Evaluating the life efficiency of Mosul before liberation

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Abstract. The research deals with the concept of urban liveability, which refers to cities that are able to satisfy the requirements of their inhabitants by providing a range of elements (healthy environment, safe public spaces, decent housing, gardens, opportunities for entertainment, social interaction, non-crowded roads and jobs). Studying the liveability of cities from the assessment of the reality of cities in order to identify the strengths of the city to conform them and identify its weaknesses to avoid them.

The Iraqi government intends to assist the donor countries and humanitarian organizations to start the extensive reconstruction of Mosul city after it was destroyed by the liberation operations. So, the study aims to evaluate the reality of the city before the occupation of the city to identify the weaknesses to be avoided, and to identify the points of strengths to be fortified. The researchers came up with a set of conclusions and recommendations that are directly relevant to the research.

1. Introduction

Loss of Mosul city center to some elements of liveable cities (livability), which makes it a city not compatible with the requirements of liveable cities, which negatively affects the inhabitants of these cities.

This research’s goal is to assess the extent to which the city center corresponds to the conditions of the liveable cities during the period prior to the destruction of the city. In order to highlight the most prominent points of power in the city to be strengthened in the reconstruction of the city and highlight the weaknesses of the city to avoid them.

The research assumes that the city of Mosul has assets and the potential to fulfill the conditions of the liveable city, and therefore can be reconstructed to improve the standard of living in the city if effective methods are used based on the diagnosis of strengths and weaknesses in the city.

Although the term "Liveability" appeared in the 1980s [1], to demonstrate the range of initiatives aimed at improving the quality of life [2], however, the term relatively depends on the human self, since the needs that may be necessary and important in the lives of some societies may not be the same in other societies, so there are no specifics and agreed-on-ways to assess the liveability of the city.

Some professionals limit the ability to live in two key factors (environmental sustainability and livelihoods), where livelihoods are referred to as people with jobs close-to-home, affordable housing and easy access to daily services. Environmental sustainability refers to a balance between the consumption of natural resources to ensure the livelihoods of existing populations and to save livelihoods for future generations [3].
2. The basic elements of a livable city

As mentioned above, there is no agreement on the definition of Liveable City and its essential elements. However, most studies have referred to a set of elements that must be met to apply the conditions of a liveable city, through which cities can be compared and evaluated for their liveability [4].

2.1 Sense of place
The sense of place is one of the essential elements for determining the viability of the city, it defines the place as "the dimension or space in which individuals' relationships with material components, individual and collective activities are formed." [5]. This is briefly expressed in the equation "place = space + meaning" [6].

Dingmans has pointed to the sense of place as "a complex bundle of meanings, symbols and attributes that a person or group of people consciously or unconsciously associates with a specific place or region" [7].

2.2 Mixed land-use
The concept of mixed land use refers to the coexistence of more than one type of land-use function (residential, commercial, industrial, etc.) in a particular area to be in an integrated manner that supports sustainable transport such as public transport, walking and cycling [8]. Mixed land use developments can enhance the economic vitality and perceived security of a region by increasing the number of people on the streets and in public spaces. Most land use planners agree that there is an effective role for mixed land uses of high density in urban sustainability, as it reduces flights between different events. Therefore, the combination of land uses ensures that most services are provided at a reasonable distance that encourages pedestrians to walk and ride bicycles. In addition, the concept of mixed spaces provides for the revitalization of large parts of the city, public spaces.

2.3 Effective communication
The diversity of transport options is one of the essentials of livable cities. The presence of walking paths, biking paths and public transport provides effective communication between different parts of the city. As livable cities often, give priority to walking, cycling and public transport to reduce the reliance on private cars, communication effectiveness not only contributes to the ease of movement but also has important benefits in promoting environmental quality and social justice.

