Global trends in sustainability rating assessment systems and their role in achieving sustainable urban communities in Saudi Arabia

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Abstract

Sustainability as a concept is tackled a lot in contemporary urbanism due to its importance; consequently, this led to the development of global trends toward achieving it. The current research attempts to identify how sustainability could be achieved in urban design and how to comply with the global concerns. This paper tackles the experiences of the global trends toward sustainability concepts in terms of its application by examining a range of contemporary global urban examples. It depends on a comparative analytical assessment using the ‘Leadership in Energy and Environmental Design (LEED) for Neighborhood Development, LEED-ND’ assessment system in order to address the criteria measuring the sustainability indicators for these examples. These criteria are mainly grouped under the following categories: sustainable planning and design, water management, energy management, waste management, transportation and construction materials and resources. The research mainly aims to identify strategies and criteria assisting in achieving sustainability concept and implementation in urbanism at international level and their role in achieving sustainable urban settlements in Saudi Arabia. In order to achieve this aim, the research methodology includes the following: review of the global sustainability assessment tools, review of the ‘LEED-ND’ assessment system, analytical comparative assessment of ‘King Abdullah University of Science and Technology’ and ‘Masdar City’ according to the ‘LEED-ND’ system as case studies and identifying strategies and criteria that achieve sustainability in urban design and planning.

Keywords: sustainable urbanism; sustainable planning and design; LEED; KAUST; Masdar City

1. INTRODUCTION

The world is currently facing many challenges that are keeping pace with the rapid urban development resulting from population growth and the development of contemporary human life, especially in urban areas, where the urban population has increased from 14% of the earth’s population in 1900 to ~50% in 2000 and is expected to reach ~80% in 2100 [1]. As a result, the consumption of natural environment resources is constantly growing with the aim of achieving the appropriate environment for human comfort, especially in urban areas, with no situation in the consideration of preserving these resources for future generations. The level of urban communities with their own self-esteem and potential and the achievement of sustainability in the field of urbanization are necessary, as the field of urbanization includes many humanitarian activities that are covered by the field of concern for sustainable development and may contribute to the achievement of sustainability or not, the establishment of clusters. Urbanization is responsible for a significant proportion of environmental degradation either directly through the excessive consumption of available resources or indirectly through the impact of these areas on the surrounding community through waste and otherwise.
Sustainable urbanization is known as the building that follows the basic principles of sustainable planning of efficiency in dealing with energy, resources and water and is characterized by vernacular architecture of association and compatibility with the surrounding environment with all its natural, artificial and social elements with functional and environmental efficiency, by providing convenience to users and reducing the negative impact on the environment and public health [2].

2. SUSTAINABILITY RATING TOOLS

The use of building sustainability measurement tools aims to encourage the design, establishment and management of environmentally friendly facilities and contribute to the development of environmentally responsible building practices and also plays another role in giving investors looking for better performance, an objective and accredited tool that reflects the quality of environmental performance for their buildings giving them a competitive advantage in the real estate market. The use of these tools has begun voluntarily, but some cities have recently begun to require certain grades on these standards so that new projects can be licensed, as is the case in some Gulf countries, particularly Qatar (where it has QSAS) and the Emirates (where it has Pearl system). Such these evaluation systems have adopted a set of criteria by which an evaluation of the building can be given so that the performance of different buildings can be compared according to the same criteria and then judge the sustainability of the building at any level of non-compliance.

2.1. LEED rating system

There are two types of ‘LEED’ certificates. The first type is intended for the accreditation of specialists working in the field of sustainable buildings and the certificate granted is called ACCREDITATION PROFESSIONAL for the practice of sustainable architecture. This certificate is awarded after the examination is performed and passed as required. Obtaining this certificate also earns the project in which the recipient participates an additional point used when evaluated for the purpose of obtaining a LEED certificate for projects [3].

The second type is dedicated to evaluating the performance of buildings and conforming to the specifications of ‘LEED’, where the buildings are evaluated to judge the extent to which they achieve the principles of sustainability through several criteria such as energy consumption, water management, the quality of indoor environment, the existence of systems for renewable energy and the existence of systems to monitor consumption and pollution rates. In such cases, the building is awarded a set of points, and the total calculation reflects the evaluation and classification of the building’s performance.

