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Towards an Integrative Theory Approach to Sustainable Urban Design in Saudi Arabia: The Value of GeoDesign

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1. Introduction

Sustainable urban design connotes a new relationship between the natural environment, urban form and structure, economic and institutional processes, and social livelihood. It requires a transformation of the existing socio-economic, environmental and urban design settings. Atkinson and Ting (2002) conceptualize sustainable urban design as an attempt to recognize the complex and hitherto-neglected relationship between the natural environment (sustainable) and the city as artefact (urban design). It seeks to enable the natural processes that sustain life to remain intact and to continue functioning alongside initiatives for the improvement of individual quality of life and the well being of the society. Sustainable urban design adopts a systemic and synergistic reorganization of environmental, economic and socio-economic goals that enhances the long-term health of natural systems and the vitality of urban communities (Wheeler, 1998). The concept of sustainable urban design requires a comprehensive framework of new urban design ethic to promote sustainable cities. Different authors have elaborated on the frameworks and guidelines of incorporating the principles of sustainable development in urban design (Carmona, 2001; Frey, 1999; Jenks and Burgess, 2000; Jabareen, 2006; Adhya et al., 2010). However, there is no agreed strait-jacket framework of sustainable urban design. The context in which the principle is applied determines the form of sustainable urban design. The challenge is to develop the appropriate urban design guidelines for a particular local context.

In Saudi Arabia, the spate of modernization has led to the replacement of traditional urban structure and form by Western models of urban form and design. This has resulted in problematic urban development (Fathy, 1973; Brown, 1973; Alshuwaikhat and Khaled, 1993; Al-Hathloul, 1981; Elaraby, 1996; Bianca, 2000; Al-Hemaidi, 2001; Eben Saleh, 2002) as

Western models are adopted without recourse to the underlying principles and socio-cultural background of the traditional form. In the drive towards sustainable cities through design, the challenge is to develop a framework that will adapt traditional urban form to changes in the face of Western models of urban form. This chapter proposes that there is a need to reorient the approach to urban design and development in favour of an approach that is integrative in terms of theory and provides for sustainable development. It examines the urban design problems in Saudi urban development, highlights the sustainability issues, proposes an integrative framework to address the issues and lays out the basic parameters of the framework and some cases of its application.

2. The integrative theory approach

The integrative theory approach was suggested by Sternberg (2000) in an effort to establish a theoretical foundation for urban design. Sternberg (2000) observed that urban design had been relying on techniques and ideas that have no clear theoretical basis and suggested an integrative approach to defining the foundations of urban design. He posited that “ideas that inform urban design usually coalesce around contending approaches” and shared principles of these approaches should be integrated to establish a general theory of urban design. Sternberg (2000) highlighted four elements of integrative urban design that include good form, legibility, vitality and meaning. The principles are mainly related to the substantive aspect of urban design due to the need for “a complement to procedural theory: a substantive planning theory that sheds light on the specific concerns of the urban designer” (Sternberg, 2000).

In his article, Sternberg (2000) highlighted some criteria (referred to as challenges) that an integrative theory should fulfill. The set of criteria include highlighting the underlying principles of contending approaches, addressing substantive urban design issues, awareness of the “constituents of human experience of built form”, unifying economic and architectural traditions and being realistic and practical. These criteria are used as reference in developing an integrative framework for sustainable urban design in Saudi Arabia. Urban design principles in Saudi could be considered to be generating from, at least, three sources; traditional urban design principles, contemporary or conventional urban design principles and recently emerging sustainable urban design principles. The idea is to integrate the underlying principles of these sources.

3. Sustainable urban design: A paradigm shift

3.1. The rationale for sustainable urban design

The spatial organization of cities in terms of structure and forms is rapidly being influenced by economic forces at the detriment of social and environmental factors. For this reason, cities are characterized by physical and environmental problems in terms of inadequate infrastructure, deteriorating environmental quality and congestion. Urban problems do not arise from the inherent nature of the cities but due to the absence of effective urban

governance and management (Jenks and Burgess, 2000). Planning and urban design are interlinked with the dynamics of urban transformation and have been recognized as having a vital role in the management of urban development. Land use planning and urban design influence urban structure and form which eventually generate social and economic activities within the city. The BEQUEST framework for sustainable urban development identified urban design as one of the activities that influence sustainability (Deakin et al., 2002). Jenks and Burgess (2000) also observed that the manipulation of urban form, and the provision of better forms of governance, may go some way to overcome city problems. In addition, the study by Banister et al. (1997) concluded that significant relationship exists between energy use in transport and physical characteristics of the city such as density, size and amount of open space.

