

# Sustainability Versus Mega Urban Development Projects

Dr. Mervat El-Shafie

Architecture Department, College of Engineering

Effat University, Saudi Arabia

[melshafie@effatuniversity.edu.sa](mailto:melshafie@effatuniversity.edu.sa)

**Abstract-**The Middle East region is under mega urban development plans. This era in the region's history is vividly revealing the conceptual understanding of the conflicting views of urban development and construction projects in the developing countries. This paper takes Jeddah city, in Saudi Arabia, as a case study to highlight the conflicting views that rise from several world issues, which mark the current practices of urban development. Sustainability views the world as a source of renewable materials and hopes to keep the world green, while the new world order views economy as the source of empowerment and the hope to remedy human and environmental deterioration and to eradicate poverty. The paper aims to explore a framework that allows a holistic approach in practices' methodology to urban development in developing countries. The main objective is to define a set of construction areas in which the use of green construction materials reduces demand for nonrenewable resources and the environmental degradation universally correlated with the mining of those resources. The paper hopes to raise awareness among developers for the use of sustainable construction materials versus the use of favored nonrenewable materials without neglect of the consequences of their impact on the urban development.

**Keywords-**Sustainable construction materials, Middle-East urban development, Jeddah development plan, green environment

## I. INTRODUCTION

The city of Jeddah is a vibrant city, and a gateway to the two Holy Cities of Makkah and Madinah. Jeddah has many centuries history, through which it has been a cultural pilgrimage and tourism centre for the Muslim world and an important historic city in the Middle-East region. Jeddah is currently growing quickly due to flourishing diverse economy resources and significant location as a strategic western gateway to the Kingdom of Saudi Arabia. However, Jeddah faces considerable urban challenges, where the uncontrolled expansions of the last century have left the city with an extensive, poorly focused structure. This urban context has resulted in an overdependence on car travel, on increasingly overcrowded roads; and a service infrastructure which does not reach all citizens. In response, the Municipality of Jeddah has initiated a comprehensive growth strategy for the city. The analysis of the spatial element of this

growth and the approach to its practices is the main aim of this paper.

## II. JEDDAH DEVELOPMENT PLAN

The Jeddah Urban Development Plan seeks to implement a sustainable city structure which provides a high quality of life for each inhabitant. It aims to permit flexible economic and physical growth to allow the city to remain energetic and competitive. This is whilst minimizing the use of resources in terms of land, materials, energy and water [1]. The best model to achieve this balance for the city structure is the 'Polycentric' or 'Network' city. In this approach the activities are concentrated in a graded hierarchy of centers. It uses disseminated levels of centers to attain the right stability between distributed accessibility and efficient concentration [2].

The urban development research conducted by the Municipality of Jeddah, as part of developing the strategic plan, has outlined key sets of criteria. These criteria were considered while defining the general limitations to the plan. The main limitations are the restrictions on development imposed by environmental and political issues such as: topography and flooding; geology and ground conditions; civil aviation restrictions; and sensitive sites. The following is an overview of these key points

### *Topography and Flooding*

Jeddah is located on a low lying narrow coastal plain oriented approximately north south, adjacent to the Red Sea to the west and a chain of hills (Jabal) to the east. The coastal plain is approximately 10km wide and 40km in length in this section between Jabal at Tawilah (in the south) and Al Kura (in the north). This plain, bounded by the view of sea on one side and hills on the other, is an important part of the character of Jeddah. The plain is at risk of occasional severe flooding as it receives run off from the large Valley (Wadi) catchments in the hills to the east during and after the region's infrequent rainstorms. The city has developed and is enhancing a system of flood protection channels which protect the main urban areas of the city.

The coastal plain, which coincides with the main urban area of the city, provides a good setting for tall buildings in which they are visible but cannot be disproportionately dominant. The Municipality of Jeddah believes that tall buildings can make a positive contribution to the growth and development

of the city, but only when they are located on sites which are appropriate and in accordance with the overall city development strategy. The Municipality has defined appropriate locations on the basis of overlaying a series of key parameters to the plan of the developable urban area of Jeddah. Unrestricted development of tall buildings based solely on the availability of land would create an unacceptable cityscape and place increased pressure on an already weak urban structure and transport and service infrastructure.

