Dijlah Journal of Engineering Sciences (DJES) Vol. 2, No. 2, June 2025, pp. 103-122
ISSN: **Printed: 3078-9656, E: 3078-9664**, paper ID: 41

Key Performance Indicators of Sustainability for Iraqi Public Buildings

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Article Info

Article history:

Received April, 13, 2025
Revised May, 01, 2025
Accepted May, 10, 2025

Keywords:

Economic indicators
Environmental indicators
Pareto Principle (20/80)%
Relative Importance Index
Social indicators

ABSTRACT

Due to the importance of Sustainable Construction, a comprehensive assessment of the sustainability of the built environment is required. Studying the sustainability performance indicators of current buildings is a crucial first step in evaluating a building's sustainability. This study aims to understand the main performance of sustainability indicators for public buildings in Iraq as a result of relying on these buildings intensively for the development and welfare of society in Iraq. Based on previous studies sustainability indicators were collected and identified, and 71 indicators were obtained, distributed among a group of categories within the three dimensions of environmental, social, and economic sustainability. The relative importance of the indicators was determined by organizing a questionnaire that was distributed to a group of engineers with experience in sustainable buildings and relied on 103 forms in the analysis. The results of the survey were analyzed using the statistical program (SPSS-V-26) to give priority to the indicators identified using the relative importance index (RII)to point out the relative importance of environmental, social, and economic indicators. The Pareto principle was also applied to reduce the number of indicators and choose the most relatively important ones.14 key performance indicators for the sustainability of public buildings were obtained.

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1. INTRODUCTION (10 PT)

Sustainability in public buildings is one of the vital issues that is receiving increasing attention in Iraq, given the environmental, economic, and social challenges facing the country. National efforts seek to develop public buildings that comply with global sustainability standards, taking into account local environmental characteristics. In this context, the "Iraqi Green Code" was launched, which aims to promote the use of recyclable materials, the application of renewable energy systems, and the improvement of the efficiency of water and energy consumption in public buildings[1] .However, these initiatives face challenges related to the absence of specific key performance indicators (KPIs) that measure the extent to which sustainability is achieved in Iraqi public buildings. Studies show that the development of an effective system of performance indicators requires the integration of environmental, economic, and social aspects, taking into account the local context[2].The adoption of global sustainability assessment systems such as LEED and BREEAM requires adapting them to suit the Iraqi environment, which requires analytical comparisons to determine their suitability[1].In addition, the institutional role plays a pivotal role in the adoption of sustainable building practices by developing supporting legislation and policies, providing the necessary training and funding[3].Assessing the sustainable maintenance needs of government buildings requires the use of multi-criteria analytical methods to ensure the continuity of sustainable performance of these buildings[4,5].

2. Literature review

The field of Key Performance Indicators (KPIs) has gained rising attention for sustainability evaluation of public buildings across Iraq during recent times. The research conducted by Mohammed and Azraig examined KPIs as tools for lowering maintenance expenses in government projects. The study demonstrated that implementing these indicators as part of maintenance operations generates effective cost reduction and higher operational efficiency [5]. Mohammed and his colleagues generated a specific framework to evaluate education building sustainability traits within the Iraqi environment. The evaluation system succeeded in uniting environmental performance and economic considerations with social aspects for evaluation purposes [2]. Through their research, Ramadan and his colleagues determined that Diyala Governorate buildings demonstrated poor performance because of inadequate performance indicators and missing sustainability standards [6]. The buildings of the University of Babylon received evaluation from Kazem and Al-Anbari, who identified water use and energy performance as the primary obstacles to sustainable development in these structures [7]. Genta, along with his colleagues, developed a complete set of performance indicators for sustainable urban development that became a valuable reference point for use in Iraqi urban planning situations [5]. An analytical research by Wadi and A'edh identified essential sustainability indicators in Iraq through factor analysis and determined that economic aspects and institutional frameworks represent the fundamental bases needed to achieve sustainable development [9]. According to the study conducted by Jasim and Mahmoud, economic and social sustainability indicators defined by the GRI framework enhanced performance rates. Better decision-making and policy implementation result from increasing awareness about these indicators, according to the research findings [10].

3. Research methodology

Sustainability indicators for public buildings were collected from previous studies. The method of content analysis was used to classify and weigh these indicators. The sustainability performance metrics were determined using a questionnaire survey approach. Relevant literature was used to frame and categorize the questionnaire. The sustainability performance indicators were determined using a questionnaire survey approach. Priority was given to the indicators through a survey of a group of experts with respondents from engineers in various engineering specialties. The relative importance index (RII) method was adopted to prioritize the specified indicators .After that, the Pareto principle was applied to reduce the number of indicators and choose the most relatively important ones, and thus, the main performance indicators of sustainability were obtained. Figure 1 summarizes the adopted methodology.