Further empirical studies have shown that urban form and structure influence the social configuration (Burton, 2000), economic efficiency (Cervero, 2001) and environmental performance (Adolphe, 2001) of the city. Adolphe (2001) asserted that urban configuration influences outdoor climate conditions, energy balance of building and diffusion of pollutants while Burton (2000) highlighted the negative and positive influences of urban compactness on social equity. The findings by Cervero (2001) suggested that the urban form and mobility characteristics of metropolitan areas have some bearing on economic performance. In essence, there is an interrelationship between the spatial, physical, and structural characteristics of a city and its functional, socio-economic and environmental qualities and this relationship should be explored to foster liveable cities (Frey, 1999).

Traditionally, urban design considers the relationship between urban structural elements, socio-economic activities and environmental quality. Lynch (1960) elaborated on the visual quality of the city and highlighted elements that are crucial to the imageability of a city. His emphasis on the interrelationship of these elements and the physical environmental quality of the city became analytical means of promoting city liveability. Gosling and Maitland (1984) lucidly stated that the physical design of the city cannot be isolated from the problematic context of existing cities and highlighted the problems that concern designers as economic, engineering considerations, social and ecological. Evidently, the emergence of the concept of sustainable development has boosted the incorporation of social, economic and environmental dimensions in urban design process. The principles of sustainable development require a balance consideration of social, economic and environmental implications of development activities. Urban designers seek to incorporate the principles of sustainability into urban design through sustainable urban design.

In Saudi Arabia, like other Middle East countries, there is growing awareness of the unsustainable water and energy consumption. Domestic energy demand is increasing due to automobile dependence and use of energy dependent air conditioners for cooling (Elgendy, 2011; Taleb and Sharples, 2011; Almatawa et al., 2012). Saudi Arabia consumes about one third of its oil production (Elgendy, 2011) and buildings are consuming about 30% of domestic usage (Almatawa et al., 2012). Water production by desalination depends on fossil energy and high water demand influences energy demand. There are indications that the usage of water has not been efficient due to wastage (Garba, 2004; Elgendy, 2011).

and high energy consumption and automobile dependence might have led to air and noise pollution in a typical Saudi city (Alshuwaikhat and Aina, 2006). Therefore, there is the imperative to charter a new course that is more sustainable. Elgendy (2010) and Mills et al. (2012) highlighted the recent drive by Middle East governments to start initiatives that will foster sustainable built environment.

3.2. Saudi pattern of urban development

3.2.1. *Traditional urban form in Saudi Arabia*

The traditional urban form in Saudi Arabia is similar to that of most traditional Muslim cities. The traditional urban fabric is characterized by organic narrow winding street pattern, with homogeneous arrangement of housing plots. The houses open inward in form of courtyards (Fig. 1) and are centred on mosques, markets 'suqs' and madrassas. As noted by Bianca (2000), "the formation of the urban structure is not subject to the purely quantitative division of large space into smaller fragments but based on an incremental or 'organic' aggregation process, originating in the definition of socially relevant micro-spaces which are then connected into larger units. The enclosure of voids by correlated solids, repeated in countless variations, is the generating principle of urban form". Pacione (2001) highlighted the elements of traditional Islamic city as the obviation of the need for public buildings; the centring of city on mosques that provide a range of welfare and education functions; the bazaar or 'suq'; the residential fabric that is composed of a compact structure of open courtyard houses; and the irregular street pattern. The irregularity of forms of the traditional urban fabric does not necessarily connote lack of order but depicts coherent and harmonious integration of diverse elements to make a whole.



Figure 1. Traditional courtyards (Source: Arriyadh Development Authority)

In spite of the general elements attributed to the traditional urban fabric, there are notable variations from place to place. The old Jeddah as a typical example of traditional town in

Saudi Arabia does have some specific characteristics that are peculiar to it. The old Jeddah town was significantly different from other Islamic cities by its lack of central space allocated to governmental or religious institutions (Fig. 2). The core of old Jeddah emerged around the central 'suq' or market surrounded by residential quarters (Khan, 1981). Nevertheless, the social and communal activity still centred on the mosque. The main arteries are very few numbering about five, including the major axis along the 'suq' or market. The width of the roads varied according to function and location. The narrower lanes were located within residential quarter (Fig. 3) while the wider streets served the shopping areas and transportation of goods.



