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Proposed Sustainable Indicators to Assess Transport Sustainability in Baghdad City

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ABSTRACT

The aim of the present work is to choose the most important sustainable urban indicator according to the opinion of local transport specialists, and using it to evaluate the urban transportation system in Baghdad city. To achieve these objectives, make Questionnaire form content 130 indicators were obtained in various environmental, social and economic dimensions. The questionnaires were analyzed using SPSS program; and Likert Scale (five-point) is adopted (5 very effective, 1 not very effective) to find out the importance and impact of each indicator at the local level. The results of the questionnaire showed that the most important sustainable indicator that can be applied and that has a very strong impact on the local Iraqi reality, is the accessibility indicator to public services and public transport, its relative importance was 93.6%, and 91.2% for the mobility management indicator.

1. INTRODUCTION

It is almost impossible to talk about sustainability and sustainable development without including transportation. Humans have always traveled. Although modes and purposes have continuously changed over time and space, people are still need to travel. Therefore, the transportation represents an important issue of sustainability discussions [1]. The sustainability concept is coincided with the sustainability measurement necessity. Many studies in the literature have been conducted to address sustainability in different contexts and to emphasize the importance of measurement methods.

The transportation sustainability concept has been found because the lack of efficient transportation systems which are able to capture the demand rapidly increasing. Many traffic problems are caused by inadequate transport facilities; this causes delays; traffic congestion, passenger dissatisfaction and the negative impact of emissions on the environment [2].

The indicators of sustainable transportation are used to measure the system and the impact of transport to communities. These indicators are defined as a performance measure which are regularly updated to help managers, engineers and transportation planners in computing the comprehensive range of economic, social, and environmental effect from policy decisions. The relation between transportation systems with environmental, economic, and social aspects represents the base of sustainable transportation indicators [3].

The aim of the present work is to choose sustainable indicators that are appropriate to the Iraqi reality for the purpose of using them when preparing urban transport plans and evaluating the transport system in Baghdad city, based on the opinion of local experts in the Iraqi transport sector.

2. TYPES OF INDICATORS

The description of a sustainable transformation utilizes numerous potential sustainable indicators. To obtain the most important information about the outcomes groups of the system, the indicators should be selected carefully. The types of these indicators are classified as [4-10]:

- Quantitative and qualitative data.
- Soft Indicators (also called individual indicators): It is "a state related to the fulfillment of one's wishes, expectations, or needs and it reflects the pleasure derived from this Individual indicator can be assessed subjectively by asking people about them which is usually done by survey studies.
- Ratio indicators: It is measurement units normalized to facilitate comparisons, such as per year, per capita, per mile, per trip, and per vehicle year.
- Relative indicators.
- Conventional transport indicators.
- Conventional Economic indicators.
- Conventional Environmental/Ecological indicators.

3. INDICATORS FOR TRANSPORT SUSTAINABILITY IN THE WORLD STUDIES

The most effective way to assess and evaluate the sustainability of a particular transport system in a particular city and to support the decision-making process is to use indicators or sets of indicators. Simplifying complex sustainability issues is one way to use indicators effectively. To evaluate the aims effectively, Litman [5] proposed the usage of indicators set due to the limitations of utilizing single indicator.

Numerous approachesare employed to collect and define indicators which are able to assess it efficiently. The indicators construction is related to a certain concern situation description or its changes over time. Although collection, evaluation and normalization of indicators are important to identify the cost and time effective indicators sets, there is no international agreement standard to collect these sustainability indicators [11].

Enormous studies were employed by Zito and Salvo [11] to collect the indicator's main requirements. They found that the easy to understand, reasonable, quantifiable, reachable, comprehensive and sensitive to changes over time, independent reflect numerous aspects of research, systematic for comparison, clearly defined and record long term process are the most effective indicators. The main characteristics of indicators which are defining the sustainable transportation's environmental dimension are based on measurement, clearly indicating the actual and potential influences and have as much as accuracy [12].

Various investigations were conducted in North America, South America, Europe and Asia to obtain sustainable urban transport variables and to examine the relation between the climate and sustainability indicators in this field. About 530 variables were provided by analyzed studies, some of them are overlapping with each other, but most of them are unique due to the divergent aims of those papers [13].

The unique variables and combined indices should be combined due to the indication of important principle of urban planning diverge as a result of variation of related challenges and features in different cities. Social wellbeing, economic achievement and ecological sustainability represent the main reflection of the gathered indicators [14].

The assessment of transport sustainability represents the main goal of Transport and Environment Reporting mechanism report which was started to publish by the European Environmental Agency (EEA) published in 2000. Providing knowledge about the demand, pressure and influence of transport sector for policy makers represent the main aim of the report [3, 15].

The ungrouped variables are about 40 and they can be classified under four main groups of indicators.