### Geology and Ground Conditions

Geological conditions and the type of foundations required are a key consideration in the structural and financial viability of a tall building. Within the coastal plain area of Jeddah the surface layer geology is primarily made up of sand, coral and other marine or wadi alluvial deposits. Whilst these conditions do not preclude the construction of tall buildings, they are not ideal. The hazards associated with the various ground conditions identified will influence the type and depth of foundations required [1]. An overview assessment of the anticipated ground conditions is shown in Figure 1, as a guideline reference.

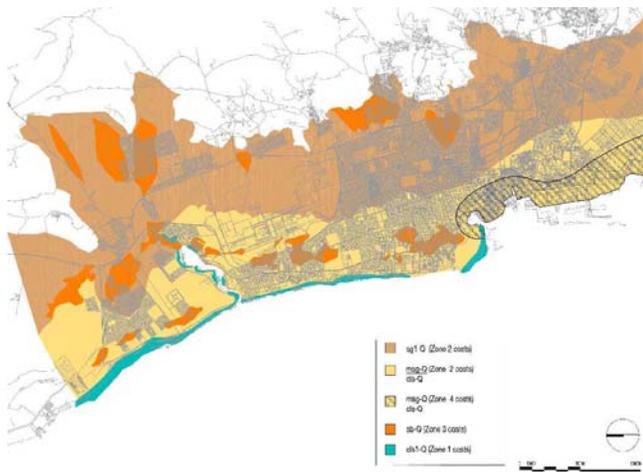


Fig. 1. Ground Conditions (Source: Jeddah Municipality)

### Civil Aviation Restrictions

Jeddah is an important air communications gateway for the Kingdom of Saudi Arabia. Jeddah airport, located in the north of the city, is busy and expanding rapidly with plans to handle up to 70 million passengers annually in future. Many urban development projects are moving towards the north of Jeddah to allow accessibility to and from the airport.

The three runways are aligned north-south with the principal landing path located over the central area of the city to the south of the airport and the principal take-off path located over Obhur and Dhaban to the north [1]. The Civil Aviation Authority (PCA) has imposed height restrictions for permanent structures under these flight paths and directly around the airport.

The PCA height restriction map shows zones of maximum height. The graded pink zone shows the flight paths of arriving and departing aircraft; these start at a ground level at

the airport, rising 16 meters for every 1000 meters as they move further away [1].

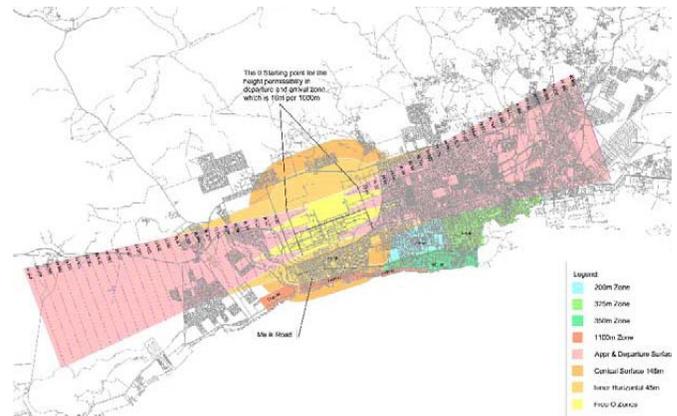


Fig. 2. Height Restrictions Map for King Abdul-Aziz Airport (Source: Jeddah Municipality)

### Sensitive Sites

Sensitive sites in Jeddah city indicate two types of sites:

#### A. Key Government Buildings and Facilities:

These are facilities where a tall building located so as to overlook the site may be judged a security risk. These zones include:

- Jeddah Airport and the related military and royal aviation facilities.
- The Naval Base located to the south of the city.
- The main Royal Palace site located on the Red Sea to the west of Tahliyah St.