2.2. Measuring the sustainability of buildings using the ‘LEED ND’ rating system

The criteria that the ‘LEED ND’ system requires compatibility to evaluate the performance of the complexes are distributed in four categories and within each category there is a set of mandatory requirements (prerequisites) and is compatible with them without obtaining points as a prerequisite for obtaining the certificate; in addition, there is a variety of other groups of the optional and different requirements in terms of the number of points [4]. These criteria are distributed as in Figure 1 [5].

- Smart location and linkage: it aims to implement strategies that encourage the preservation of natural resources such as reusing existing sites, taking advantage of abandoned and contaminated sites, protecting natural areas and connecting with the surrounding community.
- Neighborhood pattern and design: it aims to encourage the recourse to pedestrian paths and attention to them to reduce the use of fossil fuel transport, as well as to encourage the care of public spaces and the participation of the local community in the design process.
- Green infrastructure and buildings: it focuses on the use of energy and water savings, water recycling, pollution eradication and reuse strategies.
- Innovation and design process: it aims to encourage creativity in achieving the maximum benefit of dealing with the thought of sustainable planning.
The evaluation system includes four performance levels: classified, silver, gold and platinum according to the number of points gained as presented in Figure 2 [5].

3. COMPARATIVE ANALYSIS OF EXAMPLES APPLIED OF THE ‘LEED’ SYSTEM AT THE URBAN LEVEL

The research analyzes examples of the global trend toward sustainable concepts in practice by examining a range of contemporary global examples based on the comparative analytical approach at the urban level using the LEED for Development Neighborhood rating system and addressing standards by which sustainability indicators for these case studies can be assessed (‘sustainable site—energy efficiency—waste management—transportation—building and materials resources’).

Selected case studies:

First: King Abdullah University of Science and Technology (KAUST), Thuwal (near Jeddah), Saudi Arabia, was designed by HOK Architects and was completed in September 2009. The new campus of KAUST is the first LEED-certified project in the Kingdom of Saudi Arabia to obtain the platinum certificate, the highest rating in the US green building classification system, with an area ∼500 000 m², and the project also represents the largest LEED Platinum project in the world.

Second: Masdar City, Abu Dhabi—United Arab Emirates, which is expected to be the most sustainable city in the world, and in addition to being a mixed-use city to have a role worldwide in the development of the renewable energy sector and technologies clean by using renewable energy and clean.

3.1. King Abdullah University of Science and Technology [6, 7, 8, 9, 10]

The design of this project is to make a contemporary work of architecture that will reverberate with the worldwide scientific society while being strongly rooted in the local culture of Saudi Arabia (Figure 3). In short, designers are also required to produce campuses of the greatest quality material at an exceptional speed.

Additionally, given that KAUST’s research plan includes research in renewable energy and given its several collaborations with various prominent universities with obligations to sustainable development, it has also become an essential element of campus design and operation. Indeed, the project design comprised well-defined guidelines for creating a very efficient, low-energy and sustainable campus.

The decision to incorporate a low-energy and efficiency design in the project has to be realized in its regional and local contexts. In Saudi Arabia, the cost of electricity is very low (ranging between 2 and 4 cents/kWh) as a result of the large governmental subsidies. This indicates that there are few financial incentives for building holders to conserve energy and that the payback period for several energy reduction strategies applied is too long for them to be reasonably viable. Nevertheless, the university’s decision to make a low-energy campus is effective not about financial payback but instead to support a campus that would operate as an example of buildings that are responsive to the environment in the region.

3.1.1. Sustainable site

Much like the Americans and unlike most Europeans, Saudi Arabsians rely almost entirely on their private cars as the main mode of transport, with nearly no public transport. The project designers seek to make a campus relying less on the car and more on pedestrian and alternative modes of transport.

The campus is located just 1000 m from the dense new city of 10 000–12 000 people dedicated to researchers and faculty members (Figure 4). The two areas are linked by shaded footpaths giving students and faculty members chances to cycle and walk to campus. Furthermore, KAUST is also implementing a comprehensive alternative transport scheme that includes different forms of public transport involving bicycles, bikes and community electric buses and vehicles. Preferred alternative fuel vehicle parking and secure bike racks help encourage this alternative transport.