Another report about smart transportation was published by Green Apple Canada [16] to investigate new solutions of urban transport sector issues in cities of Canada. As same as EEA, the seventeen indicators were not classified by the Green Apple, however they can be classified into the sustainability dimensions.

Litman [3, 6] reported that quality and cost are crucial groups of indicators selection in transport sustainability. The indicators were divided into economic, social and environmental dimensions. However economic dimension was the domination over the two other factors due to the relation of more than half of the indicators to the economic sustainability.

Buzási1 and Csete [17] categorized sustainability indicators depending on data from other researchers as depicted in Table 1.

Table 1. Sustainable indicators categorization of indicators according to many published research [3, 17]

Category	Economical	Environmental	Social
Indicators	• Annually freight transport performance (income) • Liszt Ferenc Airport Monthly traffic • Freight transport volume index gross value • Environmental protect investment in freight transport • Environmental taxes • Individual public transport cost per capita • Total annual transport expenditure • Costs of transport per household • Total costs of individual transport • Percentage of individual costs to total transport costs • Annual urban transport performance (number of passengers) • Registered companies' number in freight transport sector • Operating companies' number in freight transport sector • Gross added value by freight transport sector • Investment value at current prices • Foreign trade turnover • Net sales value • Employees number and their average salary in freight transport sector • Average fuel cost per month • Pavement condition index • Road roughness index • Number of inland ports	• Passengers number in interurban passenger transport • Passengers' numbers in urban passenger transport • Newly registered cars by fuel type • Average traffic intensity per day • Average passenger cars age • Average age of lorries • Emissions of Carbon dioxide • Emissions of Nitrogen dioxide • Emission of NMVOC • Emissions of Carbon monoxide • PM25 emission Emitted GHG by freight transport • Travelled |Kilometers by public transport, car and bicycle • Vehicle occupancy rate	• Average distance • Average travel time • Journeys number • Journeys number by car • Percentage of journeys by car • Vehicle occupancy rate • Accidents number

4. DATA COLLECTION AND ANALYSIS

After reviewing the global experiences of sustainable indicators in the transport sector, this section deals with the suitable surveying to find a suitable study area in Baghdad City & make questionnaire form for local transport specialists to determine the most important sustainable urban indicator.

All data required in this study were obtained from:

- Scientific references and research about global experiences in evaluating urban transport system by

sustainability indicators.

- Questionnaire.

Through extracting sustainable indicators in the transportation sector from various global experiences, 130 indicators were obtained in various environmental, social and economic dimensions.

4.1 Size and characteristics of the sample

A questionnaire containing 130 indicators was prepared and distributed to the specialists in the field of transport planning and traffic engineering to know the relative importance of each indicator and its relevance and importance with the local reality. The number of samples that answered the questionnaire was twenty-five samples, divided into 52% of the doctorate degree in the specialty and 48% of master's degree. The response rate was 20% of assistant professor, 52% of lecturer, and 28% of assistant lecturer title as illustrated in (Figure 1).

4.2 Analysis of the questionnaire form

The sample question was analyzed using SPSS version 23 software. Weighted Mean, Standard deviation and the relative importance of each of the questionnaire items were extracted. Likert (five-point (scale is adopted (5 very effective, 1 not very effective) to find out the importance and impact of each indicator at the local level.

For assessing the response direction, the study depends on the hypothetical medium of (3), which represents the boundary between importance and impact and insignificance and impact, within the Likert (five-point (scale used in the questionnaire.

For the response level of the respondent on the questionnaire questions, the study used the response strength matrix, which an estimated balance according to the quintet Likert scale, as in Table 2.

The indicators were arranged according to the relative importance, level of impact, and strength of response in descending order from the highest to the lowest.

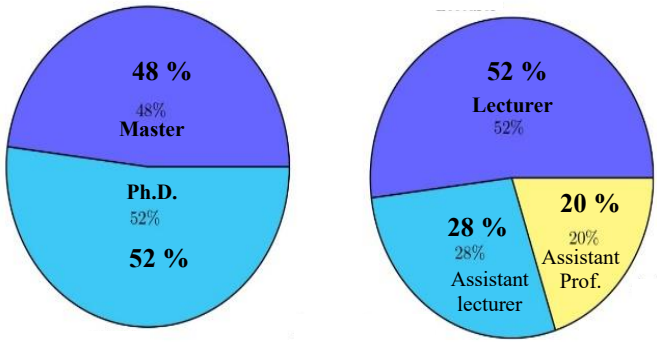

Figure 1. Academic Achievement Responses

Table 2. Arithmetic Mean, Standard Deviation and the Relative Importance of the Indicators form Questionnaire