#### B. Historic Sites:

These are buildings and sites in the city designated as having significant historic value. The main historic site in Jeddah is the Old Town (Al-Balad) district. This district is now being considered for a proposal to be listed for UNESCO World Heritage Site designation.

The harmony and unity of the urban context of Al-Balad are remarkable in that its parts created in such a unified mode of architecture expression. The analysis of the old part of Jeddah is best described by the concept of cities that grew together with their past. Christian Norberg-Schulz explained this concept, where the taking place of the experience of life and the urban configuration represent two aspects of the same occurrence. This type of cities was also made up of dominions, streets, and centers, where the quality of the primary elements was essentially similar to that of the cities that grown spontaneously [3].



Fig. 3. Conserved Traditional Houses of Al-Balad (Source: Author, 2008)



Fig. 4. Conditions of not Conserved Houses of Al-Balad (Source: Author, 2008)

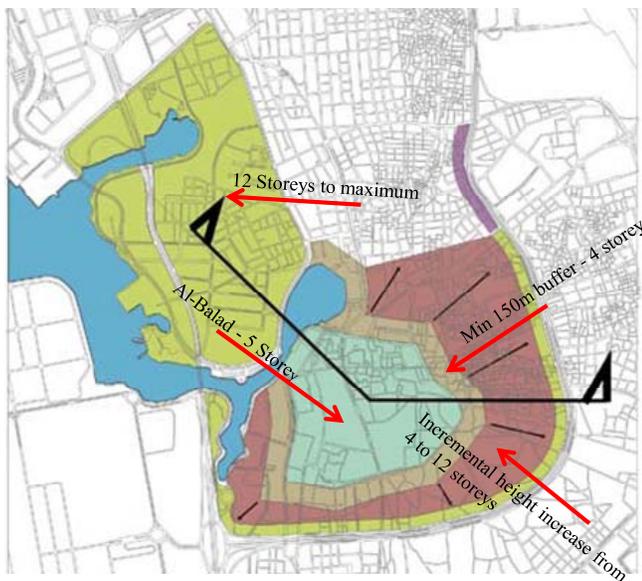


Fig. 5. Historical Area of Al-Balad (Source: Jeddah Municipality)

An important factor in that designation will be the creation of a buffer zone around the district itself to control the development in order to maintain the character and setting of the site. Such zones are site specific, and are proposed as part of the application for listing. Tall and new buildings located within or close to the old town would be inappropriate.

### III. A HOLISTIC APPROACH TO SUSTAINABLE URBAN DEVELOPMENT

Sustainability often is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs. A growing number of people are committed to reaching this goal by modifying patterns of development and consumption to reduce demand on natural resource supplies and help preserve environmental quality. Achieving greater sustainability in the field of construction is particularly important. Building construction consumes more energy and resources than any other economic activity [4]. Green buildings are designed to meet certain objectives such as protecting occupant health, improving employee productivity, using energy, water, and other resources more efficiently; and reducing the overall impact on the environment. Using green building approach, materials and products would promote conservation of diminishing non-renewable resources worldwide. In addition, integrating green building materials into building projects can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials.

#### *Sustainable Design Principles*

Sustainable design principles are concerned with four major issues to guarantee the efficiency of buildings: energy efficiency, material efficiency, water efficiency, and regional accountability. Attention should be given to the design patterns proposed for the urban development of Jeddah City. Important start is a review of a few energy basics; energy is lost from a building in three ways: conduction, convection, and Infiltration [5].

Conduction describes the process where heat energy is transferred directly from the warm side of a material to the cooler side of the material. The greater the temperature difference the greater will be the movement of heat. Materials that do not conduct heat readily are good insulators. The better the insulation properties of a material, the higher will be its insulating value. The term for heat moving through framing members is called "thermal bridging". Thermal bridges are places where there is little or no insulation in the building envelope. These areas include solid headers over windows and doors, beams in exterior walls, and solid blocking for corners and partition walls.