Figure 2. Street patterns in old Jeddah (Source: Google earth)



Figure 3. A narrow street in Old Jeddah (buildings have traditional wooden window screen "Mashrabiya" for privacy)

Religious, environmental, socio-economic and cultural factors have been cited as having influences on the elements of the traditional urban fabric. For instance, the introverted housing pattern of courtyards have stemmed from the religious concept of privacy and adaptation to the local climate. Also, the irregular street pattern reflects an adaptation to the local climate by maximizing shade. In essence the traditional urban fabric exemplified adaptation to local environment, integration of socio-economic and religious-cultural principles in developing harmonious and liveable society. The balance of socio-economic, environmental, religious and cultural factors in development of traditional urban fabric is exemplary and noteworthy. In the first instance, the origin of the city could be based on environmental, socio-economic or religious considerations. Availability of water or good agricultural land could serve as considerable environmental factor for locating traditional cities. After which the city is developed in an incremental manner without a 'formalized' planning but with a general concept of harmony, coherence and liveability.

The spatial geometry of the traditional urban fabric seems to have developed from lack of planning. Far from that, the structures are planned but the planning principles are flexible enough to allow for acceptable diversity and the principles are applied by the individuals in the society as there was limited civic planning. The main sources of these principles are the religious tenets derived from the Shari'ah (Qur'an and Sunnah). Examples are the principles of privacy, private and public space. The principle of privacy might have contributed to the development of the narrow and winding streets apart from the climatic adaptation by "shading".

3.2.2. Contemporary urban form in Saudi Arabia

The emergence of contemporary urban form in Saudi Arabia started in the 1930's when building regulations were enacted to guide building construction and street patterns. During this period, imported modern technologies and planning models were introduced to the country without due consideration of the local traditions and socio-cultural factors. Notable among the contemporary building regulations were the 1358/1938 King Abdulaziz's order to found Alkhobar city, the 1371/1951 ARAMCO home ownership plan and the 1960 circular by the Deputy Ministry of Interior for Municipalities. These orders and regulations set the background for the contemporary urban fabric in Saudi Arabia and the structure and pattern of cities and towns are influenced by the different regulations. Greater degree of urban transformation set in during the 1970's as a result of the economic boom and the inauguration of the Five Year Development Planning. Then, the government began a campaign of modern urban planning and systematic intervention in urban production (Eben Saleh, 2002). The new urban form was established with the grid-iron patterns and building regulations and zoning outlined compulsory setbacks and site-coverage limits. The new spatial models engendered the construction of freestanding, low-density "villa" dwellings (Eben Saleh, 2002).

Al-Malaz neighbourhood in Riyadh represents a typical Saudi contemporary urban structure. The neighbourhood, which is located 4.5 km north east of Riyadh, was planned in

1373/1957 when government headquarters was moved from Makkah to Riyadh. Al-Malaz was planned following a grid-iron pattern with an hierarchy of streets, rectangular blocks, and large lots which in most cases are square in shape (Fig. 4) (Al-Said, 1992). The main thoroughfares are 30 meters in width, secondary streets 20 meters, and minor streets or access streets of 10 and 15 meters. The block areas are 100 by 50 meters. The typical lot size is 25 by 25 meters, with some variations in width (Al-Said, 1992). The Al-Malaz neighbourhood structural pattern was consequent upon the contemporary building requirements which stipulated the planning of the land, subdivision with cement poles, heights of the buildings, setbacks and square lot ratio of the buildings.



Figure 4. Structural pattern of Al-Malaz neighbourhood (Source: Google earth)

3.2.3. *Issues and problems in contemporary urban form*

The contemporary urban pattern is mainly driven by economic considerations and formalized planning legislations. The streets are widened (Fig. 5) to maintain fast connectivity among different sectors of the city through the automobile. Urban development activities are evaluated mainly by economic efficiency and traffic considerations with the neglect of socio-cultural and environmental dimensions. The contemporary model of urban design encourages the extensive use of space and the fragmentation of functional spaces. In essence, the contemporary model contrasts the traditional model by being dynamic and mechanical while the traditional model is static and human in scale.

The contemporary/modern model of urban form has been found to be in conflict with some indigenous socio-cultural, environmental, economic and structural concepts. For instance, in the traditional Arab-Islamic society privacy was very important but the introduction of setbacks allowed adjoining buildings to open their windows outward thereby infringing on the privacy of other dwellings (Eben Saleh, 2002). Also, the introduction of glazed glasses as building materials results in additional costs of cooling and heating during the extremes of climate in summer and winter. These notable conflicts rendered contemporary model of urban design to be problematic. The residents have rejected contemporary urban form by

erecting additional structures over fences to ensure privacy and by not using their yards for female activities (Al-Hemaidi, 2001). Social sustainability is also affected by the use of cars for movements within neighbourhood such as going to school, mosque or shops instead of walking (Al-Hemaidi, 2001). Thus, Elaraby (1996) opined that the new mix of Western styles of design and characters that have appeared recently have changed the spatial environment of many Islamic countries for worse. The challenge is to develop a framework of adopting the modern technology and design principles without jeopardizing the elements of traditional values, forms and design.



