Sustainability Assessment System for Highrise Buildings in Iraq

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Keywords: Sustainability, Highrise buildings, Iraq, Rating system

Abstract. This study aims to prepare a standards code for sustainability requirements to contribute in a better understanding to the concept of sustainability assessment systems in the dimensions of Iraqi projects in general and in the high-rise building. Iraq is one of the developing countries that faced significant challenges in sustainability aspects environmental, economic, and social, it became necessary to develop an effective sustainability building assessment system in respect of the local context in Iraq. This study presented a proposal for a system of assessing the sustainability requirements of Iraqi high rise buildings (ISHTAR), which has been developed through several integrated steps, begin with investigates the well-known sustainability systems, experts consensus based on the Delphi technique involving 32 experts consider as sustainability world leading and local highly-informed to identify applicable assessment categories and factors for the Iraqi context and its weighting system, then analyze the results using the pairwise comparison and Analytic Hierarchy Process (AHP) technique.

Introduction

In the past two decades, it was increasing awareness of the importance of sustainable within the construction industry, it plays a major role in the use of natural resources and in the development of the quality of the natural environment. Thus, construction and civil engineering can contribute significantly to the sustainable development of our society [1]. This theme plays important roles in achieving quality, reliability and durability. The impact of the large construction industry on the sustainable actions of our society, evident in the vast amounts of resources consumed and the long-term impact on our environment [2]. These impacts were the motivation for the establishment of sustainable building standards, special certificates and classification methods and buildings sustainability assessment systems aimed at mitigating the impact of buildings on the natural environment, improving their performance through sustainable design [3].

Environmental assessment methods aim to create greener and sustainable buildings, creates economic opportunities and helps the surrounding socially and environmentally. The world's leading rating systems are such as BREEAM, LEED, CASBEE, etc. which provided various tools of assessment that can be used according to the conditions of the environmental and social construction area [2]. However, these well-established methods have not originally been designed to suit developing countries (including Iraq). Although Iraq has made efforts to observe the application of the principles of sustainability in the construction industry through legal legislation and the development of regulatory bodies and international partnerships. Recent years have seen an increase in high rise construction projects in the Iraqi construction industry market, providing economic opportunities and solutions to housing problems, but with serious sustainability challenges.

Traditionally, Highrise buildings requires a large number of resources, huge quantity of building materials, large amounts of energy and produce a large amount of waste when they are demolished in the end of their life cycle, therefore they are not considered as environmental buildings[3], current concerns and awareness of problems about rising energy costs, use of materials, limits on availability drinking water and waste disposal are affect the designers to combine more sustainable elements into
high rise development, such as the correct location right mix between human design and green as possible[4] [5].

**Methodology**

The Methodology in this research is multi-dimensional involves quantitative and qualitative approaches. These approaches included structured and integrated stages as below

1) An extensive literature review as previous studies, scientific papers, books, journals, theses, conference documents.

2) Field approach: Included open questionnaire stage and closed questionnaire it been done by conducted structured and unstructured personal interviews with some professional and authorities in constructors’ sector in Iraq which have an extensive experience in sustainability buildings and investigate the opinion of selected sample at different engineering professions and different academic levels.

3) Analysis the results: Using the statistical means to analysis the results of responds with representations the results in charts.

4) Developing a practicable model. After obtaining the experts consensus in results of the survey, a rating system model (ISH TAR) had been established as the most rating system applicable to the local range of the Iraqi construction industry

5) Prepare a list of recommendations to be submitted to the relevant authorities and institutions

**Preparation of the Survey.** The survey is an efficient and effective way to collect data and opinions, is widely used in various research studies and disciplines, this technique is appropriate in this research because it has enabled the inclusion of a wide range of sustainability relevant issues and factors. It was developed as a final result of iterative process to finalise the key sustainability category and factors in sustainability performance for Iraqi highrise buildings. The goal was to check and validate the selection and importance of each factor. Professional experts were involving certifying and assess the factors suitability and reliability and prove the process to achieve the objectives set in practice to achieve the objectives set.

**Weighting Coefficient System.** Developing weighting system of sustainability aspects, categories and factors is considered a crucial process for developing any assessment framework, it comes after establishing the systems compounds and levels. weighting system is the essence of any method of evaluating the building. The weighting coefficient system can identify the importance of each elements regarding the local context. Each valuation factor is weighted so that all weights are within the valuation category. Each factor scores are multiplied by the weighting coefficient and aggregated into summation.