S.	Indicator	scale					Arithmetic mean	standard deviation	Relative importance %	Influential level	Response Power
		Very influential	Influential	Medium	Uninfluential	Very uninfluential					
Q129	Accessibility to facilities and public transport.	17	18	0	0	0	4.68	0.48	93.60%	High	Very influential
Q44	Accessibility to facilities and public transport.	17	18	0	0	0	4.68	0.48	93.60%	High	Very influential
Q115	Mobility management.	14	11	0	0	0	4.56	0.51	91.20%	High	Very influential
Q68	Transport by cycling and walking mean for short distance trips.	18	4	2	1	0	4.56	0.82	91.20%	High	Very influential
Q101	Accessibility / Affordability/ Social Equity.	18	2	5	0	0	4.52	0.82	90.40%	High	Very influential
Q99	Safety.	14	9	2	0	0	4.48	0.65	89.60%	High	Very influential
Q24	Density of land use (people and jobs / unit of land area).	13	10	2	0	0	4.44	0.65	88.80%	High	Very influential
Q114	Planning Quality.	14	8	3	0	0	4.44	0.71	88.80%	High	Very influential
Q10	CO_2 emissions (1000 tons of carbon).	15	6	3	1	0	4.40	0.87	88.00%	High	Very influential
Q69	Walkability, pedestrian friendliness.	13	9	3	0	0	4.40	0.71	88.00%	High	Very influential
Q94	Traffic congestion delay.	14	7	4	0	0	4.40	0.76	88.00%	High	Very influential
Q105	Land Use Mix.	15	5	5	0	0	4.40	0.82	88.00%	High	Very influential
Q87	Average travel time to work.	13	8	4	0	0	4.36	0.76	87.20%	High	Very influential
Q71	Open space availability and accessibility.	14	5	6	0	0	4.32	0.85	86.40%	High	Very influential
Q16	Traffic accident rate.	13	7	5	0	0	4.32	0.80	86.40%	high	Very influential

Q33	Land paved for transport facilities (roads, parking, ports and airports).	14	6	4	1	0	4.32	0.90	86.40%	High	Very influential
Q43	Accessibility of origin/destination.	14	4	7	0	0	4.28	0.89	85.60%	High	Very influential
Q11	Average travel time.	9	14	2	0	0	4.28	0.61	85.60%	High	Very influential
Q6	Total network (km).	12	8	5	0	0	4.28	0.79	85.60%	High	Very influential
Q93	Modal Split (% car use, % public transport, % walking, cycling).	11	9	5	0	0	4.24	0.78	84.80%	High	Very influential
Q117	Land use planning.	13	5	7	0	0	4.24	0.88	84.00%	High	Very influential
Q4	Passenger cars in use (thousand units).	12	8	3	2	0	4.20	0.96	84.00%	High	Very influential
Q66	Trip length.	9	10	5	0	1	4.04	0.98	80.80%	High	Very influential
Q27	No. of public services during 10-minute walk, and job opportunities during 30-minute commute of residents.	7	12	5	1	0	4.00	0.82	80.00%	High	influential
Q50	Energy consumption efficiency of transport sector.	10	6	8	1	0	4.00	.96	80.00%	High	influential
Q45	Access to public transport.	9	6	10	0	0	3.96	0.89	79.20%	High	influential
Q15	Air pollutant emission intensity.	10	6	5	4	0	3.88	1.13	77.60%	High	influential
Q67	Security on public transport.	8	8	5	2	0	3.88	0.97	77.60%	High	influential
Q7	Urban population (% of total).	3	15	7	0	0	3.84	0.62	76.80%	High	influential
Q84	Total number of vehicles per capita.	8	8	7	3	0	3.84	1.03	76.80%	High	influential
Q108	Mode share.	7	10	5	3	0	3.84	0.99	76.80%	High	influential
Q128	Land consumption for transport.	7	9	7	2	0	3.84	0.94	76.80%	High	influential
Q21	Personal mobility (annual person-kilometers and trips) by mode (nonmotorized, automobile and public transport).	4	14	6	1	0	3.84	0.75	76.80%	High	influential
Q85	Total motor bus route length per area.	5	11	9	0	0	3.84	0.75	76.80%	High	influential
Q86	Number of available transit mode.	7	8	9	1	0	3.84	0.90	76.80%	High	influential
Q25	Per capita congestion costs.	6	8	11	0	0	3.80	0.82	76.00%	High	influential
Q48	Transport efficiency.	7	6	12	0	0	3.80	0.87	76.00%	High	influential
Q82	Annual work trips by public transportation% per total annual work trips.	6	9	9	1	0	3.80	0.87	76.00%	High	influential
Q124	Land use impacts.	7	6	11	1	0	3.76	0.93	75.20%	High	influential
Q40	Use of renewable fuels.	9	6	6	3	1	3.76	1.20	75.20%	High	Influential
Q95	Household travel costs.	7	7	9	2	0	3.76	0.97	75.20%	High	influential
Q12	Average travel cost.	8	7	7	2	1	3.76	1.13	75.20%	High	influential
Q130	Satisfaction of citizens and variety and quality of transport options.	5	13	4	2	1	3.76	1.01	75.20%	High	influential
Q1	Total Passenger kilometers.	7	8	7	2	1	3.72	1.10	74.40%	High	influential
Q19	Road share of inland freight transport.	7	7	8	3	0	3.72	1.02	74.40%	High	influential
Q111	Mode share.	6	8	9	2	0	3.72	0.94	74.40%	High	influential
Q106	Electronic communication.	6	8	9	2	0	3.72	0.94	74.40%	High	influential
Q2	Goods transported (million ton-km).	7	5	11	2	0	3.68	0.99	73.60%	High	influential
Q18	Car share of inland Passenger transport.	6	6	12	1	0	3.68	0.90	73.60%	High	influential
Q34	Portion of residents who walk or bicycle sufficiently for health (15 minutes or more daily).	9	5	6	4	1	3.68	1.25	73.60%	High	influential
Q13	Average infrastructure cost.	5	9	9	2	0	3.68	0.90	73.60%	High	influential
Q22	Vehicle travel (annual vehicle kilometers) by mode (nonmotorized, automobile and public transport).	5	10	8	1	1	3.68	0.99	73.60%	High	influential
Q57	Loss of natural areas.	6	9	7	2	1	3.68	1.07	73.60%	High	influential
Q78	Total roads length per capita.	5	9	9	2	0	3.68	0.90	73.60%	High	influential
Q98	Economic Equity / User price.	5	10	8	1	1	3.68	0.99	73.60%	High	influential
Q88	Annual public transportation expenditures per capita.	2	14	8	1	0	3.68	0.69	73.60%	High	Influential
Q104	Employment Accessibility.	5	8	11	1	0	3.68	0.85	73.60%	High	influential
Q26	Quality (availability, speed, reliability, safety and prestige) of non-automobile modes (walking, cycling, ridesharing and public transit).	3	13	6	3	0	3.64	0.86	72.80%	High	influential
Q92	Number of public transportation employments per capita.	3	11	10	1	0	3.64	0.76	72.80%	High	influential
Q122	Inclusive planning.	6	8	7	4	0	3.64	1.04	72.80%	High	influential
Q20	Investments in transport Infrastructure.	3	12	5	4	0	3.64	0.95	72.80%	High	influential
Q107	Transport diversity.	5	8	10	2	0	3.64	0.91	72.80%	High	influential