Figure 5. A wide street of the contemporary urban form

3.3. Overview of sustainable urban design principles

It is recognized that urban design could foster sustainability by incorporating the principles of sustainable development with urban design guidelines and process. Different research studies have elaborated on the key principles that should be incorporated into urban design to promote sustainability. Selman (1996) and Carmona (2001) highlighted the major tenets of sustainable development that should be integrated with urban design. These principles include intergenerational equity, public trust doctrine (maintaining environmental diversity and carrying capacity), precautionary principle, intra-generational equity, participation and polluter pays principle. Atkinson and Ting (2002) proposed a framework of transformative sustainable urban design with the following principles: acknowledgement of fundamental ecological patterns and limits, environmental and social restoration and regeneration, seeking better quality of life through liveability, employing integrative and holistic strategies and solutions and recognizing sustainable urban design as a process and product. Adhya et al. (2010) opined that sustainable urban design should be able to provide adequate answers to questions on the aesthetics of the urban form, functionality of the built environment and the sustainability of the social and economic processes.

In a bid to present the sustainable urban design principles in an applicable manner, Carmona (2001) elaborated on the key principles and highlighted ten basic tenets of sustainable urban design that are found in expounded literature. These include:

- stewardship – integrated planning, enhancement through change and town centre rejuvenation;
- resource efficiency – economy of means, minimal environmental harm, reducing travel/energy reduction and recycling;
- diversity and choice – variety, permeability, mixed development and hierarchy of services and facilities;
- human needs – legibility, aesthetics, security, low crime, social mix and imageability;
- resilience – flexibility and ability to adapt to change;
- pollution reduction – low pollution and noise, water strategy, climate and air quality;
- concentration – polycentric city, compact intensification and support services;
- distinctiveness – heritage, creative relationship, sense of place and regional identity;
- biotic support – urban greening, open space, biotic support and symbiotic town/country;
- self-sufficiency – environmental literacy, local autonomy, consultation and participation.

He also noted that the spatial scale of urban design (from local to metropolitan) should be considered in applying urban design principles. In the same vein, Frey (1999) suggested three levels of urban design interventions that include individual space, city district and city/conurbation levels. In order to be effective, urban design interventions should have development frameworks generated at these levels. Choguill (2008) argued for paying more attention to the development of sustainable neighbourhood since the city cannot be sustainable with unsustainable neighbourhood.

Jabareen (2006) identified seven concepts of sustainable design that are similar to the ones developed by Carmona (2001). His principles are more specific about the issues to be addressed in fostering sustainable urban design. The concepts include:

- compactness – intensification of built form
- sustainable transport – design that promotes walking, cycling and transit-oriented development
- density – high density development
- mixed land uses – diversity of functional land uses
- diversity – diversity of land uses, rents and architectural styles
- passive solar design – reduction of fossil fuel consumption
- greening – provision of adequate urban green areas

A number of the sustainable urban design principles enunciated above need further research to clarify effect of applying the principles on the urban environment and the direction (increasing or decreasing) of application. For instance, although different authors have tried to document the negative effects of sprawl development, the principle of concentration in form of compact city development is still debatable. As noted by Frey

(1999) that the exact forms and structure that would render the city more sustainable remain elusive and the claims in support of one or the other urban structure are not substantiated. The compactness of the city must be decided with due consideration to the cultural, social and environmental context of the city.

The principles highlighted above are substantive, in line with the criteria by Sternberg (2000), and might not achieve sustainability without sustainable design procedure. The design process and the outcome of design should be sustainable. Alshuwaikhat and Nkwenti (2002) and Abdulgader and Aina (2005) suggested frameworks for ensuring sustainability in the urban design process. Abdulgader and Aina (2005) identified five aspects of the urban design process that should be integrated. The aspects include substantive, procedural, methodological, policy and institutional. Alshuwaikhat and Nkwenti (2002) expatiated on the procedural aspect by suggesting a design framework that is within a balanced structure of "Top-Down" and "Down-Top" dialoguing with reflection of various components of the society. The sustainable design process approach consists of five principal stages: sustainable design objectives, sustainable design guidelines, sustainable design statements, preliminary design and sustainable design scheme. This framework has to be integrated with the planning process to promote sustainability of cities. The planning and urban design process should be incremental and adaptive due to the need for flexibility and adaptation to changes in social, economic and environmental contexts. The section below includes further discussion on sustainable design process.

