Abstract
Despite the considerable contributions in the developing world relevant to the development of sustainable environments, the concept of sustainable architecture is yet not widely considered within most of the developing communities whose priority lies with the immediate resolutions of many existing problems. This paper aims to analyze the challenges and applicability of sustainable architecture concepts in developing countries in order to develop a strategy to create a more sustainable built environment. It represents a pragmatic approach to investigate the role that indigenous practices and heritage-inspired architectural solutions as key elements in this respect. The study suggests that utilization of scientific studies conducted on these traditional features and solutions in the early design stages and a computer-aided adaptation using the available software can introduce a much progressive and environmentally-aware architecture. As well, the study supposes that rational and pragmatic practices should be executed through an integrative approach to produce a synthesis of both pre-industrial and high tech-based design. This approach may confer a new dimension of hybridism to a distinct regional architecture. It might result in a much more ecologically-aware built environment as well as maintain a high level of self-consciousness.

Keywords
Sustainable architecture; challenges; heritage inspiration; computational adaptation.

Introduction
Many historical practices and indigenous architectural solutions have reflected a great sense of environmental and social sustainability, with respect to the technical advancement, economic and socio-political aspects. Nevertheless, in most of the post-modern revivalist movements, emphasis was placed on the stylistic approach and typologies of historical architecture, and analysis was focused on the cultural and stylistic authenticity. Little emphasis was placed upon functional, climatic and socio-spatial aspects. On the contrary, the functionally-oriented contributions have, to an extent, reflected a limited fundamentalist approach to the role which vernacular architecture can play, through a continuous process of straight revivalism. As illustrated in fig. 1, the limited conservative approach towards heritage contextualization and symbolic meanings of regression are the major
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Challenges facing indigenous architecture.

The scope of this paper hence is limited to review the challenges and applicability of sustainable architecture in developing countries and the relevance of indigenous solutions in this respect. This would be accomplished through a major two-step process as expanded within the next few pages. The first step involves an overview of the architectural situation in the developing world, the generic perception of sustainability in context, and both economic and cultural challenges. However, the second step is dedicated to review examples of the potentially sustainable qualities in the indigenous features in relation to both climatic and cultural aspects. The last part of this paper suggests a conceptual framework for adaptation of these inherited features through conducting deliberate scientific researches and employment of the available computer-aided design tools.

This paper introduces three major hypotheses. First of all is that architecture should be conceptually influenced by its heritage along with the available technology. Combining both strategies would optimize the advantages of each. Secondly, passive environmental systems require considerations in the early design stages, initial decisions about orientation, form, and materiality, which cost nothing, yet lead to increased sustainability. The third hypothesis targets the human element. Such a functional approach will add a new evolutionary dimension to the stylistic aspects, which can change the ingrained perception of these features as

Figure 1: Constrain Against Vernacularism (Source: Author).

![Diagram showing constraints against vernacularism]
images from the past. The result might be an emphasis on cultural authenticity and increased self-consciousness. The assumed influence over the holistic approach of sustainability could be concluded through fig. 2.

**Generic Architectural Situation in the Developing World and Sustainable Architecture in Response**

The situation of contemporary architecture, in the majority of developing countries, exists between two extremes: an unconscious adoption of advanced international designs on one side and the stylistic revitalization of classical forms of architecture on the other. Most significant are those attempts which try to create a contemporary synthesis of the two. However, the architectural situation in developing countries is almost characterized by both decline in innovation and break down of traditions. This has led to a continuous process of copying, whether temporally from the past or geographically from the West regardless of both regional and cultural identities. Most of the recent projects are governed by this collective consciousness. The overall results hence were un-functional stylistic transplants and strange hybrids.