AHP method is used to determine the weightings of items according to participant’s interviews results. Expert Choice®2.10.0 Software used to establish square matrix structure to determine the relative importance (relative weight) of each category. Each element (category or factor) was compared with its level derived different values according to their importance in sustainability highrise building assessment tool in respect to Iraq local context. Finally, participants granted each item assessment and achieved the experts consensus by Delphi technique, then factor of each category were weighted in respect to their importance to that category based on total (1) full point.

**Sustainability Categories**

According to the sustainability aspects, the sustainability categories classified in 11 major categories as shown in Table 1, this had been made by experts consensus as achievement after four rounds of Delphi technique. The Delphi survey included a consensus on the factors that included in each category and their numbers shown in the Table 1. Super decision program used to find the final relative weights and the categories ranking as shown in Fig. 1, the matrix mode as shown in Table 2. Based on inconsistency value (which was 0.03567), we can argue that the results calculations reliable
provisions. The reliability of judgments also tested by the outcome calculations conducted in SPSS program, it shows that the Reliability (Alpha) Value was 0.677 which is accepted. The experts consensus on final categories listed below with the weight and descending ranked as shown in Figure (2) and these essential categories ranked based on their contribution in overall assessment of the sustainability in the highrise building. This should be a clear image for all stakeholder and professionals in the sustainability with Iraqi context.

Table 1. Sustainability categories criteria.

| No | Categories                  | No. of Factors | Cronbach's Alpha | Std. Deviation | Z calculated |
|----|-----------------------------|----------------|------------------|----------------|--------------|
| 1  | Site and Location           | 21             | .909             | 0.772          | 20.06981     |
| 2  | Energy efficiency           | 7              | .802             | 0.834          | 18.57176     |
| 3  | Water efficiency            | 12             | .868             | 1.342          | 11.54701     |
| 4  | IEQ                         | 17             | .906             | 0.799          | 19.3938      |
| 5  | Management                  | 22             | .943             | 1.401          | 11.05862     |
| 6  | Waste Management            | 9              | .911             | 1.263          | 12.26343     |
| 7  | Pollution                   | 16             | .922             | 1.025          | 15.11858     |
| 8  | Materials                   | 10             | .869             | 1.100          | 14.08635     |
| 9  | Economic Aspects            | 10             | .888             | 1.389          | 12.54796     |
| 10 | Socials Aspects             | 8              | .895             | 1.223          | 12.66924     |
| 11 | Innovation and regional contribution | 7 | .811 | 0.915 | 16.92228 |

Figure 1. Main Category respect to the goal.

Figure 2. The main Sustainability categories criteria.
Factors of Sustainability Categories

**Water Efficiency.** Through the pairwise comparison results analysis, the Water Efficiency category shows a highest weight equal to 15.4%, which is consistent with current concerns about water scarcity in the Middle East region, especially neighboring countries. Increasing the concerns of specialists is the quality of water and the strategic policy to manage it both locally and internationally. This category embraces 12 factors. By using Likert scale the participants in the general survey asked to assessment the importance of each factors to the category. The External water use had the heighst importance and the rates for all factors in this category was between (4.02) which is very importance for (External water use) and (3.46) which is moderate importance for (Planters and vertical landscaping) resp. The weights and ranking this category factors shown in Fig. 3.

**Energy Efficiency.** Came in second in participant concern with contribution equal to 13.9% , this category contents of 7 factors are closely related to energy consumption in highrise buildings, the participants assess their importance from 4.16 which it very important for (Indoor and outdoor lighting) to 3.57 for (Deterioration of disinformation) which means moderately important on Likert scale as shown in Fig. 4. Due to Iraqi fluctuated weather, the (Heating and cooling system) factor has a high concern of the stakeholder in term of its installation and efficiency in operation and energy consumption the factor was in second highest importance in this category with rate value of (4.02). This category embraces a unique factor which is the vertical transport, its related to this type of facilities, the integration of elevators and escalators in the high rise buildings causes increases the initial cost and energy consumption to make this facility smoothly operate where it contributes to a considerable percentage of energy consumption (3-9%) of total energy use [6]. This factors importance had been assessed by the respondents in the survey in value equal to (3.73), moderate important.