4. The integrated approach to sustainable urban design

As illustrated in the sections above, there are at least three contending issues/concepts of urban form and design in Saudi Arabia; the heritage of the traditional urban form, modern concept of urban pattern and the emerging and overarching concept of sustainable urban design. Contemporary urban design cannot be based solely on the traditional models as the variables that have contribution to the development of urban development are fast changing and it could be very difficult and impracticable to conceptualize these changes in the light of traditional concepts alone. On the other hand, indiscriminate adoption of modern models has been found to be problematic and incompatible with the traditional city forms. "The total neglect of the traditional forms, and the implications of their meanings and values, will cause us to lose forever our heritage and architectural identity" (Al-Hemaidi, 2001). Sustainable urban design could provide the opportunity of integrating the traditional and contemporary models in a resourceful manner, as some of the relevant elements of both models are embedded in the principles of sustainable design. As noted by Liddell and Mackie (2002) that the more sustainability principles are applied to design and planning (in Northern Europe) the more these tend to take on traditional forms. However, there should be a framework that lays emphasis on the consideration of traditional concepts for the appropriate integration of these concepts in the principles of sustainable urban design.

The integrated approach to sustainable urban design should have at least three dimensions; substantive, procedural and methodological. The other two dimensions, policies and

institutional aspects (Abdulgader and Aina, 2005), are not directly under the control of urban designers. Yet, urban designers need the skills to manoeuvre the institutional framework and also promote the implementation of sustainable policies. The procedural dimension that is adapted from the study of Alshuwaikhat and Nkwenti (2002) has been highlighted above. That is, the procedure should consist of at least five principal stages of objective, guidelines, statements, design and scheme. The integration of sustainability in urban design process is necessary because the process of urban design determines the transformation of the design and the process cannot be divorced from the product. If the design process is sustainable there is likelihood that the design itself will be sustainable and consequently the community will advance towards sustainability. The issue of implementation is very important in the procedural aspect and efforts should be made to monitor and improve the efficiency and effectiveness of the implementation mechanism.

4.1. Substantive dimension – a synergy of principles

The substantive dimension proceeds from the idea of Sternberg (2000), as mentioned in section two above, that the underlying principles of the contending approaches be integrated. Thus, the underlying substantive principles of sustainable urban design should be integrated with the traditional values and principles of urban form. Elaraby (1996) expatiated on the underlying principles of traditional Islamic design and highlighted six principles which are fundamental to traditional design. These principles include:

- Unity – functional and aesthetic forms that expresses an integrated, indivisible whole (unity in space and pattern, in light and colour and in space and form);
- Openness of space – positive, active spaces interact with negative spaces to express interrelationship between form and space;
- Simplicity of form and design – use of basic geometric shape and a pure modification and abstraction of geometrical form;
- Simplicity of structural expression – organic relationship between structural components;
- Scale – respect for human scale in both the whole environment and particular buildings;
- Harmony, compatibility and balance – harmonious integration of structure and form; and
- Privacy – respect individual right to privacy.

The traditional urban and legislative elements which interacted to shape the urban form and spatial structure should also be integrated into the design process. Some of these elements are identified by Hakim (1988) as Hisba institution, Waqf, allocation of land, traditional energy saving techniques, symbolic manifestations, water extraction and surveying and construction techniques.

A set of principles and elements from traditional and contemporary design are selected to be integrated with the principles of sustainable urban design to engender better urban form and design (Fig. 6). As shown in figure 6, the sustainability principles include mainly the

concepts from Jabareen (2006) and some issues that were not explicitly mentioned in his framework. For example, resilience to climate change and natural hazards has become an important issue in recent time due to global environmental change. Human needs such as social relationship are also very important. So, these concepts are selected from Carmona's (2001) principles. The traditional principles are deduced from issues raised by Al-Hathloul (1981), Hakim (1988), Al-Hemaidi (2001) and Eben Saleh (2002).