The boom in construction technology led to increased consumption of energy and resources that exceeded all expectations. Consequently, this necessitates investigation of alternative methods of design in order to achieve better management of natural resources and reduce the damage caused to the environment. Today, as at no other time, there is a critical need to
re-evaluate the architectural situation and to maintain a sustainable development policy which demonstrates aspects of economical, ecological, and socio-political dimensions. However, the initial cost of the new technology associated with concepts of sustainability is comparatively high and the economic feasibility of adopting such method remains unclear to real estate investors in developing countries. A sustainable built environment, however, could be more derivative and related to the regional heritage and the social collective memory.

**Perception of Sustainability and Challenges Within**

The concept of architectural sustainability attracted some architects since it represents a new trend that addresses the desire for excellence. Many developers pursue to adopt principles of sustainable architecture mostly citing the experiences of industrialized countries. However, in spite of many contributions in this field, the practices remain limited and theoretically un-integrated. The problem of the applicability of these ideas lies in how the architects perceive them, and the adoption of such method without adequate assessments of regional convenience. The methodology of adopting these concepts recalls what was followed with the international style that emerged with the ascendancy of modernism. Internationalism dominated the stylistic consciousness of most architects, and therefore, a breakdown of traditions and lack of identity were evident and a strong apprehension was imposed regarding regionalism and self-consciousness.

The techniques that were developed in Europe and the United States might not be commensurate with the natural conditions of different regions, and more importantly, they might contradict what was authentically understood as principles of sustainability. These methods and techniques require adaptation to achieve the desired convenience. Also they may require different environmental solutions due to the different climatic conditions. Such adaptation might lead, in terms of both style and materials, to significantly different practices, or even the opposite of what was originally adopted.

In terms of morphology, many local architects adopt the method as forms and expressions, not as content and principles. In many cases they follow a systematic approach of adopting non-regional imported architectural ideas without taking into account the direct relationship to their environment and its natural and cultural context. Hence, what began in the West as an alternative to save energy and an attempt to create a built environment that respects the ecological and environmental aspects, may be turned into a mere imported architectural style that ultimately lacks local peculiarities. However, challenges of sustainability, as shown in fig. 1, could be discussed mainly on economic and cultural levels.

**Economic Challenges**

The boom in urban and architectural development and increased investments in the real estate industry in many developing countries, such as in the Middle East, were both associated with high consumption of relatively cheap energy. However, the initial cost of the new technology associated with the progressive sustainable designs is comparatively...
high and the economic feasibility of adopting such methods remains unclear to real estate investors. This resulted in the investors ignoring the possibility of alternative energy sources, as well as a lack of serious consideration of the use and development of construction techniques that would significantly reduce the wasting of energy, unless through the imposed domestic regulations. In addition to the high initial cost, the projects in which these technologies are employed usually encounter maintenance and operating problems due to the lack of supporting industries and local expertise, resulting in a necessity to rely on foreign experts and outsourcing, which contradicts the basic principles of sustainability.

Cultural Challenges
In addition to the previously mentioned financial constraints, sustainable design is not yet a culturally accepted concept within the developing communities whose priority lies with the immediate resolutions of the society’s many existing problems. The concepts of sustainability then are not seriously adopted as essential design requirements of many owners and stakeholders. “Many buildings are occupied by a succession of temporary owners or renters, each unwilling to make long-term improvements that would mostly benefit future occupants” (Brown, Southworth & Stovall, 2005 p. 4). Furthermore, the architects themselves are not encouraged to acquaint themselves with such an approach due to the lack of environmental orientation, regulations, and relevant building codes.

Heritage Inspiration as a Key Element
The techniques used in the emerging sustainable architecture models are loaded with functional and ethical values that govern its formation. These values reflect a kind of honesty and
functional utilitarianism without the pursuit of aesthetic expression or stylistic considerations from outside of such a technical and functional context. However, sustainable elements could be more derivative and more related to the regional heritage and the social collective memory. Throughout a millennial history of Islamic Architecture for instance, many features can be traced in this context such as wind catchers, elements of shading and control of
natural lighting, thermal insulation and methods of using local building materials and natural techniques that were used for air cooling.

