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Research Paper

Audit of integrating urban sustainability into architecture students' projects- the case of the university of Mosul

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ABSTRACT

Creating sustainable environments has become an urgent goal for most communities all over the world. This is because creating a sustainable environment would lead to improving a community's life socially, environmentally, and economically. To do so, urban sustainability indicators need to be incorporated into the urban design process, beginning with the architecture teaching syllabus. This study aims to find out how students' projects in the urban design course could consider sustainability indicators when developing built environments, including campuses, and how architecture students' projects can consider the role of physical character in achieving sustainability when developing campuses. Therefore, students' projects designated for developing the main campus of the University of Mosul were the case study of this research. Explorative graphical analysis was adopted as the study method. Findings highlighted key characteristics of sustainable urban design that are incorporated into these projects and the way to do so.

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1. Introduction

1.1 Sustainability concept and urban design

Sustainability began to commonly spread during the eighties of the past century when environmental problems began to be exacerbated. At that time, the argument about the need for solutions to confront those problems sparked. Sustainability has been defined as a strategy to enhance communities' lives and provide well-being for people by considering all factors that support it [1]. WCED [2] has defined sustainable development as the development that encounters the current needs of societies without detracting from the probability of the forthcoming generations meeting their own needs. According to [3], the main goal of the sustainability concept is to conserve resources and give the opportunity and ability to the natural environment to compensate for the consumed resources while maintaining the potential for economic, social, and urban growth and development. Urban sustainability is one of the aspects that is given increasing attention in most countries by planners, urban designers, landscape architects, and so forth. Sustainable urban design is the process concerned with creating places that are characterized by being walkable, vital, and comfortable for people. Providing mixed, diverse, and fine-grained uses and public facilities is also an objective of sustainable urban design [4]. University campuses are one of the urban environments that urgently need to be built according to the requirements of sustainable urban design [5]. The University of Mosul, due to its cumulative emergence, is suffering from numerous problems regarding aspects such as the quality of the outdoor environment, the relationship between pedestrians' movement and vehicle traffic, and walkability issues, which affect the sustainability indicators. This represents a challenge for the students and professors of the architecture department in handling the projects in the urban design course. Accordingly, sustainable design needs to be urgently rooted in the projects of urban development all over the world. The first step to ensure that is to incorporate such an approach into the syllabus of

architecture departments, particularly the academic projects of the courses of urban and architectural design. Thus, this study seeks to answer the question: how and to what extent are urban sustainability characteristics considered in architecture students' academic projects?

2. Literature review

2.1 Urban development and sustainability indicators

Creating a sustainable built environment is significant to delivering places of high quality for communities, which is, in turn, conducive to boosting human life and allowing them to live in a well-being mode. All this could happen without haggling with the needs of the next generations if the development of built areas adopts the sustainability features in a sound and efficient way. In other words, by incorporating the sustainability indicators into the planning and design processes of any built environment. As a campus is similar to any other built environment, pursuing sustainability characteristics when creating or developing a campus shall promote the educational process, which is a principal task of a university [5,6]. The focus of this study, therefore, is on exploring the sustainability indicators in the design process executed by students of the architecture department in their academic projects designated for developing their campus. A built environment consists of the physical setting of its urban form. The morphology of the physical structure is the key component of urban form at different scales, ranging from too small scale such as façade details to the elements of larger scales such as street types, block layout, distribution of green space, and so on [7]. Such elements need to be handled carefully through the design process to create a sustainable physical form, as Wheeler [8] argued. According to him, key characteristics that are significant in meeting urban sustainability include but are not limited to compactness, connectivity, diversity, ecological form, preserving local ecosystems, contiguous urban form, and providing amenities for people.

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Nomenclature

Enclosure Ratio	: The mathematical or visual relationship between building heights and street widths.
Physical comfort	: The provision of sheltered pathways and shaded areas.
Psychological Comfort	: This is linked to the provision of attractive views and the integration of green and water elements.

Consequently, sustainability indicators are tightly related to the physical components of the urban form and the way they are designed and related to each other.