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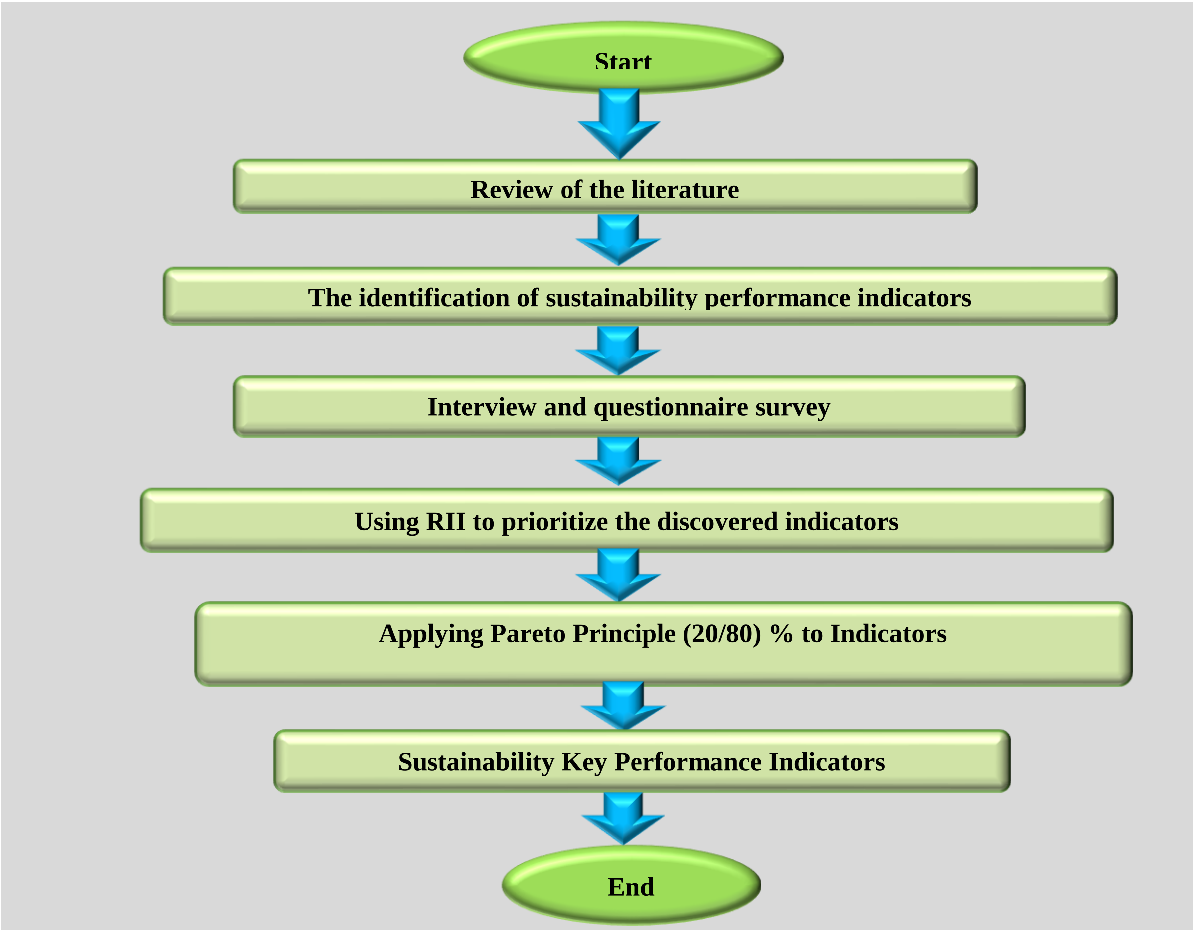

Figure (1) Flow chart for Research approach adopted

3.1 Identified indicators

Sustainability performance indicators were determined by a thorough analysis of the literature. A total of 71 indicators have emerged from the tripartite framework for environmental, social, and economic sustainability, including 43 environmental indicators classified into four distinct categories: energy efficiency, water management, green building materials, and indoor environmental quality. The social dimension consists of 19 indicators divided into two categories, including the category of Health and well-being of the occupants and the category of awareness and education for sustainable innovation. As for the economic dimension, it consists of 9 indicators distributed within one category category of life cycle cost. They are presented in Tables 1, 2, and 3.

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Table 1. Identified Environmental Indicators

NO	Categories	Indicators	References
1	Energy efficiency category	Reducing the amount of non-renewable primary energy used during operation.	[11,12,13]
		Renewable energy production and Renewable energy sources use	[12,14,15]
		Use Energy-efficient heating and cooling	[12,15,16]
		Energy conservation—lowering the amount of power used and conserving energy through the efficiency of natural gas	[15,11,14]
		Utilizing emission-free power generators and refrigerant management systems to preserve the ozone layer are two examples of outer space energy conservation.	[16]
		Energy-efficient equipment (Use of LED lighting and sensors for daytime lighting)	[16,15]
		By utilizing intelligent monitoring technology (both intelligent systems that track the energy consumed for each demand and intelligent systems that track the energy spent in the user's area),	[16,17]
		Maximize solar building orientation	[11,15]
		Local energy production	[11,13]
		Generating clean and renewable energy	[17]
2	Water management category	Hot water consumption	[12]
		Rainwater harvesting (Collect rainwater and reduce drinking water consumption)	[12,17]
		Recycled greywater (gray water and reused for irrigation)	[12,17,15]
		Minimizing water resource consumption	[14]
		Use of mechanisms to reduce water consumption (Application of innovative water-efficient equipment)	[16,15]
		Water-saving systems in the building	[17]
		Reuse non-potable water	[11]
		Reduce water consumption in the building and Drinkable water consumption	[11,13]
		Treatment of contaminated effluents (Recycling and recovery of effluents)	[13]

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		Leak detection (Building water conservation)	[15]
		Use of native vegetation in green areas to reduce water consumption	[15,11]
3	Green Building Materials category	Use Local/regional building materials	[15,17,11]
		Use of recycled materials	[15,17,13,11,16,19]
		Use of sustainable materials (The use of environmentally friendly materials)	[17,16,19]
		Employment of substances characterized by a reduced concentration of volatile organic compounds (Employment of coatings, floor coverings, furnishings, and sanitation products devoid of volatile organic constituents within the structure)	[11,16]
		Use of certified materials	[11]
		Use of cement substitutes in concrete	[11]
		Coating materials (Use wall coating materials in as of color and chemical composition)	[11,16,19]
		Resource Consumption (Reducing the use of raw materials)	[24,19]
		Reduce the use of new construction materials	[16,19]
		Use of reflective materials for heat	[16,19]
		Employ the existing architectural framework of the edifice, including the fenestration and portals, in the construction of the new establishment.	[16,19]
		Flooring (use of easy-to-clean, maintenance, recyclable, and low-emission organic matter)	[16,19]
4	Indoor environment quality category	Indoor acoustic comfort (Noise pollution, Acoustics Control, Noise protection, and maximizing acoustic comfort)	[12,19,18,11,13,15,17]
		Indoor air quality (Creating a healthy and non-toxic environment through minimizing pollution emissions such as SO_2, NO_x, PM, CO, and CO_2)	[15,14,17]
		Safety and security (Secure Surroundings)	[12,19]
		Ensure quality in creating the built environment	[14]
		Convenience and Wellbeing spaces (Space layout)	[19]
		Thermal comfort (Use the site potential to promote thermal comfort)	[14,11,13,17]
		Indoor Ventilation Efficiency and Efficiency of natural ventilation in interior spaces and public places	[14,11,13,17,18]

