Research article

Consensus-based urban sustainability framework for Iraqi cities: A case study in Baghdad

Marwah M. Mohsin [*], Thomas Beach, Alan Kwan

School of Engineering, Cardiff University, The Parade, Cardiff CF24 3AA, United Kingdom

ABSTRACT

The paper proposes a comprehensive sustainability framework for urban development projects in hot, dry developing regions. Such a framework is required due to the lack of knowledge in these regions of issues including population-inflation, traffic congestion, environmental pollution, water shortages and high energy consumption. Iraq is one such developing country having a hot, dry, semi-arid climate with unique socio-cultural factors which have been impacted by four decades of war. New development projects are underway but scant attention has been paid to sustainability, specifically in cities e.g. Baghdad. This framework has been developed using expert consultations to reach a consensus on its dimensions, three in total: the use of satellite cities around existing cities for various purposes (residential, industrial, commercial and administrative) with the creation of a green belt, the determination of criteria for future domestic energy projects, e.g. the minimum energy requirements for an average Iraqi family and on-site renewable sources such as solar energy, and the application of a set of urban sustainable development factors to improve the quality of services and human well-being. This study presents, for the first time, a comprehensive sustainability framework for a country that has suffered several decades of wars and international sanctions. This framework was subsequently validated using semi structured interviews with 15 local intra-organizational leaders. The key findings of this paper based on this validation show that 12 out of 15 intra-organizational leaders highly recommended the adoption of the developed framework, highlighting their level of understanding, accepting, feasibility and challenging, and their future scope to develop this framework in order to enhance the quality of life at the city scale. Moreover, the leaders of the Mayoralty of Baghdad emphasised to adopt the developed framework in order to mitigate the current and future challenges of the capital Baghdad, including housing deficit, traffic problems, economical issues, and environmental pollution. The key contributions of this study is its investigation of locality-specific issues in war-torn countries such as Iraq, specifically this includes; (a) analyzing locality-specific problems based on engagement with stakeholders, and the general public, (b) proposing a framework to solve multiple problems, including lack of environmental strategies, traffic congestion, housing deficit, rapid urbanization and population growth and, (c) validation of the framework through engagement with intra-organsational leadership in different ministries and organizations like, ministry of housing and construction, Mayoralty of Baghdad, ministry of water resources, UN-HABITIAT program in Iraq, ministry of electricity, National consultation engineering committee, and etc.

1. Introduction

There is broad consensus that cities are responsible for a major rise in environmental pollution, including CO_2 emissions. The built environment increases undesirable impacts on the environment through, for example, conventional power production, road traffic and rapid population growth (Fawzi and Ameen, 2017; Mohsin et al., 2018). While cities are considered the major engines of economic success, globally, more than 70% of greenhouse gas emissions are generated by cities due to high energy consumption, modes of transport and a lack of effective management (Fawzi et al., 2016).

In developing cities in particular, there is the need to combat climate change, rapid urbanization, population growth, the lack of environmental strategies, and high energy and transport demands (Ameen and Mourshed 2017). The domestic sector in most developing countries is considered the largest consumer of electric energy: Saudi Arabia reports that over 50% of their electricity is used by the domestic sector. In Iraq, this figure is higher: 82% of electric energy is consumed by domestic homes. This reliance on electricity is an issue as there are frequent power outages across the country.

Given this situation, new, comprehensive, sustainable frameworks need to include multiple practical solutions, applicable for the present and the future, for cities with high-density populations, high energy consumption, water shortages and traffic problems.

Iraq is an unstable country which has suffered from rapid urbanization and population growth due to the rapid transition of populations from rural areas to urban regions. In 1947, approximately 70% of the population lived in rural areas, the remaining 30% settled urban regions including the capital Baghdad (Mohsin et al., 2017). Currently and by contrast, more than 70% of the population now live in urban areas. A quarter of the Iraqi population currently live in Baghdad city, predictions showing that the population in the city will double by 2030 to approximately 12 million inhabitants. This will have a substantial impact on the housing sector, transportation and the capacity of an already over-stretched and under-performing infrastructure. This situation is exacerbated by the impact of war which has caused substantial damage to the infrastructure, public services, utilities and general quality of life.

Thanks to both national and international efforts to rebuild cities, many construction projects are currently underway but these projects lack attention to factors which will avoid further pressures on the existing city as mentioned above. To mitigate this, it is recommended that urban development must advance in line with the concept of urban sustainable development.

This paper describes the research conducted to develop a new sustainable framework incorporating various innovative ideas: (a) the concept of satellite cities around the capital to mitigate pressure on the city, and to meet the future requirements of a predicted growth in the population, (b) minimum design requirements to facilitate a transfer towards low energy domestic homes, and (c) development of a set of urban sustainable development indicators to improve the quality of life and well-being.

This framework has including consideration of innovative strategies e.g. the establishment of satellite cities and a green belt around the city and a semi-standardised domestic features design, in addition to a set of urban sustainability indicators to address locality-specific problems.

More specifically, this research proposes a sustainable framework for the city of Baghdad, Iraq. This framework covers a variety of factors including planning and landscaping, housing requirements and on-site renewable energy such as solar PV solutions thereby addressing urban sustainability indicators including environment, water and energy, socio-cultural factors, innovation, economy and management. This framework will therefore include reference to a future vision for Baghdad, will offer practical findings for domestic sectors to facilitate the move towards low energy projects and launch a sustainable plan for development projects under the concept of urban sustainability. Furthermore, the methodology used to develop the framework will also be appropriate to other countries, in particular cities with high densities in Arab Gulf regions and Middle East countries in general.

This new framework has been validated through semi-structured interviews with experts from various organizations. The interviews were designed to allow a critical discussion of the content of the framework, identification of any missing factors/details and an evaluation of its applicability in Iraq.

In the reminder of this paper, section two will discuss related work to illustrate some the past research conducted on sustainability frameworks. In the third section, the research methodology will be described. Section four, will detail the development of the sustainable framework by explaining the analysis and results of the main dimensions of the framework. The fifth section will present, the three main dimensions within the framework, the final section will conclude the paper.

2. Related work

Urban sustainability frameworks have emerged in recent years as a means to tackle locality-specific problems including rapid urbanization, environmental pollution, housing deficits, traffic congestion, high energy consumption and population growth.

The term 'urban sustainability framework' can be defined as a multi-faceted approach to address potential improvements in the infrastructure of a city. Its underlying principal is to reduce the use of resources thereby reducing further pressure on the environment's ability to meet current and future requirements of the area under study (Holden, 2012).

Sustainability frameworks are an integrated concept which combine a number of urban sustainability indicators, including environmental, social and economic dimensions. These factors and new strategies are combined as part of a new framework to develop applications by cities to meet present and future challenges in developing countries such as housing deficits, rapid urbanization and high energy and transport demands.

Working at two levels, sustainability frameworks comprise a set of urban sustainability factors which are designed to mitigate locality-specific issues. Addressing these issues can involve the adoption of multiple strategies which in turn feed into the process of the further development of urban sustainable development guidelines (Huang et al., 1998; Wu 2014).

Urban sustainability frameworks are characterised by the development of mutual relationships between local and global challenges such as rapid urbanization, high energy consumption and environmental problems. A number of studies have listed urban sustainability assessment tools and compared them (Rebitzer et al., 2004; Xing et al., 2009), highlighting the content, structure and output of urban sustainability development tools. Key findings suggest that no framework or tool can cover the wide range of urban design aspects required to meet both the development of new city applications, such as city districts and domestic sectors, or further improve existing ones. Many researchers have tested several practices (Alyami et al., 2015; Fawzi et al., 2016; Aldossary et al., 2015) and suggested new assessment tools which include comparative items such as environmental, social and economic aspects of urban sustainability development to understand the goals of addressing a specific region and its locality-specific issues. In contrast, authors such as (Willis 2006; Alyami et al., 2015) suggest that urban sustainability assessment tools are not fit for all regions because of diverse locality-specific factors including community features, weather conditions, levels of social awareness and standards of living.

A comprehensive understanding of climatic conditions, local priorities and social issues are also required before sustainable development frameworks can be initiated. Many studies in the past, have claimed that local frameworks/assessment tools for specific regions are inappropriate for other areas because of their different needs (Ameen and Mourshed 2017; Aldossary et al., 2017).