2.2 Physical setting and sustainability

The design of a physical setting is a crucial aspect of achieving a sustainable environment. Raven et al. [9] pointed to the urban structure as a significant aspect of creating sustainable areas, where they defined it as the arrangement of buildings, routes, and open spaces and the way they are connected. Several sustainability aspects are related to the urban structure such as legibility, ease of access to destinations, diminishing pollution and energy consumption, social interaction, a sense of place, and providing a choice of transport means. In this respect, Zarmani, Latip, and Ismail [10] indicated that providing shorter distances between areas and grouping the buildings might lead to less car use, which in turn reduces pollution and enhances air quality. Furthermore, creating walkable areas transforms them into more humanitarian and liveable places. In this regard, placing the activities and important destinations in such a way that enables people to reach them easily contributes to encouraging people to use walking and cycling over motorized vehicles, which is an important step towards urban sustainability [11]. Accordingly, adopting a compact building layout as well as a direct, integrated, and permeable rout system would support a sense of place as a sustainability indicator of urban areas [12]. Designers need to ensure community safety in urban areas by diminishing traffic speed, which is related to the design and configuration of vehicle routes, which in turn supports society's equity. Ensuring safety is also related to limiting through-traffic within residential and academic areas, which would, in addition, contribute to ensuring quietness in such areas [13]. It is worth noticing that paying attention to the architectural style can promote distinctiveness and local identity. Besides, Konstantinou and Hoces [14] revealed that careful treatment of building façades can play a great role in reducing energy consumption and enhancing the environmental response, which would reflect on the thermal comfort of the users. In line with this, it may be worth that even paying enough attention to designing building entrances would provide a sense of welcoming and enhance legibility. Moreover, it was pointed by the literature to building arrangement and clustering as well as building heights as significant characteristics in supporting a sense of enclosure, local identity as well as a sense of belonging and attachment [14, 15]. Given its role in incorporating nature into people's life in urban areas, landscape features have numerous implications on qualities such as comfort, attractiveness, social interaction, creating a healthy environment, distinctiveness, local identity as well as legibility. According to Dober [16], trees contribute to creating an attractive and thermally comfortable environment in urban places and promote a sense of enclosure and welcoming for people. It was also argued that the use of trees with suitable canopies can help enhance air quality through its role in filtering the air from dust and other pollutants. As a significant component of the landscape, water elements have an important role in creating a comfortable and attractive environment contributing to supporting society. Based on the abovementioned, numerous significant sustainability indicators and characteristics have emerged in the literature, which, when considered by urban designers in their urban development projects, would lead to create successful built environments. Indeed, this task to be rooted in the design process, should begin with the academic projects of architecture students. Hence, this study attempts to find out how architecture students incorporate sustainability indicators into their projects through design.

2.3 Temporal dimension in sustainable design in contemporary contexts

Recently, research has addressed the temporal dimension in sustainable design when dealing with contemporary contexts. Swensen, [16] revealed the importance of combining old and modern styles in the urban and architectural design. He pointed to the 'deep cities' as an approach to incorporate heritage into compact urban development. With this regard, Redyantanu and Damayanti, [17] highlighted space temporality as a key factor in promoting sustainable urban design. They submitted design guidelines that enable creating adaptable and flexible spaces. Barbara, [18] examined time-based approaches in architectural design, concentrating on how digital technologies enable spaces to adapt to human needs and behaviors over time. Pschetz et al. [19] pointed to the concept of Temporal Design, which aims to reveal the important factors influencing social interaction within specific contexts. This approach challenges traditional notions of time in design, urging designers to consider the multifaceted aspects that shape temporal experiences. These studies collectively emphasize the growing importance of incorporating temporal considerations in sustainable design practices. Accordingly, aspects that could be inspired by our traditional cities such as compact urban form, enclosure, human scale, hierarchical movement systems, and so on represent indispensable features to incorporate the temporal dimension into contemporary design processes that seek to create sustainable environments. This applies to the campuses that need such an approach to transform into sustainable environments, which enables them to perform their functions efficiently. It can be said that the temporal dimension urgently needs to be considered in what architecture students design when conducting their academic projects.

3. Method

To discover design characteristics related to sustainability indicators, the study adopts a qualitative method, which has been done through four steps. First is to conduct an observation survey by the students in the urban design studio to assess and analyze the real situation of the campus under scrutiny in terms of vehicle and pedestrian movement in conjunction with the existing land use on campus to discover the problems and highlight the aspects the campus suffers from. Second, is putting planning and design solutions based on the characteristics of sustainable urban design for the diagnosed problems. Third, a sample of five academic projects within an urban design studio has been selected to conduct the analysis. Fourth, analyzing the sample projects in terms of how design characteristics are applied to resolve the problems in line with meeting several sustainability indicators. Several design characteristics that lead to corresponding sustainability indicators are tested. The assessment of the studied projects was conducted by the researchers who are also experts in the field of sustainable urban design. Three points are given when a sustainable design characteristic is fully achieved in a certain project, two points are given when the characteristic is partially achieved, and one point is given to a characteristic when it is weakly attained. When a design characteristic is not accomplished no point is given.

