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Environmental Rating System (ERS) for assessing Infrastructure Projects in the United Arab Emirates

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Abstract: With the increasing movement towards sustainable construct on, environmental rating systems (ERSs) came into use in the Middle Eastern (ME) region as similar to many other regions. ERSs were first developed to assess buildings and many ERSs have tended related ERSs. Despite the vast infrastructure development in the ME region and in the United Arab Emirates in particular, there is no understand the regional-specific requirements to attain sustainable construction and infrastructure. Tis research addresses these pags and study the theoretical underpinnings of sustainable infrastructure in the region, to propose a regional-specific, infrastructure-related ERS. This paper examines the underpinning factors of sustainable infrastructure in the UAE through a literature review in order to provide insights to determine criteria and sub-criteria for the ERS.

Keywords: Sustainable Development, Environmental Rating Systems, Infrastructure, United Arab Emirates

I. INTRODUCTION

With the increasing movement towards sustainability in the construction industry, the development and usage of environmental assessment methods have been increased as a systematic approach to the evaluation of the environmental performance of construction projects and constructed items (Mateus and Braganca, 2011). Among these methods, ERSs provide objective and comprehensive means of simultaneously assessing a broad range of environmental considerations against explicitly declared criteria, and offer a summary of overall performance (Cole, 1998). There has been a proliferation of ERSs around the world since the launch of the Building Research Establishment Environmental Assessment Method (BREEAM) in the United Kingdom in 1990 (Todd et al., 2013) which is considered as the first ERS published for assessing buildings.

The ME region has also identified the importance of regional ERSs and as a result, there has been a considerable development of regional building rating systems across the Middle East in the last ten years (Attia and Dabaieh, 2009) such as the Green Building Standard SI 5281 (2005) in Israel, Estidama Pearl Rating System (2007) in the United Arab Emirates, the Green Pyramid Rating System (GPRS) (2008) in Egypt, the SABA Rating system (2009) in Jordan and Qatar Sustainability Assessment System (QSAS) (2010).

All modern conveniences in the UAE such as comfortable air conditioned spaces, IT resources, water on demand, a diverse range of available foods and automobile are made possible by energy derived from oil and gas which heavily impact region's future (Abu Dhabi Urban Planning Council, 2013). This reliance has driven the region to apply more sustainable practices. The financial strength of the UAE encourages more construction projects. With the increasing developmental trends and identifying its environmental drawbacks, UAE has perceived interest in ERSs such as Estidama Pearl rating system and the green rating system by the UAE Green Building Council which provides the background for research and development in sustainable construction through environmental assessment in particular.

Developing new ERSs with reference to assessment systems that originated in developed countries and importing ERSs originated in developed countries in to other regions have been identified as problematic (Lee, 2013). The customized versions in other regions do not emerge logically out of the systems originated in other regions (Cole, 1998). In a study carried out by Alyami et al. (2013) in Saudi Arabia, it was strongly suggested that the leading international ERSs such as BREEAM and Leadership in Energy & Environmental Design (LEED) are unsuitable for the country given its context. For example, many ERSs emphasize energy use but the water issues should be given priority if ERSs are applied in the Gulf region (Lee, 2013). Therefore it is important to focus on regional priorities when developing ERSs for effective assessment of buildings and infrastructure in a country.

Despite the vast development of infrastructure in the ME region, there is no regional ERS for assessing infrastructure projects has been published so far. Therefore it is worthwhile to develop a regional-specific system to assess infrastructure projects in the ME region. Since the ME region has distinct climate, financial and social contexts

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and engages in massive infrastructure development, more attention on environmental assessment of infrastructure is required and it is worth studying the factors that should be considered in assessing infrastructure projects in the region.

II. METHOD AND LAYOUT

For the ERS to contribute achieving sustainable infrastructure in the UAE, criteria and sub- criteria should be based on the key requirements of the sustainable infrastructure in the country. Therefore the study requires identifying these key requirements in the UAE. The review of literature found that it is lacking the studies addressing the theoretical basis for criteria selection in the ERSs. Existing ERSs are developed through market-based systems and are criticized for the absence of a sound theoretical basis (Cole, 1998; Retzlaff, 2009; Brandon and Lombardi, 2011). Jayawickrama et al. (2013) developed a theoretical framework for developing infrastructure-related ERSs in developing countries and the framework was applied into the Sri Lankan infrastructure sector. The framework identified the theoretical underpinning of environmental sustainability based on theories of Environmental Economics and proposed a set of factors that should be considered in infrastructure-related ERSs. This paper discusses the applicability of these factors in to the context of the UAE and presents hypothesized factors to be included in infrastructure-related ERSs in the UAE.

III. FACTORS DETERMINING CRITERIA IN ERSS ASSESSING INFRASTRUCTURE PROJECTS IN THE UAE

Minimizing Land Use

Jayawickrama et al. (2013) considered two aspects of land usage to be included in ERSs namely minimizing the need for acquiring new productive land areas and minimizing the damages to the land composition.

The total land area in the UAE is 83,600 km^2 and most of the land is desert but also including the geomorphologic features such as mountains, gravel plains, sand dunes, coastal zones and drainage basins (Akram et al., 2006). Most of the ERSs discourages new land take and encourages utilization of previously developed land or brownfield sites. However, most of the UAE's land is unoccupied so far but as shown by Achuthan and Dulaimi (2011), brownfields are unattractive for development and preference is given to developed sites due to the availability of existing services leading to minimal environmental disruption. Although the UAE has plenty of bare land areas and seems there is no land shortage issue, since new construction are mostly preferred in developed areas in order to minimize the need for new services related to a development, the factor minimizing land usage can be important for infrastructure projects.