This study has reviewed several urban sustainability frameworks designed for different regions, in order to identify their similarities and differences. Aldossary et al. (2015) designed a low carbon domestic framework for sustainable homes in Saudi Arabia. The framework included attention to the architectural design of housing both external and internal, on-site renewable energy and socio-cultural factors. It identified techniques and strategies which deal with design concepts involving building components and HVAC in hot, dry regions. This study recommended the use of on-site renewable energy e.g. PV solar in order to create low carbon homes. The appropriateness of changes to design were examined via simulated multiple domestic buildings (three houses and three flats) in various locations in the capital, Riyadh and selected IES-VE tools to simulate each building. Design weaknesses in existing domestic building were examined, this allowing the proposal of alternative solutions.

Other studies have reported on the design of urban sustainability assessment tools for use across the Middle-East (Alyami et al., 2015; Willis 2006; Mohammed Ameen et al., 2014). These comprise three major dimensions and a number of indicators and sub-indicators covering environmental, social and economic factors. These studies have investigated stakeholders' perceptions through nationwide

questionnaires to identify public priorities but have not addressed strategies for a specific city.

Guo et al. (2011) and Johansson (2006) report that in hot, dry and arid regions, over 70% of energy consumption by the domestic sector is used to maintain cool temperatures indoors. A number of studies have discussed how to minimise this energy consumption by advocating the use of alternatives such as passive solar energy (Zhang and Qi, 2005) and mechanical cooling. There are several parameters which impact energy consumption, and which can improve levels of thermal comfort including building shape, micro-climate on site, the use of alternative construction materials, the use of passive solar design and the structure of houses and landscaping. Research has focused on analysing design and urban development requirements using Analytic Hierarchy Process (AHP), some studies indicating that an energy reduction of up to 82% can be attained through the use of the principle of passive architectural design (Sadineni et al., 2011). Such reductions can pave the way for near Zero-Energy buildings in the Middle-East.

In light of the above, this study advocate changes in the features of domestic buildings as this has significant value regarding the move towards sustainability. This study also proposes to elicit a set of urban sustainable development factors covering environmental, social, economic, and cultural and innovation aspects. This framework will include several strategies which have not been used in previous studies including future planning and land use for cities suffering from population inflation and housing deficits.

This study differs from these studies in terms of establishing a framework by involving (a) specific future planning concepts, (b) specific features related to housing, and (c) a set of urban sustainability indicators including environment, water and energy, socio-cultural factors and management.

The framework developed in this paper employs unique strategies, compared with other approaches, as shown in Table 1, to establish a comprehensive local sustainability framework which may also be applicable to other regions which have hot, dry climates. Current applications can also be enhanced by implementing feasibility indicators for the future.

This framework presents three dimensions (Table 1), involving various strategies to tackle locality-specific issues. While other frameworks in this table have focused on designing assessment tools which include urban sustainability factors, these studies did not involve the use of different strategies such as urban planning and semi-standardised domestic home designs. Other research e.g. (Aldossary et al. 2014, 2017) designed dimensions focussing on low carbon homes for hot, dry, arid regions: a case study applied in Saudi Arabia looked to reduce high energy consumption in this region, proposing to reduce the footprint of domestic homes.

2.1. Local context: a case study in the Iraqi capital Baghdad

This subsection will present the case study area being considered, in order to highlight the multiple problems in this context and therefore, to show how the design of the new framework in this paper will contribute and combat the existing and future challenges of this region.

Iraq is classified as a hot, dry, arid region. Temperatures can vary significantly, for example, in the summer months temperatures frequently exceed 50 °C. Meanwhile, the temperature in the winter reaches to 5 °C and even below 0 °C. There is little rain in the summer and, in the winter, rain fall amounts to less than 40 mm between November and April.

The population of Iraq is predicted to double in size from 38.5 million in 2017 to about 70 million by 2030. Baghdad is the capital of Iraq and it houses a quarter of the total population. The population of Baghdad is predicted to reach 14 million by 2030, which will add to the city's problems including insufficient public services and infrastructure, and exacerbating undesirable environmental impacts (Roberts, 2008; Bryant, 2006).

Table 1. Uniqueness of the study in comparison with two other frameworks.

Category	Dimensions covered	Similarities	Differences
A sustainability framework for hot dry regions: Baghdad case study (current study)	(a) Planning and land use (future vision); (b) Domestic future requirements (semi-standardized); and (c) Urban sustainability indicators to enhance current and future requirements.	(1) Identify domestic features of low energy housing projects. (2) Elicit a set of urban sustainability indicators. (3) Minimise energy consumption in the domestic sector and reduce CO_2 emissions.	(1) Satellite cities around the capital and green belt areas. (2) Three main strategies to create a comprehensive framework for the design of homes in Iraq. (3) Specific concepts for the design of homes in Iraq. (4) Design strategies applicable to other hot climatic regions (5) Domestic strategies focus on local socio-cultural aspects guided by expert consultation (6) Mean rank for each indicator and strategy rates their level of importance Strategies and indicators agreed by an expert panel
The development of an urban sustainability assessment framework for Iraqi cities (Ameen and Mourshed 2017; Alyami et al., 2015)	Establish assessment tools for Iraqi urban projects which include3 main dimensions, indicators and sub-indicators under the main categories: (1) Environmental:7 main indicators (2) Social: 9 main indicators (3) Economic: 2 main indicators		(1) Offers a number of urban sustainable indicators (2) Rated these factors to deliver urban development projects in Iraq. (3) Achieves a multi-staged process for establishing a local assessment tool in Iraq
Low carbon domestic design framework for sustainable homes in Saudi Arabia (Aldossary 2015)	(a) Properties of low energy housing design; (b) Onsite renewable energy; (b) Investigated socio-cultural factors.		(1) Offers specific design concepts and strategies to fit four dimensions (2) Identify the best techniques related to the design concepts (3) Promotes the use of on-site renewable energy, e.g. PV solar.

Iraq has been selected in this study as a representative politically unstable country due to the severe post-war damage to its infrastructure and the ongoing terrorist attacks in its cities, specifically the capital Baghdad. Despite several efforts to rebuild Iraq's cities, more intensive efforts are needed to enhance the quality of life and mitigate the current problems, such as high energy consumption and demand, and traffic congestion, environmental pollution, and lack of effective planning. Of these problems, the shortage of electricity is one of the most common issues in developing countries. In particular, Iraqi citizens suffer considerable shortages in electricity, which affects their quality of life and their economy.

Since 2003, Baghdad has experienced population inflation, which includes increased demands for energy and transportation. For example, before 2003, the number of vehicles in Baghdad was proportional to the basic design of the city. The number of vehicles in the capital has since increased more than ten times, while the basic design of the city and its roads have not developed sufficiently to mitigate this increase. The percentage of the increase number of vehicles in Iraq is about 300%. This large increase in the number of vehicles is a result of the improved economy after the regime change in 2003 and also due to the end of the international sanctions, as well as the lack of public transport and the huge rise in population.

In light of these locality-specific issues in Iraq, especially in the capital, it is an essential to identify radical and sustainable solutions to mitigate the current crises. Consequently, this study will design a comprehensive sustainable framework that covers the basic aspects, including planning, transport, housing, and issues of economy and environment. This study aims to address the issues of sustainability gradually in Iraqi cities, especially Baghdad, to mitigate the current problems and secure a better environment for future generations.

3. Methodology

This research will focus on establishing of a comprehensive sustainability framework considering specific unique locality issues for developing economies, including unstable countries. An example of this is Iraq, which, as described previously, needs a specific roadmap/framework for own its cities, in particular the case study area of this paper is the capital Baghdad.

However, urban sustainability development factors are considered a controversial issue in developing countries. Because of this, a consensus is required to implement new plans/frameworks. One way to achieve this consensus is based on consultation with a panel of experts. There are three commonly used consensus techniques (Hsu and Sandford 2007; Habibi et al., 2014; Aldossary et al., 2015): (a) survey (Delphi rounds), (b) group meetings, and (c) survey and meeting.