2.4 Availability of affordable housing
Affordable housing is a concept that is strongly influenced by the local context and varies widely across cities, states and income groups. This concept refers to housing units that low- and middle-income households can afford [9]. Affordable housing for all segments of society, but the impact is clearly visible on low-income families. There is a difference between the minimum acceptable housing price and between 25% and 40% of household income ($2 per day) [10].

When talking about "affordable" housing, it means to obtain housing without the disposal of households' more than 30% of their income. It is called the threshold "the burden of rent at affordable prices." However, 30% of 1 $ million is significantly different from 30% of $ 20,000, for example. "Affordable housing" means that families with middle or low income have access to housing at the lower end of the income scale [11].

2.5 The existence of open spaces
Open areas are one of the main components of cities, as they represent the basic space for walking, leisure and an indication of access to a good living standard for the population. It plays an important
role in protecting natural resources and improving environmental conditions. It is, therefore, necessary to take into account in the planning of cities the existence of open spaces and areas interconnected through an integrated system of open area network in terms of design, planning and coordination to be able to meet the multiple needs of people.

3. Evaluation of the validity of Livable City in Mosul

The concept of measuring and arranging livable cities is a simple concept as it reflects the order of cities according to the worst and best living conditions they provide to their inhabitants [12].

The methods used in the studies are different to test the validity of livable cities. However, all of these methods are under two main methods. The first method is the Subjective Evaluation method, which is based on the questionnaire forms for the city population. The second method is known as Objective Evaluation, which uses the economic and spatial data and analyzes the models in order to reach out to results away from self-judgment. Both methods have a range of negative and positive things [4]. The researcher uses both methods to show how the city of Mosul corresponds to the conditions of a livable city.

The researcher adopted a group of specialists to identify the most important elements affecting the assessment of the validity of livable cities and conducted a questionnaire to determine priorities for the Iraqi citizen.

3.1 Education Service

The Quality of Education Service indicator is one of the most important indicators for assessing the viability of cities. Education is an important human right that contributes significantly to the creation of resources for economic, social and educational development, the evaluation of education will take place in the level of (kindergarten, primary school, elementary school, and high school), while the research will avoid university study because it is a regional service.

First: Kindergarten stage

A- (Child / Teacher) Index This indicator shows the ratio of children to teachers. The lower the student-teacher ratio, the higher is the quality of the service. Increased ratio results in less attention to the students by the teacher and increase in stress in teachers.

| Indicator  | year | children | Teaching staff | Child / Teacher | Standard | NOTES |
|------------|------|----------|----------------|----------------|----------|-------|
| Child / Teacher | 2006 | 6641 | 350 | 18.9 | 1:10 | It is clear from the table that there is a violation of the standard which affects the quality of service |
| Child \ classroom | 2013 | 18587 | 311 | 59.76 | 32-24 | It is clear that there is a large increase in the number of children in the classroom and exceeding the standard limit, which negatively affects the quality of education |

Table (1) shows the child / teacher and child / classroom index in Mosul

1 The data for 2006 were adopted because there is no modern data

2 Department of Housing - Ministry of Construction, Municipalities and Public Works Department of Housing, Planning Advisory Office - University of Baghdad, Urban and Rural Housing Standards in Iraq, Baghdad, 2018.
Source: Researcher

**B - Index (child / classroom):** this indicator shows the number of children in each division, the fewer children in the Division indicates the quality of service because of the increase in the attention from teacher to the students in the classroom, in addition to health and psychological factors.

**C - Indicator (child / kindergarten):** This indicator shows the number of children in each Kindergarten. The lower the number of children in the Kindergarten, the higher the quality of the service, due to the increase in the teacher’s attention and the increase of time specified to each child in the classroom.

| Indicator          | year | children | kindergarten | The reality | Standard | NOTES                                      |
|--------------------|------|----------|--------------|-------------|----------|--------------------------------------------|
| Child / kindergarten | 2006 | 6641     | 33           | 201         | 180      | There is a violation of the standard, which indicates the need to increase the number of kindergartens, especially in the old city of Mosul, which lacks any kindergarten |

Source: Researcher

It is clear from the previous indicators that the service of kindergartens was not on the required level in the city of Mosul in general and in the old Mosul in particular, which makes it necessary to review and improve this service in the stages of reconstruction by increasing the number of kindergartens. In addition, avoid all points contrary to the standards.