**Waste Management.** Experts agreed that one of the most important obstacles facing the implementation of sustainability projects in Iraq is waste management. This difficulty lies on the scarcity of waste separation and recycling facilities and lack of availability of landfills conforming to standard specification, this category took almost weight 11.2 %. The importance for its factors was between 4.56 very important to (Waste and rubble collection and transfer) factor and 3.05 moderately important to (Construction waste materials reuse) factor. Figure (5) illustrates the importance for the Waste management category.

**Pollution.** It’s clear from Figure (6) that the most important factor in this category is the(Air conditioning system) that coming from the participants serious concern to this factor effect in the operating of the highrise building, the important rate for this factor was (4.56) very important.
according to participants records in Likert scale , the lowest important rate was (2.79) gave to (Drying space) factors.

| NO. | Factor                                           | Mean  | Credit |
|-----|--------------------------------------------------|-------|--------|
| 1   | Reduce landscaping water use                     | 3.94  | 2      |
| 2   | Gray water recycling                             | 3.85  | 2      |
| 3   | External water use                               | 4.02  | 2      |
| 4   | Water meters                                     | 3.79  | 2      |
| 5   | Leak detection system                            | 3.9   | 2      |
| 6   | Surface water runoff                             | 3.96  | 2      |
| 7   | Surface water runoff                             | 3.69  | 2      |
| 8   | Surface and ground water contamination during construction | 3.71  | 2      |
| 9   | Planters and vertical landscaping                | 3.46  | 1      |
| 10  | Landscaping compatibility and integration with surroundings | 3.52  | 2      |
| 11  | Equipment for water conservation                 | 3.83  | 2      |
| 12  | Water system                                     | 3.79  | 2      |
| TOTAL |                                                | 23    |        |

* Credits allocation will explain in section (5-2)

Figure 3. Water Efficiency factors criteria.

| NO. | Factor                                           | Mean  | Credit |
|-----|--------------------------------------------------|-------|--------|
| 1   | General building energy performance              | 3.96  | 2      |
| 2   | Heating and cooling system                       | 4.09  | 2      |
| 3   | Indoor and outdoor lighting (Make daylight calculation) | 3.95  | 2      |
| 4   | Hot water system                                 | 3.65  | 2      |
| 5   | Renewable energy technology                      | 4.16  | 2      |
| 6   | Vertical transportations                          | 3.73  | 2      |
| 7   | Deterioration of disinformation                  | 3.57  | 2      |
| TOTAL |                                                | 14    |        |

Figure 4. Energy Efficiency criteria.

| NO. | Factor                                           | Mean  | Credit |
|-----|--------------------------------------------------|-------|--------|
| 1   | Building waste management plan                    | 3.96  | 2      |
| 2   | Waste and rubble collection and transfer          | 4.56  | 3      |
| 3   | Construction waste management plan                | 3.91  | 2      |
| 4   | Construction waste materials reuse                | 3.05  | 1      |
| 5   | Construction waste disposal                       | 3.82  | 2      |
| 6   | Solid waste treatment                             | 3.75  | 2      |
| 7   | Waste separation equipment                        | 3.73  | 2      |
| 8   | Recycling collection and storage locations        | 3.77  | 2      |
| 9   | Recycling Facilities                              | 3.73  | 2      |
| TOTAL |                                                | 18    |        |

Figure 5. Waste Management criteria.
Indoor Environmental Quality: Although this category contains important factors, but the results of the pairwise comparison was surprising in terms of ranking with only (9.5) importance value, Delphi panel experts attributed that to the Iraqi conditions imposed the importance of other factors affected in the assessment of sustainability. This category contains 18 factors are concerned with wellbeing and living healthy inside the highrise building. The (quality of drinking water) factor was in the most important with rate 4.65 and lowest important rate was 2.95 for (Textile/ Envelope/Thermal construction) factor as shown in Fig. 7.