Numerous approaches can be used to consult with experts such as, face to face interviews, focus groups and the Delphi consultation approach. The Delphi technique is best used in situations where expert opinion is required from a range of professions such as sustainability, engineering and policy making (Giannarou and Zervas 2014). One of the most significant advantages of using the Delphi technique is participant anonymity, this levelling out the effects that dominant individuals may have within the group of experts (Hsu and Sandford 2007; Aldossary et al., 2015). Online communication by e-mail also helps maintain confidentiality.

This research methodology was used to (a) develop a sustainable framework planning technique applicable to the situation in Baghdad, and (b) to identify suitable semi-automatic housing requirements for new domestic projects and also a set of urban sustainability indicators. As such, the experts participating in the Delphi-rounds have a background in construction, urban planning and urban sustainable development (Habibi et al., 2014; Giannarou and Zervas 2014).

This study has selected the Delphi technique (Aldossary et al., 2015), a survey approach, normally used to reach a consensus when complex issues are involved. Using this approach, experts can express their opinions freely, avoid face to face meetings and eliminate any possible conflict between them. Carried out over several rounds, this gives participants the opportunity to observe a variety of viewpoints and suggest additional factors to reach consensus. It allows respondents to control feedback by providing them with information offered in the previous round, in addition to statistical information. The applications of rounds are designed based on Likert-scale choices, the statistical analysis used to measure the results making use of mean ranks and standard deviations.

The Delphi technique has been chosen over others, for a variety of reasons not least that it has been used extensively in the sustainable urban development field domain. One of the main reasons for using the Delphi technique is that it can generate and forecast innovative ideas to inform the hypothesis for the research (Giannarou and Zervas 2014). Other advantages of the Delphi Technique include:

- **Sequences of rounds:** this technique is normally a 2 or 3 stage process, the aim to achieve consensus by the end of the process. This gives participants the opportunity to see their colleagues' points of view, to revise their judgment or stay as they are and to suggest additional insight and further details if need be. Anonymity: Respondent anonymity is preserved during the Delphi process to avoid any influence of position or dominance by any expert. In this context, this application allows experts to express and add their viewpoints freely without any pressure from others.
- **Controlled feedback:** The Delphi organiser receives the experts' view after each round and conducts the relevant analysis in order to proceed to the next stage. This eliminates the need for personal exchanges and facilitates the transition to the next stage in the process. Electronic questionnaires are used to allow easy exchange of questions, to conduct communications between experts online and to carry out the analysis and transition of information smoothly. This makes the technique cost and time effective.
- **Statistical analysis of responses:** Because the Delphi technique deals with complex issues, it is essential to analyse responses reliably and accurately. The following descriptive statistics, the mean, median, standard deviation (SD) or interquartile range (IQR) are used in this case. The SD's of Likert rating scale responses for each indicator in each round are used where each SD should be between 0 and 1 ($0 \leq$ SD ≥ 1) (Giannarou and Zervas 2014; Galipeau et al., 2017). The rounds involve experts narrowing down their decisions to achieve consensus.

Based on the results of the consensus approach, statistical methods will be employed to measure the degree of consensus, in order to develop the new framework.

Finally, in order to validate the proposed comprehensive sustainability framework, this study has conducted semi-structured interviews with 15 intra-organizational leaders to ensure its ability to meet locality-specific problems, in light of current and future challenges.

4. Achieving a consensus in development of a sustainable framework

A sustainable framework must include a set of urban sustainability indicators to improve well-being and semi-automatic/standardise housing criteria to promote conservation of energy in the domestic sector. The Delphi approach was used as with this, experts can also be provided with evidence regarding consensus, which can be achieved anonymously online, one of the most important reasons for using the Delphi approach to gathering data is anonymity. Online communication can also be maintained confidentially. The Delphi technique requires consultation with a number of different experts over three rounds: (a) brainstorming ideas to suggest, organise and assess various planning strategies; (b) trimming-down of ideas to reduce the number which can then be further refined by the addition of points and techniques, and (c) a final-stage round to assess the final indicators

and strategies and to reach a consensus in the context of the research aim.

In the remainder of the next section, the process of the Delphi rounds will be discussed to illustrate the sequence of rounds, the selection of the experts' panel, and the sections of the Delphi questionnaires.

4.1. Expert panel selection

For a successful Delphi procedure, it is important that qualified experts are properly selected (Aldossary et al., 2015). It is also essential that the correct number of experts are engaged. In response to this, the size of the panel in this research is in line with the recommended guidelines followed in a number of previous Delphi studies. Hsu and Sandford (2007) reported using less than 50 consultants while Masoso and Grobler (2008) proposed that panels averaging between 10 and 30 provide an acceptable range. Other studies suggest between 10 and 18 experts (Maguen et al., 2012; Aldossary et al., 2015). 50 experts carried out the Delphi process in this study, invited via face to face meetings or email. Figure 1 shows the process used to select the expert panel.

All the experts who agreed to take part in the study, agreed to participate in the three Delphi rounds. According to Hsu and Sandford (2007) and Aldossary et al. (2015), experts should be selected from various field including decision-makers, academic and private sector/-industries and should include international professionals as the Delphi technique is a panel decision engine that requires qualified experts with professional experiences in locality-specific problems (Maguen et al., 2012). This was a defining feature of the selection process resulting in experts from multiple fields as detailed above. Their background knowledge and experience differ according to their organization and their particular role as summarized below (see Table 2):

(a) Academics: Depending on their research fields, these experts can bring unique ideas and strategies to the discussion that they may have encountered developed countries as many completed their PhD's in different developed countries such as the UK, USA and Australia. Academics were selected from the University of Baghdad, Al-Nahrain University, Al-Mustansyria University, the Centre of Urban and Regional Planning, Technology University, and the University of Diyala.

(b) Decision-makers: Decision-makers were defined as those in government ministries having policy-making power. They included one minister, managers, heads of departments, engineers, architects, urban designers and managers of municipalities working in ministries of water resources, housing and construction, the Centre of Statistical Organization and other related ministries. Some experts recommended other specialists as suitable participants. The importance of engaging with those experts lies in their practical experience, the reality of locality-specific issues, policies

and regulations. This relates to difficulties in establishing new plans in terms of national schemes about low energy construction, sustainable plans and urban sustainability indicators, which have already been used in many developed regions.

(c) Private sector (NGO): Experts such as engineers, contractors and consultants can engage and give a feedback according to their practical experience. Their participation in the Delphi rounds focuses on how to link sustainable plans/urban development to the private sector and future urban projects. A number of experts from construction companies and general contract offices in the private sector were involved. International industrial representatives were also involved from foreign companies and international organizations.

4.2. Description of the questionnaire

A questionnaire was designed for the three-round implementation of the Delphi process, which included several sections: planning strategies related to future developments, new strategies for domestic projects towards low energy housing, and a set of urban sustainable development indicators, including environmental, social, and economic aspects.

The Delphi technique was then conducted with 50 experts (as described in the previous section). Three round were performed and, between rounds, the results are summarized, and, eventually, consensus will reached through the process of these rounds or until the number of new points offered decreases (Habibi et al., 2014). Consensus was reached by the end of round three. Each individual round had particular features as explained below:

- R**ound one:** brainstorming ideas relevant to the design of a sustainable plan for development in Baghdad. This comprised four main sections: (a) Planning for new urban development areas around the capital including satellite cities for multiple purposes e.g. residential, industrial, commercial and administrative), (b) the use of semi-automatic criteria in the domestic sector to move towards low energy housing, including on-site renewable energy and a decrease in the size of houses, and (c) a set of urban sustainable indicators to develop socio-cultural factors designed to address human-well-being. Each expert assessed how important each category was using a Likert rating scale from 1 to 5. The categories/indicators which were not considered to be significant were dismissed. Each expert then was asked to suggest and add further details and planning strategies which were not already included in the questionnaire, based on their experience.
- **Round two**; a narrowing-down round. The process described above was repeated using the newly suggested indicators and planning strategies. Indicators and strategies which were considered unsuitable were removed. The expert panel re-evaluated the strategies and
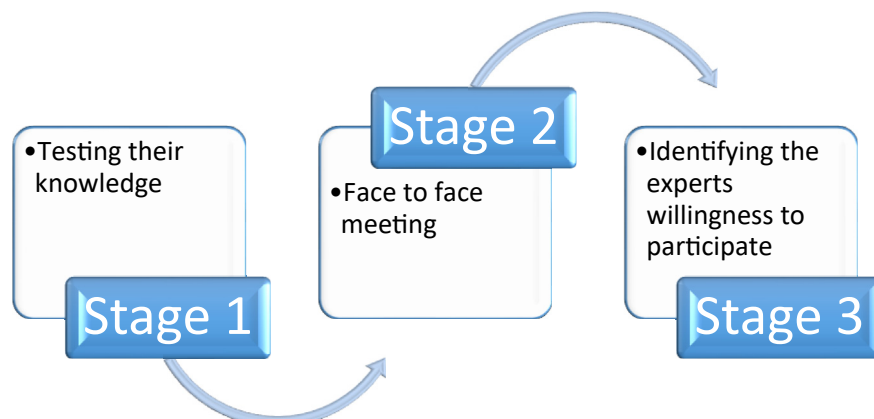

Figure 1. The process of selecting the expert panel.

indicators, rated and evaluated those points put in place from other experts in the first round.