Q126	Energy use.	4	10	9	2	0	3.64	0.86	72.80%	High	influential
Q77	Yearly motor fuel used by transportation / total vehicles.	4	10	9	2	0	3.64	0.86	72.80%	High	influential
Q89	Yearly transportation revenues / transportation expenditures.	4	8	12	1	0	3.60	0.82	72.00%	High	influential
Q23	Freight mobility (annual tonne-kilometers) by mode (truck, rail, ship and air).	4	8	12	1	0	3.60	0.82	72.00%	High	influential
Q90	Annual public transportation revenues per public transportation expenditures.	5	6	13	1	0	3.60	0.87	72.00%	High	influential
Q103	Commute Time.	4	9	10	2	0	3.60	0.87	72.00%	High	influential
Q35	Portion of children walking or cycling to school.	9	4	5	6	1	3.60	1.29	72.00%	High	influential
Q17	Traffic noise.	6	6	9	4	0	3.56	1.04	71.20%	High	influential
Q96	Facility costs.	5	5	14	1	0	3.56	0.87	71.20%	High	influential
Q127	Population exposed to noise.	7	4	11	2	1	3.56	1.12	71.20%	High	influential
Q80	Vehicles percentage with renewable fuels per total number of vehicles.	7	5	9	3	1	3.56	1.16	71.20%	High	influential
Q118	User rating.	5	7	10	3	0	3.56	0.96	71.20%	High	influential
Q65	Car independence.	4	9	9	3	0	3.56	0.92	71.20%	High	influential
Q32	Universal design (transport system quality for people with disabilities and other special needs).	6	5	10	4	0	3.52	1.05	70.40%	High	influential
Q53	Public revenues from taxes and traffic system charging.	4	7	12	2	0	3.52	0.87	70.40%	High	influential
Q54	Benefit of transport.	5	7	9	4	0	3.52	1.00	70.40%	High	influential
Q58	Proximity of transport infrastructure to designated nature areas.	6	4	12	3	0	3.52	1.00	70.40%	High	influential
Q100	Livability.	7	4	10	3	1	3.52	1.16	70.40%	High	Influential
Q30	Affordability (portion of household budgets devoted to transport, or combined transport and housing).	5	8	7	5	0	3.52	1.05	70.40%	High	influential
Q110	Transport diversity.	4	8	9	4	0	3.48	0.96	69.60%	High	influential
Q120	Cultural preservation.	5	7	9	3	1	3.48	1.08	69.60%	High	influential
Q91	Yearly damage of public transportation property by public transportation incidents per yearly unlinked passenger trips by transit.	4	7	11	3	0	3.48	0.92	69.60%	High	influential
Q97	Transport cost efficiency.	7	3	10	5	0	3.48	1.12	69.60%	High	influential
Q112	Freight efficiency.	2	10	11	2	0	3.48	0.77	69.60%	High	influential
Q121	Children's travel.	3	8	12	2	0	3.48	0.82	69.60%	High	influential
Q31	Rating of overall transport system satisfaction (based on objective user surveys).	4	7	11	3	0	3.48	0.92	69.60%	High	influential
Q83	Yearly percentage of annual non motorize work trips per total yearly work trips.	4	9	7	4	1	3.44	1.08	68.80%	High	influential
Q36	Housing affordability in accessible locations.	6	6	6	7	0	3.44	1.16	68.80%	High	influential
Q49	Utilization rates.	4	5	13	3	0	3.40	0.91	68.00%	High	influential
Q5	Commercial vehicles in use (thousand units).	4	7	9	5	0	3.40	1.00	68.00%	High	influential
Q81	Number of alternative fuel station per number of alternative fuel vehicle.	6	4	10	4	1	3.40	1.15	68.00%	High	influential
Q41	Efficiency resource of transport facility (such as use of renewable materials and energy efficient lighting).	2	8	13	2	0	3.40	0.76	68.00%	High	influential
Q62	Runoff pollution from transport infrastructure.	4	7	9	5	0	3.40	1.00	68.00%	High	influential
Q109	Freight	2	9	11	3	0	3.40	0.82	68.00%	High	influential
Q125	Resource efficiency.	3	7	12	3	0	3.40	0.87	68.00%	High	influential
Q51	External transport costs.	4	6	12	2	1	3.40	1.00	68.00%	High	influential
Q55	Fragmentation of land.	2	7	14	7	0	3.36	0.76	67.20%	medium	medium
Q39	Habitat preservation in transport planning.	3	7	11	4	0	3.36	0.91	67.20%	medium	medium
Q61	Greenhouse gas emissions from manufacture and maintenance.	2	10	9	3	1	3.36	0.95	67.20%	medium	medium
Q79	Vehicles percentage with alternative fuels / total number of vehicles.	5	5	10	4	1	3.36	1.11	67.20%	medium	medium
Q73	Vertical equity (income).	2	10	8	5	0	3.36	0.91	67.20%	medium	medium
Q29	Quality of transport for disadvantaged people (disabled, low incomes, children, etc.).	5	5	9	5	1	3.32	1.14	66.40%	medium	medium
Q75	Public opinion profile on transport and transport policy issues.	5	2	15	2	1	3.32	1.03	66.40%	medium	medium
Q116	Pricing reforms.	4	6	11	2	2	3.32	1.11	66.40%	medium	medium