**Second: primary stage**

**A- Pupils/ school** This indicator explains the ratio of pupils to school. The lower the number of pupils in the school, the higher the quality of education.

| Indicator        | year | Pupils | schools | reality | Standard | NOTES |
|------------------|------|--------|---------|---------|----------|-------|
| Pupils/ school   | 2013 | 213334 | 404     | 528     | 240-960  | The percentage is acceptable for Iraqi standards |

| Indicator        | year | Pupils | staff   | reality | Standard | NOTES |
|------------------|------|--------|---------|---------|----------|-------|
| Pupils/ teachers | 2013 | 213334 | 6782    | 31      | 25       | The proportion of teachers to students exceeded the Iraqi standard, which negatively affects the quality of education at this stage |

| Indicator        | year | school | Teaching | reality | Standard | NOTES |
|------------------|------|--------|----------|---------|----------|-------|
| school/ teachers | 2013 | 404    | 6782     | 17      | 12 at least | The percentage is acceptable for |
Iraqi standards

Source: Researcher

**B - Index (pupil / teacher)** This indicator shows the proportion of pupils to teachers and the smaller the number of students for teachers indicates the quality of service because of the increase in the use time of students from teachers and reduced stress on teachers.

**C - Index (school / teacher)** This indicator refers to the ratio of the number of teachers to the number of schools. The higher the number of teachers, the better the quality of service.

**D - (pupils / classrooms)** This indicator shows the number of pupils per semester. The lower the number of pupils per class, the higher the quality of service, because of the increase in pupil’s use of teachers and the increase in time specified to each child in the classroom.
Table (4) shows school/ teachers indicator in Mosul

| Indicator | year | Pupils | classrooms | reality | Standard | NOTES |
|-----------|------|--------|------------|---------|----------|-------|
| pupils / classrooms | 2013 | 213334 | 5043 | 42 | 30 optimal number | Very overcrowded classrooms are a very negative indicator of the quality of education |

Source: Researcher

E. Service distance indicator for primary schools
This indicator shows the distance the pupil’s walks on foot and the Iraqi urban and rural housing standards guide at a distance of 500 m.

It is clear from the map that there is a defect in the spatial distribution of schools, indicating the need to reconsider the distribution especially in the destruction of most schools, a good opportunity for redistribution based on scientific methods.

It is clear from the analysis of the primary education service that three basic elements must be reconsidered:
1. Re-distribution of schools according to the scope of service and overcrowding.
2. Increase the number of faculties according to the standard.
3. Increase the number of classrooms to reduce overcrowding in the classroom.

Third: secondary school stage

Table (5) shows Student /school indicator in Mosul

| Indicator | year | Student | school | reality | Standard | NOTES |
|-----------|------|---------|--------|---------|----------|-------|
| Student /school | 2013 | 99194 | 191 | 519 | 360-288 | It is clear that there is overcrowding in schools and exceeds the highest limit for |
Table (6) shows teacher /school, Student / teachers indicator and Student / classroom and in Mosul

| Indicator          | year | Teaching | school | reality | Standard | NOTES                                                                 |
|--------------------|------|----------|--------|---------|----------|----------------------------------------------------------------------|
| teacher /school    | 2013 | 4403     | 191    | 23      | 12 at least | The percentage is acceptable for Iraqi standards                      |
| student / teachers | 2013 | 4403     | 99194  | 23      | 25       | NOTES                                                                  |
| Student / classroom| 2013 | 2404     | 99194  | 41      | 30-36    | NOTES                                                                  |