- **Round three**; the purpose of this round was to rate the categories, the indicators and sub-indicators, of the three dimensions e.g. planning strategies, future domestic design and a set of urban sustainability indicators, as a final assessment to reach consensus (Hsu and Sandford 2007).

In round three, the panellists re-rated the additional factors added from the second round. It is believed that statistical analysis such as using the standard deviation applied for 3 rounds allow a consensus to be reached. Some previous studies claimed that continue with more than 3 rounds can be resulted in bias forming (Ba 2000).

The three rounds of questionnaires were divided into three main categories as mentioned in the previous section.

The questionnaire for each individual round comprised three main sections: (1) planning strategies and future vision for the capital city, (2) housing/domestic sector regarding semi-automatic design requirements; strategies for on-site renewable energy and (3) a set of urban sustainability indicators which will also include strategies for on-site renewable energy. Each of these sections is described in more detail below:

- **Planning strategies and future vision:** this section includes planning strategies that help urban designers and decision-makers to plan the shape of the future city. With reference to Baghdad, a high density and crowded city, a sustainable framework should include plans for establishing satellite cities.
- **Housing design, requirements and strategies:** this section includes categories designed to establish the minimum requirements for new domestic projects. These strategies are related to the use of on-site renewable energy and low energy housing designs.
- **A set of urban sustainability indicators;** a set of indicators have been used in this framework, covering the environment, water, energy, transportation and infrastructure, social, economic, safety, innovation and management, in addition to on-site renewable energy such as solar energy as PV systems. Experts assess each indicator and technique individually and add further feedback if necessary.

The results of these questionnaires will then be analysed and the results used to design the proposed sustainability framework (Section 3).

5. Results and discussion: designing a framework for sustainable urban development projects

This section presents the analysis of the Delphi process described in Section 2, reporting on results of each of the rounds.

This study used the Delphi technique, a systematic method applied over three rounds with the aim to achieve a consensus amongst expert

Table 2. Categories of the expert panel.

	Organization	Percentage %
Decision -makers	(a) Council of ministries (b) Mayoralty of Baghdad (c) Ministry of water resources (d) Ministry of water resources (e) National centre for engineering consultancy (f) Ministry of planning (g) Ministry of housing (h) Ministry of municipalities (i) Ministry of municipalities (j) Ministry of electricity (k) Ministry of electricity (l) Ministry of electricity (m) Ministry of electricity (n) Renewable energy centre (o) National Investment committee	32%
Academics	(a) University of Baghdad (b) Al-Nahrain university (c) Al-Mustansyria university (d) University of Karbla (e) Centre of urban and regional planning (f) University of Kufa (g) Technology university (h) Environment research centre (i) University of Wasit (j) University of Erbil (k) University of Dylia	30%
International experiences	(a) Construction centre- Najran university/Saudi Arabia (b) DBG Dr. Bluhm GmbH company/Germany (c) Hanwah/Korean construction company (d) NB-consultancy (e) University of Nottingham (f) Vienna city council (g) University of Strathclyde	%16
Private sector (NGO)	(a) UN-Habitat-Iraq program (b) Bunatt Organization (c) Dar-Al-Imara consulting Engineers (d) Al-Ghalaow construction company (e) Alamco construction engineering centre (f) Al-Qaram construction company (g) Adnan group company (h) Consultation syndicate engineering (i) Alsaqa'a Co. For general Contracts	22%
All total categories		100%

Table 3. The main dimensions of the proposed framework.

Framework items	Main categories/criteria	Total number of indicators	Status of consensus
Future city	Planning and land use	11	✓ Achieved
Domestic future requirements	Housing patterns	12	✓ Achieved
Urban sustainability indicators	Environment, social, and economy factors	63	✓ Achieved

participants. The mean rank and standard deviation were selected as the most common statistical methods to measure consensus for each individual factor/indicator in this framework. A Likert rating scale was used for the three dimensions, including the indicators and sub-indicators, where 1 = Not important; 2 = Little importance; 3 = Moderately important; 4 = Important, and 5 = Very important. The statistical analysis including Mean rank and Standard Deviation (SD) have been used in this study to show the consensus through three rounds of Delphi technique.

Table 3 and Table 4 show how and to what level consensus was achieved amongst the experts. The main dimensions and strategies in the proposed framework, were agreed on by the expert panel as relevant for a local framework for Baghdad. In this context, a locally sustainable framework can be adopted by decision-makers and professionals in the construction sector to meet future needs and requirements as shown in Table 3.

Planning strategies and land use were also evaluated by the experts over the three rounds. With reference to the concept of satellite cities around the capital to mitigate pressure on the city, 29 of 50 (58%) experts rated this strategy as very important, achieving a mean rank of 4.33. The creation of a green belt was also voted as very important by 75% of the panellists. They suggested that satellite cities and the green belt should be located around the capital, in other words in suburban regions in order to keep the optimum size of the city and avoid more pressure on existing city's applications.

It was found that the suggested strategies, such as the concept of establishing cities around the capital, the green belt, and a few additional indicators from the experts, were considered to play a vital role in replacing the traditional plans lack in depth involving sustainability concept to tackling the existing and future challenges, including saving energy and replacing the traditional methods by adopting renewable solutions such as investing.

Another significant subject in the survey, is how to design future housing projects which have reduced house sizes, in order to monitor and reduce cooling and heating requirements. This study suggested a variety of building areas and number of rooms/spaces, the panellists voting to provide multiple housing areas within the same project. The minimum domestic design requirements for a single-family house was voted as 150–200 sq. metres (mean rank 3.9). The experts rated mix-pattern dwellings as the most significant feature (mean rank = 4.25). Affordable housing and improvements in the quality of the indoor climate were suggested in the second round as additional factors, consequently voted as very important at means of 4.7 and 4.64, respectively. Several different strategies can be adopted to standardise domestic buildings and create low energy housing as well the use of on-site renewable energy.

Three Delphi rounds were used to develop the framework. Each round aimed to reach consensus and rate the list of suggested indicators. The new sustainability framework will be built on ratings of the factors proposed in the three Delphi rounds. The factors receiving low ranks will not feature in the new framework. The final design of the proposed sustainability framework will be presented in section 5.2.

5.1. A set of urban sustainability indicators findings

This section will describe the set of sustainability indicators that were generated from the Delphi Survey (Described in Section 2). In comparison with the prior studies, the indicators elicited by this work are

significant because they consider locality-specific issues in the target context of war-torn countries. In previous work, many researchers have identified new assessment tools (Alyami et al., 2015; Fawzi et al., 2016; Aldossary et al., 2015) which include different rating system for a set of urban sustainable development items such as environmental, water, energy, social and economic, impacting their locality-specific issues regions. A few of researchers, however found that these urban sustainability assessment tools are not fully applicable for all regions due to locality-specific condition. For example according to Pearl UAE guideline and QSAS for Qatar, these guidelines rated water indicator is the most important priority, because of climatic conditions, while BREEAM and LEED guidelines identified environment and energy are the most important indicators.