Q63	Wastewater from manufacture and maintenance of transport infrastructure.	3	6	12	3	1	3.28	0.98	65.60%	mediu m	medium
Q102	User satisfaction.	4	5	11	4	1	3.28	1.06	65.60%	mediu m	medium
Q3	Two-wheelers (per 1,000 people).	2	6	14	3	0	3.28	0.79	65.60%	mediu m	medium
Q14	Average industrial backward linkage effect.	4	3	14	4	0	3.28	0.94	65.60%	mediu m	medium
Q46	Supplier operating costs.	3	5	13	4	0	3.28	0.89	65.60%	mediu m	medium
Q37	Community livability ratings.	2	9	8	5	1	3.24	1.01	64.80%	mediu m	medium
Q70	Traffic calming.	1	9	10	5	0	3.24	0.83	64.80%	mediu m	medium
Q113	Delivery services.	2	9	9	3	2	3.24	1.05	64.80%	mediu m	medium
Q74	Vertical equity (mobility needs and ability).	2	6	13	4	0	3.24	0.83	64.80%	mediu m	medium
Q42	Intermodal terminal facility.	2	6	13	3	1	3.20	0.91	64.00%	mediu m	medium
Q76	Violation of traffic rules.	2	7	11	4	1	3.20	0.96	64.00%	mediu m	medium
Q119	Community livability.	3	5	12	4	1	3.20	1.00	64.00%	mediu m	medium
Q9	Arable land (hectares).	1	6	14	4	0	3.16	0.75	63.20%	mediu m	medium
Q52	Gross added value.	4	3	12	5	1	3.16	1.07	63.20%	mediu m	medium
Q72	Horizontal equity (fairness).	4	3	11	7	0	3.16	1.03	63.20%	mediu m	medium
Q123	Other air pollution.	2	6	12	4	1	3.16	0.94	63.20%	mediu m	medium
Q59	Light emission.	2	7	10	4	2	3.12	1.05	62.40%	mediu m	medium
Q64	Generation of non-recyclable waste.	2	7	9	6	1	3.12	1.01	62.40%	mediu m	medium
Q28	Portion of households with internet access.	3	6	8	6	2	3.08	1.15	61.60%	mediu m	medium
Q60	Collisions with wildlife.	3	6	9	4	3	3.08	1.19	61.60%	mediu m	Medium
Q8	Illiteracy rate, adult total (% of people 15+).	2	5	10	8	0	3.04	0.93	60.80%	mediu m	medium
Q38	Water pollution emissions.	4	4	8	5	4	2.96	1.31	59.20%	mediu m	medium
Q47	Related expenditures of the household.	2	5	11	4	3	2.96	1.10	59.20%	mediu m	medium
Q56	Damage of underwater habitats.	1	5	11	6	2	2.88	0.97	57.60%	mediu m	Medium