The site also includes key sensitive marine habitats that require protection: mangrove forests and coral reefs. These two habitats have been secured from the effects of development by creating a 50-meter buffer zone that restricts construction and development processes within the boundaries of coral and mangroves. The surrounding natural environment is also preserved by treating rainwater before it leaves the site and capturing re-pollution and sediments.

Moreover, to moderate the effects of the thermal island impact, particularly considering the solar heat gain and sun’s intensity in Saudi Arabia, light-colored paving materials have been chosen to maximize solar reflectivity and reduce overall outdoor temperature.

3.1.2. Energy efficiency

The high temperature and humidity levels of the site had enormous implications for the design of project approaches. The building’s directions limited exposure to the unpleasant eastern and western sunlight. The unpleasant heat gain in the morning and evening from the northeast and northwest was moderated by appropriate shading of the opposite façades.

Nonetheless, the design tried to decrease exposure to sunlight; moreover, it sought to increase daylighting to enhance occupant comfort and lessen the demand for lighting (Figures 5 and 6). Therefore, the compact form of the campus has taken the form of fingers with shallow floor panels, permitting natural daylight to reach all the surrounding spaces in addition to some of the interior spaces.

Along with shading and daylighting, the design of campus supported natural ventilation. A pre-design investigation of the wind direction in the northern Red Sea presented the direction of the northwesterly winds consistent with a velocity of 5 m/s; nevertheless, a more detailed investigation of the site displayed...
that its climate involves winds coming directly from the Red Sea in a northeastern direction. The solar orientation assisted the building benefit of the predominant Red Sea winds and used it as a cooling mechanism.

But possibly the most pleasant natural ventilation element of the project is the use of two solar wind towers. These wind towers cause natural daytime ventilation even when there is no wind by absorbing solar heat using a dark roof at the top of the tower. The dark, hot roof heats the surrounding air, which rises through an opening at the top of the tower and draws cool air from below to take its place. Air drawn at the base of the tower create aerodynamic movement in the rotating spines attached to the
tower. Fluid dynamics computer studies (CFDs) were conducted out of solar towers to improve their design.

The use of solar chimneys, wind towers, along with the predominant Red Sea winds assisted to make the effect of natural ventilation providing a high level of comfort during the year for people who use spinal circulation areas, providing almost the need for condition almost 1 million square feet.

After using as many passive techniques as possible to decrease energy loads, the design team designated the most suitable and climate-efficient mechanical and electrical systems for more reduction of energy requirements. The design included low-energy cooling techniques for instance heat recovery wheels, chilled beams and displacement ventilation to decrease ventilation and cooling loads. It moreover involved high-efficacy lighting with controls for example daylight and occupancy sensors to decrease light usage while increasing occupant productivity levels. These systems combined with the campus-wide buildings automation systems will support decrease energy usage drastically.

Along with the energy conservation methods, the design also performs renewable energy production. The roofs of campus are covered with large arrays of solar photovoltaic cells to generate electricity, in addition to solar thermal arrays for heating household water. The two systems together generate 8% of the on-site energy requirement. Another 75% of the campus's energy load was obtained through renewable energy appropriations. The overall campus energy saving is 28% (compared to ASHRAE 90.1-2004), which is a significant accomplishment given that the campus includes laboratory buildings that need high levels of practical energy loads that reduce overall energy savings.

3.1.3. Water management

Water conservation is vital in Saudi Arabia as well as throughout most of the Middle East. The average rainfall on the KAUST site is 55 mm annually, with a lot of rain occurring during the winter. The majority of the use of potable water in Saudi Arabia is produced by the desalinated sea water, as Saudi Arabia desalinates more sea water than any other country. Given the shortage of water and the high energy use related with desalination, water conservation is possibly a similarly pressing issue in Saudi Arabia as energy conservation.

The design team has applied several approaches to decrease the undrinkable water amount required for irrigation the KAUST campus. Consistent with the comprehensive irrigation plan on campus, all black and gray water is treated and reused for irrigation. Native and adaptive plants have been grown on site, needing less water and thus helping to reduce the demand for irrigation water. Effective drip irrigation system is also used to decrease the potable water amount lost due to runoff and evaporation. As well as providing irrigation water, other water-saving approaches were integrated to decrease water demand by 45% using low-flow features in campus buildings.