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		Greenhouse gas emissions	[12,15]
		Use of indoor plants, indoor skylights	[17]
		Minimum VOC (Use of materials with a low content of VOCS) and (Use of low-carbon and renewable sources)	[17]

Table 2. Identified Social indicators

NO	Categories	Indicators	References
1	Occupant Health and Wellbeing category	Occupation rate (day/year) and (hour/year)	[12]
		Ensure there is inter-generational equity	[14]
		Ensure equitable distribution of social costs and benefits of construction	14[14]
		Ensure fair treatment and respect of stakeholders	[14]
		Developing human resources (Improve the quality of human life, which includes poverty alleviation)	[14]
		Operational Services Management	[19]
		Job creation (Promote employment creation)	[14]
		Impact on workers' health (promoting and protecting health through a healthy and safe working environment)	[14]
]		Evidence-based design that integrates architecture, landscape, and health planning (Innovation of the project design)	[17,11]
		Availability of green spaces with easy access for users	[11]
		Maximize access to living areas, gym	[11]
		Dedicated space (work, rest, change)	[18]
		Furniture quality	[18]
		Transportation management	[18]
2	Awareness and education for sustainable innovation category	Use social activities	[12]
		Culture and heritage (Ensure local culture and heritage are conserved and Impact on cultural and historical heritage)	[12,14]
		Uplifting communities	[14]
		Education of occupants (Educating the building occupants about the concepts of sustainability)	[17,11]
		Innovation in the design of the project	[17]

Table 3. Identified Economic indicators

NO	Categories	Indicators	References
1	life cycle cost category	Operational energy expenses (Reduce operating costs related to energy consumption)	[11,12]
		Operational water expenses	[12]
		Ensure there is support for local economic/business diversity (Hiring local goods and services)	[14,13]
		Ensure to acquire financial benefits/profits	[14]
		The application of real cost pricing and full cost accounting to determine tariffs and prices for products and services that accurately account for social and biophysical costs	[14]
		Affordability (Ensure financial affordability for beneficiaries by minimizing the overemphasis on technical sustainability)	[14,15]
		Long-term costs management (Initial investment cost)	[19,17]
		Operation and maintenance costs	[17]
		Increase the life of the building	[17]

3.2 Closed Questionnaire

The questionnaire consists of four axes. The first axis represents the personal information of the surveyed category, the second axis represents the environmental indicators of sustainable public buildings, the third axis represents the social indicators of sustainable public buildings, and the fourth axis represents the economic indicators of sustainable public buildings. The five-point Likert scale is adopted from (1) completely unimportant to (5) very important, as shown in Table (4). Priority was given to the indicators through a survey of a group of experts with respondents from engineers in various engineering specialties. The questionnaire was distributed to 105 participants, including engineers, academics, and those with experience in sustainable public buildings. 103 answers were taken, and two answers that did not meet the requirements and criteria of the research were excluded.

3.3 Closed Questionnaire Analysis

The analysis of the questionnaire is divided into two sections: the first section analyzes the respondents ' information, and the second section analyzes the questionnaire data

3.3.1 Analysis of Respondents' Information

This part aims to determine the academic qualifications of the profession of the research sample, their sector of work, the number of years of professional experience, the nature of their work, the address (name) of the department they work for, as well as the place of work (name of the province) for the respondents where the number of repetitions and percentage were used to summarize the basic information of the participants in the questionnaire, as follows.

Figure (2) shows the percentage of academic degrees of the survey participants. It turned out that the highest percentage (57%) had a bachelor's degree and the lowest percentage (3%) had a higher diploma. The remaining percentage is (32%) a master's and (8%) a Ph.D.

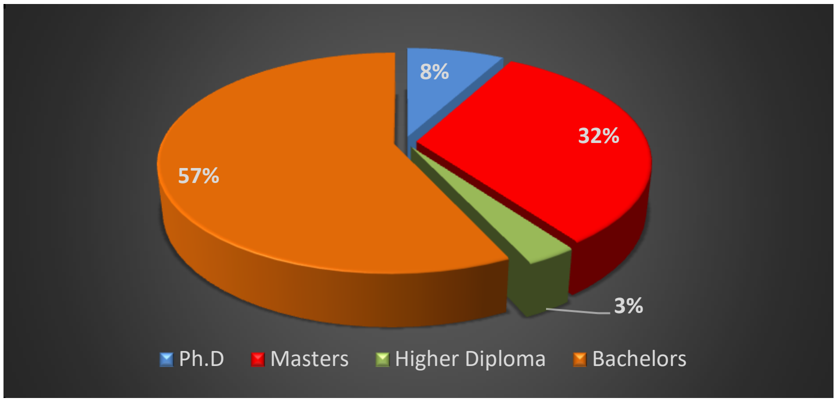

Figure 2. Percentage of the academic certificate of the respondents

Figure (3) shows the percentage of respondents ' work sector. The highest percentage of respondents (67%) work in the public sector. The lowest percentage (33%) of workers is in the private sector.

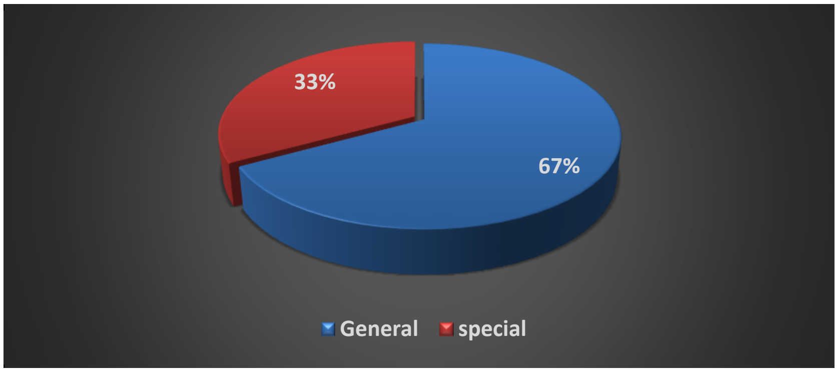

Figure 3. Percentage of respondents ' work sector

Figure (4) shows the percentage of the general specialization of the respondents, as it turns out that the highest percentage of respondents (57%) is in the civil engineering specialty, while the lowest percentage (3%) is in the mechanical engineering specialty. The remaining percentage is (32%) in the field of architecture and (8%) in the field of Water Resources Engineering.