Source: Researcher

3.2 Health Services

The presence of health services is one of the most important indicators of urban liveability. Quality of health services is evaluated in several ways. There are qualitative methods, such as immunization coverage, time for each case, number of visits of pregnant women to the center during the period of care, etc. There are quantitative indicators such as the scope of health service centers, and the adequacy of medical staff. The following are the main indicators:

A. The coverage ratio of health centers

This indicator means the number of the population covered by the health center service and calculated according to the following equation

"Coverage ratio for the region = number of population served by standard / total population of the area"

"Number of Served Population = Number of Health Centers in the Region * Planning Standard (10,000)"

Table (7) shows Student / classroom indicator in Mosul

| Indicator          | year | population | centers | Coverage ratio | Standard | NOTES                                                                 |
|--------------------|------|------------|---------|----------------|----------|----------------------------------------------------------------------|
| student / classroom| 2013 | 1294636    | 30      | 23%            | 1-10000  | Coverage is very low.                                                  |

B. Indicator (population / health center)

This reflects the extent to which the center is overcrowded, the smaller the number of inhabitants per health center, the more efficient the service is. Reducing overcrowding means increasing the time specified to each patient.
Table (8): shows Coverage of health centers in Mosul city

| Indicator (population / health center) | Year | population | centers | inhabitants / health center (reality) | assumed centers | Standard | NOTES |
|----------------------------------------|------|------------|---------|-------------------------------------|-----------------|----------|-------|
|                                        | 2014 | 1294636    | 30      | 43154                               | 129.4636        | 10000    | people / center |

There is a big difference between the reality and the supposed number, which casts a shadow on the health reality in the city.

C. (Doctor / 10,000 people)

The number of doctors in each health center indicates that the number of doctors in each center increases the chance of people benefiting from increased time for diagnosis or treatment.

Table (9): shows (Doctor / 10,000 people) indicator in Mosul in Mosul city

| Indicator (Doctor / 10,000 people) | Year | population | Number of doctors available | Number of doctors 1000 (reality) | The average Iraqi | The average Iraqi | notes |
|------------------------------------|------|------------|----------------------------|---------------------------------|-------------------|------------------|-------|
|                                    | 2014 | 1294636    | 269                        | 4.8                             | 7.3               |                  |       |

This rate is good compared to the global average (1.86)

Source: Researcher

D. Number of hospital beds per 10,000 people

This indicator refers to the number of beds specified for every 10,000 inhabitants. The greater the number of beds compared to the population, the more the treatment service is distinguished.

E. Coverage of health center

This indicator is used to analyze the efficiency of spatial allocation of health centers. Housing standards in urban and rural areas define a service area of 800 meters, the distance a person must walk to the health center.
3.3 Green areas
The researcher relied on satellite images and (GIS) program to determine the green areas available in the city of Mosul. The researcher found that there is a large shortage of green areas depending on the global average as shown below:

| Population | The standard area | Green available area | Per capita area | area required |
|------------|------------------|----------------------|----------------|---------------|
| 1294636    | 13m²             | 5.27 km²             | 1.74m²         | 16.83 km²     |

3.4 Collection and disposal of waste
In his study, the narrator pointed out that the problem of solid waste was not prominent in the city of Mosul until the nineties of the twentieth century, where the municipality, despite its modest capacity was able to deal with solid waste, collect, and transport it outside the city. But the situation in Iraq, the changes that have taken place since the 1990s, and the plundering operations that accompanied the US invasion of Iraq have paralyzed the municipality's capabilities, stolen its cars and equipment, weakening its ability to perform the required services. While one study indicated that the city's production of solid household waste is estimated at about 400 tons a day, a big part of it is not being removed from residential areas, which may be transported through the sewage network to the banks of the Tigris river; forming an additional source of organic pollution in the river. Therefore, the waste service in Mosul suffers and confirms the residents of Mosul dissatisfaction with the waste collection service, so it is necessary to follow modern methods of dealing with waste of all types and at all stages of management (collection, transport, treatment, disposal, and recycling).