For instance, a brilliant fenestration employment for providing privacy without preventing the day-light was introduced with the mashrabiya system (see Fig. 2). The solution was simply through a gradual arrangement of perforation to control both air-flow and visual contact, in addition to incorporating an over-hanging eves for shading. Furthermore, based on basic rules of physics which dictate that hot air rises and cold air falls, as well heat radiates from warm to cooler bodies, proper solutions took place through controlling the manner of cross ventilation and air-flow through the wind catcher and roof pop-up (see Fig. 3).

The centralization of a plan around an internal courtyard for instance, can significantly increase the potential functional efficiency of the building. It contributes to moderate climate extremes and sun glare and provides cross ventilation and air-flow. Moreover, it provides privacy and comfortable outdoor space to enjoy gentle microclimate (see Fig. 4). “An abundance of literature claims that courtyards are an environmentally responsive building form for hot arid climates... Despite the apparent logic, most of these statements are vague and based largely on anecdotal monitoring, qualitative observation and common sense.” (Ratti, Raydan & Steamers, 2003, p. 54). The interrelation for instance between the height and footprint of the courtyard is rare to be accurately quantified. Therefore, in accordance with the available technical advancements, estimates and observation became no more sufficient in this respect. A scientific quantification through experimental research-work hence is significant, as it would be subsequently clarified.

Along with the geographical and topographical considerations of the building site, there are many indigenous and passive solutions that might contribute to facilitate the process at a lower cost. For instance, the succession of masses provides shaded areas and reduces the areas exposed to the sun, in addition to the use of aerodynamic forms, air-catchers and water fountains as natural cooling elements. The pre-insulated CMU might be substituted, in many cases by building materials that absorb heat during the daytime and lose it at night without allowing it to penetrate the wall. Moreover, the use of double walls and ceilings allows the free flow of air and minimizes the impact of the sun. To reduce the undesirable sun effect, the number and area of exterior fenestration might be minimized, in addition to the use of horizontal and vertical louvers and oriel's and proper plantation in both interior and exterior.

The recent studies dedicated to the discussion of the issues of sustainable architecture in developing countries fall into two categories; progressive and conservative approaches. The majority of contributions in this field were through the conservatives' work which to an extent has reflected a limited fundamentalist approach to the definite role which vernacular architecture can play. This has led to the exaggeration assessing the potentials of traditional practices, which confined the practices to limited building types, scales, and clients through a continuous process of straight revivalism. To generalize the primitive practices of sustainability, which are based totally on vernacularism, is an
overall regressive movement. Most of the sustainable initiatives that adopted traditional and indigenous solutions target the small-scale buildings, mainly small houses consisting of one or two floors, which can be entirely governed by the straight revivalist approach. Such an approach targets a limited sector of both clients and building types. However, pragmatically speaking, the majority of building types in residential, commercial, educational, and healthcare facilities demand more interest in a larger scale, four or five stories in average. Moreover, multi-storey buildings are more practical considering the client’s culture, mixed land use, and land prices.

**Perception of Vernacularism**

“Vernacular architecture is abandoned due to its being considered insufficient, uncomfortable.” (Karaosman, 1996, p. 9). Here, questions about the re-evaluation of vernacularism are insisting.
These questions mainly concern the nature of vernacular architecture in relation to passive environmental response and human action. “What is the relation between vernacular architecture and human action? Should an understanding of the fundamental nature of architecture be derived from an analysis of the built environment based on passive environmental response? Or theory about human nature?” (Turan, 1988, p. 135). However, the efforts of Hassan Fathy for instance, who was one of the pioneers in this field in Egypt, was undoubtedly remarkable. He attempted to introduce a rational and regionally accepted as well as environmentally valid architecture that is sensitive to the economical circumstances and regional traditions. With the lowest cost and the most available materials, mud bricks, he employed inherited traditional features to create environmentally friendly buildings (see Fig. 5). “The economy of vernacular architecture depends on raw materials and energy. It benefits from local materials and techniques, moreover comprises a long-lasting process of experimentation of human being related with spatial and temporal context.” (Gülmez, 2007, p. 3). Nevertheless, his sustainability standpoint was not culturally accepted due to the symbolic meanings of poverty they bear, and the lack of official support and propagation.