Potable water accounts for only 3% of the total amount of water on earth and is particularly rare in the Middle East. By implementing efficient water installations and waterless urinals, the KAUST campus has reduced its expected annual consumption of portable water by 55%. The original and adaptive species were selected for most plantings on the campus. These species do not need large amounts of irrigation to survive and will reduce the overall demand for water at KAUST (Figure 7).

Potable water is a rare resource in the region. The massive majority of potable water at KAUST will be provided from a desalination plant, but desalination is an energy-intensive process. For reducing the total demand for water and energy for KAUST, all sewage (black water, gray water and rainwater) will be sent and carried from the campus to the wastewater treatment plant (WWTP), located in the south of the campus and community, to be recycled. The WWTP is a sophisticated plant designed to handle the average daily sewage flow of 10 000 m$^3$ per day, or $\sim$10 million l per day, and 3.6 million l per year. The recycled water will be used for many irrigation needs, thereby significantly reducing the demand for potable water for the university.
3.1.4. Waste management

The KAUST campus and the local community will apply a comprehensive recycling program that recycles paper, plastic, glass, metal and corrugated cardboard and assembles all compostable materials for mulch reuse. All dwellings will have built-in chutes on all floors for collecting recycling materials and composting. Outdoor recycling bins will be provided in dense pedestrian areas near the city center and campus. All food wastes from the campus and the harbor area will be crushed, packaged and transported to a central allocation point to be integrated into the Organic Landscape Sawdust program. Waste management vehicles for the KAUST campus and the local community will use substitutional fuels that will not have a carbon footprint.

The KAUST develops an integrated waste management plan (Figure 8) to minimize the amount of solid waste. The campus plan addresses issues and initiatives such as follows:

- Centralized and decentralized composting systems;
- Recycling and salvaging of demolition and construction waste;
- The extension of multi-material recycling programs to all multiunit buildings;
- Promoting and allowing the use of recycled and salvaged building materials in KAUST buildings, where possible, involving materials from the deconstruction of existing buildings in the site;
- Educational and encouragement programs to promote reduction, reuse and recycling;
- Waste reduction system and recommended voluntary practices.

The campus is also working to reduce construction waste by >75% by trying to recycle surplus escarpments such as concrete and wood. The campus also imposes fast restrictions on contractors for proper disposal of construction waste.

3.1.5. Transportation

KAUST accomplishes higher transport quality with less use of resources through intelligent design, integration of new technologies and innovations (Figure 9). The community’s comprehensive substitutional transport strategy is an innovative way to reduce the overall carbon footprint of the project by reducing the impact of individual occupancy vehicles through careful design and planning.

Substitutional fuel vehicles and shuttle buses for use on campus and the community uses, particularly KAUST Security, utilize the Segway Electric Travel Co-program for short-distance travel. The KAUST buses system has set up stops throughout the campus and the community to guarantee easy access for all users who want access to the Harbour District center, campus, recreational zones and secondary schools. Bicycles are usually used with generally available bicycle racks.

The development of a pedestrian-friendly public realm should be encouraged (Figure 10), through street design, landscaping, furnishings and lighting. In addition, high levels of facilities for cyclists, both private and public, should be provided in all areas of KAUST to encourage walking around the city to reduce emissions from the use of traditional transportation means. In addition, private parking spaces have been provided at the edges of the campus, which is connected by public transport to the rest of the campus.
The campus adopted a transportation plan which promotes the following:

- Emphasizing alternatives to the car transportation;
- Promoting cycling and walking;
- Providing convenient and safe road crossings for pedestrians;
- Giving more spaces for cyclists;
- Providing bike lanes as a top priority;
- Guaranteeing cycling facilities and bikeways are visible;
- Emphasizing the provision of a high standard of bicycle services;
- Enhancing the comfort, frequency and convenience of transit facilities;
- Giving more road spaces to transit;
- Using smaller buses where big ones are not available;
- Accommodating goods movement without increasing road capacity.

