Civil and Architectural Engineering

Developing an Indoor Environment Assessment Tool for Residential Buildings

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ABSTRACT

The Indoor Environmental Quality (IEQ) describes an indoor space condition that the wellbeing and comfortability are provided for the users. Many researchers have highlighted the importance of adopting IEQ criteria, although they are not yet well defined in the Kurdistan region. However, environmental quality is not necessary for the contemporary buildings of the Kurdistan Region, and there is no measurement tool in the Region. This research aims to develop an IEQ assessment tool for the Kurdistan region using Mixed method methodology, both qualitative and quantitative. Therefore, a Delphi Technique was used as a method initially developed as systematic, interactive forecasting on a panel of experts. Thirty-five Delphi Candidates have reached an agreement on selecting the criteria for the IEQ, as Spss and a particular equation has used to find criteria weights. As a result, seven criteria with 22 indicators have been selected by expert ratings. A computer-based tool (KIEQA) has been created based on the scores selected by experts. Research results show that good IEQ is essential for interior design. It also offers a suitable indoor environment for users. This research has many significant advantages since it can raise awareness of issues of indoor environmental quality for architects, experts, and policymakers. Furthermore, to draw up an action plan for existing and new interior design projects in the Kurdistan Region. Future researches may concentrate on the correlation between IEQ criteria and to develop this tool regarding different building typologies.

Keywords_:_ Indoor Environment Quality, Indoor Environment Assessment, Human Comfort, Delphi Technique, Sustainable Interior Design

تطوير أداة تقييم البيئة الداخلية للمباني السكنية في إقليم كوردستان

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الخلاصة

تعبر جودة البيئة الداخلية (IEQ) عن كفاءة أداء البيئة الداخلية بما يتعلق بصحة ورفاهية المستخدمين. وقد ابرز العديد من الباحثين اهمية اعتماد معايير (IEQ) مع انها لحد الان ليست محدد بمما فيه الكفاية، ومع ذلك، فان الجودة البيئية لاتعد ضرورية

في مباني اقليم كردستان ، واصلا لا توجد معايير معتمدة لهذا الغرض. يهدف هذا البحث الى تطوير اداة تقييم جودة البيئة الداخلية (IEQ) في إقليم كردستان باستخدام منهجية مركبة لتغطي الجانب الكمي والنوعي . لذا تم الاعتماد على طريقة مختلطة كمنهجية تم تطويرها لاستخلاص التوقعات استناد الى هيئة من 35 خبيرا وبما يمكن من وضع معايير جودة البيئة الداخلية باوزانها. وبموجب ذلك تم اختيار سبعة معايير ذات (22) مؤشرا، بعد انشاء اداة حاسوبية تستند على تصنيفات الخبراء والدرجات التي تم وضعها من قبلهم، لتمثل تقييم جودة البيئة الداخلية في اقليم كردستان (KIEQA) .اظهر نتائج البحث بأن (IEQ) امرا حيويا في التصميم الداخلي؛ كما يوفر للمستخدمين بيئة داخلية مرغوبة. يحتوي هذا البحث على العديد من المزايا الهامة لأنه يمكن أن يزيد من الوعي بقضايا جودة البيئة الداخلية للمهندسين المعماريين والخبراء وصناع السياسات. ووضع خطة عمل لمشاريع التصميم الداخلي الحالية والجديدة في إقليم كردستان. قد تركز الأبحاث المستقبلية على العلاقة بين مؤشرات IEQ ولتطوير هذه الأداة فيما يتعلق بأنماط البناء المختلفة.

الكلمات الرئيسية: جودة البيئة الداخلية, تقييم البيئة الداخلية, راحة الإنسان، تقنية دلفي ، التصميم الداخلي المستدام.

1. INTRODUCTION

1.1 Sustainability and Built Environment:

For many decades, the subject of sustainability has become core attention for researchers, scientists, and governmental organizations as well. The main idea of this mystery is described as an advancement that provides the current demands without creating a risk of prohibition thing the next generation from these demands (**Moore, et al., 2017**). Nowadays, this term has been studied and applied in the construction of buildings and built Environment (**Balaras, et al., 2020**). Many researchers stated that existing buildings are consuming more than 40% of total worldwide energy (**Cao, et al., 2016**). The maximum number of energy consumption and carbon emissions are caused by buildings and their occupants (**Kolokotsa and Santamouris, 2015**). The central role of a built environment is conducted with comfort and a desired healthy atmosphere for people because human beings are spending ninety percent of their lives indoors. (**Arif, et al., 2016**). Sustainable design is a collective process whereby the built environment achieves unprecedented levels of ecological balance through new and retrofit construction, with the goal of long-term viability and humanization of architecture. Focusing on the environmental context sustainable design merges the natural, minimum resource conditioning solutions of the built environment and interior design, especially with the innovative technologies of the present.

1.2 Indoor environmental quality (IEQ):

The definition of Indoor Environmental Quality (IEQ) can be stated as the quality of indoor space with regarding occupant's condition and comfort (**Li, et al., 2019**). Besides, expanding consideration is paid to the (IEQ) planned for structuring an agreeable indoor condition with a spotlight on clients' prosperity (**Esfandiari, et al., 2017**). As knowledge of the significance of IEQ in the home environment is growing, detailed studies have been conducted to systematically assess and analyze the IEQ of buildings (**Geng, et al., 2020**). However, the conceptual properties of the IEQ have been cited as a barrier to the creation of a holistic structure and, to date, experiments have been carried out by researchers or test subjects on a stand-alone basis, considering health-related environmental factors, IEQ has been seen as an integral part of the overall construction efficiency (**Geng, et al., 2020**). IEQ has a big impact on human comfort and enhances health conditions since it is focused on reducing the environmental footprint, the resources consumed, and the waste produced in indoor environments.

The idea of IEQ thus has a comprehensive scope, and there are many variables linked to the relation to indoor environmental quality and comfortability of the dwellers (e.g., Thermal comfort; Indoor air comfort, lighting comfort, Acoustics (**Tang, et al., 2020**). It has been conducted by many researchers that have an impact on the buildings in comfort, the health of human beings (**Mujan, et al., 2019**). Many IEQ schemes have been proposed regarding the significance of

wellbeing and human comfort. Several codes have been developed by the formal institutes and organizations like (ISO) American society Organization, (WBDG) Whole Building Design Guide, (ASHRAE) American Organization of heating and air-conditioning Engineers, and (REHVA) Federation of European Heating and Air conditioning. The goal of these tools is to meet the human need for comfort inside the built environment. Moreover, IEQ is unpredictable to characterize because it pertains to changing controls.

1.3 Assessment tools for Indoor Environment Quality

Many tools have been proposed worldwide, like; (LEED) (CASBEE) (ESTIDAMA) require tests on multiple indoor environmental quality attributes (IEQs), each of which carries credit points that add to the final score **(Zarghami and Fatourehchi, 2020).** Although certain buildings can ultimately reach the prescribed criteria, the inhabitants too sometimes complain about various parameters. Daylighting and thermal warmth lead to increased IEQ and positively impact an occupant **(Paul and Taylor, 2008)**.

More research on this subject needs to be carried out, particularly about buildings in Kurdistan, so that standards can be changed for the good of the inhabitants. Such buildings require a good IEQ as it impacts the efficiency and safety of the inhabitants of the house. It is, therefore, important that sustainable interior design results not just in the reduction of resources but also in the increase of the productivity and wellbeing of the occupant.