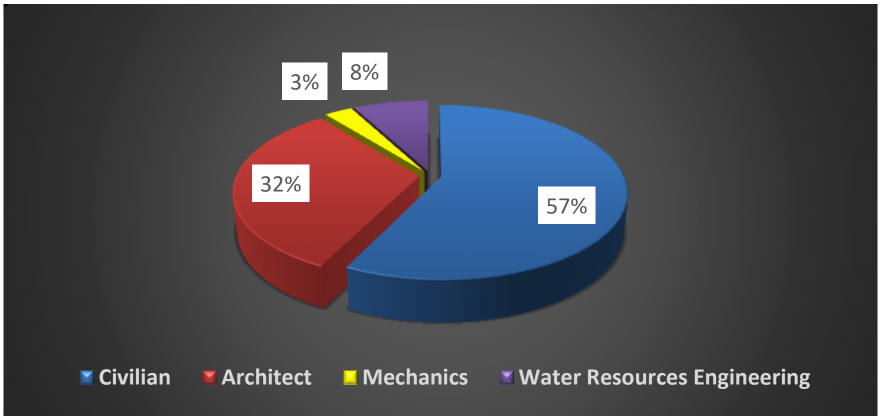

Figure 4. shows the percentage of general specialization of the respondents

Figure (5) shows the percentage of the nature of the respondents ' work. It was found that the highest percentage of respondents (88%) are project managers and the lowest percentage (1%) Working in the business of estimation. The remaining percentage is (2%) Planning and follow-up, (4%) site engineers and (5%) supervision works.

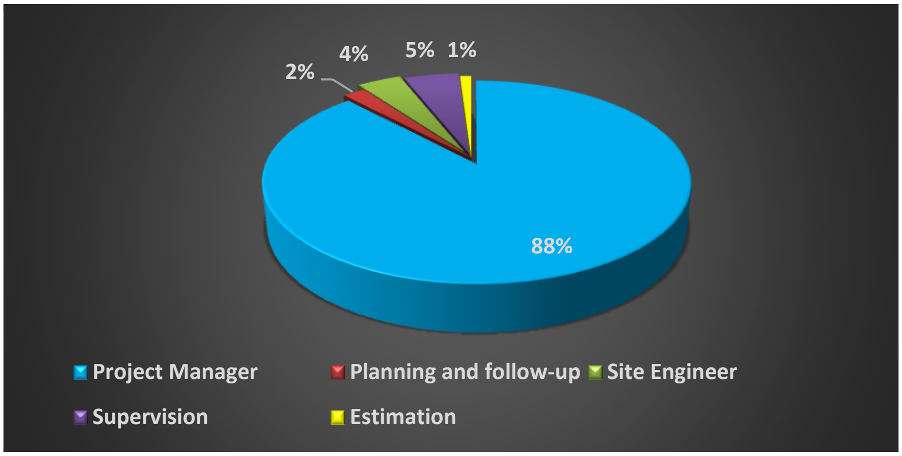

Figure 5. shows the percentage of the nature of the respondents ' work

Figure (6) shows the percentage of years of professional experience of respondents. It turned out that the highest percentage (58%) ranges the number of years of their experience from (5) to (10) years, and the lowest percentage (9%) ranges the number of years of their experience from (16) to (20) years. The remaining percentage represents (19%) the number of years of their experience ranges from (11) to (15) years, and (14%) their experience is more than (21) years.

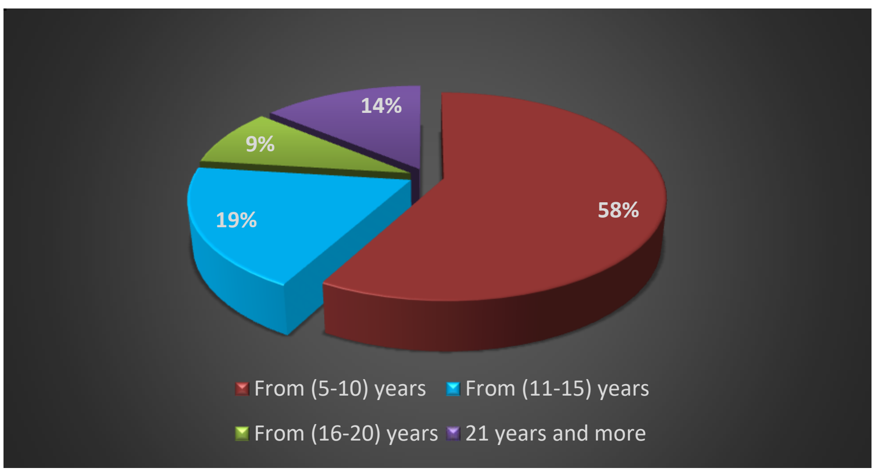

Figure 6. shows the percentage of the number of years of professional experience of the respondents.

Figure (7) shows the percentage of the address (name) of the Department for which the respondents work. It turned out that the highest percentage (16.5%) of the survey participants is a private contracting company, the lowest rate (1%) is the Office of Endowments, (1%) the Water circuit, and (1%)the United Nations Organization (UN). The remaining percentage represents (6.8%) Diwan of Salah al-Din governorate, (7.8%)engineering office, (1.9%) Ministry of Water Resources, (15.5%) Ministry of Education (Directorate of Education), (7.8%) Ministry of Electricity, (7.8%) engineering department at the University, (11.7%) works and maintenance department, (4.9%) Directorate of sewerage, (2.9%) Ministry of Higher Education, (3.9%) Municipal Directorate and(1.9%) Directorate of Agriculture, (3.9%) the Department of Health, (1.9%) the Directorate of roads and bridges and(1.9) the Ministry of defense.