3.1.6. Building materials and resources

The selection of building materials for larger projects as KAUST may have significant environmental impacts. The design team have selected building materials that minimize any adverse environmental impacts (Figure 11). The building terms of KAUST involved the following:

- Local steel and concrete with high levels of recycled content;
- Use of water paints that do not contain volatile organic compounds (VOCs) or chemicals that may harm human health;
- All the wood used in the KAUST campus was purchased from sustainability managed forests and is Forest Stewardship Council (FSC) certified;
- Use of recycled aluminum panels in building facades;
- Interior furniture system that contains no VOCs are Green-guard Certified and have high levels of recycled content;
- Using low VOCs interior finishing and high levels of recycled ingredients (gypsum panels—carpet cutting—roof tiles—paint materials—adhesives—timber works);
- More than 70% of all construction wastes were recycled for the KAUST campus.

3.2. Masdar City [11, 12, 13, 14]

Masdar City (Figure 12) is a planned city project in Abu Dhabi in the United Arab Emirates. Its core is being built by Masdar, a subsidiary of Mubadala Development Company, with the majority of seed capital provided by the Government of Abu Dhabi. Started in 2006, the city was conceived to cover 6 km² (2.3 square miles). According to the design, the city will be home to 45 000 to 50 000 people and 1 500 companies, primarily manufacturing and commercial facilities specializing in environmentally friendly products. In contrast, more than 60 000 workers are expected to travel to the city every day. Masdar City will be the newest of a small number of highly planned, specialized, research and technology-based municipalities with a living environment.

Masdar City is the most sustainable city in the world as it is an expected global complex of clean technologies, which helps major companies to take it as a headquarters due to its proximity to the centers of development of the renewable energy sector and clean technologies. It can also be a platform for reviewing, researching, testing and application of renewable energy and clean technologies.

Masdar City is strategically located 17 km from Abu Dhabi and is in the middle of Abu Dhabi’s transport infrastructure. It will be connected to the surrounding residential complexes, with downtown Abu Dhabi and Abu Dhabi International Airport with a vital network of existing roads, a train railway and new public transport routes.

3.2.1. Sustainable site

The city’s planners were inspired by the traditional planning of Arab cities (Figure 13). The design includes several strategies to deal with the desert climate, which is characterized by relatively low energy consumption, where the city’s planning relied on the use of compact pattern, high population density and the use of shaded footpaths. It is also a socially diverse place where people work and live in the same context with full of life.

The master plan plays a pivotal role in achieving the goals of sustainability and the most important elements of this planning are the following:

- The city, as well as the road network, has been oriented toward the SE-NW direction to provide shade on the roads throughout the day in a way that reduces the exposure of the solar radiation. The city was also directed toward the prevailing winds, 38° anticlockwise from the North axis to enhance airflow in the spaces and streets.
- Low-rise buildings with high density where most of the buildings are only five floors away. This is central to an urban society that does not consume much energy, both in mobility and in the heating and cooling loads.
• Pedestrian-friendly city where the city encourages walking through shaded walkways, in addition the integrated nature of the city also allows walkability to many destinations.

• It is identified that the housing and other buildings are integrated into the heart of the society as well as the facilities of entertainment and entertainment so that the residents and those who move to the city who live and work can find all their demands.

• Great attention has been paid to public spaces between buildings with at least a focus on the buildings themselves as the streets and spaces of Masdar City attract people to enjoy the outdoor environment.

• It was taken into account when designing Masdar City to offer high quality of life with the least negative effects on the environment, which confirms that providing the requirements of environmentally friendly life is not as difficult as it is thought.

3.2.2. Energy efficiency
Building Energy Management relies on leading standards, allowing it to achieve a high level of efficiency while reducing construction costs. In addition, effective strategies and systems have also helped to reduce energy consumption, such as the use of high-performance finishing materials and reducing the ratio of windows to walls, etc.

The energy required for lighting was reduced by >50% through the use of intelligent systems, sensors, low-energy lighting, natural lighting and lighting control systems. The city is currently operating entirely based on the renewable energy generated in the city. Nevertheless as the city grows, the situation will change with a medium-term goal of at least 20% of the energy supply coming from renewable sources.

The remaining energy will come from external renewable sources and there are currently several renewable energy projects under way or are in the early stages that will provide the city with clean energy sources. Moreover, an 10 MW solar power plant (Figure 14), the largest of its kind in the Middle East, has been launched, which provides energy for building established currently in the city.