This paper is trying to find criteria for IEQ then to develop a measurement tool, especially for the Kurdistan region. The Absence of IEQ criteria created a serious problem situation that few designers are following the guidelines because the inspection after construction is weak and the guidelines itself need to be updated

1.4 Research Problem statement :

Although Indoor Environment quality is increasingly getting attention, yet there is no unified assessment tool for it. Many Sustainability assessment methods and IEQ methods have been proposed worldwide. However, much debate exists about the efficiency of sustainability assessment in other countries or regions, regarding the difference in, geographical, cultural, and local context, the criteria of IEQ in Kurdistan region is not well defined. Most of the designers and constructors are not following any policies regarding IEQ from the municipality in Kurdistan region-Iraq. Existing residential buildings are suffering from problems in IEQ conditions such as high-level humidity-based problems, property damage and damage to the building's structure, thermal discomfort lack of natural lighting, and natural ventilation. Furthermore, a gap in knowledge to defines IEQ criteria for the Kurdistan region in interior design, well established, IEQ criteria urgently needed.

Aims of the Research:

- To define appropriate indoor environment quality situations in the Kurdistan region.
- To create new weights for IEQ criteria according to the Kurdistan region
- To develop an IEQ assessment tool regarding the Kurdistan region context
- To increase awareness about sustainability application in interior design
- To create a new actionable framework that supports local authorities to set new applicable rules for interior design construction and implementation.

2. THEORETICAL BACKGROUND:
2.1 Sustainability Assessment Tools in General :
Sustainable societies care about all their property, economic, human, social, and built environment to better life continuously. **(Kamas, et al., 2019)** Throughout the years, the green building movement grows progressively in the global built environment industry, the variety of green certification emerges due to a range of green initiatives areas tailored to suit each country **(Halla and Binder, 2020)**. A variety of green rating tools appears in different countries to accommodate the difference in geographical importance, climate, and people without compromising the standards of green buildings **(Bernardi, et al., 2017)**. Since the 1990s, many sustainability assessment tools and IEQ measurement tools have been proposed that linearly evaluate the built environment with one accumulation of the results **(Rodriguez, et al., 2020).**

Some examples of these tools that have been proposed on a national and international scale: (ESTIDAMA in the UAE, LEED in the USA, NABERS in Australia, HQE France, Ecoprofile Norway. Moreover, they did not depend mostly on the holistic criteria for building the schemes, and much debate exists about the applicability of these tools in other countries **(Abdul-Rahman, et al., 2015)**. Furthermore **(Lee and Burnett, 2006), (Alyami and Rezgui, 2012), (Chang, Chiang, et al., 2007) (Cole, 2005), (Chang, et al., 2007)** confirmed the inapplicability of using international sustainability assessment tools in a different place than its origin. Although many sustainability assessment tools have been proposed worldwide, yet their efficiency in assessing sustainability in other countries is not proved. The use of environmental standards is initially designed for a specific region and promoting their application across different regions of the world that lead to uncured re-emergence. That sustainability assessment tool and IEQ criteria should be customized and prioritized to match geographical circumstances. Various related studies have been carried out to modify the criteria for building inspection, to suit local conditions and, in turn, to tackle regional barriers to acceptance.

2.2 Indoor Environmental Quality Assessment (IEQA)

The term by **(Guida, Pagliuca, et al., 2008, Larsen, Rohde, et al., 2020)** indicates the confined environment of life that provides a suitable and comfortable living condition for the occupants.

The designers and researchers have been focused on the quality of the built environment recently, and they suggest following regulations and standards related to temperature, humidity, space arrangement, lighting, acoustic, and ventilation **(Godish, 2016)**

Every IEQ has its own way of category assessment **(Alyami and Rezgui, 2012)**. The main distinction between assessment methods and weighting schemes s that the first one collecting all the scores, whether it has been weighted or not at the final Assessment **(Sev, 2011)**. Previous studies concentrated on the evaluation of the building environment at running time in recognition with specific criteria **(Alborz and Berardi, 2015)**. Shi and Ta established a framework called (CPD) that consists of measuring the quality of indoor air, acoustics, and thermal comfort based on the database computation proposed by **(Fanger, 1988).** The evaluation of the tool is divided into five parts (uncomfortable, slightly uncomfortable, comfortable, comfortable, and very comfortable).

Various measurement schemes have been proposed due to having multi factors affect IEQ**. (Van Den Wymelenberg and Inanici, 2016)** established a regional IEQ adoption model. The regression constants were calculated by the occupant assessments and the degree of agreement on the subjective reaction of the occupants for each parameter. Bureau IEQ may be divided into three groups of performance ranking, (good, average, and bad) for the development of the comfort index model, experimentally recorded the data for a year of indoor temperature, humidity, and light. **(Dakwale and Ralegaonkar, 2015)**

(Lai, et al., 2009) developed a model to evaluate The indoor environmental quality (IEQ) in residential buildings is examined from the prospect of an occupant's acceptance in four aspects: thermal comfort, indoor air quality, noise level, and illumination level. Based on the evaluations by 125 occupants living in 32 typical residential apartments in Hong Kong, he proposed empirical expressions to approximate the overall IEQ acceptance concerning four contributors, namely operative temperature, carbon dioxide concentration, equivalent noise level, and illumination level, via a multivariate logistic regression model. A range of IEQ acceptances for regular residential conditions is determined, and the dependence of the predicted overall IEQ acceptance on the variations of the contributors is discussed. The proposed overall IEQ acceptance can be used as a quantitative assessment criterion for similar residential environments where an occupant's evaluation is expected. Besides that, the weaknesses of this study are that he used questionnaires and interviews as the main methodology and depended on the rating of occupants only, which makes the results less reliable.

(Chiang and Lai, 2002) presents a series of detailed indoor-environment assessments designed to provide residents with a safe and secure indoor-environmental atmosphere. Such criteria were established through a literature review, focused on functionality, economy, and feasibility. Factors involved in the categories of acoustics, vibrations, illumination, thermal comfort, indoor air quality, water quality, greens, and electromagnetic fields were considered. The goal is to perform key criteria by specialist consulting to assess existing buildings quantitatively. The AHP (Analytic Hierarchy Process) approach has been used to measure the measures within the same group. In order to remove the null questionnaire, the consistent ratio has also been determined. Finally, an overall index (IEI) of filtered metrics to assess the healthy environment in the built buildings is provided. Besides that, the number and background of experts involved in the study were unknown, and the Delphi process of generating the criteria and their weights is not so clear.

(Malmqvist and Glaumann, 2007) selected aspects and criteria in environmental assessment methods for residential and commercial buildings in Sweden. They developed a Swedish environmental rating method for residential and commercial. They tested several selection approaches. Also, they judged aspects that fell out as significant when basing the selection of severity of problems and official objectives to be more prioritized. The selected criteria were Indoor air quality Noise and acoustics Thermal climate Daylight conditions Illumination.
Furthermore, indoor air quality and noise and acoustics have been selected to be the most significant aspects. The research further argues that criteria for monitoring aspects/problems be tested concerning at least validity, cost, and other criteria since such a testing procedure facilitates a discussion with different criteria. This feature is important in methods that give weighted ratings. Besides, the selection of the criteria was not reliable as there was no consultation with experts, and the weighting system has not been generated.

(Laskari, et al., 2017) presented the methodology for the estimation of an indoor residential efficiency measure. The "Environmental Quality Index for Housing" was created to benefit both households and administrators. Based on three basic and widely calculated composite impacts indoor environmental parameters – air temperature, relative humidity, and CO_2 concentrations index represents, in a single value, the consistency of the indoor environmental conditions for the duration under study. Furthermore, the use of the Dwelling Environmental Quality Index in single dwellings and building blocks is illustrated. The usefulness of the index as a coordination and management resource for specific households and property managers is also shown. Besides that, the number of criteria and criteria was very limited (Three criteria), and the study depended on objective methodology only that may face difficulty in the interpretation of the index by non-scientists or increased cost from a large number of measured parameters.