Convection is the movement of air caused by the properties of warm air to rise and cool air to fall. Convection leads to stratification of air in tall spaces as the warm air collects at the top of the space. Convection is a factor in the calculations of preferred ventilation and air conditioning (V&AC) results within various building components.

Infiltration is a term used to describe the movement of air in and out of a building. Infiltration is one of the most significant ways heat and cooling energy is wasted in buildings. All warm objects radiate heat energy to cooler objects. The process of radiant heating can cause discomfort if the temperature of the surrounding surfaces is too different.

### A. Energy Efficiency

Buildings use several related energy systems that constantly respond to changing climatic conditions and the comfort requirements of the occupant. Thus, an energy-efficient building minimizes energy costs, increases occupant comfort, provides a healthier living environment, and reduces negative impact on the environment. Creating an energy-efficient building requires planning, foresight, and follow-up. This can result long term comfort and energy savings. Many design patterns are linked to basic energy systems [4]. The patterns that directly impact the energy efficiency of a building are: site, orientation, and building envelop. There are also ventilation and air conditioning (V&AC) systems, lighting, landscape, and building operation patterns which affect energy systems and should be considered in a sustainable design.

Site selection has a significant impact on the design of a building. Making use of the quality of the site offers high energy performance and several sustainable features [6]. Orientation of a building will allow for passive solar gain and day lighting. In winter, windows facing east and south allow for early warming of rooms [4]. While south-facing windows will add to the afternoon heat in summer, thus not desirable in Jeddah. West-facing windows need to be carefully designed so they do not add to overheating the interior space due to the low angle of the setting sun.



Fig. 6. Impact of Mega Urban Development Projects on the City Image (Source: Author 2009)

The envelope of the building has a great impact on how much energy is required to cool the building. The challenge in designing the foundation, walls, and roof is to minimize conductive heat gain, while minimizing the uncontrolled movement of air into the building. The comfort of the building during the long hot season of Jeddah will depend in large part on interior surface temperatures of the floors, walls, and roof as well as the amount of outside hot air entering through leaks in the envelope.

The building envelope gives attention to the ventilation and air conditioning (V&AC) systems. These systems use more energy, cost more to operate, and are more complex than other energy systems in the building. Reducing the heat load of the building allows for the installation of a smaller cooling

system, which should be properly sized. In Jeddah electricity is the only type of energy source to cool a building. Therefore, the exterior envelope of the building needs to be ultra-efficient. The mechanical ventilation system is also used for ventilating, including fans installed in the bathrooms and kitchens.

Energy research found that lighting and appliances consume 14 percent of the energy used in a residence. Occupants want houses that are bright and inviting. Energy-efficient houses use natural daylight in areas of high occupant use such as living rooms, family rooms, and kitchens [5]. The same design concept can be implemented in public buildings for energy-efficient building to include clearstory, atriums, and skylight elements. The type of appliances such as entertainment systems, stereos, and computers installed in a home or in a public building can have a large impact on energy use. Appliances that are tested and marketed for the energy-efficient operation are a smart choice, although they might cost more initially.

Landscaping is an integral part in helping an energy-efficient building to perform better. Using the lay of the land to shelter the building to stay cooler in the summer and allow summer breezes should be considered. Carefully selecting and strategically planting chosen trees can provide maximum effective shade in the hot summer season [7].

One of the most important elements in an energy-efficient building's performance is the manner in which it is operated. Energy-efficient buildings are not a new concept, but the materials and equipment used are. Occupants and users need to be educated on how to make them perform. It is important to take a balanced approach to addressing energy efficiency. Looking and investigating all of the options available during the design phase will help sustainable decision-making. A single energy system or component can lead to diminish opportunities [4]. For example, increasing exterior wall insulating values beyond a reasonable point would be imprudent if there are more cost-effective energy-efficiency options for windows or ventilation system. Energy-use analysis software can be a very useful tool in making balanced and cost effective design decisions.