Authors based on SPSS

5. RESULT

Table 2 shows that the highest indicator with a significant impact on the local reality is the accessibility to facilities and public transport with a relative importance of 93.6%, and access to public services with a relative importance of 92.8%, followed by the management of Mobility for its importance in organizing and improving the transportation system in Iraq As an important tool in achieving sustainable transport with a relative importance of 91.2%, and with the same relative importance in the use of transportation, such as bicycles and walking in short distances. The remaining high impact indicators show that they are related to the planning process, land use, traffic safety and pollution, and therefore it is possible to reach a framework for sustainable indicators at the local level and classify them as follows:

First: Definition the concerned authorities include:

- Legislative bodies: are the bodies that include preparing and organizing sustainable indicators, legislating their laws and monitoring the implementation of indicators, and they include universities, the Ministry of Municipalities, Planning, and Parliament.
- Executive bodies: They are the bodies that work to implement the indicators and apply them in Iraq and give feedback to the legislative bodies for the purpose of giving dynamism and renewal to sustainable indicators in a manner that takes into account scientific and technological progress in the world. These entities include the Ministry of Municipalities and the Interior and the agencies associated with the application of indicators.
- Civil-society organizations: they are specialized in the transport sector, and they have a link with the legislative and executive bodies, working to

participate in the transfer of society's needs and requirements as well as participation in decision-making.

Second: Preparing and classifying sustainable indicators in the transport sector

Most of the sustainable indicators depend on the three pillars of sustainability (environmentally, socially, economically), The researcher proposes adding another corner which is the organizational and administrative pillar and governance which plays a big role in Iraq and the most important pillars of sustainability through which the transport sector is organized in general and the application of sustainability indicators in particular.

Through the questionnaire and the results extracted from it in Table 2 and by relying on the indicators with a high impact and very influential response force, these 23 indicators were classified as follows:

1) **Economic indicators**: Include the following (Table 3): It focus on the principle of easy access to services and means of transport and the consequent delay in the time and length of the trip, congestion and accidents, all linked to the economic aspect.
2) **Social indicators**: Include the following (Table 4): It focus on social justice in the ease of access to various services and open areas which requires the provision of safety and security.
3) **Environmental indicators**: Include the following (Table 5): It focus on using sustainable transportation such as walking and bicycles as environmentally friendly means of transportation and reduce polluting emissions.
4) **Organizational, administrative and governance indicators**: include the following (Table 6): It focus on planning land use in a holistic manner and managing mobility as they are the main elements for controlling urban transport planning and therefore are the elements that control all other indicators.

Table 3. Proposed Local Economic Indicators

S.	Indicator	scale					Arithmetic mean	Standard deviation	Relative importance %	Influential level	Response Power
		Very influential	Influential	Medium	Uninfluential	Very uninfluential					
Q129	Accessibility to facilities and public transport.	17	8	0	0	0	4.68	0.48	93.60%	High	Very influential
Q44	Accessibility to facilities and public transport.	19	3	3	0	0	4.64	0.70	92.80%	High	Very influential
Q94	Traffic congestion delay.	14	7	4	0	0	4.40	0.76	88.00%	High	Very influential
Q87	Average travel time to work.	13	8	4	0	0	4.36	0.76	87.20%	High	Very influential
Q16	Traffic accident rate.	13	7	5	0	0	4.32	0.80	86.40%	High	Very influential
Q43	Accessibility of origin/destination.	14	4	7	0	0	4.28	0.89	85.60%	High	Very Influential
Q11	Average travel time.	9	14	2	0	0	4.28	0.61	85.60%	High	Very influential
Q4	Passenger cars in use (thousand units).	12	8	3	2	0	4.20	0.96	84.00%	High	Very influential
Q66	Trip length.	9	10	5	0	1	4.04	0.98	80.80%	High	Very influential
	Average						**4.36**	**0.77**	**87.11%**	**High**	**Very influential**