The city has established a distinct project in the field of geothermal in order to achieve integration between different systems in an innovative way. This resource is generally used for heating and power generation.

3.2.3. Water management
The city’s water needs have been reduced to less than half of the usual needs for similar buildings. In the first phase, the city seeks
to consume 180 l daily per person, which is significantly lower than the usual consumption rate of 550 l per day in the UAE. The city’s ultimate goal is to gradually reduce this to 40% lower when all facilities are completed (Figure 15). However, this does not include the water needed for cooling, which may double the amount of water needed for the city.

In order to achieve this reduction in consumption, a variety of techniques and systems have been used that contribute to reduce water use, where high-efficiency installations, connections and appliances are already used, as well as smart water meters that predict the population’s volume of water consumption in addition to reveal cases of leaking in the network.

The percentage of water used for irrigation has been reduced by 60% per square meter by using a highly efficient sprinkler irrigation system and designing green spaces in a way that reduces water evaporation from plants. The selection of local trees and plants with low water consumption. Moreover, 100% reuse of sewage is also used in irrigation, which in turn helps to reduce the total consumption of drinking water. Furthermore, rainwater was treated through channels to be collected and discharge effectively.

Most of the water areas in public places are designed to be shaded to reduce the amount of water wasted by evaporation. Drinking water consumption has been reduced by 54% compared to the minimum in the UAE by using the best practices in supply and using the most efficient equipment.

3.2.4. Waste management
Masdar City plans to decrease waste as much as potential through an easy-to-use recycling program applied through the city (Figure 16). Wastes are divided into three paths: dry recyclable (paper, bottles and cans), wet recyclables (food and organic waste) and waste (i.e. other wastes that do not fit the first two groups). These paths of recyclable materials will have easily accessible warehouses incorporated into every building in Masdar City, so recycling will become a second nature. A fourth path will gather hazardous materials for instance medical wastes and batteries. Waste paths will be collected and transported to recycling facilities, and wet organic waste will be converted into compost for gardening and agricultural use. The city plans to build a waste-to-power plant in future construction stages.

3.2.5. Transportation
In response to one of the main priorities of Masdar City’s master plan to be a pedestrian-focused community, a rich network of public and personal transport options will ensure easy mobility through the city. Consequently, walking and self-propelled transport will be the most appropriate means of transport to many destinations through the city, as well as the most enjoyable. This is the consequence of planners’ focus on making wide shaded sidewalks and corridors within the city. In addition to public transport.

Cycling and walking are expected to be the preferred way to travel in Masdar City; though, some innovative transport routes (Figure 17) are integrated in addition to adding the city’s future attraction. Electric buses and an electric rail systems will deliver mass transit choices through the city. Cars will be parked on the outer edges of the city and will not be allowed inside.

But possibly the coolest feature in Masdar City is the first large-scale application of Freight Rapid Transit and Personal Rapid Transit. The systems will be fully electric personal ‘capsules’ that will act as single-cabin taxis to transport people and deliveries from one place to another at the touch of a button. Just sit in the cabin, tell the PRT where you want to go, you will be automatically transported there, and no guidance is required. This technology is firstly included in the Masdar Institute area of the city but will be assessed for development with technological improvements.

3.2.6. Building materials and resources
During the construction and operation of Masdar City, there is a constant trend to use the latest environment-friendly products, materials and sustainable services. Throughout detailed product assessment processes that include economic (including cost and quality), environmental and social attentions, Masdar City is working to reduce the overall impact of selected materials for the city's infrastructure and buildings.

There are many significant attentions in this assessment, involving cradle-to-grave life cycle analysis, assessment of recycled contents, manufacture process, level of energy and water needed in manufacturing, assembly plant location, distribution, logistics, durability and recycling (Figure 18). Through the inspection process and product specifications, Masdar City has a positive local and regional impact by promoting the overall supply chain to become more sustainable.