(Devitofrancesco, et al., 2019) proposed an appraisal instrument dependent on the SB Method and the Malty-Benchmarks Assessment for the evaluation of IEQ. Every indicator of IEQ is dissected through target pointers and figuring techniques. The apparatus gives two fundamental results: a worldwide score communicating the general execution of the structure from the IEQ point of view; quantitative assessments of all indoor solace segments through checking and estimation of the ecological factors. The above adds to choose mediation territories to streamline indoor structure and to recognize advancements planned for guaranteeing the best IEQ levels for clients at the operational stage the selected criteria were (Indoor Air Quality, Thermal comfort, Visual comfort, Acoustic Quality, Electromagnetic Pollution). Observing exercises and estimations are completed to recognize the indoor and open-air factors influencing the IEQ.

A review of previous academic studies shows that various criteria and systems of sustainability and efficiency of the indoor atmosphere are being used to determine the sustainability of residential projects in different parts of the world, as shown in **Table 1**. Metrics and their meaning are heavily reliant on the use's environmental, social, and economic contexts. As reported, Thus, most authors aim to establish national frameworks for determining Indoor environment quality **(Ning, Li et al., 2017)**. Scholars still differ with both the scale and scope of the criteria to be calculated. The calculation and appraisal methodology, as well as the complexity of their overall characteristics; thereby, there is a shortage of an effectively organized system to support groups engaged in the implementation of sustainability is missing **(Higham, et al., 2016).**

Table 1. The summary of the studies mentioned in the theoretical background.

References	Title	Criteria	Indicators	Methodology
(Laskari, Karatasou et al., 2017)	A methodology for the determination of indoor environmental quality in residential buildings through the monitoring of fundamental environmental parameters: A proposed Dwelling Environmental Quality Index.	Thermal comfort, heating/ cooling need Occupant health, building disorder air quality, ventilation	Air temperature, Relative Humidity, CO_2 concentrations	Objective measurement
(Malmqvist and Glaumann, 2007)	Selecting aspects and indicators in environmental assessment methods for buildings	Indoor air quality Noise and acoustics Thermal climate Daylight conditions Illumination		objective measurement
(Devitofran cesco, Belussi et al., 2019)	Development of an Indoor Environmental Quality Assessment Tool for the Rating of Offices in Real Working Conditions	Indoor Air Quality, Thermal comfort, Visual comfort, Acoustic Quality, Electromagnetic Pollution	Air quality with Air temperature and air humidity mechanical with mechanical heating Air velocity, Visual Comfort Daylighting, and Illuminance, Noise from air-conditioning, Power frequency fields Radiofrequency and Microwave electromagnetic fields	SB method and Multi Criteria Analysis
(Chiang and Lai, 2002)	The study on the comprehensive indicators of indoor environment assessment in Taiwan	Acoustics, illumination, thermal comfort, Indoor air quality, water quality, greens, vibration, electromagnetic field	Acoustics, illuminance, , glare, of lights, indoor temperature, Humidity, air velocity, Carbon dioxide Radon, VOC, water quality, Greenery	Mixed method methodology with AHP
(Lai, Mui et al., 2009)	An evaluation model for indoor environmental quality (IEQ) acceptance in residential buildings	thermal comfort, indoor air quality, noise level and illumination	IEQ, thermal comfort, PMV index thermal sensation vote CO_2 concentration horizontal illumination level sound pressure level	Questioner survey and interviews

2.1 Indoor Environment Quality situation in Kurdistan Region:

The contemporary residential dwellings in the Kurdistan region did not contemplate climate consideration properly, especially in the construction stage because of the weakness in the inspection that caused the consumption of more than fifty percent of overall consumed energy **(Morad and Ismail, 2017).** Therefore, thermal comfort is missing in most of the residential projects inside the Kurdistan region **(Morad and Ismail, 2017)**. The component of IEQ in the Kurdistan region has been done studied individually by researchers, **(Zebari and Ibrahim, 2016)** stated that the heating and cooling comfort is a massive problem in Kurdistan region housing units. Moreover, as it was stated by **(Shokri, et al., 2018),** the hot and dry climate conditions in Erbil city have a primary effect on the energy consumption and thermal performance of the house. In the last decade, the residential sector in the Kurdistan Region government has consumed about 50% of total energy consumption **(Shokri, et al., 2018).** The environmental quality of present dwellings does not contemplate to be essential; therefore, there was difficulty in achieving thermal comfort conditions, and reducing usage of electrical or mechanical devices like air- conditioning. The main reason for failing to achieve thermal comfort is the lack of insulation within buildings. During winter times buildings become very cold is (lower degrees are between 2-7°, and higher degrees are between 7°-13° and very warm during summer times 39°-43° up to 50° Celsius **(KRG, 2020).** Due to the many layers of building envelopes, most residential buildings in developed

countries are well insulated. However, the residential buildings in Kurdistan Region use any sort of insulation. (**Zebari and Ibrahim, 2016**). While A variation of 21-29% of power consumption can be observed between buildings that follow the sustainability principles versus those who are neglecting it (**Salih, 2018**).   Unfortunately, the criteria of IEQ in the Kurdistan region are not defined yet. There are many efforts to be spent by the local government and the academic society no policy to be taken against this to manage this lousy situation and enhance the thermal performance of residential buildings in Kurdistan region.

3.   METHODOLOGY:

In this research, the mixed-method methodology has been used because it is hybrid. It employs hybrid approaches that blend quantitative and qualitative techniques, collecting data, and evaluating procedures. The techniques became widely accepted in the last decade and are structured to explore different study issues using multiple approaches (**Creswell and Zhang, 2009**). This methodology is reasonable because building evaluation subjects are viewed as multidimensional and require an Agreement Based Methodology. The method is an associative methodology that consists of several stages and ratings and steps that provide adequate results (**Chew and Das, 2008**). Moreover, participants of the Delphi technique are giving their ratings anonymously far away from pressure (**Creswell, et al., 2003**).

Sustainability assessment paradigms are diverse and nuanced strategies that facilitate initiatives and policy-making on measures that improve the sustainability of the community in a natural, social and economic climate (**Sala, et al., 2015**) because of this complexity. This study employs an exploratory, mixed methodology (hybrid) approach to best understand the environmental, social, and economic dimensions in the Interior Design sustainability domain. Many studies have adopted this approach for both theoretical and empirical Research (**Juan, et al., 2010**), (**Musa, et al., 2015**) (**Nilashi, et al., 2015**)

