Land use of Al-Ramadi City and its Impact on Sustainable Transport Strategies Using (AHP)

Thaer Sh Mahmood, Arwa H Ibraheem

1Directorate of Strategic Studies Center, University of Anbar, Iraq
2Fallujah Education Department of Planning and School Buildings, Iraq

Email: drthaersh@uoanbar.edu.iq

Abstract. Ramadi, the capital of Anbar province, has long suffered from a series of urban problems, mainly the problem of transport and traffic in the city. Sustainable development and climate change are high on the agenda for most cities around the world today. Urban transport is at the heart of these changes. For the purpose of proposing and implementing sustainable transport strategies in the city, this research presents a study to answer the most important question of how to prioritize strategies resulting from the impact of land use on sustainable transport standards. It is of paramount importance to give the decision-makers, administrative and technical staff in the city enough room to make the appropriate decision spatially, temporally and artistically using a modern method to apply descriptive and quantitative analysis together, which is the hierarchical analysis method (AHP). The research has encountered a number of difficulties, the most important of which is the scarcity of the field data, especially the road and transport data in the city, which led researchers to rely personally on the analysis and collection of data related to research and based on the opinions of experts and specialists in the field of transport planning, the analysis found that the strategy of integration of land use with the transport network, is of paramount importance, followed by the strategy of avoiding unnecessary trips and then a number of strategies according to priority and importance in the service of the city.

1. Introduction
The development of modes of transportation promoted the idea of moving into new areas and stability on the suburbs of cities, therefore transport was one of the most important service activities [1]. It provided for the exchange of benefits and played a prominent role in the prosperity and growth of countries. Progress in transport activities is reflected in the contribution it makes to the development, social, economic and environmental dimensions, which are the basis for the growth and development of society and towards the rational exploitation of resources. On the other hand, one of the most important contemporary problems in the cities are the problems resulting from the change in the uses of different land, and the change in the proportions of their area according to the city area. The most important of these problems are transportation problems, and their negative impacts on all aspects of development. Transportation has become a major concern in developing and developed countries and is highly controversial among planners and decision-makers, especially in light of the acceleration in population growth and the corresponding increase in demand for transport and increased urbanization [1]. According to United Nations estimates, 66% of the world's population will live in urban areas by 2050, thereby increasing the consumption of non-renewable energies, increasing visual and audio pollution and air pollution [2].

1.1 Significance and objective of the study
The significance of the study is to measure the impact of urban land uses on the strategies proposed in planning sustainable transport in Iraqi cities in general and Ramadi city as a case study. And to build a comprehensive data base on the role of urban land uses as planning indicators that influence the development of strategies for sustainable transport planning, and to develop strategies and proposals to guide the city's future development in line with the objectives of transport sustainability in the study area.

1.2 Methodology of the study:
In this study, descriptive analysis is linked to quantitative analysis by:

- First, a descriptive study evaluating the sustainability indicators in Ramadi, which is expressed by the surveying criteria for urban land use using Geographic Information Systems (ARC GIS).
- Second, an analytical study using the multi-criteria decision-making system, which contains many tools that help prioritize the standards, most notably the Analytical Hierarchal Process (AHP).

2-The importance of sustainable transport and its relationship to the uses of land in cities:
Cities today are the place of production and consumption of the most industrial goods, consuming three-quarters of the world's energy and causing at least three quarters of the earth's pollution [2]. The transport sector in the Iraqi cities suffers from the absence of an integrated strategy that reflects the comprehensive view of the various elements of the transport sector and focuses on the interdependence of the components of the sector. Therefore, it needs an organized decision-making process and a proposed methodology for the development of the national transport strategy. The concept of sustainable development is today associated with the importance of resource conservation and is one of the most common concepts at a time when resources are scarce. Sustainable development is defined as a development, which aims to pay attention to the mutual relationship between man and natural surroundings. It is not a mathematical equation we deal with assumptions and figures, but a method and a political approach and lifestyle.

Land use planning is a true and balanced distribution between competing and different uses, especially in cities where populations are rapidly increasing. It is important to achieve integrated planning for transportation and land use. Both transportation and land use are complementary to each other and the streets and tracks are used by multiple land uses [3].