### B. Material Efficiency

Sustainability in construction relates not only to the extraction and manufacture of raw materials, but also to efficiency in terms of the design implementation of the structure [8]. Tons of materials go into the constructing of a building. There are three principal approaches to improving the material efficiency in a sustainable urban development project:

- Reduce of the amount of material used in construction.
- Reduce of waste generated in the construction process.
- Use of recycled materials that otherwise would have been waste.

Reduce of materials use: Several specific strategies can be employed to reduce the amount of materials used in the construction of a building. Choosing material-efficient

components and assemblies is an important means of achieving an overall materials reduction. For instance, using engineered steel framing, roof trusses, and individual resource-efficient materials, which are materials that do more with less, are an important way to reduce materials use [5]. Reduce materials use are conscious simplification of framing, space-efficient design principles that allow smaller buildings, and efficient floor plan layout that creates a central utility core and minimizes wasted space.

**Reduce of waste:** There are three main ways to reduce waste generated in the construction method. The first is source reduction, which prevents material waste before it happens by designing buildings on module. That can use standard sizes of material without requiring the added labor and waste of cutting materials to fit on site. This technique is basically a procedure of comparing alternative materials and methods to decide the least expensive combination that will affect a standard product. The second means of avoiding waste at the site is the use of prefabricated construction systems such as structural insulated panels (SIPs). The third way of source reduction also includes careful, accurate materials ordering to avoid leftover materials. In the broadest sense, this concept simply extends on the practice to provide an effective, systematic total systems approach [5].

**Use of recycled materials:** Material efficiency also can be achieved by using recycled materials in construction. This helps relieve the expenses pressure on deteriorating supplies of natural resources, and also helps remove costly and challenging waste disposal confronts by converting waste into useful new products. Furthermore, recycled materials often require less energy to produce than new building materials, so choosing recycled materials can help save both energy and material resources [7]. Recycled building materials can be made from post-industrial or post-consumer recycled paper, wood, rubber, plastic, glass, metal, and other products. Many directories of recycled building products exist, and these products are becoming more widely available due to the increasing environmental awareness. Even greater energy and materials savings can be attained by reusing salvaged existing building materials in a project rather than consuming new or even recycled, building products. Recycled products can be used in the structure, interior and exterior finishes, and landscaping of homes and buildings. Developers in Jeddah need to be aware of these techniques and benefit from the experiences of others in this regard.

Despite the best efforts at source reduction, there will be waste produced at any construction site, and particularly on job sites that involve demolition of existing buildings. Dealing with this waste by rescuing and reusing materials, and by recycling fragment material and packaging, will re-supply the building materials market with material and reduce the waste disposal costs for a building project. Materials that can be salvaged for reuse include doors, brick, windows, glass block, fixtures, beams, and some dimensional lumber. Materials that can be recycled from the job-site include cardboard packaging and metals.

### C. Water Efficiency

Water is a natural resource found in varying levels of abundance or shortage throughout the world. Thus, planning for consumption is based on the current global availability of water. The shortage of water resources in Jeddah has resulted in using sea water desalination, which depends on energy consumption. The approach of sustainable water management is essential in the urban development plan of Jeddah. Sustainable design addresses the two largest sources of water use in homes and public buildings in order to reduce overall consumption of water:

- Improve the efficiency of plumbing fixtures.
- Reduce the water demand of landscaping.

In addition, sustainable design considers opportunities to confine and recycle water. Reducing water consumption benefits both the resident, in terms of cost savings, and the environment. There are several environmental benefits of water management. Conserving water helps ensure that there will be adequate groundwater supplies for future generations, and preserves the habitat values of surface water supplies. Reducing water use also reduces requirements for wastewater treatment, which can be a significant community expense, or individual homeowner expense in the case of infected systems.