3.1 RESEARCH DESIGN

The development of an Indoor Environment Quality assessment tool for the Kurdistan region involves different theoretical and empirical investigations, as shown in **Fig 1**. The structure of the framework comprises five key stages as follows :
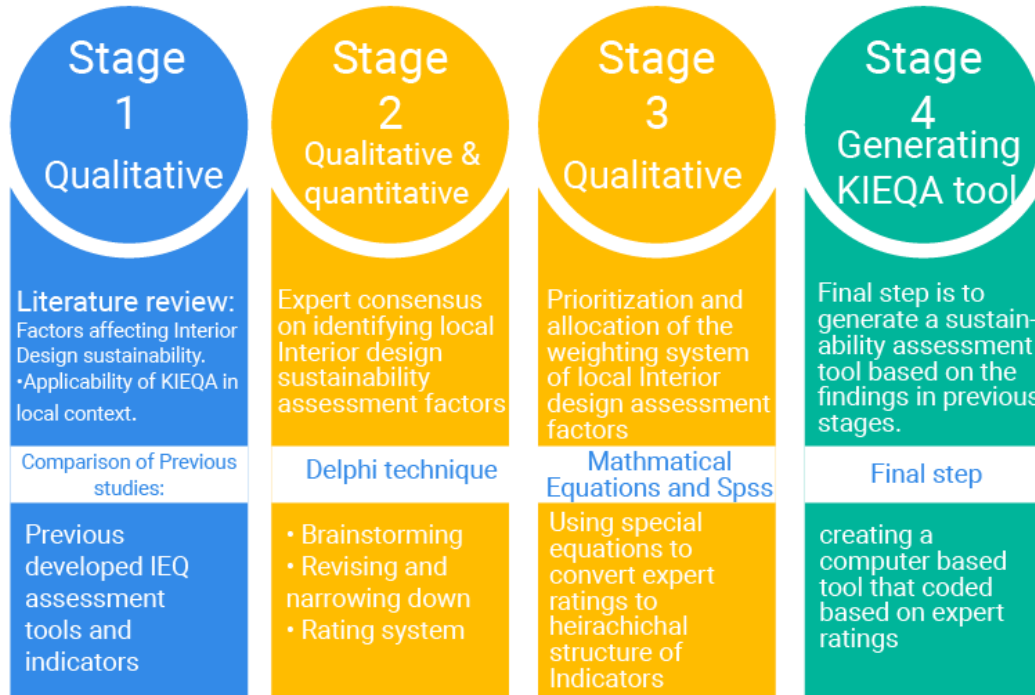
Figure 1. Shows the theoretical framework of the research design.

3.1.1   STAGE ONE:

An analysis of previous literature helps to clarify the aspects of the research issue and to define the emphasis of the report, to help create a better interpretation and perspective into the practice in specific areas and to recognize similar work and findings that have arisen **(Saunders, 2008).**

Consultation with the experts is important to obtain expert opinions from a wide range in a common platform, namely academics, public authorities, and the private sector**. (Chang, et al., 2007).** This will require a consensus-based approach to be developed; it is the most appropriate approach for designing a robust and practical sustainability assessment criteria. **(Chew and Das, 2008).**

3.1.2 STAGE TWO: IDENTIFICATION OF INTERIOR DESIGN SUSTAINABILITY ASSESSMENT FACTORS

For the effectiveness of any research project, the right choice of analysis methodology is important. However, consensus methods are commonly used. Consensus methodologies are reliable tools used to create an expert decision-making consensus to evaluate important Research and practice on critical questions, to build decisions and successful strategies **(Ager, et al., 2007).**

It is applied in healthcare, pharmacy, education, social services, engineering, economics, business, manufacturing, trade, and government **(Fink et al. 1984; Potter et al. 2004).** Because of the growing interest in sustainable development, strategies of collaborative decision-making have become more evident. They were used to address interior design challenges related to a wide range of issues that are built into the core dimensions of interior design sustainability **(Barnard, 1992).** The sustainability indicators in interior design are increasingly recognized as a reliable resource, capable of helping stakeholders such as interior design consultants, designers and construction managers make decisions on choosing sustainable interior design criteria for the future.

This research has examined three methods for systematic consensus: Delphi, Minimal Classes (NGT), and RAND / UCLA. The analysis reflects on the technique and the relative benefits and inconveniences of each process. These strategies were chosen because of their widespread use in the field of sustainable interior design creation **(Nair, et al., 2011).**

3.1.1.1 DELPHI TECHNIQUE

Established in 1960 by the RAND Corporation to build consensus, the methodology from Delphi is designed to achieve a community of experts ' reliable consensus on a structured process on every issue. It is applied by cumulative questionnaires based on surveys and feedback for data collection. **(Dalkey and Helmer, 1963).** The Delphi technique creates a discussion community on expert opinions **(Habibi et al. 2014).** It was used to define and categorize various issues through priority and creation of forecasting structures. To this end, trained professionals and experts with a broad knowledge of related issues must be involved **(Okoli and Pawlowski, 2004).**

The Delphi technique has four essential features stated by **(Hsu and Sandford, 2007)** follows :

A. Iteration of rounds: the Delphi technique is a multi-stage procedure involving more than one round of Candidates.

B. Anonymity: The Delphi technique coordinator must maintain professional anonymity. Experts should openly express their views without any interference from others

C. Regulated feedback: Data exchange between experts is tracked and filtered. After each round, the Delphi administrator receives the expert opinions and reviews to plan the next round. This approach removes informal conversation and makes the transition to the next round of questions easier.

D. Group response statistical agreement: Since the Delphi technique often addresses complex cases, reliable statistical analysis methods are necessary to reflect an exact overall group assessment. Mean, Median, Standard Deviation (SD), and Cronbach Alpha is used for this reason.

Delphi's main uses are to create alternatives and projections to ideas and views and to investigate the condition which is conducive to any underlying theory **(Alyami, et al., 2013).**

3.1.1.2 DELPHI TECHNIQUE DESIGN IN THIS STUDY

The Technical Delphi questionnaire was developed using potential interior design variables found through a comparative study of global assessment methods and the findings of interior design professionals through questionnaires and interviews. The respondent's opinions were gathered on a 5-point Likert type scale, ranked from 'Unimportant' to 'Very important.' The Delphi survey is derived from several stages, as shown in **Fig.2.**

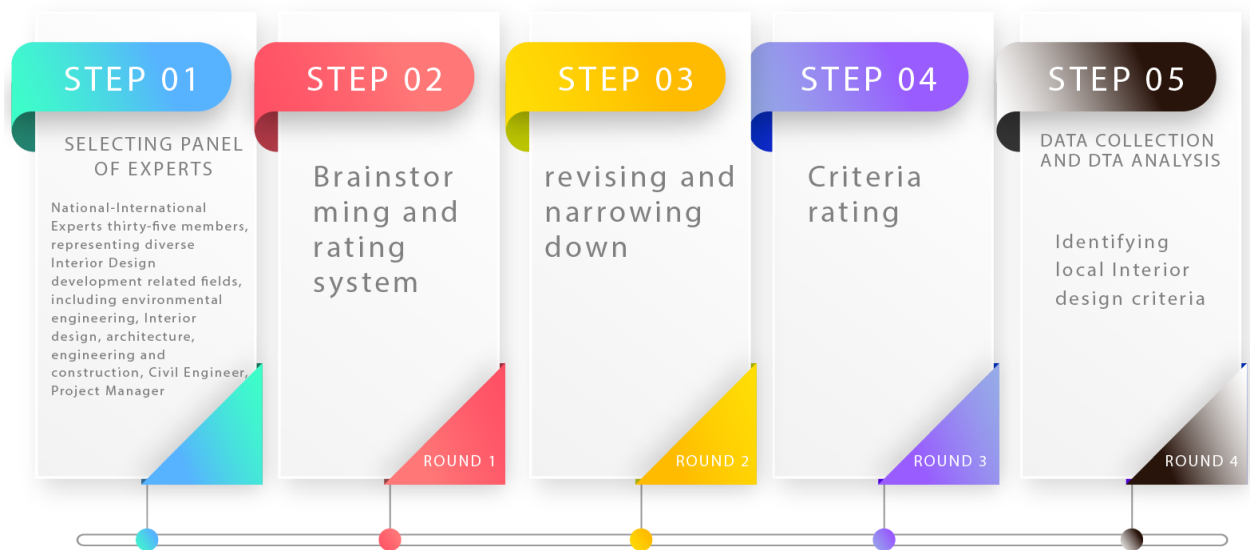| STEP 01	STEP 02	STEP 03	STEP 04	STEP 05
SELECTING PANEL OF EXPERTS	Brainstorming and rating system	revising and narrowing down	Criteria rating	DATA COLLECTION AND DTA ANALYSIS
National-International Experts thirty-five members, representing diverse Interior Design development related fields, including environmental engineering, Interior design, architecture, engineering and construction, Civil Engineer, Project Manager				Identifying local Interior design criteria
	ROUND 1	ROUND 2	ROUND 3	ROUND 4

Figure 2. The stages of Delphi survey.