The land use is the spatial distribution of activities. It determines the patterns and scale of the trips using the transport system that controls the level of accessibility, which is more effective where development takes place. The use of the land varies according to the transport infrastructure, which affects the demand for trips as well as the direct effect of the shift in paths and roads which results in the use of new roads more than planned. The concept of sustainable transport is a term that refers to the use of means of transport with the least negative impact on the environment and the use of transport systems, policies and networks that integrate economic, social and environmental objectives together as an integrated whole without focusing on one side and neglecting the other. Needs for successive generations [2][3].

2. 1 Factors affecting sustainable urban transport planning:
2.1.1 Planning factors.
They are looking for a significant urban Centre in terms of the proportions of meeting the usual daily needs of families as a source of mobility. This may be limited to some design decisions as a building that reduces these needs or through the urban node that is characterized by activity and intersections such as bus terminals, or through some economic corridors or some historical or heritage cultural diversity as a means of attracting and gathering individuals [4].
2.1.2 Social factors. The transport system is an important part of the structure of the urban economy and contributes directly to building society and improving the quality of life. Transport systems that achieve social justice and equity between the Generations must be provided and the basic transport needs that meet the needs of all the population in all their social strata [4].

2.1.3 Economic factors. The sustainable transport systems should be cost-effective, and the transport decision-makers must create a system of calculation for total and integrated costs, including long-term costs to achieve equality and fairness in payment by transport users as compared to total costs. [3].

2.1.4 Environmental factors. Human activities contribute to the destruction or consumption of natural resources at rates that exceed the ability of nature to re-establish or replace them, increase pressure on the environment and its limited capacity to absorb pollution. Efforts must be made to develop transport systems that are environmentally sensitive but not exceeding consumption rates to meet transport needs without contributing to the generation of emissions that threaten public health such as the use of alternative energy and to keep abreast of scientific and technological development [5].

3. Applied Study:

Ramadi is located in the south-east of AL-Anbar province in AL-Iraq, at the intersection of Euphrates and Al-Warar rivers. It is the political and administrative Centre of the province. The city is considered one of the important commercial stations and the main port for transporting oil tankers to Syria and Jordan. It is about 283 km from the Jordanian border in the west and about 290 km from the Iraqi-Syrian border to the north. It is also penetrated by road transport routes linking the Mediterranean Sea to the Arabian Gulf coasts. Ramadi was chosen as one of the cities most affected by the terrorist attack out of 96 Iraqi cities damaged in recent years according to the UN reports to be a model for dealing with similar situations. The destruction included houses, basic infrastructure, public services and displacement of unprecedented population. The main strengths of the city include its location on the international road and railways, as well as its centralization in the middle of the governorate-wide roads which gives it the central role in administration and services [9].

3.1 Limits of the study area

The boundaries of the study area are the boundaries of the Municipality of Al-Ramadi, which is the basic master plan in force. It consists of 30 residential neighborhoods spread over the area of the city's master plan. The Euphrates River, on the western side and the Al-Warar channel feeding Lake Habbaniyah. For the purposes of this study, the city was divided into (8) sectors based on the conventional municipal sections as shown in Figure 1 and Table 1.
The land use in Ramadi city, Source / Researcher based on the map of Ramadi. The Table (1) represents the land use in AL-Ramadi city, although there are empty spaces in the Master plan of the city that has not been calculated.

Table 1. Land use in Ramadi city according to the Eight Municipal Divisions

| Land use | Administrative or public use % | Slums area % | Road Area % | Health use area % | Educational use area % | Commercial Use Area % | Industrial use area % | Residential use area % |
|----------|---------------------------------|--------------|-------------|-------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 1        | 7.64                            | 32.57350829  | 17.07167218 | 73.182753         | 56.24019643           | 12.53212691           | 94.6103223           | 22.1965462           |
| 2        | 5.87                            | 18.98522949  | 5.3886378   | 4.3403183         | 1.124844866           | 7.873799408           | 5.083725542           |
| 3        | 10.81                           | 9.415938433  | 9.90868127  | 4.6092637         | 13.2364409            | 6.90885637            | 9.347613531           |
| 4        | 32.67                           | 1.98174097   | 11.2413659  | 8.4472627         | 6.209622712           | 7.4020631             | 5.38967773            | 10.60483648          |
| 5        | 8.55                            | *            | 3.16655563  | 7.4240283         | 2.438525013           | 13.31770605           | 2.987253043           |
| 6        | 13.48235                        | 36.8346413   | 46.6467753  | 1.7254606         | 19.18588214           | 27.47796657           | 44.00545509           |
| 7        | 18.79                           | 0.208941515  | 5.21135228  | 0.2709126         | 1.056777358           | 4.06805564            | 4.916265423           |
| 8        | 2.20                            | *            | 1.36473351  | *                 | 0.507710581           | 20.08128273           | 0.858304696           |