Table 4. Proposed Local Social Indicators

S.	Indicator	Scale					Arithmetic mean	Standard deviation	Relative importance %	Influential level	Response Power
		Very influential	Influential	Medium	Uninfluential	Very uninfluential					
Q101	Accessibility / Affordability/ Social Equity.	18	2	5	0	0	4.52	0.82	90.40%	High	Very influential
Q99	Safety.	14	9	2	0	0	4.48	0.65	89.60%	High	Very influential
Q71	Open space availability and accessibility.	14	5	6	0	0	4.32	0.85	86.40%	High	Very influential
	Average						**4.44**	**0.77**	**88.80%**	**High**	**Very influential**

Table 5. Proposed Local Environmental Indicators

S.	Indicator	Scale					Arithmetic mean	Standard deviation	Relative importance %	Influential level	Response Power
		Very influential	Influential	Medium	Uninfluential	Very uninfluential					
Q68	Transport by cycling and walking mean for short distance trips.	18	4	0	1	0	4.56	0.82	91.20%	High	Very influential
Q10	CO_2 emissions (1000 tons of carbon).	15	6	3	1	0	4.40	0.87	88.00%	High	Very influential
Q69	Walkability, pedestrian friendliness.	13	9	3	0	0	4.40	0.71	88.00%	High	Very influential
	Average						4.45	0.80	89.07%	High	Very influential

Table 6. Proposed Local Organizational, Administrative and Governance Indicators

S.	Indicator	scale					Arithmetic mean	Standard deviation	Relative importance %	Influential level	Response Power
		Very influential	Influential	Medium	Uninfluential	Very uninfluential					
Q115	Mobility management.	14	11	0	0	0	4.56	0.51	91.20%	High	Very influential
Q24	Density of land use (people and jobs / unit of land area).	13	10	2	0	0	4.44	0.65	88.80%	High	Very influential
Q114	Planning Quality.	14	8	3	0	0	4.44	0.71	88.80%	High	Very influential
Q105	Land Use Mix.	15	5	5	0	0	4.40	0.82	88.00%	High	Very influential
Q33	Land paved for transport facilities (roads, parking, ports and airports).	14	6	4	1	0	4.32	0.90	86.40%	High	Very influential
Q6	Total network (km).	12	8	5	0	0	4.28	0.79	85.60%	High	Very influential
Q93	Modal Split (% car use, % public transport, % walking, cycling).	11	9	5	0	0	4.24	0.78	84.80%	High	Very influential
Q117	Land use planning.	13	5	7	0	0	4.24	0.88	84.80%	High	Very influential
	Average						4.37	0.76	87.30%	High	Very influential

Third: Applying sustainable indicators in evaluating the urban transport system: The development of a framework for sustainable indicators in the urban transport sector requires testing the indicators by assessing the transportation system to demonstrate the feasibility of the indicators in setting a vision and goal for the transport sector and thus setting plans to solve urban transport problems.

The process of applying sustainable indicators and evaluating the urban transport system requires the following (Figure 2):

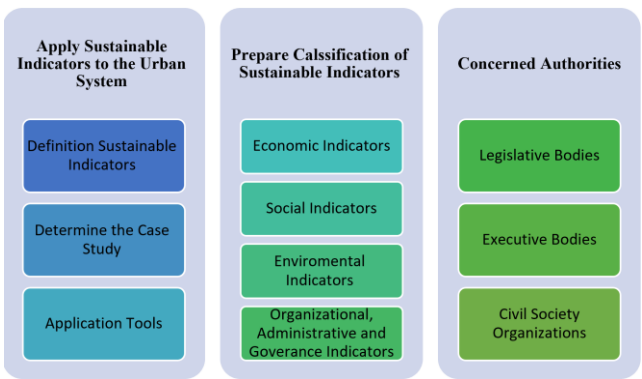

Figure 2. Applying Sustainable Indicators

- Determining sustainable indicators: The evaluation of the urban transport system requires the identification of appropriate indicators to solve the transport problem in a manner that guarantees the best results.
- Determining the study area: When determining the study area, multiple plans and data are required to ensure their use in the evaluation process.
- Application tools: To access data analysis and obtain accurate results that requires the use of various computer programs such as SPSS, Auto CAD, GIS and others.

6. CONCLUSIONS

A. The indicators are the most important planning tools for evaluation, whether for transport plans or systems. Among the most important of these indicators that evaluate transport systems are urban sustainability indicators.

B. The local Iraqi reality requires sustainable indicators in the aspect of governance, management and organization to solve most problems in all sectors, including the urban transport sector.

C. The process of preparing sustainable indicators in the transportation sector requires an integrated participation by government and societal bodies to reach sustainable indicators that are compatible with the local reality.