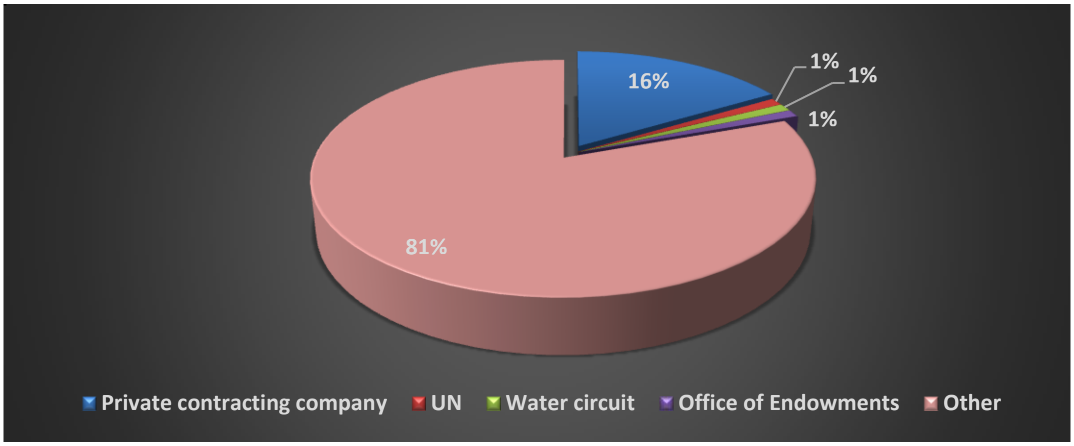

Figure 7. Percentage of the address (name) of the Department

Figure (8) shows the percentage of respondents by place of work (governorate name).The highest percentage (27.2%)of the respondents came from Baghdad governorate, followed by (26.2%)from Salah al-Din governorate, the lowest percentage (1%)from Thi Qar governorate, (1%) AL-Sulaimaniyah governorate, (1%)Misan governorate and(1%)AL-Muthanna governorate, while the remaining percentage represented (8.7%) AL-Mosul governorate, (6.8%) Diyala Governorate, (2.9%) Kirkuk governorate, (2.9%) AL-Basrah governorate and(6.8%) Karbala governorate (1.9%) Babil governorate, (6.8%) AL-Anbar Governorate, (2.9%) Wasit governorate and(2.9%) AL-Najaf governorate.

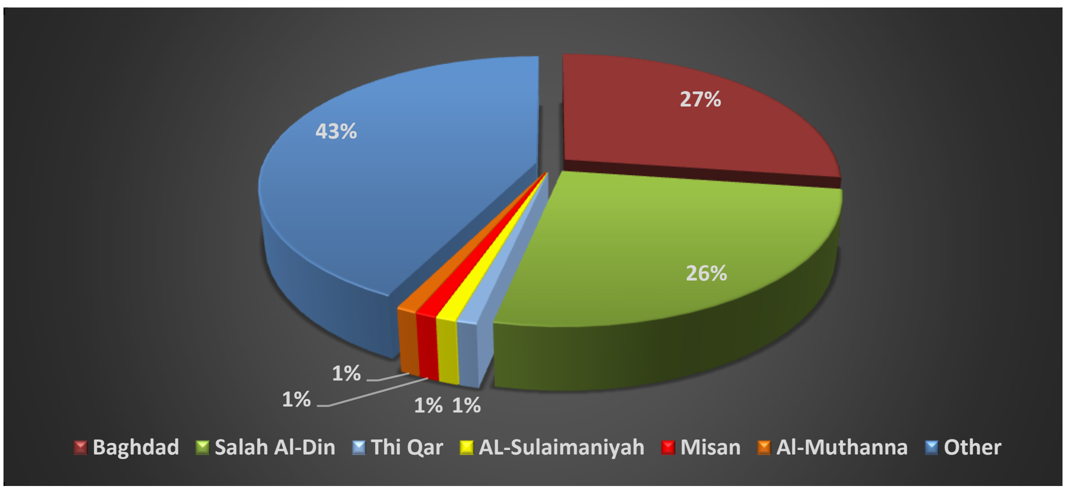

Figure 8. Percentage of respondents ' place (governorate name)

3.3.2 Analysis of Questionnaire Data

The data were analyzed using SPSS-V-26 software, and the weighted mean and standard deviation were obtained using the software. Applying the equation of the relative importance index number 1, the relative importance index of the three-dimensional indicators was obtained. The level of importance was determined based on the obtained relative importance index and in accordance with Table 5. Based on the relative importance index and the standard deviation obtained, the rank of each indicator was determined under the three headings, namely, environmental, social, and economic.

3.4 Relative Importance Index (RII)

The relative importance index is an important tool for determining priorities and ranking the level of importance of indicators. It is useful as a standard for questionnaires that use the five-point Likert scale. the value of the relative importance index ranges from 0 to 1. The relative importance index can be calculated using Equation No. (1), and depending on the values of the relative importance index, the level of importance can be determined according to Table No. (5) [20]**.** This method is one of the most commonly used and has a highly accurate value when rating variables using a questionnaire [21]. Therefore, the calculation of the relative importance index is very important in this study to determine the relative importance of sustainability indicators in both the environmental and socio-economic dimensions.

$$\text{Relative Important Index (RII)} = \frac{\sum W}{A \times N} \quad (1)$$

Where:
RII: Relative Important Index
W: (Weightage is given to each indicator.) The respondents gave the weight of each indicator in numbers 1, 2, 3, 4, and 5, respectively.
A: is the highest weight (i.e., 5 in this study)
N: the total number of respondents

Table 5. Importance Level of (RII)

(RII) Values	Importance Level	
$0.8 \leq RII \leq 1$	High	(H)
$0.6 \leq RII \leq 0.8$	High-medium	(H-M)
$0.4 \leq RII \leq 0.6$	Medium	(M)
$0.2 \leq RII \leq 0.4$	Medium-Low	(M-L)
$0 \leq RII \leq 0.2$	Low	(L)