3.1.1.3 THE SELECTION OF THE PANEL OF EXPERTS:

The procurement of qualified experts for the Delphi process is a crucial step in ensuring that important and accurate outcomes are obtained. Experts, as defined in the literature, are people who have a high level of knowledge or skill in a field **(Okoli and Pawlowski, 2004).**

The selection of the panel of experts for the Delphi technique was guided by the criteria recommended by Edgell & Seely (1980), where individual panelists should :

• Be well versed and up to date in the area of study .

• Have experience of working in the study area

• Be willing and available to take part in the Delphi process. In a previous Delphi study among Interior Design sustainability professionals, **(Alyami, et al., 2013).** suggested that the panelists could come from the following groups:

• Academics, professionals, and specialists in the domain of sustainable development .

• Practitioners, managers, and decision-makers in the field of sustainability, and

• Professionals from cognate fields who have practical experience and knowledge of sustainable development .

The involvement of experts from diverse backgrounds is to combine opinions, viewpoints, and perceptions, which are crucial for deciding the validity of the study results. The number of experts in the forum will range from 10 to 50; one important consideration is that the panel should be large enough to allow multiple comments to be heard **(Okoli and Pawlowski, 2004).**

The Delphi panel in this study comprises thirty-five members, representing diverse from national and international experts from interior design development-related fields, including academics (professors, assistant professors, Ph.D. holders, and MSc.), environmental engineering, interior design, architecture, engineering and construction, civil engineer, project manager. Panelists' work

experience relates to the practice, decision-making, research, and teaching of sustainability and environmental policy and regulations. They have national and international experience and recognition for their work. To ensure balance in representation, panel members were recruited from governmental and non-governmental organizations and the private sector, as shown in
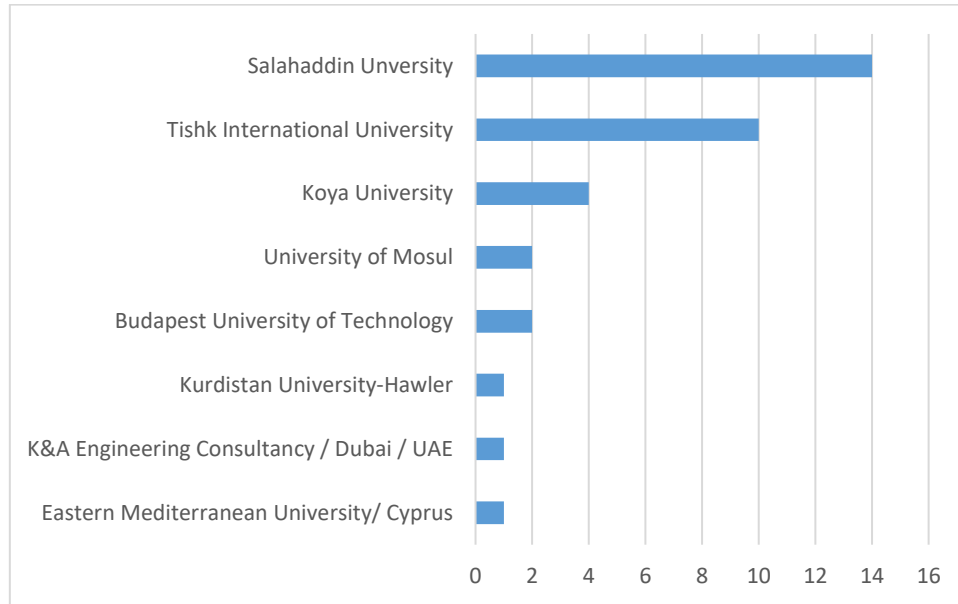
Fig. 3

Figure 3. The participated national and international experts in this study from Various universities and companies.

3.1.2   STAGE THREE: PRIORITIZING IEQ CRITERIA FOR RESIDENTIAL BUILDINGS IN THE KURDISTAN REGION

Establishing a suitable weighting system that corresponds as accurately as possible to local needs and gives priority to local interior design issues

Since the main goal of this study is to develop a framework for assessing urban sustainability, the analysis is continued using Spss for finding mean and standard divisions a special statistical analysis to generate weights of each criterion and equation (1) and (2) to f or IEQ at the end generating of a weighting system. The rating will be converted by mathematical equation not by finding means because sometimes means are misleading, especially when the outliers are big in different very low or very high in the difference at two ends **(Coontz, 2013).** Therefore, the sum of indicator/summation of the whole category x 100 the same system that has been used for developing the SB tool **(Devitofrancesco, et al., 2019).**

$$\text{Wi} = 100 \; \frac{\sum_{i=1}^{n} Ri}{\sum_{i=1}^{n} Ti} \tag{1}$$

$$\text{Ta} = \sum_{i=1}^{n} Wi \tag{2}$$

Wi = weight of each indicator, Ri= ratings for each indicator, Ti total ratings for all indictor, Ts = Total score, Wi= weight of each indicator

3.1.3 STAGE FOUR: FINAL STAGE:

The final step is to generate a sustainability assessment tool based on the findings in previous stages. Creating a computer-based tool that coded based on expert ratings that could be used for assessing residential interiors. The tool will be coded in a way that does not allow to insert a value greater than the weight of each criterion derived from the Delphi survey.

4. RESULTS AND DISCUSSION:

National and international experts participated in the rating from four national three international universities with the local architecture consultations bureau and interior designers with had adequate experience and knowledge in the field of the sustainable built environment. The experts were four professors, nine assistant professors, six Ph.D. holders in the field of architecture, interior design and civil engineers, four eight assistant lecturers, experienced architects, three interior designers, and one project, owner as shown in **Fig. 4** below.
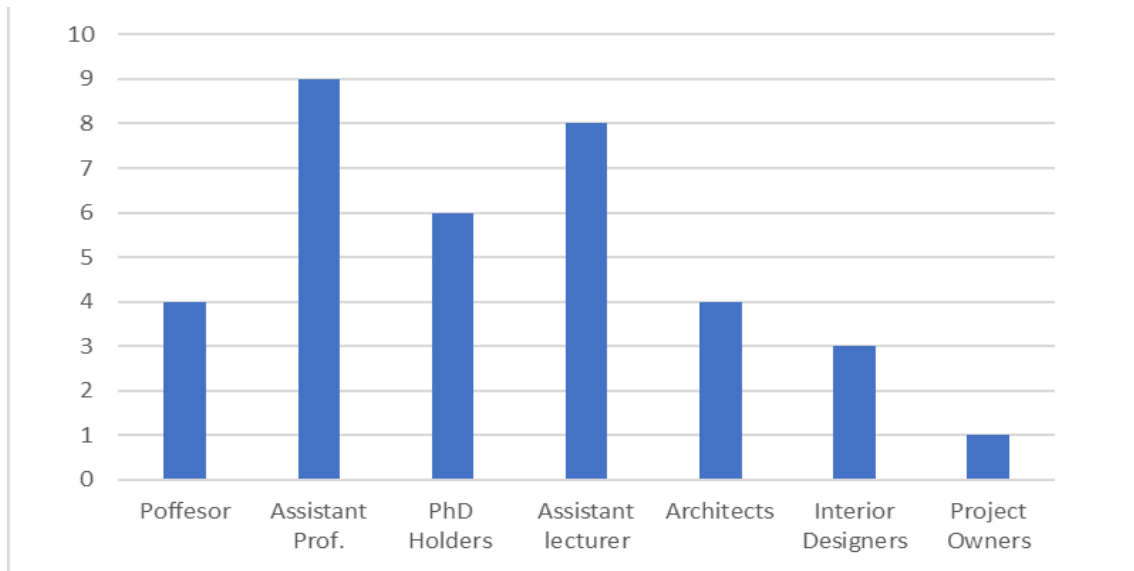

Figure 4. The academic level and specialty of the expert panellist.

