	6
Heath	2	2	5	1	2	1	0.273	1
Public	1	1/3	1	1/2	1	1/3	0.095	5
Environment	2	2	3	2	3	1	0.261	2
	λmax=6.2949 CI= 0.0590 RCI= 1.24 CR = 5 %							

The consistency index value of CR = 0.05 was less than 0.1 of the values (Shokati & Feizizadeh, 2019). Saaty at the first hierarchical level of the AHP process, which means that the weight distribution among the factors is acceptable and shows good consistency in judgment (Abediniangerabi *et al.*, 2014).

Table 4

Results of AHP among Key Criteria and among Sub-Criteria

Key criteria	Sub-Criteria	Weight	Rank	Final weight	Rank
Security	<2,000 m	0.574	4	0.151	3
	2,000–3,000 m	0.361	8		
	>3,000 m	0.065	18		
Education	<500 m	0.717	1	0.135	4
	500–800 m	0.217	13		
	>800 m	0.066	17		
Culture	<800 m	0.537	5	0.084	6
	800–1,500 m	0.364	7		
	>1,500 m	0.099	14		
Heath	<800 m	0.588	3	0.273	1
	800–1,500 m	0.323	10		
	>1,500 m	0.089	15		
Public services	<800 m	0.649	2	0.095	5
	800–1,300 m	0.279	11		
	>1,300 m	0.072	16		
Environment	Green areas	0.413	6	0.261	2
	Public parks	0.260	12		
	Water bodies	0.327	9		

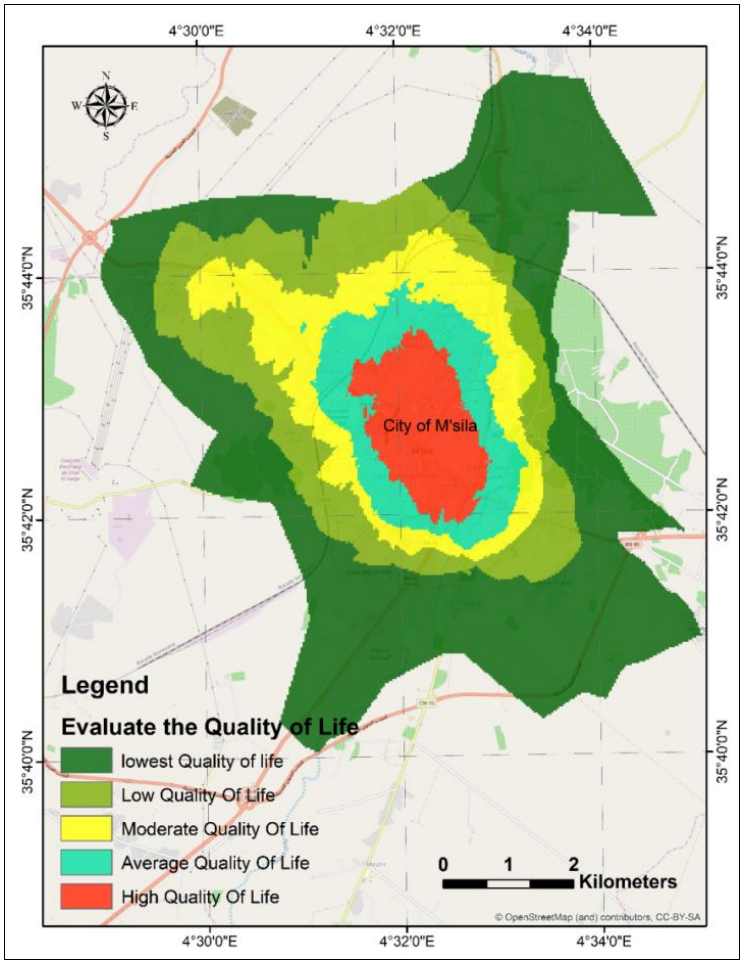

Fig. 4 – Quality of Life Map in The City of M'sila.

Based on the previous hierarchical analysis of the quality of life criteria in the city, the role of Geographic Information Systems comes in the form of a model that summarizes all the stages of work in "QGIS". We collect all pre-defined standard maps in the GIS programme via the Raster calculator tools with each standard multiplied by the weight generated by the AHP process, to produce the map of the quality of life in the city (Fig. 4).

Percentages of AHP for Quality of Life in M'sila. From the percentages, we notice that (7%) of the study-area achieves a High Quality of Life with an area of (3.77 km²) and (9%) an Average Quality of Life with an area of (4.70 km²) and (14%), Moderate Quality of Life with an area of (6.98 km²) and (19%) achieved Low Quality of Life with an area of (9.75 km²) and (51%) the Lowest Quality of Life with an area of (26.02 km²) (Table 5).

By reading the quality of life map, one notes that the areas that have achieved a high quality of life according to AHP are the center of the city and the surrounding areas. That is, there is a distinction between the neighbourhoods of the city and the lack of fair distribution of services and facilities.

Table 5

Percentage of AHP Standard of Quality of Life in M'sila City

	Classes	Area Sq. km.	%
1	High Quality of Life	3.77	7%
2	Average Quality of Life	4.70	9%
3	Moderate Quality of Life	6.98	14%
4	Low Quality of Life	9.75	19%
5	Lowest Quality of life	26.02	51%

4. CONCLUSIONS

In this paper, a method of evaluating the quality of life in cities was proposed by combining the Delphi approach with AHP and GIS techniques. M'sila was chosen as a case-study for this research. A Delphi-based Questionnaire was conducted for a group of experts to come up with a set of criteria, which evaluate the quality of life in cities. These criteria were then measured by conducting a questionnaire with the inhabitants of the study-areas to test factors, which achieve the quality of life in cities. AHP was used to extract measures for the quality of life criteria evaluation. The consistency ratio (0.05) of (<0.1), was therefore acceptable. After creating a geographical database of the predetermined criteria, the measures derived from the AHP process were used in a GIS environment by creating a model, including all spatial analysis processes in the software by using all the measurements to extract the Quality of Life Map with three categories: high, acceptable, and low. The results from the map of the area of the study were: (7%) of the study area achieved a high quality of life with an area of (3.77 km²) and (9%) achieved an Average Quality of Life with an area of (4.70 km²) and (14%) achieved a Moderate Quality of Life with an area of (6.98 km²) and (19%) a Low Quality of Life with an area of (9.75 km²) and (51%) achieved the Lowest Quality of Life with an area of (26.02 km²). The participation of the inhabitants and the integration of the Delphi method with a multi-criterion analysis through the hierarchical analysis in the GIS environment are effective methods which give accurate results relying on the scientific basis of the culture of the community and its ambitions, in evaluating the Quality of Life criteria (EQLC) and identifying areas which require life improvement for the development of cities. This method proved to be effective in evaluating the Quality of Life according to factors determined by the experts and in defining the areas of high Quality of Life and the areas requiring improvement. Still, these factors are local and exposed to change according to each area. The results of the map can be used to identify the areas, which require improvement, to select the best areas for housing, or to determine the value of the real estate, and help decision-makers to establish a balanced development of the city by using this map.

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