3.5 Pareto Principle (20/80) %

It is a statistical method in decision-making processes and is used to select a specific number of tasks that result in a general effect of some importance. It is the idea that by doing 20% of the work, we can get 80% of the benefit of doing the whole work .Named for an Italian economist and sociologist, the Pareto principle is an intriguing pattern that goes like this: "20% of effort produces 80% of the result, and the remaining 80% of effort produces only 20% of the result." According to legend, Vilfredo Federico Damaso Pareto discovered that only one-fifth of the pods produced the majority of the peas in his garden in 1897 when he was enjoying looking at the pea plantings. The fact that 80% of the ripe pea pods are produced by 20% of the most viable plants startled him, and he wrote it down in his research notebooks. Captivated, Pareto chose to search for examples of the 80/20 principle in other spheres of life and discovered that it is applicable in nearly every situation. The unequal distribution of causes and effects found in nature is reflected in the Pareto principle[22].

4. Results and Discussion

The results of this research are divided into two parts: (1) Calculation of the index of the relative importance of key performance indicators for the sustainability of public buildings and (2) Applying Pareto Principle (20/80) % to Indicators, as follows:

4.1 Calculation of the relative importance index (RII)

The index of the relative importance of the indicators of the three environmental, social, and economic dimensions was calculated. Based on the relative importance index, the level of importance was found for each indicator to indicate the relative importance of all indicators. Based on the obtained relative importance index as well as based on the standard deviation, the rank of each indicator was determined as shown in the Tables 6, 7, and 8.

Table 6. The relative importance Index (RII) of environmental dimension indicators

1-Energy efficiency category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Reducing the amount of non-renewable primary energy used during operation.	4.0971	3.68759	0.81942	1	(H)
Renewable energy production and Renewable energy sources use	3.7087	1.11699	0.74174	3	(H-M)
Use Energy-efficient heating and cooling	3.4854	1.28996	0.69708	8	(H-M)
Energy conservation—lowering the amount of power used and conserving energy through the efficiency of natural gas	3.8252	1.07034	0.76504	2	(H-M)
Utilizing emission-free power generators and refrigerant management systems to preserve the ozone layer are two examples of outer space energy conservation.	3.5243	1.13625	0.70486	6	(H-M)
Energy-efficient equipment (Use of LED lighting and sensors for daytime lighting)	3.4757	1.32728	0.69514	9	(H-M)
By utilizing intelligent monitoring technology (both intelligent systems that track the energy consumed for each demand and intelligent systems that track the energy spent in the user's area).	3.5825	1.15914	0.7165	4	(H-M)
Maximize solar building orientation	3.3301	1.24765	0.66602	10	(H-M)
Local energy production	3.5146	1.26696	0.70292	7	(H-M)
Generating clean and renewable energy	3.5340	1.16160	0.7068	5	(H-M)

2-Water management category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Hot water consumption	3.4078	1.44464	0.68156	6	(H-M)
Rainwater harvesting (Collect rainwater and reduce drinking water consumption)	3.5534	0.88260	0.71068	3	(H-M)
Recycled greywater (gray water and reused it for irrigation)	3.2913	1.34041	0.65826	8	(H-M)
Minimizing water resource consumption	2.9806	1.27557	0.59612	11	(M)
Use of mechanisms to reduce water consumption (Application of innovative water-efficient equipment)	3.3883	1.21456	0.67766	7	(H-M)
Water-saving systems in the building	3.5146	1.33478	0.70292	4	(H-M)
Reuse non-potable water	3.6311	1.20449	0.72622	2	(H-M)
Reduce water consumption in the building and Drinkable water consumption	3.0485	1.34586	0.6097	10	(H-M)
Treatment of contaminated effluents (Recycling and recovery of effluents)	3.4854	1.18705	0.69708	5	(H-M)
Leak detection (Building water conservation)	3.1262	1.35531	0.62524	9	(H-M)

Water-efficient landscaping (Use of native vegetation in green areas to reduce water consumption)	3.7573	1.17545	0.75146	1	(H-M)

3-Green Building Materials category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Use Local/regional building materials	3.6505	1.13508	0.7301	3	(H-M)
Use of recycled materials	3.9612	.99924	0.79224	1	(H-M)
Use of sustainable materials (The use of environmentally friendly materials)	3.2427	1.27161	0.64854	9	(H-M)
Employment of substances characterized by a reduced concentration of volatile organic compounds (Employment of coatings, floor coverings, furnishings, and sanitation products devoid of volatile organic constituents within the structure)	3.5049	1.30515	0.70098	7	(H-M)
Use of certified materials	3.5437	1.27400	0.70874	6	(H-M)
Use of cement substitutes in concrete	3.7961	1.10577	0.75922	2	(H-M)
Coating materials (Use wall coating materials in as of color and chemical composition)	3.1553	1.31922	0.63106	11	(H-M)
Resource Consumption (Reducing the use of raw materials)	3.6214	1.12124	0.72428	5	(H-M)
Reduce the use of new construction materials	3.4175	1.20069	0.6835	8	(H-M)
Use of reflective materials for heat	3.0485	1.10594	0.6097	12	(H-M)
Employ the existing architectural framework of the edifice, including the fenestration and portals, in the construction of the new establishment.	3.6311	1.26018	0.72622	4	(H-M)
Flooring (use of easy-to-clean, maintenance, recyclable, and low-emission organic matter)	3.1748	1.24008	0.63496	10	(H-M)

4-Indoor environment quality category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Indoor acoustic comfort (Noise pollution, Acoustics Control, Noise protection, and maximizing acoustic comfort)	3.4175	1.24084	0.6835	17	(H-M)
Indoor air quality (Creating a healthy and non-toxic environment through minimizing pollution emissions such as SO_2, NO_x, PM, CO, and CO_2)	3.7087	1.11699	0.74174	9	(H-M)
Safety and security (Secure Surroundings)	3.8641	1.06687	0.77282	4	(H-M)
Ensure quality in creating the built environment	3.9029	1.00503	0.78058	1	(H-M)
Convenience and Wellbeing spaces (Space layout)	3.7476	1.09113	0.74952	6	(H-M)
Thermal comfort (Use the site potential to promote thermal comfort)	3.7184	1.07025	0.74368	8	(H-M)
Indoor Ventilation Efficiency and Efficiency of natural ventilation in interior spaces and public places	3.6505	1.13508	0.7301	11	(H-M)