| No. | Factor                                      | Mean  | Credit |
|-----|---------------------------------------------|-------|--------|
| 1   | Renewable technologies                      | 3.83  | 2      |
| 2   | CO2 Emissions                               | 3.96  | 2      |
| 3   | Light pollution reduction                   | 3.93  | 2      |
| 4   | Global warming potential                    | 3.83  | 2      |
| 5   | Nitrogen Oxide (NOX) emission               | 3.65  | 2      |
| 6   | Natural ventilation                         | 3.94  | 2      |
| 7   | Air conditioning system                     | 4.53  | 3      |
| 8   | Prevent cooling leakage                     | 3.76  | 2      |
| 9   | MVHR-mechanical ventilation and heat recovery system | 3.70 | 2 |
| 10  | Building fabric/ envelope/ thermal comfort   | 3.70  | 2      |
| 11  | Environmental impact of materials           | 3.81  | 2      |
| 12  | Fire hazard                                 | 3.98  | 2      |
| 13  | Risks resulting from disasters such as flooding | 3.80 | 2 |
| 14  | Protection from storms                      | 3.60  | 2      |
| 15  | Heat island effect                          | 3.69  | 2      |
| 16  | Drying space                                | 2.79  | 1      |
|     | TOTAL                                       | 32    |        |

Figure 6. Pollution criteria.

| No. | Factor                                      | Mean  | Credit |
|-----|---------------------------------------------|-------|--------|
| 1   | Sound and noise control                     | 3.67  | 2      |
| 2   | The surrounding view                        | 3.70  | 2      |
| 3   | Control and measurement of lighting         | 3.64  | 2      |
| 4   | Control and measurement of glow             | 3.46  | 2      |
| 5   | Take advantage of daylight                  | 4.07  | 2      |
| 6   | Natural ventilation                         | 3.86  | 2      |
| 7   | Mechanical ventilation                      | 3.45  | 1      |
| 8   | Indoor air quality sensors - CO2 ratio control | 3.77 | 2 |
| 9   | Organic volatile compounds                  | 3.67  | 2      |
| 10  | Microplastic contamination                  | 3.93  | 2      |
| 11  | Indoor chemical and radiology pollutant detector | 3.88 | 2 |
| 12  | Ventilation of the building -dust prevention | 4.09 | 2 |
| 13  | Heat control systems                        | 3.79  | 2      |
| 14  | Temperature control systems                 | 3.93  | 2      |
| 15  | Quality of drinking water                   | 4.65  | 3      |
| 16  | Plantations and internal reforestation      | 3.64  | 2      |
| 17  | Textile/ Envelope/ Thermal construction      | 2.95  | 1      |
|     | TOTAL                                       | 33    |        |

Figure 7. Indoor Environmental quality.
Management. This category comprises 21 factors, Fig. 8. In pairwise comparison, the Management came sixth in sequence of importance in the process of assessing sustainability in highrise buildings with 8.8 weight value. Safety and infrastructure efficiency factors were in the top priority in this category with importance 4.66 for both, then Security factor in evaluation importance value 4.54, the (Supply chain management) was in the bottom of priority with 3.59. It is clear that these results are affected by the local circumstances surrounding the Iraq construction market.

Site and Location. The Delphi panel give site and location category value of importance equal to 8.4%, is included 21 factors their importance ranging from 4.13 for (Pollution prevention) to 3.32 for (Improve site aesthetics) in the bottom of the grading list (Figure 9).

This category embraces one unique factor (Rezoning the property) added by the experts with to respect to Iraqi condition in construction industry and its important was assessed as (3.38). This reflects the experts growing concern of from the phenomenon of investing agricultural land in residential and commercial projects, which negatively affects sustainability in general the Iraqi environment.

Materials. category included some important factors. The material choosing has a key role in all sustainability aspects in high rise building, the participants rated the importance for this category factors form 4.54 (very important) for (low environmental impact) to 3.14 (Material designed to deal with future climate changes). Delphi panel has been mentioned that the use of produced local material should have positive impact on the sustainability performance for the high rise building regarding the local context, this factor came in second priority with important value equal to (3.53). Figure (10) illustrates its criteria.

Economic Aspects. The results of this questionnaire were identical to the context of global sustainability assessment systems and the same problem with this category, which despite its importance but neglected or came in low stages in the sequence of importance as its share 7.9% in the assessment of general sustainability. Figure 11 shows the rates of the importance for this category factors was between very important (4.53) for the (Cost of life cycle) and the lowest rate was (3.16) (mordantly important) for the (Building adaptive capacity) Factor.

Social Aspects. The social life in Iraq has an impact on sustainability projects and higher construction more clearly so the experts agree not to remove any of the factors of these eight category factors and be subject to evaluation as mandatory requirements. The importance evaluation was between 4.14 very important for (Providing employment opportunities for local workers) and 3.28 mordantly important for (Community facilities) as shown in Fig. 12.