3.5 Infrastructure services
Structural systems represent the main artery on which the modern city is based and its urban structure, without which any group can be included under the name of the city. These services have a high value in assessing the viability of cities.

3.6 Sewage networks
According to the Central Bureau of Statistics, Nineveh province is one of the least provinces in terms of the proportion of workers in sewage networks. Only 1.0% of the population of Nineveh governorate have a sewerage system, while the percentage of sewerage workers in the city of Mosul (sewage and joints) reached 38.4%. HABITAT pointed out that the city of Mosul lacks an adequate sewage network.
network, where the city has suffered from sewage leakage, soil and water sources pollution caused by the widespread use of casting tank. The problem of sanitation is one of the most important problems facing the people of Mosul, where the amount of untreated water in the Tigris River in Mosul is about (400,000) cubic meters per day.

3.7 Electricity service
The population of Iraq is suffering from a major deterioration in the provision of electrical power, including the city of Mosul, where the population relies on diesel generators to compensate for the breakout hours.

![Figure 3 Green areas available in the city of Mosul](image)

3.8 Water treatment services
The average share of citizens in the province of Nineveh in 2015 of drinking water is 319 liters / day per capita amounted to the proportion of those employed by drinking water distribution networks in Ninawa Governorate (85%), according to the Urban Renewal Study, the water distribution network services reach most of Mosul. However, the per capita share of drinking water and the percentage of service members are insufficient to assess the quality of water service. The quality of water provided has a major role in evaluating the service. The percentage of failure in the bacteriological models tested for drinking water throughout Iraq was 15.6% 82.0%.

3.9 Transportation Service
The city of Mosul lacks an efficient and diversified transport system. It relies heavily on small buses of 11 passengers, which are run randomly by the private sector and lacks a variety of transportation options. The city lacks an internal train network, walking and Bicycles paths. Therefore, a plan must be developed to develop the transport system in the city of Mosul.

Table 10 shows the results of the objective and subjective evaluation and the degree of evaluation of each service.

| Elements of evaluation | Subjective evaluation¹ | Objective evaluation⁴ | Weight⁵ | Degree⁶ |
|------------------------|------------------------|-----------------------|---------|---------|

¹ The researcher relied on a questionnaire distributed to residents of Mosul to determine their satisfaction with each of the services mentioned above.

⁴ This field refers to the results of the scientific analysis of each service based on what was exposed in the research based on the comparison of the situation with the standards.

⁵ This field indicates the importance of each service based on a questionnaire conducted by the researcher to determine priorities of services for the Iraqi citizen.
Educational services

It was clear from the results of the questionnaire that there was satisfaction (65% satisfaction and 18% dissatisfaction) with the quality of the educational services in the city of Mosul. Through the review of the research, it became clear that there is a defect in the service of education in the three levels (kindergarten, primary, secondary).

Health Services

The questionnaire and the researcher's visit to Mosul showed that there was dissatisfaction (44% satisfaction and 30% dissatisfaction) with the quality of health services in the city. Through the indicators followed by the researcher in his study, it became clear that the health reality in the city of Mosul was not of the required level.

Municipal Services (Waste Collection and Sanitation)

It is clear from the questionnaire that there is dissatisfaction with the quality of municipal services (33% dissatisfaction and 20% satisfaction) through what was presented previously, it became clear that the municipal services were not at the required level, especially the sewage service, which relied on the open drains for the discharge of heavy water, which is contrary to health and environmental conditions.

Drinking water service

There is considerable satisfaction (69% satisfaction and 9% dissatisfaction) over the quality of potable water in Mosul. The water service is very good in terms of the proportion of service and regularity of service. However, there is a problem in the examination models where the percentage of failure in the bacteriological models examined for drinking water is 82.0%.

Green areas

It was clear from the questionnaire that there was dissatisfaction with the quality of green areas (44% dissatisfaction and 17% satisfaction). The city of Mosul, especially on its right side and its historic center, suffers from a significant shortage of green areas.