ISSN: **Printed: 3078-9656, E: 3078-9664**, paper ID: 41

Greenhouse gas emissions	3.7379	1.12860	0.74758	7	(H-M)
Use of indoor plants, indoor skylights	3.4951	1.13650	0.69902	15	(H-M)
Minimum VOC (Use of materials with a low content of VOCS) and (Use of low-carbon and renewable sources)	3.7087	1.16847	0.74174	10	(H-M)
Use of high-reflectance, low-emissivity roofing	3.4660	1.25100	0.6932	16	(H-M)

Table 7. The relative importance Index (RII) of social dimension indicators

1-Occupant Health and Wellbeing Category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Occupation rate (day/year) and (hour/year)	3.2524	1.35559	0.65048	14	(H-M)
Ensure there is inter-generational equity	3.8544	1.01371	0.77088	1	(H-M)
Ensure equitable distribution of social costs and benefits of construction	3.5049	1.13650	0.70098	13	(H-M)
Ensure fair treatment and respect of stakeholders	3.6602	1.24107	0.73204	9	(H-M)
Developing human resources (Improve the quality of human life, which includes poverty alleviation)	3.7476	1.16920	0.74952	5	(H-M)
Operational Services Management	3.7087	1.19337	0.74174	8	(H-M)
Job creation (Promote employment creation)	3.6505	1.16070	0.7301	10	(H-M)
Impact on workers' health (promoting and protecting health through a healthy and safe working environment)	3.7573	1.20835	0.75146	3	(H-M)
Evidence-based design that integrates architecture, landscape, and health planning (Innovation of the project design)	3.7573	1.23245	0.75146	4	(H-M)
Availability of green spaces with easy access for users	3.7184	1.13256	0.74368	7	(H-M)
Maximize access to living areas, gym	3.7961	1.16618	0.75922	2	(H-M)
Dedicated space (work, rest, change)	3.6117	1.15668	0.72234	12	(H-M)
Furniture quality	3.6505	1.20219	0.7301	11	(H-M)
Transportation management	3.7282	1.12192	0.74564	6	(H-M)

2-Awareness and education for sustainable innovation Category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Use social activities	3.6602	1.26455	0.73204	2	(H-M)
Culture and heritage (Ensure local culture and heritage are conserved, and Impact on cultural and historical heritage)	3.7087	1.19337	0.74174	1	(H-M)
Uplifting communities	3.4757	1.21142	0.69514	5	(H-M)

Education of occupants (Educating the building occupants about the concepts of sustainability)	3.6117	1.13960	0.72234	3	(H-M)
Innovation in the design of the project	3.6117	1.27751	0.72234	4	(H-M)

Table 8. The relative importance Index (RII) of economic dimension indicators

1-life cycle cost category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Operational energy expenses (Reduce operating costs related to energy consumption)	3.8058	1.06696	0.76116	1	(H-M)
Operational water expenses	3.7476	1.14377	0.74952	2	(H-M)
Ensure there is support for local economic/business diversity (Hiring local goods and services)	3.5534	1.07309	0.71068	7	(H-M)
Ensure to acquire financial benefits/profits	3.5922	1.14135	0.71844	5	(H-M)
The application of real cost pricing and full cost accounting to determine tariffs and prices for products and services that accurately account for social and biophysical costs	3.4804	1.13216	0.69608	9	(H-M)
Affordability (Ensure financial affordability for beneficiaries by minimizing the overemphasis on technical sustainability)	3.6311	1.12886	0.72622	3	(H-M)
Long-term cost management (Initial investment cost)	3.5534	1.12658	0.71068	8	(H-M)
Operation and maintenance costs	3.6117	1.09574	0.72234	4	(H-M)
Increase the life of the building	3.5825	1.06204	0.7165	6	(H-M)

4.2 Applying the Pareto Principle (20/80) % to Indicators

After determining the order of each indicator and finding the level of relative importance of indicators based on the relative importance index to indicate the most relatively important indicators, the number of indicators reached 43 indicators within the environmental dimension, 19 indicators within the social dimension, and 9 indicators within the economic dimension. The number of indicators for each dimension has been reduced by applying the Pareto Principle, which states that 20% of indicators have an 80% impact on sustainability compared to the rest of the indicators. The Pareto principle was applied to each category of the environmental dimension separately, and it turned out that 20% is equivalent to only 8 indicators within the environmental dimension distributed over 4 categories, which represent the relatively most important indicators within the environmental dimension, as shown in Table 9. The Pareto principle was also applied to each category of the social dimension separately, as it turned out that 20% is equivalent to only 4 indicators within the social dimension distributed over two categories, where these indicators represent the relatively most important within the social dimension, as shown in Table 10. The Pareto principle was also applied to each category of the economic dimension separately, as it turned out that 20% is equivalent to only 2 indicators within the economic dimension distributed within one category, and these indicators represent the most relatively important within the economic dimension, as shown in Table 11 **.**

The overall values of the relative importance index were found to be between 0.71 and 0.82, which shows moderate to high agreement among the participants on the importance of these indicators. It turned out that the highest indicator of relative importance reached 0.81942 for the indicator of reducing the consumption of primary non-renewable energy at the operational stage within the energy efficiency category, and that the focus in Iraq seems to be on the environmental side first, then the social side, and then the economic side**.**

The results showed that environmental indicators, especially those related to energy efficiency and the use of recycled materials, were the top priorities of the participants, reflecting a clear awareness of the importance of rationalizing the consumption of Natural Resources. The social dimension also highlighted the importance of promoting justice between generations and achieving health and well-being within the building environment, while the most prominent economic indicators were the reduction of operating expenses.Based on these results, it can be said that enhancing the sustainability of public buildings in Iraq requires adopting a holistic approach that integrates technical, social and economic solutions with a focus on raising awareness and developing supporting legislation and policies.The application of the achieved indicators will contribute to improving the efficiency of resource use, reducing environmental impact and enhancing the quality of life of users in line with the Sustainable Development Goals .