Innovetation And Regional Contribution: This category, after discussion and deliberation among the experts, was obtained by consensus as an advocacy tool for the sustainability application and is calculated as additional points above the general assessment. This category includes seven factors that encourage innovation in all three aspects of sustainability and (Site orientation) was the highest rated by 3.93 and (Area of planting) factor Lowest rated by 2.91, as illustrated in Fig. 13.
Figure 8. Management criteria.

| No. | Factor                                      | Mean | Credit |
|-----|--------------------------------------------|------|--------|
| 1   | Safety                                     | 4.66 | 3      |
| 2   | Security                                   | 4.54 | 3      |
| 3   | Arrangements for disabled people           | 3.80 | 2      |
| 4   | Construction management plan or scheme     | 3.80 | 2      |
| 5   | Supply chain Management                    | 3.62 | 2      |
| 6   | Sound insulation                           | 3.70 | 2      |
| 7   | Lighting control (Un-occupied area)        | 3.78 | 2      |
| 8   | Heat control                               | 3.63 | 2      |
| 9   | Energy labelled white goods                | 3.59 | 2      |
| 10  | Orientation and passive solar gains        | 3.69 | 2      |
| 11  | Daylighting                                | 3.67 | 2      |
| 12  | Extent of communication                    | 3.74 | 2      |
| 13  | Pedestrian facilities                      | 3.67 | 2      |
| 14  | Contracting and procurement methods        | 3.69 | 2      |
| 15  | The extent to which stakeholders focus on the project | 3.65 | 2 |
| 16  | Equipment management                       | 3.70 | 2      |
| 17  | Integration of services                    | 3.87 | 2      |
| 18  | Function and ease of use                   | 3.70 | 2      |
| 19  | Flexibility and the possibility of air conditioning with the changes | 3.71 | 2 |
| 20  | Durability and reliability                 | 3.78 | 2      |
| 21  | Maintenance and good implementation        | 3.84 | 2      |
| 22  | Infrastructure efficiency                  | 4.66 | 3      |
| TOTAL |                                           |      |        |

Figure 9. Site and Location criteria.

| No. | Factors                                      | Mean | Credit |
|-----|----------------------------------------------|------|--------|
| 1   | Urban redelopment                            | 3.91 | 2      |
| 2   | Pollution prevention                         | 4.13 | 2      |
| 3   | Mitigation of environmental impact           | 4.04 | 2      |
| 4   | protection of biodiversity and Ecological features | 3.83 | 2  |
| 5   | Ecological value of site                     | 3.65 | 2      |
| 6   | Ecological enhancement                       | 3.60 | 2      |
| 7   | Shading and Afforestation                    | 3.85 | 2      |
| 8   | Redelopvement of brown land                  | 3.53 | 2      |
| 9   | Easy access to the site                      | 3.76 | 2      |
| 10  | Density in development area                  | 3.57 | 2      |
| 11  | Community communication                      | 3.52 | 2      |
| 12  | Car parking areas                            | 3.33 | 1      |
| 13  | Transportation alternatives                  | 3.61 | 2      |
| 14  | Impact on ecosystems and water ways          | 3.55 | 2      |
| 15  | improve site aesthetics                      | 3.32 | 1      |
| 16  | Promote corrosion reduction                  | 3.37 | 1      |
| 17  | community consultation                       | 3.37 | 1      |
| 18  | Weather hazards                              | 3.42 | 1      |
| 19  | Improve positive effects                     | 4.08 | 2      |
| 20  | Building footprint                           | 3.60 | 2      |
| 21  | Rezoning of property                         | 3.38 | 1      |
| TOTAL |                                           |      |        |
| NO. | Factor                                           | Mean | Credit |
|-----|-------------------------------------------------|------|--------|
| 1   | Local production                                | 3.53 | 3      |
| 2   | The materials are recyclable                    | 3.68 | 2      |
| 3   | Reuse of building structure                     | 3.70 | 2      |
| 4   | Material efficiency within the life cycle (LCA)  | 3.75 | 2      |
| 5   | Material designed to deal with future climate changes | 3.14 | 2      |
| 6   | Reliable sources of materials                   | 3.79 | 2      |
| 7   | Materials with a high thermal mass              | 3.28 | 2      |
| 8   | Low environmental impact                        | 4.54 | 2      |
| 9   | Quality finishing materials                     | 3.81 | 2      |
| 10  | Components of insulation materials               | 3.64 | 1      |
|     | **TOTAL**                                       | **20** |        |