The process issues such as public participation and institutional framework are not substantive but they are also important. So, they are shown in red boxes outside the substantive triangle (Fig. 6). Some of the issues feature in more than one set of principles to

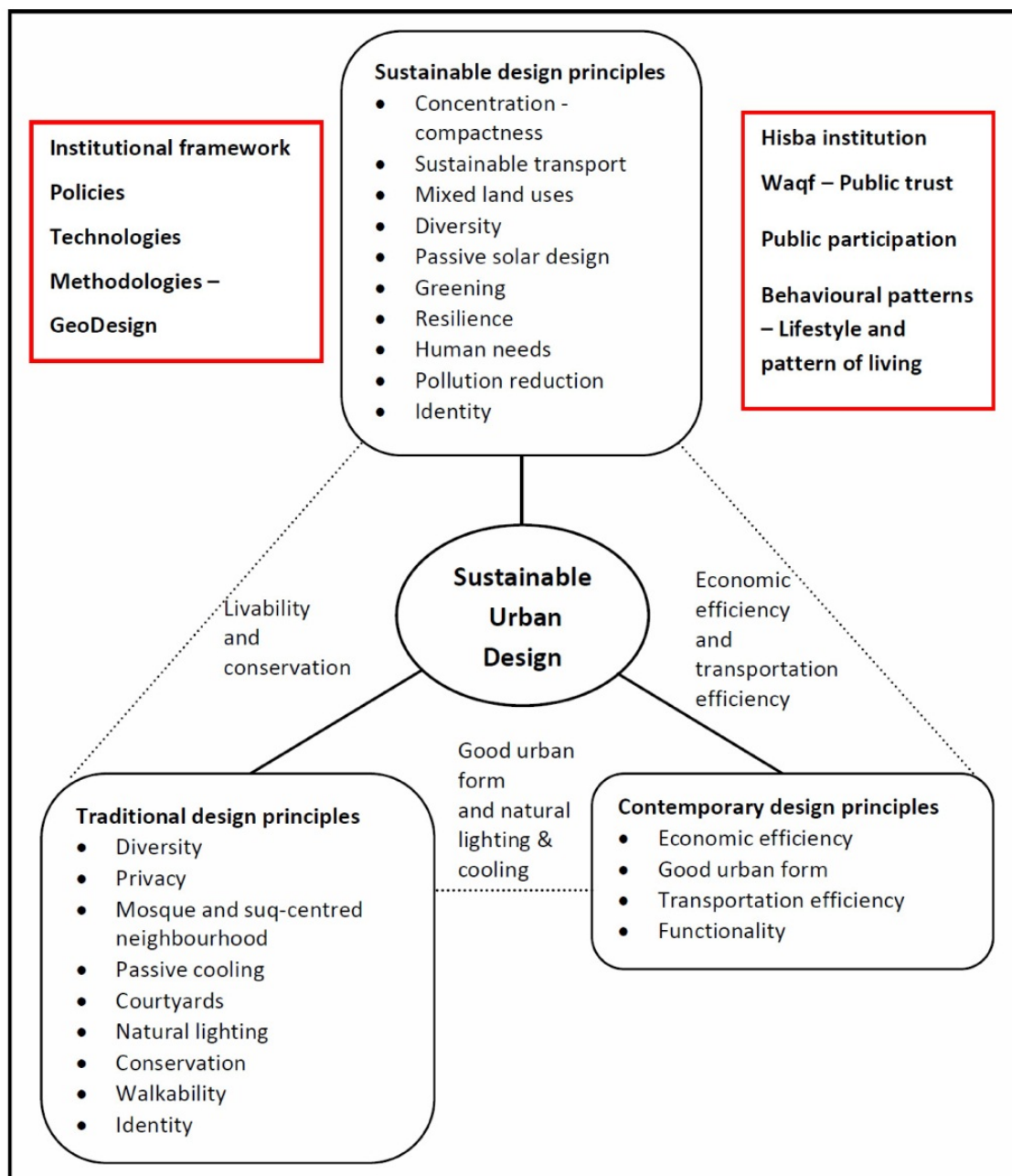


Figure 6. Conceptualization of the integrative theory approach

show the overlap between some of the contending principles. Some challenges might arise from the issues that are conflicting among the principles. For example, promoting urban greening might conflict with conservation in a desert environment. Maintaining green areas require a lot of water and it might impact on energy demand. Also, it might be difficult to achieve high density neighbourhood with design of courtyards. The principles highlighted in this study are not conclusive and other principles could still be valid and relevant. In essence, the paper proposes that different principles of traditional, modern and the overarching sustainable urban design should be applied in an integrative approach to achieve better and liveable cities.

4.2. Methodological dimension – a case for GeoDesign

The methodological dimension involves the utilization of different analytical, descriptive and modelling techniques to fully grasp the complexity of different factors involved in sustainable urban design. No single method is capable of analyzing the components of urban systems in a comprehensive manner. Thus, there is the need to integrate different methods of analysis with a view to further understand and model the urban system. Efforts have been made in this direction with the development of space syntax, cellular automata, GIS and the collaborative planning support systems. It has been noted by Batty et al. (1998) that the advances in computer models and information systems have hardly been fully utilized in urban design. It is highly pertinent now to find ways of utilizing the powerful potentials of different computer models and information systems to support urban design. Batty et al. (1998) identified about four ways in which urban system can be represented (by the information systems) at the level of urban design. These include the representations of socio-economic, functional, behavioural and physical information. Virtually all the information can be stored and analyzed digitally by the current level of technology. There is just the need to fully integrate the available information systems and make them amenable to supporting sustainable urban design process and product.