Efficient plumbing fixtures can reduce household water consumption. Furthermore, the use of water-conserving fixtures and appliances, such as low-flow showerheads, faucet aerators, water-efficient dishwashers, and clothes washers can help in increasing water-efficiency. Occupants behavior plays a significant role in water consumption, so providing occupants with indicators on water – management practices can reduce long-term water use and raise awareness of sustainable use of water.

Landscaping also consumes a significant amount of water in homes and urban open spaces [6]. Although landscaping in Jeddah uses grey and recycled water, incredible amounts of water are used to support conventional green lawns. There are several ways to reduce landscaping water use. In general, irrigation needs can be reduced by choosing plants native to the local area, or known for their drought tolerance, thus reducing the supplementary water needs of the landscape. The efficiency of water delivery also can be improved. For example, underground drip irrigation systems reduce water loss caused by evaporation of surface water.



Fig. 7. Green Areas in Effat University Use Recycled Water (Source: Author, 2010)

There are opportunities to increase water resources in Jeddah by using water captures and reservoirs for storm water [6]. Many communities are making significant efforts to control storm water runoff that can cause erosion, overwhelm water-treatment facilities, and contaminate surface water [8]. Designing a neighborhood landscape that can capture runoff and store storm water for later irrigation use is one strategy [6]. Another way to reduce household water use is to allow grey water systems to recover used household bath and wash water for landscaping use.

#### *D. Regional Accountability*

Although the old part of Jeddah, Al-Balad, is in a state of desolation, this does not reflect on the spirit of the community living there. The district is a working example of a dense, self-sustained community deriving its great strength from the fact that its structure is logical outgrowth of viable sets of social and economic rules governing group and individual behavior.

Regional design adapts a building to perform well and endure in its particular location by:

- designing for climate and microclimate;
- planning to withstand extreme events;
- considering regional vernacular architecture; and
- conforming to applicable local building codes.

Designing a building for its region is an important, yet often overlooked, aspect of sustainable design [9]. Designing for a region involves suiting buildings form and materials to the daily climate and conditions of its location. It also involves consideration of severe weather events and natural disasters that are apt to strike a particular site. Designing buildings specifically for their regions helps them to be energy-efficient, durable, and comfortable for their occupants and users.

Suiting a building to its climate involves many aspects of the design process, ranging from how the building is oriented on the site, to the space and room layout, to the choice of windows, insulation, and roofing material. A building must be suited to the terrain, soils, and orientation of its particular site. These considerations affect buildings suitability for renewable energy systems, its thermal efficiency, and the eventual comfort and expense the occupants will experience in operating them. The longitude of an area also affects appropriate design. Aspects of passive solar design, such as window placement and overhang lengths, are governed by the angle of the sun in the sky during the different seasons of the year.

The durability of a building as a whole, and the materials used in its construction, is determined largely by how well the building is designed for its region [10]. Different materials are appropriate for buildings that are exposed to extreme moisture than for buildings built in the desert. Similarly, design, materials, and installation procedures can help enhance the longevity of buildings built in coastal zones, flood plains, or areas subject to wildfire. Some building designs may be more appropriate for cooling climates than for heating climates. Paul Oliver explained that all buildings, whatever their functions, have to meet certain physical constraints. Whether they are the outcome of a long tradition of received

techniques, assembled by trial, error, and experimentation, or based on detailed mathematical calculations they have to stand up and not collapse [8]. Specifications of local climate of Jeddah may call for yet another set of design characteristics.

Over time, different regions of the country have developed some distinctive housing and building styles. Often these styles evolved from the materials that were available locally, and in response to regional climatic designs. As mechanical heating and cooling systems became more efficient, the need to use specific design elements to provide building comfort declined. As a result, housing styles became more uniform nationwide. Fascinatingly, looking back at the distinctive vernacular architecture of Hijazi region prior to centralized heating and cooling can frequently provide clues about the most effective, cost-efficient home designs for this particular climate.