Figure 10. Materials criteria.

| NO. | Factor                                           | Mean | Credit |
|-----|-------------------------------------------------|------|--------|
| 1   | The cost of construction                        | 3.93 | 2      |
| 2   | Cost of life cycle                              | 4.53 | 3      |
| 3   | Cost of operation maintenance                   | 3.86 | 2      |
| 4   | Levels rent offers                              | 3.38 | 1      |
| 5   | Using the total cost of the stages of the life cycle of the building | 3.48 | 1      |
| 6   | Identify the lowest operating cost in the level of rent | 3.54 | 2      |
| 7   | Economic activities of the local population      | 3.46 | 1      |
| 8   | Building adaptive capacity                      | 3.16 | 1      |
| 9   | Carbon credits/ Carbon reduction commitment     | 3.63 | 2      |
| 10  | Commissions                                     | 3.29 | 1      |
|     | **TOTAL**                                       | **16** |        |

Figure 11. Economic Aspects criteria.

| NO. | Factor                                           | Mean | Credit |
|-----|-------------------------------------------------|------|--------|
| 1   | Knowledge of the historical and cultural community | 4.05 | 2      |
| 2   | Providing employment opportunities for local workers | 4.14 | 2      |
| 3   | Social equity and contributing to the fight against poverty | 3.42 | 1      |
| 4   | The influence of hobbies and habits on the community building | 3.44 | 1      |
| 5   | The personal behavior of the building occupants and its beneficiaries | 3.33 | 1      |
| 6   | Recognize and encourage the use of the building and the site as an educational resource to establish environmental awareness | 3.42 | 1      |
| 7   | Community facilities                            | 3.28 | 1      |
| 8   | Areas of community privacy                      | 3.33 | 1      |
|     | **TOTAL**                                       | **10** |        |

Figure 12. Social Aspects criteria.
Developing (ISHTAR Model) Sustainability Assessment for Iraqi Highrise Building

Based on the previous findings that included the assessment categories, assessment factors, and their weighting coefficient, a basic framework had been proposed for the coherent and comprehensive system of the sustainability assessment in Iraqi highrise buildings, and have been developed and establish its criteria by the informed consensus of international and local experts. It suggest to be called (ISHTAR), inspired on the gate of Ishtar, the eternal symbol of Babylonian civilization, which built the oldest sustainability buildings that known to man.

By systematic consultation with informed experts in reviewing the results, the framework of the assessment system composed of (11) categories, ten of them are mandatory they are (Water Efficiency, Energy Efficiency, facility Management, Site and Location, Materials, Pollution, Waste Management, Indoor environmental Quality, Economic Aspects and Social Aspects) and one encouraging category which is (Innovation and regional contribution),these categories embraces different numbers of factors their total is (139) factors. The expert’s consensuses that the suggested green building assessment framework is comprehensive, efficient and most appropriate for Iraqi local context. They agree on that all the items (categories and Factors) are crucial and should be adopted in the sustainability assessment processes in the highrise buildings.

Practical ingredients for ISHTAR. ISHTAR system had been developed by a methodology process included a set of sustainability elements (categories and factors) derived from literature and further complemented by piloting the practical application through questionnaire, Delphi panel judgements and a case study, to optimise items weightings and subsequent ranking. Different statistical tools were used to finalise the eleven categories and 139 factors of ISHTAR system which including social, economic and environmental parameters

1) 1. This framework been developed based on scientific research and technical knowledge.
2) 2. Local and international Experts, world well-known rating systems agency actors, elected official’s decision makers, designers, and stakeholder with different roles others participated in the development as key participants in the process of this method.
3) 3. The sustainability strategies and objectives were defined and addressed as a key objective.
4) 4. The rating system must design to fit the country’s local context, depending on its culture, issues, actors, practices and institutions, this should not prevent from that countries can learn from each other’s in investing the experts work and ideas as inputs in the system developing process.
5) 5. ISHTAR as a rating system not only allow for the assessment of the buildings sustainability, but also it could be used as a decision-making tool in identification the most suitable development alternative to achieve high rate of sustainability as well as the improving of building operation and efficiency.
6) 6. The main approaches for assessment the sustainability building performance in ISHTAR was the Total Quality Assessment (TQA) systems, which evaluate environmental (ecological), economic and social aspects, same means in well-known Sustainability rating systems such as