In the first stage of the research method, a list of criteria and indicators that has been collected from previous studies presented to experts and the expert agreed to select these criteria and indicators for KIEQA. The criteria for indoor environment quality for the Kurdistan region were included: Acoustic, Visual comfort, Thermal comfort, Indoor air quality, Dust protection, ventilation, Greenery. While the total number of indicators were 22 indicators set in the first round of Delphi survey selecting from the indicators with the mean less than (3) has been removed from the list. Also, the indicators with standard deviation more than (1) have been neglected. View to outside scored 1.12, humidity control scored (1.1) tobacco smoke control (1.1) standard division. Therefore, they excluded them from the indicators list and moved to sub-indicators by the opinion of experts. Humidity control moved from indicators as sub-indicator for thermal comfort indicator, view and illumination moved to visual comfort criteria, as shown in **Table 2**:

Table 2 .The mean and the standard deviation of the indicators rated by experts.

Questioner item	Round one		Round two	
	Mean	SD	Mean	SD
• Acoustical performance	4.15	0.67	4.15	0.67
• Ventilation (natural and mechanical)	4.45	0.826	4.45	0.83
• View to outside	3.73	1.12	-	-
• Visual comfort	-	-	4.15	0.61
• Illumination	4.18	0.8	-	-
• Thermal comfort	4.38	0.53	4.65	0.59
• Indoor Humidity control	3.5	0.63	-	-
• Indoor air quality	4.70	0.55	4.7	0.57
• Dust prevention	3.75	0.9	3.75	0.72
• Environmental Tobacco Smoke Control	4.01	1.1	-	-
• Greenery			Required	

4.1 Reliability:

Cronbach's Alpha standard is between (0-1); this coefficient provides the ratability ratio by approximation of correlation between averages of rating and internal constancy for every component in the survey. Several social studies suggested $\alpha = 0.70$ and higher are deemed to be acceptable reliability **(Webb, et al., 2006),** and our statistical analysis result of Alpha was 0.803, which means it is good as it is shown in **Table 3.** below:

Table 3 The statistical analysis of Cronbach's Alpha for our expert respondent analyzed by Spss software.

Cronbach's Alpha	Standardized Cronbach's Alpha	NOs
0.803	0.818	11

4.2 Weighting criteria

The ratings have been converted to indicators weightings by mathematical equation not by finding means because sometimes means are misleading, especially when the outliers are big in different very low or very high in the difference at two ends. Therefore, the Sum of indicator/summation of the whole category x 100 as given in Eq. (1).

The results of generating weights for KIEQA tool from the total rating over 100%: %, indoor air quality scored the highest percentage by 19%, following by ventilation 17%, thermal comfort 17, visual comfort 16%, acoustic got 16 %, dust prevention 15% as shown in **Fig. 5**.
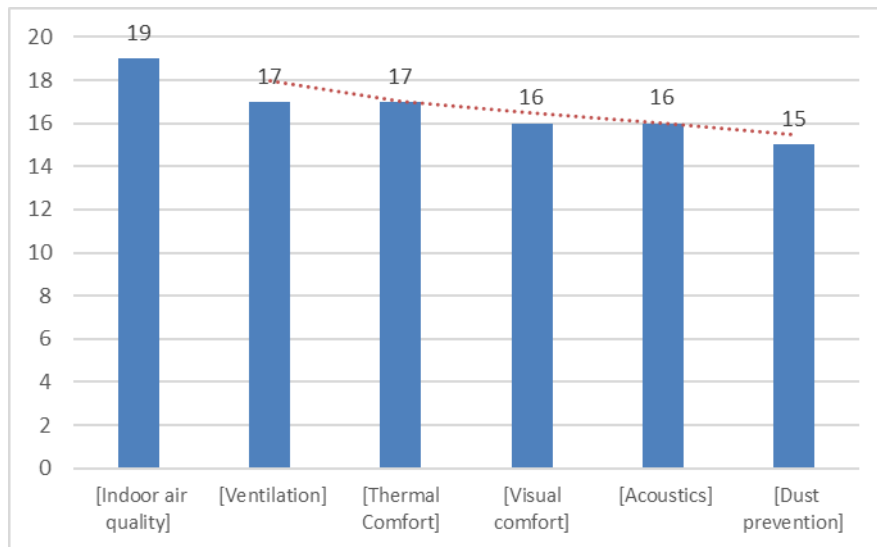

Figure 5. The proportion of the IEQ indicators.

The subjective meeting was made with the experience of people in the field of the sustainable built environment, to check the results of the Delphi procedure. These criteria were moved to be listed as indicators of humidity control, lighting, view.   In the next stage, an equation derived from the SB tool has been used to identify the weighting hierarchy for each indicator and sub-indicators. Greenery was added as a required indicator for the tool by the request of the experts. A tool has been created based on expert weightings that converted to a computer-based program using Microsoft Excel that works based on equation (1) and (2). The weighting of each indicator has been derived as some of the criteria weightings. Among its indicators according to their degree of importance. The tool has been coded in a way that each input of indicators will not allow inserting a value, which is more than it weighs by the reference of expert ratings that have fixed that.

The summation of indicators will indicate the total score of each criterion, and the summation of criteria will indicate the IEQ final score of the assessed interior. It will be automatically collected and presented as a final score. If the result below %30, it will show as red color declaring that the interior is not certified. The rest of the final score will appear as the certification color name; below will not be certified if the final score Is between 30-45%, it is bronze certified will appear with bronze color, between Fs 45-60% silver, Fs + 60-75 % score gold, Fs 75-85 % score diamond, platinum Fs + ≥ 85 % score as shown in **Table 4.**

Since the development of the BREEAM, the findings of any appraisal process have been translated into a single ranking term, usually referred to as the performance standard, to be granted certifications **(AlTalebi and Al-Bazzaz, 2018).** Other global evaluation approaches, such as CASBEE, LEED, SBtool, and PCRS, also adopted the same approach **(Mattoni, et al., 2018).** Rating benchmark levels aim to enable stakeholders to compare the performance of any individual indicator with other factors of any assessment tool. The (KIEQA) adopts a similar approach to

BREEAM Co. and Estidama by using a percentage-based scale. It includes seven different levels of certifications, as shown in **Table 4** below:

Table 4. The certification and scoring levels of (KIEQA).