Building in a regional vernacular style can not only create a building that performs well in the local climate, but also one that fits within an existing neighborhood and community [7]. Matching the style of existing homes helps to maintain a sense of cultural heritage in the region and in Jeddah, connects new developments with the community, and helps preserve the property values of older homes [8]. Some examples of housing design that paid particular attention to preservation of regional vernacular style are those designed by Hassan Fathy (Bait Nassif) and Sami Enqawi (Bait Al-Makkiyah) in Jeddah.



Fig. 8. Hassan Fathy (Bait Nassif) In Jeddah (Source: ArchNet Digital Library [11])



Fig. 9. Sami Enqawi (Bait Al-Makkiyah) in Jeddah (Source: ArchNet Digital Library [11])

At a minimum, buildings should conform to local building codes, energy codes, and regulations for civic protection. However, adopting the sustainable approach and creating buildings that are truly suited to their climate and their particular site means that these buildings will be more durable, comfortable, and sustainable over time [6].

#### IV. CONCLUSION

When a development is planned, minimizing the project's initial impact should be a priority. The practice of sustainable development is strongly linked to the conservation of natural resources. The ability to care for the environment resides in the successful management of resources that can be refilled or reused, as well as the effective use of those that are nonrenewable. A key performance indicator of a good decision-making for a sustainable system is its ability to sustain itself throughout its lifecycle. A holistic sustainable approach to construction can add considerable value to a building project. The use of modern methods of construction, such as off-site building systems and prefabricated components, can help architects and developers achieve their sustainability objectives with the benefits of cost, speed, quality and efficiency. Off-site construction offers developers the unique opportunity to improve both efficiency and sustainability. The use of lower cost products made of recycled materials may help address environmental concerns but may also give a developer a price advantage over competitors and benefit the project financially. Mechanisms must be initiated from the start of an urban development project to include social development and several social aspects should be studied early on and considered while generating sustainable strategy. Awareness must be raised among inhabitants of Jeddah to value and conduct efficient management of natural resources, especially water. Developing strategies for urban development in Jeddah should start with studying local zoning to identify old bylaws that do not allow much needed social and physical changes.

#### REFERENCES

- [1] Municipality of Jeddah, (2007). *Jeddah 1450*. Report for Tall Buildings Regulations. Happold consulting. UK
- [2] Edmund N. Bacon, (1967,1976). *Design of Cities*. Penguin Books, USA.
- [3] Christian Norberg-Schulz, (2000). *Architecture: Presence, Language, Place*. Skira, Italy
- [4] Avi Friedman, (2007). *Sustainable Residential Development: Planning and Design for Green Neighborhoods*. McGraw-Hill International, Singapore.
- [5] Derek Thomas, (2002). *Architecture and the Urban Environment*. Architectural Press, Italy.
- [6] John Ormsbee Simonds & Barry W. Starke, (2006). *Landscape Architecture, A manual of Environmental Planning and Design*. McGraw-Hill
- [7] David Sucher, (2003). *City Comforts*. City Comforts Inc. Seattle.
- [8] Paul Oliver, (2003). *Dwellings*. Phaidon Press Limited, London.
- [9] Jon Lang, (2005). *Urban Design*. Architectural Press, UK.
- [10] Christian Norberg-Schulz, (2000). *Principals of Modern Architecture*. Andreas Papadakis, Publisher, London.
- [11] ArchNet Digital Library, ArchNet.org, available: <http://www.archnet.org>

**Author** Dr. Mervat El-Shafie, Assistant Professor of Architecture, is the Chair of the Architecture Department in the College of Engineering, Effat University. Dr El-Shafie received her Ph.D. in Built-Environment from Lincoln University, New Zealand in 1999. Her thesis entitled "Phenomenology of Built-Environment" deals with the interrelationships between people and their land, houses and places and how this is being affected by the processes of Modernization and Globalization. Dr Mervat is a registered architect; she has practiced architecture over the last three decades, and has taught architecture in New Zealand, Egypt, and Saudi Arabia between 1997- 2010. Her research interests include architecture studies in relation to philosophy, culture and identity; in addition to research on architecture pedagogy and curriculum development.