Many of the suggested indicators were considered very important or important, and included categories such as the environment, water, energy, transportation and infrastructure, social-cultural, economy, innovation and safety and management. In terms of environmental indicators (Table 4), they include six factors from the environmental indicators and four factors from the ecology indicator. Most of these factors were rated very important and important, the average mean rank between 4 and 4.5. The results show the top factor in this category was to reduce pollution, ranked 4.85, followed by green areas e.g. parks, rated 4.81 out of 5. This was followed by waste separation and recycling, rated at 4.77. The least important item was water bodies, rated 4.04.

- Water indicators, also the most significant factor in hot dry regions including Iraq. Because of, Iraq has recently experienced water shortages because of an increase in desertification. There are different strategies to monitor water usage for future applications and enhance the efficiency of the water system. This category involves 5 factors. The findings revealed that 'Water conservation', 'Provide onsite water quality' and 'efficient water systems' were deemed to be very important with mean ranks of 4.8, 4.71 and 4.7, respectively. The remaining factors 'diversity of water resources' and 'wastewater recycling' were rated as important with means of 4.14 and 4.45, respectively as listed above in Table 4.

- Regarding Energy indicators, this study emphasised the minimisation of energy consumption as one of the most important factors to reduce CO_2 emissions and environmental pollution. The findings of three Delphi rounds showed that 'Use alternative renewable energy e.g. PV solar' and 'minimising energy consumption' were rated the most important indicators with means of 4.57 and 4.55, respectively. This study also focused on the using of solar energy techniques for new buildings, but some suggested techniques were not rated as functional e.g. 'Use solar wall techniques' and 'PV on external windows'.

- In terms of Transportation, infrastructure and public services and utilities, these included public transport, walkability, and safe streets. The most popular factors were 'mitigate traffic congestion' and 'walkability' (means = 4.77) to tackle the major problem of traffic congestion in the capital Baghdad. The third important factor was 'diversity of transport modes' (mean = 4.53) as compensation for the acute shortage of alternative transport solutions including buses, subways and trains. The lowest rated factor was 'use of private car' (mean = 2.89) as an essential method of transportation. Current acute traffic congestion is the result of the use of private cars by local families as there are no other modes of public transport available.

Table 4. Indicators and sub-indicators of a set of urban sustainability factors.

Indicator	Sub-indicators	Round 1		Round 2		Round 3		Status
		Mean	SD	Mean	SD	Mean	SD	
Environment	Ecology							
	Reduce pollution	4.72	0.53	4.85	0.36	-	-	Achieved
	Vegetation cover and green areas	4.7	0.53	4.81	0.5	-	-	Achieved
	Site micro-climate	4.37	0.69	4.45	0.66	-	-	Achieved
	Waste separation and recycling	4.6	0.65	4.77	0.46	-	-	Achieved
	Use sustainable construction materials	4.26	0.75	4.34	0.7	-	-	Achieved
	Shaded streets and protected open spaces	4.36	0.71	4.51	0.66	-	-	Achieved
	Water bodies	4.01	0.86	4.06	0.86	-	-	Achieved
	Balance ratio between green spaces and built-up areas	4.56	0.59	4.72	0.56	-	-	Achieved
	Conservation of agriculture land	-	-	4.74	0.55	4.71	0.6	Achieved
Water	Water conservation	4.77	0.53	4.83	0.42			Achieved
	Onsite wastewater recycling	4.32	0.71	4.58	0.66			Achieved
	Provide onsite water quality	4.67	0.6	4.75	0.47			Achieved
	Diversity of water resources onsite	4.07	0.8	4.21	0.83			Achieved
	Efficiency water system	-	-	4.6	0.62	4.8	0.44	Achieved
Energy	Minimise energy consumption	4.52	0.69	4.58	0.63			Achieved
	Use of insulation	4.4	0.73	4.58	0.63			Achieved
	Use alternative renewable energy	4.44	0.7	4.7	0.6			Achieved
	Smart energy management	4.19	0.79	4.31	0.89			Achieved
	Smart and safe energy distributed system	-	-	4.06	0.75	4.34	0.64	Achieved
	Smart solar heating water	-	-	4.22	0.83	4.24	0.8	Achieved
	Use the PV on top of the building	4.33	0.77	4.35	0.77	-	-	Achieved
Transportation	Promote of public transport	4.75	0.45	4.89	0.37	-	-	Achieved
	Walking as a mean of mobility particularly nearby distance	4.34	0.7	4.89	0.37	-	-	Achieved
	Use of private car	3.08	0.94	2.7	0.81	-	-	Achieved
	Mitigate traffic congestion	4.7	0.56	4.83	0.42	-	-	Achieved
	Provide bicycle streets networks	3.91	0.9	4	1.05	3.96	0.98	Achieved
	Safe streets network onsite	4.27	0.74	4.43	0.77	-	-	Achieved
	Diversity transport modes	4.67	0.63	4.83	0.42	-	-	Achieved
	Public car parking availability	4.38	0.77	4.45	0.72	-	-	Achieved
Public services and infrastructure	Provide activities areas for the elderly and disabled	4.2	0.81	4.45	0.72	-	-	Achieved
	Designated activities areas for children's play areas	4.49	0.64	4.77	0.46	-	-	Achieved
	Provide recreational facilities	4.36	0.72	4.6	0.53	-	-	Achieved
	Promote cultural activities	4.04	0.85	4.21	0.81	-	-	Achieved
	Develop healthcare centres	4.24	0.61	4.66	0.55	-	-	Achieved
	Emergency paths network	-	-	4.42	0.71	4.4	0.6	Achieved
	Use of camera security system in motorways	-	-	4.55	0.69	4.62	0.6	Achieved
Social and cultural	Preservation of traditional building	4.55	0.72	4.6	0.65	-	-	Athieved
	Promote traditional design for the new buildings	3.98	0.84	4	0.87	-	-	Achieved
	Provide the hierarchy in public and residential places	4.07	0.82	4.19	0.75	-	-	Achieved
	Promote use of natural lighting and for diversity buildings	4.41	0.68	4.43	0.66	-	-	Achieved
	Promote intensive social programs	4.57	0.62	4.57	0.6	-	-	Achieved
	Provide social awareness programs through educational curriculum	4.55	0.59	4.53	0.6	-	-	Achieved
	Stakeholders' participation in decision-making	4.53	0.64	4.51	0.6	-	-	Achieved
	Skills improvements programs, women involvement	-	-	4.18	0.71	4.23	0.73	Achieved
	Fines for violators	-	-	4.7	0.57	4.64	0.56	Achieved
Innovation factors	Smart shading devices	3.91	0.8	3.91	0.78	-	-	Achieved
	Use of innovative methods	4.21	0.7	4.37	0.61	-	-	Achieved
	Use smart traffic and time management system	4.38	0.75	4.32	0.65	-	-	Achieved
	Provide smart guidelines in the buildings	4.04	0.85	4.26	0.76	-	-	Achieved
	Adopt Building Information Modelling (BIM)	-	-	4.17	0.77	4.14	0.8	Achieved
Economic factors	Promote investment	4.63	0.58	4.62	0.58	-	-	Achieved
	Develop the tourism sector	4.45	0.66	4.55	0.69	-	-	Achieved
	Employment	4.74	0.5	4.75	0.51	-	-	Achieved
	Foreign experience	4.11	0.8	3.81	0.83	-	-	Achieved
	Promote use of local materials	4.56	0.64	4.7	0.5	-	-	Achieved
	Diversity of economic activities instead of single economy (oil)	-	-	4.87	0.44	4.92	0.27	Achieved
	Cooperating between public and private sector	-	-	4.58	0.6	4.64	0.55	Achieved
	Commercial awareness's programs onsite	-	-	3.87	0.91	4	0.69	Achieved

Table 4 (*continued*)

Indicator	Sub-indicators	Round 1		Round 2		Round 3		Status
		Mean	SD	Mean	SD	Mean	SD	
Management factors	Reduce Life Cycle Assessment (LCA) cost	4.24	0.7	4.47	0.66	-	-	Achieved
	Ensure a long- term maintenance and management	4.59	0.55	4.72	0.56	-	-	Achieved
	Use an electronic governance system	4.57	0.62	4.64	0.68	-	-	Achieved
	Establish postal code system	4.21	0.72	4.3	0.86	-	-	Achieved
	Create various opportunities for local people to participate in multiple activities	4.39	0.77	4.3	0.77	-	-	Achieved
	Comprehensive updates schemes	-	-	4.4	0.76	4.62	0.56	Achieved

- Cultural factors, this category includes four urban factors that deal with community culture. The most important indicator was 'preservation of traditional building' rated with a mean of 4.58. This was followed by 'promote the use of natural lighting for diversity building' (mean = 4.42). The lowest rated factor was 'promote traditional design for the new buildings' (mean = 3.99). In the context of Social factors, there are three urban indicators in terms of social context, a further two indicators added by the expert panel. The most important factor was 'fines for violators' (mean = 4.67) including those who tamper with public services, violate laws and regulations thus increasing social problems. The next important indicator was 'provide social awareness programs through educational system (curriculum)' (mean = 4.57). The remaining indicators were considered to be the least important and included 'promote intensive social programs', 'stakeholders' participation in decision–making', 'skills improvements programs', and 'women involvement'.