Examples of the supply chain outcomes in the six existing buildings of Masdar City include the following:

- Green concrete that used ground granulated blasted slag to replace cement, resulting in a decrease of the concrete carbon footprint by ∼40% of CO₂.
- 100% sustainably sourced timber.
- 90% recycled-content aluminum used for the inner façade.
4. DISCUSSION AND CONCLUSION

The study concluded that the application of sustainable global thought at the urban level is carried out by applying two types of strategies as follows:

**Type I:** general strategies (applied in any project that promoting contemporary sustainable thought) including the following:

- Follow the compact pattern in the planning process.
- The existence of pedestrian walkways encourages walking (with a different method of encouragement depending on the nature of each project).
- Exploitation of renewable energy resources at the project site (with different types and in varying proportions).
- Reducing water consumption (depending on multiple strategies).
- The use of alternative means of transportation.

**Type II:** strategies for each project (differ depending on the nature of each project) including the following:

- Orientation of the city and traffic corridors.
- The use of heating systems.
- Dealing with the water of rain.
- Recycling operations at the project site.
- Promoting the car sharing system.
- The use of wood with the FSC certification.

From the above, it is noted that the application of sustainable global thought depends largely on the use of advanced and modern technologies and systems to reach the maximum sustainability according to global thought at the urban level.

This research analyzed the experiences of the global trend toward concepts of sustainability in terms of thought and application by studying the ‘LEED’ rating system as one of the global sustainability assessment systems and using it as an analytical criteria for the selected contemporary examples in order to identify the global trend toward sustainable thought.

The research findings that have be achieved as follows:

- International assessment rating systems are a global trend tool for sustainability and the overriding goal of using them is to improve the quality of life and preserve the environment for future generations, by promoting the practice of sustainable thought and working to increase users’ awareness of the benefits of sustainability.
- Global sustainability thought aims to make the most of the use of advanced and modern technologies and systems to achieve the maximum sustainable level at the urban level.

The research results can be summarized as follows:
Globalization has become a reality with its pros and cons and has become the abolition of the privacy of the place and identity, which is an attempt to impose the global trend in all fields, especially in urbanization and architecture.

Sustainability does not require a change in the nature of life but rather a change in values and behaviors toward a less resource-consuming lifestyle and sustainable thinking, and these changes must follow a national vision of responsible
I. Hegazy et al.

environmental management and social responsibility for everyone in society.

• Contemporary trends of sustainable urban design aims to develop a mixed use development approach, which in turn encourages the integration between residential, commercial, administrative and recreational spaces, which gives users the option of living near their workplaces, shopping and entertainment, which achieves a growing sense of the unity of the neighborhood and belonging to the community more than the traditional thought.

• There are specific criteria for each urban settlement to achieve more sustainability at the urban level (orientation, location, connectivity and recycling); in addition, there are general standards that can be used unconditionally in any urban settlement to keep pace with sustainable global thought (renewable energy—use of water management systems—use of highly efficient cooling and conditioning systems—recycling systems—etc.).

Finally, the research identifies a set of recommendations that promote achieving the concept of sustainability in Saudi Arabia’s urban communities as follows:

• Include some standards of sustainable thought as a minimum within the building specifications of the Saudi code of construction to be mandatory (design of the outer shell of the building, the shape and size of external opening ratios, the type of glass used, materials used in the internal finishing, insulation with its types, cooling and heating systems, use of renewable energy, etc.).

• Support projects that are designed according to sustainable thought and where the minimum requirements are needed for the building and which has already been discussed above. This may be achieved by reducing taxes and fees or supporting developers who contribute to sustainable construction.

• The establishment of a national body responsible for adopting sustainable thought in urbanization so that the builders are committed to providing technical support and following up on the application of the principles of sustainability in projects in the stages of construction, operation, demolition and maintenance, as well as in demolition and reconstruction methods.

• Select appropriate locations for future urban development in strategic and structure plans and take into account aspects of sustainability in terms of site planning and design, public transport, water resources, construction resources and future expansion.

• Providing support to construction industries based on available materials and resources that are locally produced or depended on the primary resources that are available in the local market as well as that do not require complex manufacturing processes. Consistently, providing support to industries that are related to energy technology and improve energy efficiency levels and their applications in architecture.

• The establishment of a national institution providing the transfer of experience to the local workforce and providing training in dealing with sustainable construction systems and techniques in terms of installation, operation and maintenance, especially related to renewable energy technologies such as solar and wind energy.

CONFLICT OF INTEREST

There is no conflict of interest.

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