Efforts towards the integration of information systems for urban design have led to the emerging concept of GeoDesign. It is the adaptation of geography, geographic information system and other information systems in a synergetic way to support urban design. That is, “integrating geospatial technologies into the design process with the goal of living more harmoniously with nature” (Artz, 2010). Goodchild (2010) defined GeoDesign as “planning informed by scientific knowledge of how the world works, expressed in GIS-based simulations”. Apart from utilizing the sketching and simulation capability of GIS (Goodchild, 2010), with geographic reference, GeoDesign uses web and visualization technologies to enhance collaboration and stakeholders participation during the design process. The broad idea is to have all design related technologies, such as computer-aided design (CAD) and building information modelling (BIM), integrated into GIS to be able to design in a spatially aware environment.

GeoDesign has been demonstrated to include the following essential elements (Dangermond, 2009; Abukhater and Walker, 2010; Goodchild, 2010, Wheeler, 2010):

- Sketching – drawing proposed designs or plans

- Spatially aware simulations – modelling different systems (environmental, economic and so on) and how they will respond to proposed design in terms of impacts and change (with geographic reference)
- Fast feedback – supporting collaboration
- Iteration – trying and visualizing different alternatives
- 3D visualization – presenting design alternatives and impacts in three dimension

In their article, Abukhater and Walker (2010) exemplified how GeoDesign can be used in making cities grow smarter. GeoDesign has also been applied in planning new electricity networks (Moreno-Marimbaldo et al., 2012), green infrastructure design (Hehl-lange et al., 2012) and landscape planning (Pietsch, 2012). The capabilities of GeoDesign make it a valuable tool for urban designers in promoting sustainable built environment. Urban designers need capable analytical, modelling and visualization tools to synthesize the varying issues of urban complexity, climate change and human social needs.

A model by Dangermond (2009) successfully highlighted the importance of GeoDesign in design process (Fig. 7). The model incorporates the design process with the elements of GeoDesign such as designing, sketching and geo-accounting. It showed that Geodesign could be a veritable box of tools that enables “a rapid and adaptive process for creating a sustainable future” (Dangermond, 2009). In terms of usage, most of the applications of GeoDesign are still in Europe and North America but there is a growing adoption in other