Requirement	Rating achievement	Assessment Description
Fs + < 30 % score	☆	Unclassified
Fs + ≥ 30 %	☆☆	Bronze
Fs + ≥ 45 % score	☆☆☆	Silver
Fs + ≥ 60 % score	☆☆☆☆	Gold
Fs + ≥ 75 % score	☆☆☆☆☆	Diamond
MF + ≥ 85 % score	☆☆☆☆☆☆	platinum

Each criterion of KIEQA has been divided into several indicators; experts have chosen the best ones that suit for Kurdistan region climate and context. In conclusion, 22 indicators have been selected among the collected indicators from previous studies. Each indicator that Greenery is a mandatory criterion, as it is shown in **Fig. 6** below:

Measurement	C. Weight	Criteria	I. weight	Indicators	70
Credit	16%	Acoustic	4	• Sealing of gaps around windows and doors,	3
			4	• openings of high sound conduction	3
			4	• Use of materials for increasing sound absorption and insulation	3
			4	• Reduction of vibration noise arising	3
Credit	16%	Visual comfort	4	•Maximization of the use of natural daylight through openings without impairing the structure • Use of light-colored interiors that reflec light from windows or skylights • Use of high performance artificial lights and appropriate configuration • Physical environment	3
			4		2
			4		2
			4		2
Credit	17%	Thermal comfort	4	• Insulation Layers •Increase air tightness through air barriers around windows and doors • Use of passive technologies, shading, reflection, absorption devices • Humidity control	2
			4		1
			4		3
			5		2
Credit	19%	Indoor air quality	2	• mechanical flushing of pollutant • Air purification filters to prevent outdoor pollution • Improving air circulation • Prevent interior pollution migration •Tobacco Smoke Control • Air quality monitoring systems • Removal of sources of water or moisture	2
			3		3
			3		3
			3		3
			3		2
			3		1
			2		2
Credit	15%	Dust protection	15	window & door treatment to prevent dust	15
Credit	17%	ventilation	10	natural ventilation	6
			7	Mechanical ventilation	4
required		Greenery		adequate amount of greenery ins	Required
TOTALS		**Total Score**			**70**

Measurement column left spanning cell: Indoor environmental quality

Bronze: 30-45 points, **Silver: 45-60** points, **Gold: 60 -75** points, **Diamond 75-85,Platinum: ≥ 85**

Figure 6. An example of KIEQA for a rating system, shows indicators, sub-indicators, and their weighting values an example IEQ Assessment for Cihan city complex.

5. CONCLUSION:

The Indoor Environmental Quality (IEQ) can be described as a condition of the internal built environment that provides comfort and enhance health condition to the occupants. IEQ is a universal concept considering various components such us: cooling and heating, natural and artificial lighting, air quality, and acoustics. In the Kurdistan region, the environmental quality of contemporary dwellings does not consider to be essential; thus, a comfortable indoor environment did not meet yet. Hence there is no such a tool to measure the degree of sustainable interior designs in the Kurdistan region, and building regulations are neglected. The hypothesis set by this research was that international tools for assessing IEQ are not suitable for the Kurdistan region. The hybrid methodology was used to test the raised hypothesis. This study supports the development of an IEQ assessment tool to assess the interior design and promote a sustainable built environment. Thirty-five Delphi panelists have been reached the agreement to select the criteria and weight for

their indicator for the Kurdistan Region Assessment Tool KIEQA. The conclusion of the Delphi results declared that the international assessment tools do not apply to our country.

Experts in indoor environmental quality ratings agreed to include indoor air quality, acoustics and noise control, ventilation, thermal comfort, visual comfort, dust prevention, fire protection, every indicator has a list of sub-indicators. Seven indicators and twenty-two indicators were selected as criteria for indoor environment quality in residential building assessment in Kurdistan Region. However, indicators and sub-indicators that scored less than (3 out of 5) recorded as have lower importance for the criteria by the panelist. View to outside scored 1.12 standard division. That is why it was excluded from the indicators list and moved to sub-indicators by the opinion of experts. Humidity control moved from indicators as a sub-indicator for thermal comfort indicators. The statistical analysis result of Alpha of the result analyzed was $\alpha = 0.803$, telling us it is good and reliable.

Spss software was used to find means and standard division of the ratings. Also, an equation has been used for making weighting indicators. As mentioned in the methodology, the results are as shown in **Table 2**. From the total rating over 100%: acoustic got 16 %, ventilation 17%, visual comfort 16%, thermal comfort 17%, indoor air quality 19%, dust prevention 15%. Moreover, fire protection and Greenery are added as a required indicator for the tool by the request of the experts. A computer-based software has been created that was coded using Microsoft Excel-based on the weights of the indicators. The percentages of each criterion have been divided among its indicators according to their degree of importance. The tool has been coded in a way that automatically converted the input numbers to indicators' values based on the weights of experts. The tool will not allow inserting a value, which is more than it weighs the reference of expert ratings has fixed that. The summation of the whole indicators will be collected to represent the final score.

Furthermore, it will show a red color declaring that the interior is not certified. The rest of the final score will appear as the certification color name; below will not be certified if the final score is between Fs + ≥ 30-45 %, it is bronze certified will appear with bronze color, between Fs + ≥ 45-60 % silver, Fs + ≥ 60-75 % score gold, Fs + ≥ 75-85 % score diamond, platinum MF + ≥ 85 % score.

Research shows that good IEQ is important for interior design; it also offers an adequate indoor environment for the customer. This research has many significant advantages as it raises awareness for architects, experts, and policymakers of the issues of indoor environmental quality. Besides, an action plan on existing and new interior design projects in the Kurdistan Region should be developed. Future research can focus on the correlation between IEQ criteria and develop this tool concerning different types of buildings.

6. REFERENCES:

- Abdul-Rahman, H., Wang, C., Wood, LC, and Ebrahimi, M., 2015. Integrating and ranking sustainability criteria for housing. Proceedings of the Institution of Civil Engineers-Engineering Sustainability, Thomas Telford Ltd.

- Ager, A., Boothby, N., and Wessells, M., 2007. The use of consensus methodology in determining key research and practice development questions in the field of intervention with children associated with fighting forces. *Intervention: International Journal of Mental Health, Psychosocial Work and Counselling in Areas of Armed Conflict* 5(2) 124-129.]

- Alborz, N., and Berardi, U., 2015. A post occupancy evaluation framework for LEED certified US higher education residence halls. *Procedia Engineering* 118 19-27.

- AlTalebi, R.A., and Al-Bazzaz, I., 2018. Aspects of General and Secondary Indicators that form a Local System to assist Sustainability Verification in Buildings. *Journal of Engineering* 24(2) 25-53.

- Alyami, S.H., and Rezgui, Y., 2012. Sustainable building assessment tool development approach. *Sustainable Cities and Society* 5 52-62.

- Alyami, S.H., Rezgui, Y., and Kwan, A., 2013. Developing sustainable building assessment scheme for Saudi Arabia: Delphi consultation approach. *Renewable and Sustainable Energy Reviews* 27 43-54.

- Balaras, C.A. et al., 2020. A transnational multicriteria assessment method and tool for sustainability rating of the built environment. IOP Conference Series: Earth and Environmental Science, IOP Publishing.

- Barnard, S.S., 1992. Interior design creativity: The development and testing of a methodology for the consensual assessment of projects. Virginia Tech.

- Bernardi, E., Carlucci, S., Cornaro, C., and Bohne, R.A., 2017. An analysis of the most adopted rating systems for assessing the environmental impact of buildings. *Sustainability* 9(7) 1226.

- Cao, X., Dai, X., and Liu, J., 2016. Building energy-consumption status worldwide and the state-of-the-art technologies for zero-energy buildings during the past decade. *Energy and buildings* 128 198-213.

- Chang, K.-F., Chiang, C.-M., and Chou, P.C., 2007. Adapting aspects of GBTool 2005—searching for suitability in Taiwan. *Building and Environment* 42(1) 310-316.

- Chew, M., and Das, S., 2008. Building grading systems: a review of the state-of-the-art. *Architectural Science Review* 51(1) 3-13.

- Chiang, C.-M., and Lai, C.-M., 2002. A study on the comprehensive indicator of indoor environment assessment for occupants' health in Taiwan. *Building and Environment* 37(4) 387-392.

- Cole, R. J., 2005. Building environmental assessment methods: redefining intentions and roles. *Building Research & Information* 33(5) 455-467.