Table 9. The eight most important indicators within the environmental dimension, according to the Pareto Principle (20%)

1-Energy efficiency category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Reducing the amount of non-renewable primary energy used during operation.	4.0971	3.68759	0.81942	1	(H)
Energy conservation—lowering the amount of power used and conserving energy through the efficiency of natural gas	3.8252	1.07034	0.76504	2	(H-M)
2-Water management category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Water-efficient landscaping (Use of native vegetation in green areas to reduce water consumption)	3.7573	1.17545	0.75146	1	(H-M)
Reuse non-potable water	3.6311	1.20449	0.72622	2	(H-M)
3-Green Building Materials category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Use of recycled materials	3.9612	0.99924	0.79224	1	(H-M)
Use of cement substitutes in concrete	3.7961	1.10577	0.75922	2	(H-M)
4-Indoor environment quality category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Ensure quality in creating the built environment	3.9029	1.00503	0.78058	1	(H-M)
Lighting control	3.8835	1.17407	0.7767	2	(H-M)

Table 10. The four most important indicators within the social dimension, according to the Pareto Principle (20%)

1-Occupant Health and Wellbeing Category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Ensure there is inter-generational equity	3.8544	1.01371	0.77088	1	(H-M)
Maximize access to living areas, gym	3.7961	1.16618	0.75922	2	(H-M)

Impact on workers' health (promoting and protecting health through a healthy and safe working environment)	3.7573	1.20835	0.75146	3	(H-M)

2-Awareness and education for sustainable innovation Category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Culture and heritage (Ensure local culture and heritage are conserved, and Impact on cultural and historical heritage)	3.7087	1.19337	0.74174	1	(H-M)

Table 11. The two most important indicators within the economic dimension, according to the Pareto Principle (20%)

1-life cycle cost category	**Weighted average**	**Standard deviation**	**RII**	**Rank**	**Level of importance**
Operational energy expenses (Reduce operating costs related to energy consumption)	3.8058	1.06696	0.76116	1	(H-M)
Operational water expenses	3.7476	1.14377	0.74952	2	(H-M)

Recommendations

A set of recommendations has been developed for each of the indicators of the environmental dimension, the social dimension, and the economic dimension as follows :

First: the environmental dimension

1. Adoption of renewable energy systems, such as solar energy, in public buildings to reduce dependence on non-renewable primary energy.
2. Improving the efficiency of natural gas use through modern and environmentally friendly technologies.
3. The use of local plants in the design of green spaces to reduce water consumption.
4. Construction of gray water treatment systems and their use in irrigation and cleaning works.
5. Encourage the use of recycled materials in construction and maintenance.
6. Partially replace cement with alternative materials such as fly ash and industrial slag to reduce the carbon footprint.
7. Improve the quality of the indoor environment through good ventilation and the use of non-toxic building materials.
8. Using intelligent lighting control technologies to rationalize electricity consumption

Second: the social dimension

1. Embedding the principles of intergenerational justice in urban policies and practices.
2. Providing recreational and health facilities inside public buildings, such as sports clubs and open areas.
3. Strengthening Occupational Safety and health standards within the work environment inside buildings.
4. Preserving the local cultural identity by incorporating architectural and heritage elements into the design

Third: the economic dimension

1. Reduce operating expenses through the use of highly efficient energy and water systems.
2. Providing economic incentives for projects that are committed to sustainability, such as tax exemptions or partial financial support when using green materials or energy-saving technologies.
3. Implement smart periodic maintenance programs to reduce sudden breakdowns and associated costs

Conclusions

1- As the population continues to grow, there is increasing pressure on existing resources, threatening their availability for future generations. It is the duty of every individual to conserve these resources, ensuring they are used wisely. Sustainability involves utilizing resources in a way that does not jeopardize the ability of future generations to meet their own needs. This concept encompasses three key dimensions: environmental, social, and economic sustainability, which are the primary focus of this study.

2-There is a huge number of indicators, their numbers and types vary according to the region and their suitability for the indicators. These indicators are best determined by experts who live in this region

3-The number of indicators of the environmental and social dimension is many and less in the economic dimension, this is due to many reasons, including that the indicators of sustainable development are initially environmental indicators, as for the indicators of the social dimension, they are many because they specialize in development plans and development related to sustainability, as for the indicators of the economic dimension, it is difficult to access relevant information, and perhaps another reason lies in the difficulty of separation from the economy of each city belonging to the state due to the centrality of that state to the cities and this is found in Iraqi cities.

4-It is possible to choose the categories of indicators in a traditional way by analyzing the content of the components of the indicator framework in previous studies and research.

5-Indicators are developed and established continuously, without being fixed; they require evaluation and feedback, rely on measuring results, and are continuously disseminated in addition to procedures for improvement.

6-Under the three dimensions of sustainability, 71 key performance indicators were identified, and distributed among a range of categories from previous studies, and these indicators were ranked according to the relative importance of each indicator through a questionnaire survey and interviews with engineers of various engineering specialties and experts in sustainable public buildings.

7-The Pareto Principle (20/80)% was applied to the collected indicators to reduce the number of indicators and select the most relatively important indicators, and 14 key performance indicators for the sustainability of public buildings were obtained within the three dimensions of sustainability.

ACKNOWLEDGEMENTS
First and foremost, I would like to express my gratitude and thankfulness to **ALLAH** for giving me the opportunity and strength to complete my research. I would like to extend my sincere thanks and appreciation to the official bodies that contributed to supporting this research by providing data and information, especially the Department of Public Works and maintenance, the Department of school buildings, the Department of sanitation, and the Department of water in Salah al-Din governorate. I would also like to express my sincere thanks and gratitude to Dr. Maysoon Abdullah Mansour for her scientific efforts, continuous guidance, and valuable observations that played a key role in producing this work in the required Scientific form.

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ISSN: **Printed: 3078-9656, E: 3078-9664**, paper ID: 41

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