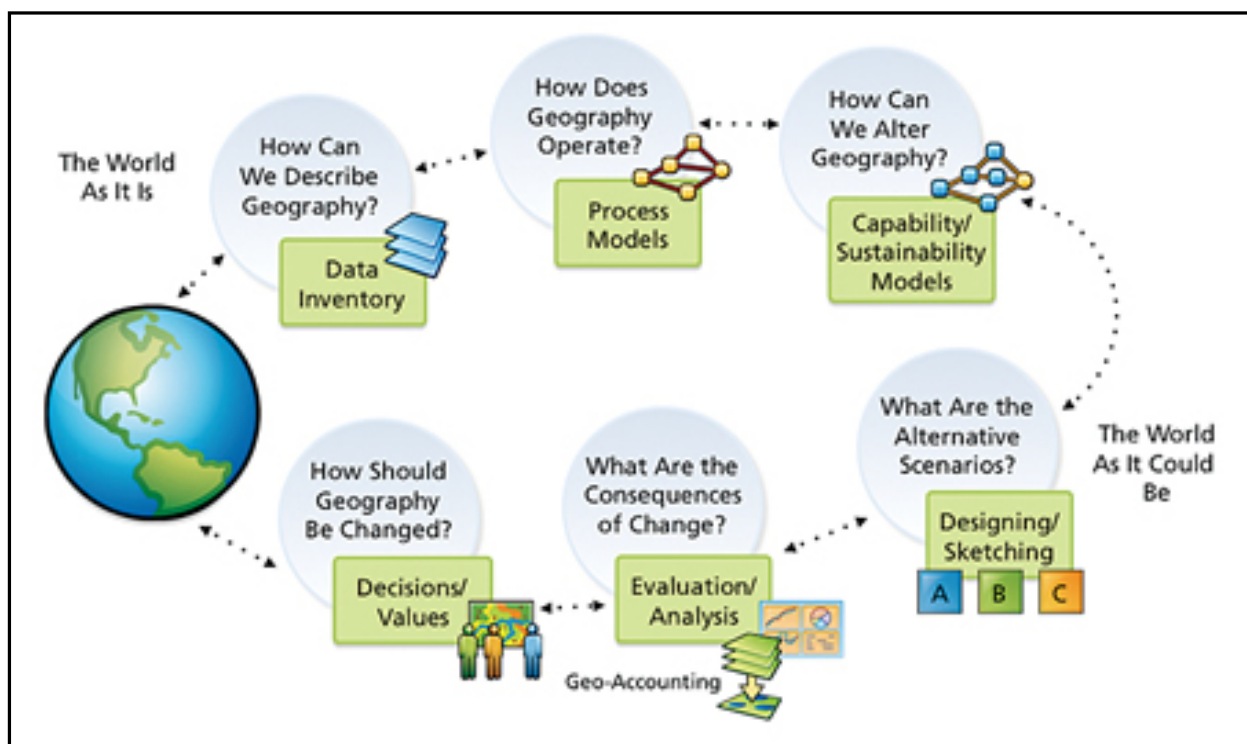


Figure 7. GeoDesign in the sustainable design process (Source: Dangermond, 2009) Graphic used by permission. Copyright © Esri. All rights reserved.

countries. In Saudi Arabia, GeoDesign is gaining momentum because GIS technology (backbone of GeoDesign) is already being used in the kingdom to solve different geospatial and design problems. Aina (2012) highlighted some of the recent applications of GIS in Saudi Arabia and affirmed that the utilization of the technology is growing in the Kingdom. Another indicator of the growing application of GIS and GeoDesign is the GeoDesign conference that took place in Riyadh in 2011. The conference (<http://www.iqpc.com/Event.aspx?id=554952>) recognized the need to enhance Saudi's GeoDesign capabilities to support the increasing infrastructure expansion projects.

4.3. Case studies – Mashair metro and KAUST campus

Saudi Arabia has carried out some projects that are exemplary for sustainable urban design. One of the projects is the Mashair metro project, which was inaugurated to improve transportation system during the yearly pilgrimage (Hajj). The Mashair trains have the capacity to transport about 550,000 pilgrims between the holy sites (Arab News, 2012). The project could promote sustainable urban design, by reducing carbon emissions and encouraging transit-oriented development, as the trains will replace about 53,000 buses (Barry, 2009). Due to the initial success of the project, other metro projects have been initiated for Jeddah and Riyadh cities and to link Makkah with Madinah (Haramain Metro). Another prominent design project is King Abdullah University of Science and Technology (KAUST) campus project. This is the first project to be awarded LEED certificate in Saudi Arabia (Almatawa et al., 2012). The project was based on sustainability principles from the scratch and they implemented a sort of GeoDesign for the design of the campus and monitoring of different sustainability parameters (Elgendy, 2010). The sustainable and traditional design principles implemented in the project include; compact city planning, traditional suq (market), traditional passive ventilation, mashrabiyyah (Fig. 8), passive design, energy and water conservation (Elgendy, 2010).



Figure 8. Building facade with window screen similar to traditional mashrabiyyah (Source: A. T. Service – Wikimedia commons)

These highlighted constitute a very bold start in embracing the principles of sustainable urban design in the Kingdom. The challenge is in replicating such projects across the Kingdom and making the adoption of sustainability principle the norm. Al-Hemaidi (2001) noted that there few promising traditional designs here and there but there is no coordinated effort to implement them on a general level. Another challenge is the ability to change the behavioural pattern of the populace. Authors like Abdulgader and Aina (2005) and Choguill (2008) have noted the requirement and importance of changing living pattern to achieving sustainability. Implementing sustainability principles is necessary but not enough for sustainable urban development (Choguill, 2008).

5. Conclusion

The concept of sustainable urban design is an overarching concept that can serve as a platform to resolve the conflicting values of the traditional urban form and modern design models. However, the principles of these models both traditional and modern should be integrated with the sustainable urban design principles to effectively incorporate them in urban planning and development. This chapter has tried to highlight some of the pertinent and core principles of traditional urban form and sustainable urban design that should be integrated to foster liveable cities. It also highlights the importance and value of GeoDesign to sustainable urban design. Although the approach that has been proposed by this chapter evolves from the analysis of Saudi Arabian urban design context, it could be applied in any other planning and design environment with little variations. As it is evident that the tendency in almost every society is to follow the new trend of the globalization of cities, by which forces that are 'alien' to cities dictate their structure and morphology. There is the need to further examine how to operationalize these integrated principles especially in the local context of the Kingdom of Saudi Arabia.

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