D. The results of the questionnaire showed that the most important sustainable indicator that can be applied and that has a very strong impact on the local Iraqi reality is the accessibility indicator to public services and public transport, its relative importance was 93.6%. It showed a relative importance of 91.2% for the mobility management indicator in Baghdad city as an indicator with a very strong impact on the evaluation of the urban transportation system.

   The preparation of sustainable indicators appropriate to the local reality through the questionnaire indicated that the indicators related to the environmental dimension have obtained the highest relative importance has reached 89.07%, followed by indicators related to the social dimension with a relative importance of 88.8%, and the relative importance of the indicators related to the administrative and organizational dimension and governance reached 87.3%, Finally, indicators related to the economic dimension have a relative importance of 87.11%.

E. We suggest preparing modern laws that are in line with the informational and technological advances in the sustainable transport sector, including the indicators that have been extracted.

F. We recommend applying the extracted indicators within the transportation plans in Iraqi cities, and the most important of these indicators is accessibility.

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REFERENCES

[1] Ismael, N.T., Hussain, A.A.H., Abdulwahab, M.A. (2020). Proposed vision for green buildings in Iraq. In Fifth International Engineering Conference on Developments in Civil & Computer Engineering Applications 2019 - (IEC2019) -Erbil – IRAQ, pp. 55-59. https://doi.org/10.1109/IEC47844.2019.8950623

[2] Al-Anbari, M., Alkaissi, Z. (2017). Assessment of sustainable indicators for road transportation: A case study of palestine arterial street. International Journal of Science and Research, 6(4): 270-279. https://doi.org/10.21275/ART20172243

[3] Litman, T. (2022). Well measured: Developing indicators for sustainable and livable transport planning. Victoria Transport Policy Institute. https://www.vtpi.org/wellmeas.pdf, accessed on Jan. 10, 2023.

[4] Litman, T. (2003). Measuring transportation: Traffic, mobility and accessibility. Institute of Transportation Engineers (ITE) Journal, 73(10): 28-32.

[5] Litman, T. (2003). Economic value of walkability. Transportation Research Record: Journal of the Transportation Research Board, 1828(1): 3-11. https://doi.org/10.3141/1828-01

[6] Litman, T. (2011). Transportation cost and benefit analysis: Techniques, estimates and implications. Second Edition, Victoria Transport Policy Institute, https://www.vtpi.org/tca/tca00.pdf.

[7] Litman, T., Burwell, D. (2006). Issues in sustainable transportation. International Journal of Global Environment Issues, 6(4): 331-347. https://doi.org/10.1504/IJGENVI.2006.010889

[8] Toth-Szabo, Z., Várhelyi, A., Koglin, T., Angjelevska, B. (2011). Measuring sustainability of transport in the city – development of an indicator-set. Bulletin 261. Traffic & Roads, Department of Technology and Society, Lund University. https://doi.org/10.13140/RG.2.1.1451.0240

[9] Seghezzo, L. (2009). The five dimensions of sustainability. Environmental Politics, 18(4): 539-556. https://doi.org/10.1080/09644010903063669

[10] Alshamari, H.A., Ismael, N.T., Adelphi, H.S.O., Hamza, S.M. (2022). Promoting the social cohesion in the traditional cities. International Journal of Sustainable Development and Planning, 17(6): 1855-1864. https://doi.org/10.18280/ijsdp.170620

[11] Zito, P., Salvo, G. (2011). Toward an urban transport sustainability index: An European comparison. European Transport Research Review, 3(4): 179-195. https://doi.org/ 10.1007/s12544-011-0059-0

[12] Zietsman, J.; Ramani, T., Potter, J., Reeder, V., De Florio, J. (2011). A guidebook for sustainability performance measurement for transportation agencies. Washington, D.C: Transportation Research Board, National Academy of Sciences. NCHRP REPORT 708. https://doi.org/10.17226/14598

[13] Litman, T. (2010). Sustainable transportation indicator data quality and availability. Transportation Research Board 89th Annual Meeting 2010, Transportation Research Board, Washington, DC United States. https://trid.trb.org/view/910553

[14] Ismael, N.T. (2020). Urban expasion indicators of cities "case study for Arab cities". Journal of Techniques, 2 (1): 1-21. https://doi.org/10.51173/jt.v2i1.5

[15] European Environment Agency. (2013). A Closer Look at Urban Transport: TERM 2013: Transport Indicators Tracking Progress Towards Environmental Targets in Europe. https://doi.org/10.2800/94848, accessed on Jan. 1, 2023.

[16] Appleton, B., Davies, M., Tansey, J., Atwal, P., Dore, G.P., Muzyka, D. (2008). GreenApple Canada 2008: SMART Transportation Ranking Report, Appleton Charitable Foundation.

[17] Buzási1, A., Csete, M. (2015). Sustainability indicators in assessing urban transport systems. Periodica Polytechnica Transportation Engineering, 43(3): 138-145. https://doi.org/10.3311/PPtr.7825