| NO | Factor                                    | Mean | Credit |
|----|-------------------------------------------|------|--------|
| 1  | Site orientation (Innovative design)      | 3.93 | 2      |
| 2  | Internal space management                 | 3.26 | 1      |
| 3  | Area of planting                          | 2.91 | 1      |
| 4  | Regional or local material                | 3.46 | 1      |
| 5  | Recycled content                          | 3.75 | 2      |
| 6  | The team members professional sustainability on the project | 3.71 | 2      |
| 7  | school or university as an educational tool | 3.79 | 2      |
|    | TOTAL                                     | 11   |        |
LEED and BREEAM

Credits Allocation. Credits in the ISHTAR system will allocate based on the Likert scale Rate assessment obtained for each factor and reached by consensus of the Delphi panel on the relative importance of the factor, the ISHTAR credits will present ways of distinguishing between these factors. Figure 14 as an example, illustrates the (Economic Aspects) credits allocation. In order to distinguish these factors, therefore, a three-tiered credit allocation was proposed A factor that exceeds 50% of the scale range or 2.5/5 is applicable to highrise buildings in Iraq. In other words, criteria rated more than 2.5/5 can grant one credit; more than 3.5/5 classification criteria can be granted two credits; classification criteria over 4.5/5 can be awarded three credit. Then the total available credit in this category will be equal to 1*3+4*2+5*1=16 credits. This method is promoting the increasing compliance with higher requirements According to the weighting system derived from AHP, the ISHTAR scores, which reflect the rate or the sustainability level in the Iraqi Highrise building, can be achieved by means of the following procedure:

1) Determine the number of available credits for each category,
2) Assess the number of reached credits for each factor of the category
3) Calculate each category score by equation (1), ISHTAR has 10 categories: that’s mean 10 different rating scores will be calculated
4) Adding any innovation points that may have been achieved.

![Credit allocation for Economic Aspects factors.](image)

The calculation is as follows: the overall rating score will provide by the summation of these 11 rating scores (Eq. (2))

$$CS = \frac{cr}{ca} * W * 100$$  \hspace{1cm} (1)

Where:
- CS: Category Sustainability Scores
- Cr: Credits Reached
- Ca: Available Credits
- W: Weighting Coefficient

$$SBR = \sum_{n=1}^{11} CS_n$$  \hspace{1cm} (2)

Where:
- SBR: Building Sustainability Rate
- n: The category numbers included the Innovation category

ISHTAR Rating Benchmarks. ISHTAR Followed (BREEAM and LEED) in the environmental assessment method where the result of sustainability building assessment process is converted into a single ranking expression. The assessment score in BREEAM and LEED, have been calculated out of 100 percent and then converted into a single rating expression. The Delphi panel in this search had
reached consensus to use of a percentage-based classification scale as illustrated in Figure (18) divided in five levels of certification as follow

ISHTAR classification starts from 40 as base line, it’s the level of meeting the basic criteria, therefore any building rated below 40 will be considered "UNCLASSIFIED”;

Level 1: Buildings rated $40 \leq 50$ will considered "PASS and grant “BLUE ISHTAR”
Level 2: Buildings rated $51 \leq 60$ will grant “GREEN ISHTAR”
Level 3: Buildings rated $61 \leq 70$ will grant “BRONZE ISHTAR”
Level 4: Buildings rated $71 \leq 80$ will grant “SILVER ISHTAR”
Level 5: Buildings rated $81 \leq 100$ will grant “GOLD ISHTAR”

Conclusions

The main conclusions of this study can be drawn as follows:

- The largest concerning in most assessment systems was to energy conservation, but in ISHTAR, the largest weight was for both water efficiency (15.4%) and energy efficiency (13.9%) among all the performance categories. It demonstrates the Iraq crucial circumstances of water and energy conservation, due to its mostly semi-dry climate.
- The proposed rating system comprised some vital categories and factors were not considered in several assessment systems such as “Economics” and the “Waste Management”. Furthermore, some extra factors were eliminated or merged together in the proposed assessment framework of Iraq
- As a result of the research findings it was observable there is awareness lack about the importance of applying the sustainability approach in Iraqi construction.
- Adopting sustainability practice in highrise buildings well provide extra work opportunities for local community and reduce the unemployment such as the process of waste management and materials recycle.

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