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3.2 Analytical Study (AHP)
3.2.1 Analytic Hierarchy Process. Decision-making involves criteria and alternatives to choose from criteria usually have different priorities, and alternatives in turn vary in terms of achieving each of the
criteria for the optimal decision [6]. The hierarchical analysis is one of the processes that help decision-makers make complex decisions with multiple criteria. This method is characterized by quantifying inappropriate standards [7]. The Iraqi scientist Thomas Saati has been credited with inventing and developing this method. It has produced more than thirty books and has contributed greatly to the fields of scientific research in various fields and has been developed by other scientists [8].

3.2 - 2 Steps of hierarchical analysis. The method of hierarchical analysis summarizes the problem in a hierarchical way and then makes relative comparisons between the elements of the problem at one level, based on the selection criteria as follows [6]:

Step 1: Build the hierarchy of the study problem.
Step 2: Calculate priorities.
Step 3: Measure the degree of stability.

\[ CI = \frac{\lambda_{\text{max}} - n}{n-1} \]  
\[ \text{where } \lambda_{\text{max}} \text{ is the maximum eigenvalue of the matrix.} \]
\[ n \] is the order of the matrix.

After obtaining a consistency index (CI), it should be compared with random pointer values to determine the consistency ratio.

\[ CR = \frac{CI}{RI} \]

Where CR is a stability ratio
CI = stability index
RI = random stability indicator

The maximum acceptable level of stability is (0.1) or 10%. If this percentage increases, the provisions are a kind of contradiction and, therefore, the decision should be reviewed [6].

3.3 The main and secondary criteria for the impact of land uses on sustainable transport in the city. Four main criteria have been chosen to study and evaluate the reality of the city's transport network, drawing on previous studies and global literature indicating that the most important criteria for the study of sustainable transport are (social, economic, environmental and planning). These criteria are also subdivided into secondary criteria. The use of spaces for each land use in Ramadi has been chosen as the best secondary criterion for the basic criteria. It can be measured and evaluated. In addition, the process of identifying the areas of use in the city and at the level of the eight municipal departments, and it was done in the light of field surveys (social, economic, environmental, and finally planning or urban) and linked to the standard standards adopted in each city. The relationship between each use of the land with the basic criterion was the reason for its selection without the versatility of the uses. The economic criterion is more affected by the educational and administrative use space, despite the effect of other uses and so on to the other basic criteria. The aim of using AHP is to reach priority and important factors in city planning [10].

We note that the highest priority was given to the planning criterion and specifically to the sub-factor (road and transport network area), where it is obtained (6.72) points. Followed by another sub-factor; (administrative use area), which is one of the social factors and got (6.3) points, while the sub-factor, which ranked third, is (residential use area) and got (6.14). An analysis of the results of the above table shows that the total score obtained by the main criteria was in the following sequence. The "Planning Standards" group ranked first and the social standards group ranked second. Environmental standards ranked third and finally the economic standards. The result of the questionnaire distributed to (11) experts from the concerned authorities emphasizes the importance of the criterion (schematic) in achieving the research objectives. This standard is the mainstay of any development. This result may also be due to many of the standard sub-factors that have arisen because of the opinion in the agreement that has been incorporated into the important factors affecting the achievement of the research objectives in subsequent steps.
Binary comparisons are then made between the four main criteria chosen: the economic criterion, the social criterion, the environmental criterion and the planning criterion. It is ascertained that the consistency ratio shows that there is no contradiction in the provisions as shown in Table (2).

To derive the arithmetic, mean of the values of the binary comparison matrices of the main criteria of all questionnaires. Followed by the extraction of the standard matrix shown in Table (3) by extracting the column totals of the basic matrix and dividing each of the values of the matrix columns extracted in the preceding paragraph by the sum of the column values for that value.