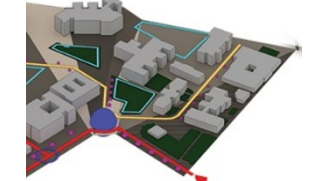
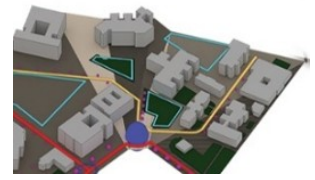
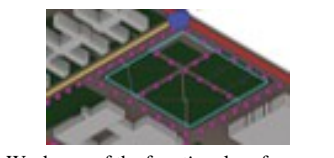
4. Result and discussion

Based on the literature review, several potential design procedures used to promote various sustainability indicators were characterized. They are summarized in Tables 1, 2 and 3.

Table 1. Potential design characteristics used to meet sustainability indicators.

Sustainability indicators	Design characteristics
Space containment	• Organizing the relationship between buildings and space
Solving pedestrian-vehicle conflict	• Prevent vehicle penetration
Views and vistas quality, air quality, and psychological comfort	• Incorporating nature into the physical environment
Protection from climatic conditions	• Provision of sheltered pathways and shaded areas
Walkable environment	• Compactness and cohesion of urban fabric
Quality of the outdoor environment	• Provision of seats and artwork / • Provision of water and green / • Floor paving quality
Conspicuousness	• Locations the building's entrances / • The hierarchy of paths / • Landmarks
Usability and accessibility	• Enhance the urban space / • Enhance the shortcut paths / • Enhance pedestrian environment

Table 2. Sustainability indicators integrated into the design process in the sample project.

Diagram characterizing sustainable design solution used.	Problem characterization in the reality of the campus situation.	Diagram characterizing sustainable design solution used.	Problem characterization in the reality of the campus situation.
 Provision of a safe environment for pedestrians independent from automobile traffic (as possible). Source: snapshot from student's project	 Pedestrian-vehicle intersection. Source: snapshot from the model of the real situation.	 Provision of pedestrian paths sheltered by awnings and tree canopy. Source: snapshot from student's project	 Lack of pedestrian environment protected from climate conditions. Source: observation survey.
 Transmitting negative spaces into positive ones and promoting their functional efficiency. Source: snapshot from student's project	 Existence of negative and useless spaces. Source: snapshot from the model of the real situation.	 Provision of benches along footpaths and within urban squares. Source: snapshot from student's project	 Lack of physical comfort requirements for campus users. Source: observation survey.
 Integrating the natural environment with the physical environment. Source: snapshot from student's project	 Lack of natural environment within the physical environment of the university campus. Source: observation survey.	 Rise the quality of outdoor spaces by providing attractive views and improving elements of paving, urban space furniture, water, and green. Source: snapshot from student's project	 Poor quality of the outdoor spaces on campus. Source: observation survey.
 Enhance enclosure and containment of spaces at the two- and three-dimensional levels by adding buildings, trees, and other structures. Source: snapshot from student's project	 Weakness of urban space enclosure and containment Source: snapshot from the model of the real situation.	 promote conspicuousness by enhancing the hierarchy of walkways and adding landmarks at important points. Source: snapshot from student's project	 Weakness of conspicuousness and way-finding. Source: observation survey.
 Strengthening compactness and cohesion of the campus urban fabric. Source: snapshot from student's project	 The disintegration of the urban fabric on campus. Source: snapshot from the model of the real situation.	 Enhance the functionality of urban spaces. Source: snapshot from student's project	 Weakness of the functional performance of the urban spaces on campus. Source: snapshot from the model of the real situation.

The abovementioned features in Table 1 were studied through an explorative graphical analysis applied to the sample projects to show how the designs considered sustainability indicators to solve the problems in the studied campus. The observation survey conducted by the students diagnosed the problems the campus is suffering from. The analysis identified the corresponding design solutions used to overcome those problems in a way that considers sustainability indicators. Table 2 shows the analyzed features of one of the sample

projects. Another phase of the analysis is conducted to find out what are the more significant sustainability indicators that were focused on by the studied projects in the development process of the campus and the corresponding design characteristics used to achieve them in the sample projects as shown in Table 3. According to Table 3, enclosure gained the maximum rate of achievement in the investigated projects with 14 points. This indicator was achieved in the evaluated projects by rearranging the buildings around the spaces they

Table 3. Assessment of design characteristics used to meet sustainability indicators.