The road network

In the survey prepared by the researcher, there is 22% satisfaction and 48% dissatisfaction with the quality of the road network. Through the field visit by the researcher, the city of Mosul has a good network and acceptable in terms of

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* This field indicates the final score of the efficiency of each service and the result is obtained from the following simple mathematical equation:

\[
\text{Rating} = \text{Weighting for each service} \times \text{Community satisfaction ratio}
\]
| Component          | Description                                                                                                                                                                                                 | Quantity | Score |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------|
| Public transport   | It was found by the questionnaire that there was 22% satisfaction and 61% dissatisfaction about the quality of public transport services in the city. Paving roads and the provision of traffic lights, but the public transport in the city is similar to public transport in all Iraqi provinces in terms of lack of parking stations and inaccuracies of the times. | 6        | 1.32  |
| Security stability | It was clear through the questionnaire that there is considerable dissatisfaction with the security situation in the city before 2014 (22% satisfaction and 69% dissatisfaction). Mosul has suffered from clear security deterioration and the spread of crimes, terrorist acts, sectarian killings, and forced displacements since the regime changed in 2003 to its occupation of terrorist groups. | 10       | 2.2   |
| Electricity service| Despite the existence of electricity network in all parts of the city of Mosul, there is a significant shortage of electricity distribution hours, where cutting hours up to 15 hours in some cases. | 7        | 2     |
| Environment        | Despite the lack of governmental interest and the absence of a culture of environmental protection in the community, environmental statistics indicate that Iraq does not exceed the permissible limits. | 6        | 4     |
| Social component   | The Musli community is characterized by cultural, religious and sectarian diversity, and Moslems throughout history have known peaceful coexistence. The researcher adopted three indicators to assess the social side (number of relatives, community cooperation, place of birth and period of residence in the city). | 5        | 3.5   |
| Communication and Internet Service | Through the questionnaire it was found that (38%) are satisfied with the Internet and telecommunications service in Iraq is the worst in the region. | 6        | 2.28  |
communication service and (62%) high prices. dissatisfied with the communication service

| Adequate housing | 8 |
|------------------|---|
| Job opportunities | 8 |
| The results show that 90% of the city's population have jobs. | 7.2 |
| Total | 46.61 |

It is clear from the city's evaluation table that the city lacks many of the elements of life despite its possession of the city's livable assets, which the researcher proved by asking the city dwellers to leave the city if they have accommodation in another city where all amenities are available. The answer was the refusal to abandon their city, which confirms the strong link between the people and the city.

4. Conclusions

1. It turned out that the center of the city of Mosul has shortage in many of the utilities of the city, where it got 46.61%, which is very little percentage.
2. The old city of Mosul has many elements to be one of the most important tourist and commercial cities in the region, because it is full of many churches, mosques, historical and archaeological sites.
3. The distinctive traditional fabrics, unique architectural styles and location overlooking the Tigris River must be considered when starting reconstruction and refuse any reconstruction strategy away from identity of the city behind aim of modernization of the city center.
4. The city of Mosul was severely damaged by the occupation and the liberation of the city where the estimated damage rate was 80-90%, which gives us a measure of freedom to act in the reconstruction and development of the city, but two major topics must be respected: covering minimum or more of requirement of livability and preserving the characteristic of community and its heritage.
5. The Mosul community has flexibility to accelerate the reconstruction and development of the city.

5. Recommendations

1. Concentrate work of reconstruction on the infrastructure in the old city center, to be able to make it fit for humans to live.
2. Help center community with renewal of dwellings, especially the extended families.
3. Make urgent plans for re habitation of the social services.
4. Focusing in the media on all the heritage and historical sites to bring donors to rebuild these sites with the facilities, so we can later establish these as investment nodes to save jobs and increase incomes.
5. Necessity to prepare schedule of priorities for reconstruction of the city center.
6. The need to involve the local community in the preparation of plans for the development and reconstruction of the city.

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