A reconsideration of the basic principles of regional architecture is essential. Regionalism was always concerned with maintaining functional sustainability; responding to the environment, and to express identity within a distinct regional expression. The basic principles of regional architecture are to mediate the influence of imported styles and to maintain a high level of self-consciousness. “By way of general definition we can say that it upholds the individual and local architectonic features against more universal and abstract ones.” (Frampton, 2002, p. 81). Kenneth Yeang wrote, discussing regionalist design intentions: “Its intentions are for a contextual architecture which responds self-evidently to the local conditions. It should relate to the deeper sensibilities and tangible realities of the place, rather than relating primarily to international influences and trends.” (Yeang, 1997, p. 146).

Most contributions in this field in developing countries are confined to individual studies and practices that adopt a single approach, either progressive or conservative. Undoubtedly, rational and pragmatic practices should be executed through an integrative approach to produce a synthesis of both methods. However, the high tech-based designs are conditioned to various economic aspects and governmental subsidies. However, with respect to the boom of computational design within the past decades, we have the choice of “improving, modernizing and re-introducing traditional construction technologies, building designs and settlement patterns” (Plessis, 1999, p. 6). Hence, indigenous practices and heritage-inspired solutions can be deliberately adapted to be reintroduced in a contemporary meaningful way. “Now we have the difficult task of trying to let a new architecture grow, but we have to do it consciously. What was simply allowed to happen in the past must now be consciously created.” (Doxiadis, 1963, p. 136). This process can be achieved in the early design stages through computational experiments using the available tools such as various energy simulation programs and air-flow prediction methods.
Towards Deliberate Adaptation of Indigenous Features

“The global demand for more sustainable development has resulted in an increasing number of new technologies and design strategies aimed at improving buildings with respect to a variety of performance considerations, such as energy, comfort, cost, aesthetics, environmental impact, etc.” (Holst, 2003, p. 507). The objective here is to establish a methodological framework to create a progressive heritage-inspired sustainable architecture. This paper hence suggests conducting a scientific evolutionary program that aims towards the adaptation of the historical features, which are potentially sustainable through a precise and sequential two-step process. The process principally aims to examine how to adapt these features in the early design stages using the available technology and design tools, such as energy

Figure 7: The Village of New Quma-Hasan Fathy (Source: Fathy, 1973).
simulation programs and air-flow prediction methods.

The first step can be crystallized through extensive regional studies of the accumulative experience in climatic design in historical building within which such features were incorporated. This step should discuss examples which reflected a high level of climatic and regional awareness. As indicated in fig. 6, the study should concern the extent to which the basic principles of sustainability were fulfilled with relevance to historical and social contexts through the following: Overall building analyses (function, orientation, and materials); Plan analysis; Façades, building envelope and climate control; Study of the air-flow pattern and ventilation and Illumination method.

"Over the past 50 years, literally hundreds of building energy programs have been developed, enhanced and are in use" (Crawley, Hand, Kummert & Griffith, 2005, p. 231). Through sequential computational experiments many aspects can be quantified, and the potential capabilities of the suggested features therefore could be accurately assessed, and the optimization of which could be more tangible. Such a scientific process will result in more precise estimates about durability and fire resistance; energy saving and thermal insulation; and hence the consequential architectural solutions. Consequentially, a statement of considerations could be made regarding the following: optimization of building envelope; building orientation; building materials and

Figure 8: Adaptation of Traditional Forms through Computational Experiments (Source: Author).
Cultural authenticity and increased self-consciousness and intimacy to place. A progressive heritage-inspired architecture hence is that one which contextualizes the available technology and contemporary global trends in relation to a distinctive spirit of place and regional requirements to create a deliberate functionally-oriented yet identity-reflective architecture.

References


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