- Coontz, S., 2013. When numbers mislead. *New York Times*.

- Creswell, J.W., Clark, V.P., and Garrett, A., 2003. Advanced mixed methods research. *Handbook of mixed methods in social and behavioural research. Thousand Oaks, CA: Sage* 209-240.

- Creswell, J.W., and Zhang, W., 2009. The application of mixed methods designs to trauma research. *Journal of Traumatic Stress: Official Publication of The International Society for Traumatic Stress Studies* 22(6) 612-621.

- Dakwale, V.A., and Ralegaonkar, R.V., 2015. Development of thermally insulated sustainable building model. Proceedings of the Institution of Civil Engineers-Engineering Sustainability, Thomas Telford Ltd.

- Dalkey, N., and Helmer, O., 1963. An experimental application of the Delphi method to the use of experts. *Management Science* 9(3) 458-467.

- Devitofrancesco, A., Belussi, L., Meroni, I., and Scamoni, F., 2019. Development of an Indoor Environmental Quality Assessment Tool for the Rating of Offices in Real Working Conditions. *Sustainability* 11(6) 1645.

- Geng, Y., Lin, B., and Zhu, Y., 2020. Comparative study on indoor environmental quality of green office buildings with different levels of energy use intensity. *Building and Environment* 168 106482.

- Godish, T., 2016. *Indoor environmental quality*: CRC press.

- Guida, A., Pagliuca, A., and Rospi, G., 2008. Underground spaces and indoor comfort: the case of "Sassi di Matera". *Underground Spaces: Design, Engineering and Environmental Aspects* 102 1149.

- Halla, P., and Binder, C.R., 2020. Sustainability Assessment: Introduction and Framework. *Sustainability Assessments of Urban Systems* 7.

- Higham, A.P., Fortune, C., and Boothman, J., 2016. Sustainability and investment appraisal for housing regeneration projects. *Structural Survey* 34(2) 150-167.

- Hsu, C. C., and Sandford, B.A., 2007. The Delphi technique: making sense of consensus. *Practical Assessment, Research, and Evaluation* 12(1) 10.

- Juan, Y.-K., Gao, P., and Wang, J., 2010. A hybrid decision support system for sustainable office building renovation and energy performance improvement. *Energy and buildings* 42(3) 290-297.

- Kamas, W.M., Hasan, A.A., and Fadel, A.H., 2019. Economic Benefits for the Application of Standards of Sustainability in Construction Projects. *Journal of Engineering* 25(3) 117-126.

- Kolokotsa, D., and Santamouris, M., 2015. Review of the indoor environmental quality and energy consumption studies for low income households in Europe. *Science of the Total Environment* 536 316-330.

- KRG., 2020. *Kurdistan's geography and climate* [*online*]. Kurdistan Regional Government official website: Department of Foreign Relations
- Kurdistan Regional Government. Available at: http://dfr.gov.krd/p/p.aspx?p=293&l=12&r=367 [Accessed 28/4/2020 2020].

- Lai, A., Mui, K., Wong, L., and Law, L., 2009. An evaluation model for indoor environmental quality (IEQ) acceptance in residential buildings. *Energy and buildings* 41(9) 930-936.

- Larsen, T.S. et al., 2020. IEQ-Compass–A tool for holistic evaluation of potential indoor environmental quality. *Building and Environment* 172 106707.

- Laskari, M., Karatasou, S., and Santamouris, M., 2017. A methodology for the determination of indoor environmental quality in residential buildings through the monitoring of fundamental environmental parameters: A proposed Dwelling Environmental Quality Index. *Indoor and Built Environment* 26(6) 813-827.

- Lee, W., and Burnett, J., 2006. Customization of GBTool in Hong Kong. *Building and Environment* 41(12) 1831-1846.

- Malmqvist, T., and Glaumann, M., 2007. Selecting aspects and indicators in environmental assessment methods for buildings. International Conference on Sustainable Construction, Materials and Practices, Lisbon, PORTUGAL, SEP 12-14, 2007, IOS PRESS.

- Mattoni, B. et al., 2018. Critical review and methodological approach to evaluate the differences among international green building rating tools. *Renewable and Sustainable Energy Reviews* 82 950-960.

- Moore, J.E., Mascarenhas, A., Bain, J., and Straus, S.E., 2017. Developing a comprehensive definition of sustainability. *Implementation Science* 12(1) 110.

- Morad, D.H., and Ismail, S.K., 2017. A comparative study between the climate response strategies and thermal comfort of a traditional and contemporary houses in KRG: Erbil. *Kurdistan Journal of Applied Research* 2(3) 320-329.

- Mujan, I. et al., 2019. Influence of indoor environmental quality on human health and productivity-A review. *Journal of Cleaner Production* 217 646-657.

- Musa, H.D., Yacob, M.R., Abdullah, A.M., and Ishak, M.Y., 2015. Delphi method of developing environmental wellbeing indicators for the evaluation of urban sustainability in Malaysia. *Procedia Environmental Sciences* 30 244-249.

- Nair, R., Aggarwal, R., and Khanna, D., 2011. Methods of formal consensus in classification/diagnostic criteria and guideline development. Seminars in arthritis and rheumatism, Elsevier.

- Nilashi, M. et al., 2015. A knowledge-based expert system for assessing the performance level of green buildings. *Knowledge-Based Systems* 86 194-209.

- Ning, Y., Li, Y., Yang, S., and Ju, C., 2017. Exploring socio-technical features of green interior design of residential buildings: Indicators, interdependence and embeddedness. *Sustainability* 9(1) 33.

- Okoli, C., and Pawlowski, S.D., 2004. The Delphi method as a research tool: an example, design considerations and applications. *Information & Management* 42(1) 15-29.

- Rodriguez, L.J., Peças, P., Carvalho, H., and Orrego, CE., 2020. A literature review on life cycle tools fostering holistic sustainability assessment: An application in biocomposite materials—*Journal of Environmental Management* 262 110308.

- Sala, S., Ciuffo, B., and Nijkamp, P., 2015. A systemic framework for sustainability assessment. *Ecological Economics,* 119 314-325.

- Salih, K.T., 2018. Finding Alternative Methods for Controlling the Power Shortage in Kurdistan through Improving Buildings' Energy Performance. *Academic Journal of Nawroz University* 7(4) 124-132.

- Saunders, T., 2008. A discussion document comparing international environmental assessment methods for buildings. *BRE March.*

- Sev, A., 2011. A comparative analysis of building environmental assessment tools and suggestions for regional adaptations. *Civil Engineering and Environmental Systems* 28(3) 231-245.

- Shokri, R. et al., 2018. A comparative study of the environmental health and safety of urban and rural schools of Abadan and their compliance with national standards. *Journal of Advances in Environmental Health Research* 6(1) 9-16.

- Tang, H., Ding, Y., and Singer, B., 2020. Interactions and comprehensive effect of indoor environmental quality factors on occupant satisfaction. *Building and Environment* 167 106462.

- Van Den Wymelenberg, K., and Inanici, M., 2016. Evaluating a new suite of luminance-based design metrics for predicting human visual comfort in offices with daylight. *Leukos* 12(3) 113-138.

- Webb, N.M., Shavelson, R.J., and Haertel, E.H., 2006. Reliability Coefficients and Generalizability Theory.

- Zarghami, E., and Fatourehchi, D., 2020. Comparative analysis of rating systems of developing and developed countries: a systematic review and a future agenda towards a region-based sustainability assessment. *Journal of Cleaner production* 120024.

- Zebari, HN., and Ibrahim, R.K., 2016. Methods and strategies for sustainable architecture in Kurdistan region, Iraq. *Procedia Environmental Sciences* 34(2016) 202-211.