- In terms of Innovation factors, the five factors related to the innovation indicators were all rated as less important because the experts considered this category as secondary to the need to enhance essential requirements. That said, the most important indicator was 'Use of innovative methods' (mean = 4.37) because of the aim to develop current and future applications.

- Another issue Safety and security factors, the experts rated safety and security indicators as a significant issue because of policy problems and deteriorations in security. Four safety indicators emphasised identifying protection policy, both at the city and individual building level. The most important indicator in this context was 'provide camera security onsite' and 'provide smart existing doors' (means = 4.49) because of the aim to improve difficult living conditions in politically-unstable regions. 'Fire alarm system' was rated to be the important factor.

- One of the most important factors is Economic factors, this category includes eight indicators all of which were rated as important to the development of the local economy. That said, two were rated as less important than the others; 'foreign experience' and 'commercial awareness programs onsite' (means of 3.96) because of encouragement from the experts to employ locals to reduce the high percentage of employment. 'Diversity of economic activities instead of a single economy (oil)' has occupied the most important position (mean = 4.9) among a set of overall urban sustainability indicators due to the sharp decrease in the state budget which is dependent on the export of oil, this declining from time to time. As a result, this issue has negatively affected the labour market and the economy of the country. This was followed by, 'employment' (4.75) as the second important factor, strongly related to the previous indicator.

- Finally, Management factors, there are six factors in this section which were rated as important or very important, the experts considering these key to enhance public services and facilities for the local population. One of the most significant indicators was 'ensure long-term maintenance' (mean = 4.66) followed by 'use an electronic governance system' (mean = 4.61) because of the need to change the traditional system. In addition, 'mitigate traffic congestion and 'comprehensive updates schemes' were rated as very important factors (means = 4.51) due to the essential need to mitigate traffic

problems and develop institutional work i.e. municipality activities and research, as illustrated in Table 4.

5.2. Development of a comprehensive sustainability framework

The new sustainability framework comprises 86 different factors organised into three hierarchical levels, as shown in Figure 2. The first dimension is future vision, this consisting of two major strategies, planning strategies and land use, and 11 sub-indicators/strategies. The second dimension includes 3 key indicators and 12 sub-indicators, the third dimension including 12 main indicators and 63 sub-indicators.

The following figure details the three main categories, each section including many strategies/indicators which could constitute a locally sustainable framework for the future development of the built environment in Baghdad. The three main categories are: planning and future vision, semi-automatic criteria for low carbon domestic sector housing, and a set of urban sustainability indicators encompassing the environment, water, energy and socio-cultural indicators in order to enhance well-being at a city level.

In response to this, the proposed framework in Figure 2 details different strategies including satellite city projects and a green belt around the city.

Multi-purpose satellite cities and a green belt around the capital: planning and land use play an important role when developing a city plan to meet future requirements including population growth, traffic congestion and environmental pollution. Planning needs to mitigate pressures in the capital city such as high population density and traffic problems while still considering the optimum size of the city. Features which may provide a comprehensive solution and form the shape of a future city, include low energy housing and the use of on-site renewable energy. Suggestions also include establishing a green belt around the city to combat climate change, help to enhance weather conditions and observe the size of a city. One of the problems of existing applications in Iraq is poorly designed strategies to mitigate current and future challenges. This vision for planning and land use strategies could therefore play an important role in the development of the city.

As Iraq has a hot dry climate, homes need to be built which will reduce energy consumption because this sector currently makes the highest energy demands. One of the most significant problems for existing homes is their poor design. Minimum requirements involve housing area, shading techniques and a minimum number of spaces/rooms required for the average Iraqi family. Air conditioning accounts for almost 70% of the energy demand in the domestic sector. These strategies would allow for the use of innovations such as on-site renewable energy, solar PV systems, this helping to establish a semi-automatic framework for housing.

A set of urban sustainability indicators for well-being: The classification of various urban sustainability factors depends on their priority according to the level of importance scale and evaluation process. For example, current guidelines and criteria are not sufficient to meet future requirements such as traditional methods for planning, housing features, environment pollution, water shortages and intensive energy consumption. Therefore, a new set of effective urban sustainability indicators will play an important role enhancing well-being and tackling current and

future challenges. The new comprehensive sustainability framework includes dimensions, indicators, and sub-indicators as illustrated in Figure 2.

5.3. Prioritisation of the urban sustainability indicators

This section describes the prioritisation given to urban sustainability indicators. These are the more important factors required to mitigate problems in the local context. Environmental and ecology indicators were deemed the most important followed by transportation, public services and infrastructure factors (4.73). Water factors were rated as the third important priority because of a recent decline in rainfall percentage and global concerns about climate change, while the previous studies such as (Ameen et al., 2015) was deemed water indicator the most important indicator and environment indicator rated as the second priority. Energy and solar energy techniques were voted as the fourth important priority, with an emphasis on renewable sources such as solar

energy. The least significant factor among the ten indicators was innovation possibly because of the need to identify essential factors required to improve the city. The remaining factors were also rated at different mean ranks as illustrated in Table 5. This section discusses the order of importance of factors starting with the most important challenges according to expert feedback via the Delphi rounds.

6. Validation of the comprehensive sustainability framework

The validation stage followed the development of the framework. The methodology for this validation was based on a series of semi-structured interviews carried out with 15 intra-organizational leaders from a variety of organizations and 7 intra-organizational leaders from official government departments charged with the promotion of sustainability practices. These leaders were responsible for promoting, planning, developing and implementing schemes/plans regarding environmental, social and economic sustainability issues in their respective organizations.

Figure 2. Local sustainable comprehensive framework for Baghdad (LSCFB).

Table 5. Rankings of urban sustainable indicators.

Indicators	Average/Mean	SD
Environmental and ecology indicators	4.78	0.45
Water indicators	4.67	0.55
Energy and solar energy indicators	4.51	0.65
Transportation, public services, and infrastructure factors	4.73	0.73
Cultural indicators	4.11	0.67
Social factors	4.16	0.58
Innovation indicators	4.1	0.83
Safety and security indicators	4.44	0.66
Economic indicators	4.46	0.66
Management indicators	4.5	0.69

The aim of the validation stage was to ascertain if the developed framework is correct and suitable for the Iraqi context. This was done by inviting intra-organizational leaders to comment on their understanding of, and acceptance of, the framework in their context. Perceptions were also gathered regarding proposed strategies and indicators, and how they can be applied. The profile of leaders within different Iraqi organizations, in particular in urban development and construction sector who were interviewed are listed in Table 6.

All those mentioned in Table were interviewed and a summary of these interviews is presented below:

The first expert **'A'** as in Table 6, a leader of water resources and management in the ministry of water resources mentioned;

'I totally agree with the main dimensions of the proposed framework to mitigate local current and future challenges including water issues in Iraq'.

In addition, the minister recommended adoption of the framework as a roadmap for local government to be used as a strategy to solve the most important local challenges. There is wide consensus by government officials and policy-makers regarding water shortages as a new challenge, one that has emerged in recent years due to climate change and reduced rainfall.