Sustainability indicators	Design characteristics used	Project 1	Project 2	Project 3	Project 4	Project 5	Weight points
Space's containment	◦ Organizing the relationship between buildings and space and giving buildings suitable heights	••	•••	••	•••	•••	14
Solving pedestrian-vehicle conflict	◦ Prevent vehicle penetration	—	••	•••	—	•	6
views and vistas quality, air quality and psychological comfort	◦ Incorporating nature with a built environment	••	•	•	•••	••	9
Protection from climatic conditions	◦ Sheltered pathways and shaded areas	••	•••	•••	••	••	12
Walkability	◦ Compactness, cohesion of urban fabric, and landmark	•••	••	••	•••	•••	13
Quality of the outdoor environment	◦ Provision of seats and artwork elements, provision of water and green Elements and floor paving quality	•	••	••	•	•••	9
Conspicuous-ness	◦ Locations and design of the building's entrances and the hierarchy of the paths	•	•	•	••	••	7

overlook to create a contained and surrounded space. Sound building heights also contribute to enhancing a space enclosure. This might be attributed to the importance of enclosure and containment in creating more desired open spaces for the users as it stems from a feeling of security in an open space and the desire of people to exist in a space that is open but bounded. Furthermore, walkability recorded a second position of 13 points in the analysis as shown in Table 3. This is because walkability has become the base of creating sustainable built areas in the present era [6]. It is also necessary to lessen motorized vehicle reliance leading to minimizing air pollution, accidents, and noise. An important design feature, namely creating a compact and cohesive built environment was used by the students to achieve this indicator. A compact fabric contributes to enhancing the accessibility to the services and encourages people to walk as Matloob et al. [11] asserted. According to the table, physical comfort scored 12 points as a presence rate in the studied sample of the projects. This rate was achieved according to design interventions represented by protecting people from climatic conditions through the provision of sheltered pathways and shaded areas in the open space. This might be attributed to the severe nature of Iraq's climate, particularly in summer, where the temperature may touch 50 degrees Celsius. The rest sustainable indicators with the corresponding design treatments were all achieved in the studied projects but at lower rates. Some have taken their significance from being essential to the present trends of handling cities and urban areas towards sustainability. Others are deemed as key design features for the designers to deal with local nature, and society's culture and preferences.

5. Conclusion

The study, with its theoretical and practical parts, presented a clear vision of how students' projects in urban design studio dealt with the role of the physical environment in improving the life of the university according to urban sustainability indicators. It presented the way the students' projects used urban and architectural design characteristics to achieve sustainability indicators in the campus development process. The theoretical part presented the requirements of sustainability to be achieved in campus spaces. The practical study presented some of the various planning and design characteristics adopted by the selected academic projects, which represented solutions for the problems extracted from an observation survey of the existing main campus of the University of Mosul, Iraq. Those solutions contribute to creating a sustainable urban environment by providing a safe, comfortable, walkable, and legible environment on campus. The study presented the importance of incorporating sustainability indicators in the urban design process, where it explored the way, the architectural academic projects used to deal with developing the campus according to sustainability indicators. Some sustainability indicators and the corresponding design characteristics emerged as effective and have the most importance in creating a sustainable campus. These included enhancing enclosure and containment. This is due to a sense of enclosure and containment has a direct impact on how the users experience the space and contributes to creating a comfortable space. In addition, this indicator is in harmony with and rooted in the local context, where the traditional architecture of Mosul is characterized by an enclosed urban fabric and fully bounded open spaces [19]. Incorporating this indicator into a campus development project would contribute to promoting the character of open space, the relative importance of each space, and the legibility of the campus as a whole, which is, in turn, reflected in the level of user satisfaction towards their campus. Hence, it is deemed a key characteristic of sustainable urban design as it is directly related to social sustainability. In addition, enhancing walkability on campus, protecting from climatic conditions, and promoting physical comfort requirements for

campus users arose in the results as being the significant indicators with high rates. In addition, enhancing walkability, protecting from climatic conditions, and promoting physical comfort requirements for campus users arose in the results as being the significant indicators with high rates. It is worth noting that the local context in terms of climate conditions and the society culture had an indispensable role in giving those indicators their importance. This is because sustainability requirements might change from one built environment to another and from one community to another and there is no one paradigm for all conditions. Accordingly, the findings of this study could contribute to introducing the importance of incorporating sustainability into the design process of academic architectural projects and the way to do this. This step is deemed the basis for consolidating sustainability principles in the field of urban design as its role in transforming built environments into places for people, particularly university campuses.

Authors' contribution

All authors (Khalid J. Aldeen Ismail, Faris A. Matloob, Ahmad Y. Tohala) have read and agreed to the published version of the manuscript and contributed equally to the core development of the study according to the specified percentages. Specifically, all authors participated in the conceptualization, methodology, and data curation of the study. Furthermore, all authors were actively involved in the formal analysis, investigation, drafting, writing, and critical review of the manuscript.

Declaration of competing interest

The authors declare no conflicts of interest.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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