Table 2. The assessment of the main and secondary criteria used to determine priorities for sustainable transport

| The main criteria       | Sub-criteria                          | Rating (1-9) |
|-------------------------|---------------------------------------|--------------|
| Social standard         | Educational use area                  | 5            |
|                         | Administrative Use Area              | 6.3          |
| Economic standard       | Industrial use area                  | 4.6          |
|                         | Commercial Use Area                 | 4            |
| Environmental standard  | Health use area                      | 6            |
|                         | Residential use area                 | 6.14         |
| Schematic Standard     | Area of road and transport network    | 6.72         |
|                         | Slums area                           | 5.7          |

Table 3. The standard matrix of basic standards

|     | C1 | C2 | C3 | C4 | approximate Priorities |
|-----|----|----|----|----|------------------------|
| C1  | 0.12 | 0.2 | 0.25 | 0.1 | 0.1675 |
| C2  | 0.2  | 0.14 | 0.37 | 0.1 | 0.2 |
| C3  | 0.33 | 0.31 | 0.26 | 0.64 | 0.39 |
| C4  | 0.35 | 0.35 | 0.113 | 0.18 | 0.248 |

3.4 Suggested Strategies:
A number of strategies have been proposed to achieve the objectives of sustainable transport in Ramadi city. Based on the opinions of (11) experts who worked through a workshop that included many different disciplines of decision in the field of roads and transport in the city.
1. The strategy of non-automatic and clean transport
2. Development of various public transport
3. Improve pedestrian routes and reduce walk distance
4. Adapting the city in a modern way linking the uses of land transport.
5. Avoid unnecessary trips and change mobility behavior.

After extracting the priorities of the sub-criteria in the four options, by multiply the priorities of the basic questionnaire by the priorities of the sub-criteria in the first alternative and the other in the second, third, fourth and finally the fifth alternative, as shown in Table (4). The highest result is the winning alternative which was used in the development process.
Table 4. The calculation of priorities (1 * 2 * alternatives)

| Main criteria | sub-criteria | Non automatic or clean transport | Development of public transport | pedestrian routes and minimize walking distance | Integration of land uses | Avoid unnecessary trips |
|---------------|--------------|----------------------------------|---------------------------------|-------------------------------------------------|-------------------------|------------------------|
| Social (0.2)  | Educational use area | 0.12 | 0.1 | 0.18 | 0.3 | 0.28 |
|               | Administrative Use area | 0.15 | 0.21 | 0.24 | 0.45 | 0.39 |
| Economic (0.167) | Industrial use area | 0.1627 | 0.20925 | 0.279 | 0.3255 | 0.2325 |
|               | Commercial Use Area | 0.111 | 0.13 | 0.167 | 0.3 | 0.2 |
| Environmental (0.4) | Health use area | 0.56 | 0.84 | 0.98 | 0.91 | 1.05 |
|               | Residential use area | 0.33 | 0.15 | 0.25 | 0.42 | 0.42 |
| Planning (0.24) | Area of transport network and roads | 0.308 | 0.231 | 0.5 | 0.58 | 0.54 |
|               | Slums area | 0.18 | 0.1125 | 0.225 | 0.315 | 0.225 |
| Total         |               | 1.9217 | 1.9835 | 2.821 | 3.6 | 3.34 |

4- Conclusions:
The research reached a set of conclusions after quantitative and descriptive analysis using AHP:
1-The development of an appropriate land-use integration and transport strategy is the most appropriate strategy for evaluating sustainable transport strategies in Ramadi.
2-The hierarchy of other strategies affecting sustainable urban transport includes the strategy of avoiding trips, improving the predecessor network, the strategy of developing public transport, and finally the strategy of using automatic or clean transportation.
3-The strategic direction in the sustainable transport of the city depends primarily on the philosophy of the distribution of land uses in the various municipal sections of the city.
4-There is a clear variation in the quality of different land uses at the level of the eight municipal sections of the city, which negatively affects the development of sustainable development strategies of different types in general and urban transport strategies in particular.
5-Introducing land use criteria when developing sustainable transport strategies in Iraqi cities with a focus on sustainable urban transport strategies.
6-The adoption of planning modeling in the development of the master plan of Iraqi cities, which depend on the best distribution of land uses / transport.
7- Consider the current distribution of land use in the city, with its relation to areas of future expansion, and try to link in the development of future planning strategies that ensure the close relationship between sustainable urban transport strategies and distribution patterns of different uses in their spatial and planning dimensions.

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