The second expert **'B'**, this expert expressed his opinion regarding the understanding of the framework

'I highly recommended adopting this framework as a governmental guideline through a qualified teamwork engage with the governmental committee to implement the national strategy for the capital Baghdad'

Interview with **'C'** described the understanding of the framework effectively claiming that

'This framework is considered a key role to develop new urban zones and improve current city applications unless the politically problems impact directly to pose the implementation of the development frameworks'

Participate **'D'** agreed to the three dimensions of sustainability by saying:

"Sustainability framework considers a comprehensive vision of how to develop the whole aspects of our cities and how it impacts directly to improve quality of life and human well-being on the wider local communities".

There are numerous local problems which need to be addressed via a specific roadmap to mitigate current and future requirements. This requires a practical knowledge about how to implement the new framework. The construction sector is considered more aligned towards sustainability dimensions e.g. environmental, social and economic. That said, intra-organizational leaders and policy-makers need to consider the full range of perceptions held by the community, in order to successfully implement this framework.

For instance, interviewee **'E'** mentioned that:

"A comprehensive sustainability framework is difficult to implement in this duration due to the politically unstable conditions in Iraq but it might be applicable whenever the local conditions will enhance towards a government of independent competencies that takes into account the main objectives of community development; citizen first, climate change and how to

Table 6. Profile of 15 intra-organisational leaders interviewed in Iraq.

Interview	Job title	Type of organisation
A	Minster of water resources	Ministry of water resource
B	Manager of national consultation engineering centre	National consultation engineering centre
C	Head of general secretary of prime minster	General secretary of prime minster
D	Head of urban studies institute	National institute of urban studies
E	Manager of housing studies department	Ministry of housing and construction
F	Leader of environmental sustainable development centre	Environmental sustainable development centre
G	Manager of urban design department	Mayoralty of Baghdad
H	Leader of renewable energy department	Ministry of electricity
I	Leader of construction projects	Ministry of planning
J	Leader of Iraqi engineers syndicate	Engineers Syndicate
K	Manager of Urban and Regional Planning	Ministry of planning
L	Leader of UN-HABITIAT in Iraq	UN-HABITIAT program in Iraq
M	Expert in Architecture Sustainable Design	National consultation engineering committee
N	Manager of construction company	Al-Mumar construction company
O	Project Officer and Research Associate in Advanced Sustainable Manufacturing Technologies/Academia	Centre for Advanced Manufacturing Systems, UK/University of Technology, Iraq

mitigate the undesirable impacts, responsible behaviour and social awareness programs, environment issues energy and carbon emissions and low energy homes towards renewable energy'

In addition, interviewee '**E**' described some of the important challenges concerning implementation including a comprehensive transportation plan before planning and carrying out of new construction projects/satellite cities around the capital. Moreover, providing public services and utilities and strict laws are the most important factors to create urban sustainable development and sustainable community.

Respondent '**F**', who is head of the Environmental Sustainable Development centre, expressed his understanding of sustainability framework by saying that:

"I believe there are three fundamental concepts which need to be addressed in any sustainability framework: effective governance, innovative technology and a SD educated community, these factors called sustainability wheels"

Interviewee '**G**' view pointed out that, sustainability frameworks become essential in order to mitigate major issues for the capital Baghdad by dividing this city into 3–4 main zones by ensuring the establishment of the green belt around the capital'

According to the long period of practical experience for the interview '**G**' also noted that;

'This city has suffered from harsh conditions impact directly to increase the level of degradation in multiple aspects such as public services and utilities, educational system and healthcare. Therefore, a comprehensive sustainability framework is considered a significant value to improve the quality of life-based on enhancing the level of public services, infrastructure, and social awareness programs through 14 municipalities inside the capital. However, a comprehensive sustainability framework can be adopted through sleeted various neighbourhoods, because a neighbourhood is a basic part from the city level, so that by selecting different parts of neighbourhoods across the capital'.

Interviewee '**H**' highlighted that;

'On-site renewable energy is an essential need to meet future requirements by adopting green architectural design within a ceiling roof in order to implement this technology for the coming years'.

Interview '**H**' noted that politically unstable conditions in Iraq impact directly to delay the effective planning towards sustainability in order to move from consumer houses into producer homes by using PV system for each individual dwelling unit. Also, 'H' revealed that the current challenge to provide governmental guideline regarding the financial policy to promote demand price marketing of PV cells in order to be applicable for the coming years, affecting to increase the quality of life and reduce CO_2 emissions.

The interview '**I**' and '**J**' claimed similar opinions regarding the understanding of sustainability framework. In terms of urban development projects:

'New criteria regarding the housing sector and construction project needed to update according to the current and future challenges. In addition, there is an essential need to adopt strict laws and establish environmental laws protection in order to create the basic part towards urban sustainable development'.

The interview '**K**'noted that;

'The understanding of a comprehensive sustainability framework including multiple directions of planning stages inside and outside the capital in order to tackle the current and future requirements, including the establishment the concept of satellite cites or integrated cities around the capital, in particular, administrative city in order to mitigate traffic congestion in the centre of Baghdad'.

Interviewee '**L**' recommended adopting urban agenda/strategies with intensive analysis by participating multiple organizations including the consultation committee of the prime minister with various directions such as the UN-Habitat leaders in Iraq, the mayoralty of Baghdad, and the ministry of planning to optimise the comprehensive plan. In terms of urban strategies they said;

'Sustainable urban criteria regarding the city's applications can be adopted to mitigate the current and future issues including green belts around the capital. Also, there is an essential need to adopt strict laws and establish environmental laws protection in order to create the basic foundation towards urban sustainable development'.

Interviewee '**N**' advised for the need update the construction projects criteria in Iraq according to green code or friendly environmental design as a conditional criterion in order to pose the random projects with lack of effective planning:

'The use of effective planning and a comprehensive sustainable framework can lead to developing this city within a short and long-term by understanding the weakness design in the current applications, then improving the existing and future requirements'

The last Interviewee '**O**'claimed that sustainable manufacturing strategy is the most important issue should be established in Iraq to mitigate multiple problems involving employment due to the economic crisis in this country;

'The understanding of a sustainability plan priority should be given to creating jobs opportunities by activating the private sector and setting up smart industrial cities around the capital, including the location of these projects, in order to ensure a comprehensive vision for the near and distant future, effectively contribute to mitigate the organization of the mother city and creation of sustainable urban development poles'.

The main reason for using semi-structured interviews was to gain a deeper understanding of the topics under discussion. Data analysis confirms that this framework is key to solving most local issues such as housing deficits, traffic congestion, high energy consumption and environmental pollution in the capital Baghdad. As such, this framework can be applied in the short and long term to begin to address the locality-specific problems described previously.

7. Conclusion

Iraq has the unique opportunity to develop own its cities using a wide range of natural resources and human power. There is also the opportunity to reduce energy consumption in the future in the domestic sector, to improve well-being and quality of life by adopting a set of urban sustainability indicators as described in this paper. To achieve this, a comprehensive sustainability framework for Baghdad city has been established, based on its climate conditions, culture and locality-specific issues.

This framework differs from others, as discussed previously, and illustrated in Table 1. Indicators and strategies have been assessed and investigated through three rounds of consultations. Several strategies are new and unique as they were a product of consultation with experts. In this context, this framework will be developed as a guideline reference for policy-makers, designers and city developers who need to design local frameworks applicable for the development of a sustainable comprehensive plan for Baghdad. The following recommendations can be made:

(a) Traditional Iraqi guidelines can be retrofitted based on sustainable solutions to mitigate existing and future issues, as described in the introduction, including the problem statement.
(b) There is an essential need to combat climate change in hot, dry climatic regions. Solutions should consider low energy criteria and strategies to semi-standardize domestic dwellings as well as

making maximum use of renewable resources such as solar energy. This is considered one of the most important issues, covered by the second dimension of the proposed framework in this research.

(c) There is the need to identify effective planning strategies to meet future requirements for new urban development. This should include new policies and techniques, enforcing the proposed concept of satellite cities around the capital for multiple purposes e.g. residential and industrial to mitigate major problems in cities including traffic congestion. This was the first dimension identified for the new framework.

(d) There is the need to adopt a set of urban sustainable indicators to improve the quality life for local citizens. These should be based on expert consultations and include a number of factors such as the environment, socio-cultural issues, water and energy, this dimension the third section in the proposed framework.

(e) Public awareness needs to be raised in terms of the development of low energy housing and reductions in energy consumption.

As such, low energy domestic homes are recommended in this framework due to the high level of energy usage in this sector.

This research has been validated using semi-structured interviews by engaging with an expert panel involving 15 experts from various organizations to validate the proposed framework in this paper, in order to make a reliable and applicable comprehensive sustainability framework for the current and future period of the times. The interviews emphasised gaining an understanding of the new framework and the perceived weaknesses of aspects related to this, e.g. in terms of future vision regarding planning new cities around the capital. Interviewees saw the need to establish legal foundations to inform policy-makers regarding forward planning.

The issue of the role of policy-makers in a sustainable built environment is facing more challenge due to the growing needs of the built environment in sustainable ways in order to mitigate current and future requirements. The urban construction needs various intra-organizational leadership at different levels that can adopt new strategies, recommends and rewards the adoption of sustainable practices. Social aspects should be addressed at the centre of the development strategies because culture, social, economic, and management factors impact directly to enhance the level of development role in different ways. The integration of the environmental, social, and economic dimensions of sustainability should, therefore, be adopted through the education system and public practices towards a sustainable framework/built environment.

The key contributions of this study are twofold: first, it investigates the urban sustainability factors and local priorities in a war-torn developing region such as Iraq; and second, it develops a methodology for developing urban sustainability frameworks, including expert consultation and consensus, engagement with the public's viewpoints of urban development factors and their priorities, for an appropriate assessment/comprehensive local framework.

This research investigates the views of the public in issues that have not been addressed in the literature. In addition, there are wide differences between the public's perceptions and the views of expert stakeholders. These public perceptions, gathered via a public survey, enabled factors to be identified and recognised before an expert consultation had taken place. The multi-method approach combined the public's views with expert consultations using the Delphi technique, which is a unique approach that can be adopted for the future development of local sustainability frameworks.

Sustainable manufacturing strategy is the most significant issue could be established in developing countries such as Iraq to mitigate multiple local problems involving employment due to the economic crisis in this country based on the concept of cities are engines of economic prosperity.

Finally, while this study has focused on Iraq, the methodology can be adopted in other developing countries that have also suffered from difficult conditions. This may include other Middle East capitals facing population inflation and traffic problems, e.g. Cairo.

Declarations

Author contribution statement

Marwah M. Mohsin: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Thomas Beach & Alan Kwan: Conceived and designed the experiments; Wrote the paper.

Funding statement

Competing interest statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

References

Aldossary, N.A., et al., 2014. Domestic energy consumption patterns in a hot and humid climate: a multiple-case study analysis. Appl. Energy 114, 353–365.

Aldossary, N.A., et al., 2015. Consensus-based low carbon domestic design framework for sustainable homes. Renew. Sustain. Energy Rev. 51, 417–432.

Aldossary, N.A., et al., 2017. Establishing domestic low energy consumption reference levels for Saudi Arabia and the Wider Middle Eastern Region. Sustain. Cities Soc. 28, 265–276.

Aldossary, N.A.R., 2015. Domestic Sustainable and Low Energy Design in Hot Climatic Regions.

Alyami, S.H., et al., 2015. The development of sustainable assessment method for Saudi Arabia built environment: weighting system. Sustain. Sci. 10 (1), 167–178.

Ameen, R.F.M., et al., 2015. A critical review of environmental assessment tools for sustainable urban design. Environ. Impact Assess. Rev. 55 (August), 110–125.

Ameen, R.F.M., Mourshed, M., 2017. Urban environmental challenges in developing countries—a stakeholder perspective. Habitat Int. 64 (April), 1–10.

Ba, F.H., 2000. Research guidelines for the Delphi survey technique. J. Adv. Nurs. 32 (4), 1008–1015.

Bryant, M.M., 2006. Urban landscape conservation and the role of ecological greenways at local and metropolitan scales. Landsc. Urban Plan. 76 (1–4), 23–44.

Fawzi, R., et al., 2016. Environmental , Social and Economic Challenges for Urban Development : Stakeholder ' S Perception in a Developing Economy. July.

Fawzi, R., Ameen, M., 2017. A Framework for the Sustainability Assessment of Urban Design and Development in Iraqi Cities (September).

Galipeau, J., et al., 2017. An international survey and modified Delphi process revealed editors' perceptions, training needs, and ratings of competency-related statements for the development of core competencies for scientific editors of biomedical journals. F1000Research 6, 1634. Available at: https://f1000researchdata-s3-amazonaws-co m.proxy.bib.uottawa.ca/manuscripts/13429/3baeb1f0-39cf-4648-8158-6a1ae3124e 35_12400_-_david_moher.pdf?doi=10.12688/f1000research.12400.1%0Ahttp:// www.ncbi.nlm.nih.gov/pubmed/28979768%0Ahttp://www.pubmedcentral.nih.

Giannarou, L., Zervas, E., 2014. Using Delphi technique to build consensus in practice. Int. J. Bus. Sci. Appl. Manag. 9 (2), 65–82.

Guo, J.J., et al., 2011. A new approach to energy consumption prediction of domestic heat pump water heater based on grey system theory. Energy Build. 43 (6), 1273–1279.

Habibi, A., et al., 2014. Delphi technique theoretical framework in qualitative research. Int. J. Eng. Sci. 3 (4), 2319–2813. Available at: www.theijes.com.

Holden, M., 2012. Urban policy engagement with social sustainability in metro vancouver. Urban Stud. 49 (3), 527–542.

Hsu, C., Sandford, B., 2007. The delphi technique: making sense of consensus. Practical Assess. Res. Eval. 12 (10), 1–8.

Huang, S.-L., et al., 1998. A framework of indicator system for measuring Taipei's urban sustainability. Landsc. Urban Plann. 42 (1), 15–27.

Johansson, E., 2006. Influence of urban geometry on outdoor thermal comfort in a hot dry climate: a study in Fez, Morocco. Build. Environ. 41 (10), 1326–1338.

Maguen, S., et al., 2012. Gender differences in military sexual trauma and mental health diagnoses among iraq and afghanistan veterans with posttraumatic stress disorder. Women's Health Issues.

Masoso, O.T., Grobler, L.J., 2008. A new and innovative look at anti-insulation behaviour in building energy consumption. Energy Build. 40 (10), 1889–1894.

Mohammed Ameen, R.F., et al., 2014. Sustainability assessment methods of urban design: a review. In: *EG-ICE 2014, European Group for Intelligent Computing in Engineering - 21st International Workshop: Intelligent Computing in Engineering 2014* (July). Available at: http://www.scopus.com/inward/record.url?eid=2-s2.0-84912567343&partnerID=tZOtx3y1.

Mohsin, M.M., et al., 2017. Public Perceptions of Urban Sustainable Challenges in Developing Countries, vol. 226, pp. 131–140.

Mohsin, M.M., et al., 2018. Energy Forecasting, Based on ANN Machine Learning, for Domestic Properties in Dry Hot Arid Regions : A Case Study in Baghdad, vol. 10, pp. 505–511 (6).

Rebitzer, G., et al., 2004. Life cycle assessment Part 1: framework, goal and scope definition, inventory analysis, and applications. Environ. Int. 30 (5), 701–720.

Roberts, S., 2008. Effects of climate change on the built environment. Energy Policy 36 (12), 4552–4557.

Sadineni, S.B., et al., 2011. Passive building energy savings: a review of building envelope components. Renew. Sustain. Energy Rev. 15 (8), 3617–3631.

Willis, J., 2006. Fast Forwards, pp. 114–119.

Wu, J., 2014. Urban ecology and sustainability: the state-of-the-science and future directions. Landsc. Urban Plann. 125, 209–221.

Xing, Y., et al., 2009. A framework model for assessing sustainability impacts of urban development. Account. Forum 33 (3), 209–224.

Zhang, G.P., Qi, M., 2005. Neural network forecasting for seasonal and trend time series. Eur. J. Oper. Res. 160 (2), 501–514.