Also the site selection is important in the UAE to be benefited from connectivity to public transport and other existing infrastructure. This is to encourage using public transportation and minimize construction of new infrastructure facilities. This will reduce the usage of privately owned vehicles thereby reducing the energy usage, greenhouse gas emissions and reducing the encroachment of green space on the site for providing more parking slots (Achuthan and Dulaimi, 2011).

Considering the factor, minimizing damages to the land composition, one may think that this is not relevant in the UAE where the country does not have natural forest areas. However, the country has taken effort to plant and maintain forest areas and as a result, the UAE has planted forest area of about 3170 km^2 which creates a forest cover of 4% of the total land area. Also there are other resources such as mangroves, estuaries, beaches, and creek which are valuable endowments to the country. In the UAE, site selection is often based on the commercial viability of the location and therefore land take for new development and excessive human activities can be adversely affected the land composition consisted of these natural endowments (Achuthan and Dulaimi (2011).

Minimizing Usage of Materials (renewable resources)

As a rapidly developing country, the UAE experiences an extraordinary economic growth and with that came the increased demand for energy and resources. In the WWF Living Planet Report 2006, the UAE has been ranked with one of the highest per capita Ecological Footprints in the world (WFF, 2006). The Living Planet Report in 2008 showed that although it is declined compared to in 2006 report, the UAE still had an Ecological Footprint of 9.5 global hectares per capita which is far beyond the global average of 2.2 hectares/person (WFF, 2008).

UAE has one of the highest water consumption levels in the world where per capita demand in the UAE has been estimated at 378 litres/day compared with the international benchmarks of 189 – 265 litres per day (Achuthan and Dulaimi, 2011). Moreover, to alleviate water shortages due to the absence of natural supply of fresh water, the UAE is making continuous efforts to produce water through desalination as of in many Gulf countries. In fact, desalinated seawater is the major water supply for the UAE including the large plants in terms of daily production capacities totalling to a 4.15 million m3/day (Al Barwani and Purnama, 2008). Desalination causes some detrimental environmental effects such as high levels of energy consumption leading to large greenhouse-gas emissions, brine and chlorite effluents causing damage to human health, groundwater, and sand dune and wetlands ecosystems (Al Barwani and Purnama, 2008).

The environmental damages associated with various sources of water are different and therefore it is important to consider the source of water consumed when assessing environmental sustainability. Therefore it is important to consider water usage issues including quantity and the source of water specifically in the context of the UAE.

Minimizing Usage of Non-renewable Energy Sources

UAE is one of the highest energy consumers per capita in the world. This is driven by the factors that the UAE being an oil-abundant country with relatively low energy cost (Sweidan, 2012), rapid and increasing economic expenditure with huge architectural projects, and population growth rates (Radhi, 2010). The emirate of Dubai alone has the world's highest per capita energy consumption at 20,000kWh per year (Sinclair, 2008 cited Achuthan and Dulaimi, 2011). In the decade from 1997 to 2007, the primary energy of this region increased by 55.8% with a 15.3% change between 2007 and 2008 (Radhi, 2010). A recent study by the UAE national power authority regarding the demand for electricity found that the demand for electricity in the UAE is likely to rise to more than 40,000 MW by 2020 (Sweidan, 2012).

Not only this higher energy consumption leads to the rapid exhaustion of planet's non-renewable energy sources, but also it carries the danger of other associated environmental problems such as increasing CO_2 emissions, rising temperature and heat island effect in the UAE. If the demand for energy continue to rise, it may also lead the country to turn into nuclear power generation in the future. For example, in December 2009, Emirates Nuclear Energy Corporation announced that it had selected a consortium led by Korea Electric Power Corporation to design, build and help operate civil nuclear power plants for the UAE (Sweidan, 2012).

Moreover, onsite renewable energy is gaining popularity worldwide and utilisation of solar energy has become a trend in the UAE. This will be a favourable option due to the higher potential the country owns. For example, the major project, Masdar City is planned to be a carbon-neutral, zero-waste city with the aim of being one of the world's most sustainable urban development powered by renewable energy (Reiche, 2010 cited Radhi, 2010). Projects which are incorporating renewable energy generation and usage can be recognized and rewarded through ERSs to promote renewable energy in the country. However, any environmental impacts associated with the generation and usage of renewable energy should be considered due to different impacts associated with various sources of renewable energy.

Minimizing Waste Disposal Issues

UAE is considered as one of the biggest producers of waste, 75% of which is from construction waste and it is ranked second to USA in waste share per capita among the world countries (Al-Hajj and Hamani, 2011). Not only the solid waste issues but also the the CO_2 emission is increasing in the UAE. The increase in CO_2 emissions is within the range of 33% and 35% between 1997 and 2006 (Radhi, 2010). Production and consumption of energy are the dominant source of greenhouse gas emissions in the UAE (The Environment Agency of Abu Dhabi cited Radhi, 2010). Water pollution is a serious concern in the UAE where this critical problem is made even more serious with the fact that water is very scarce in the region (Brook et al., 2006). For example, oil refineries generate enormous quantities of wastewater which may contain toxic pollutants (Brook et al., 2006).

Jayawickrama et al. (2013) considered sub factors under waste issues including quantity, level of harmful quality and the location of the waste disposed of. Moreover, considering the types of waste and emissions separately is important in the context of the UAE such as gaseous emissions, solid and liquid wastes.

Investing in Natural Capital

Due to excessive economic activities, useful resources are depleting, waste disposal is increasing and as a result, the natural environment will no longer retain its equilibrium while the quality of the natural environment is degraded (Boulding, 1966; Turner et al., 1994; Thampapillai, 2002). Since it is not possible to attain a target of zero harm to the environment during economic and development activities, Environmental Economists propose to include ways to compensate for the harm to the environment in economic activities in order to cope with the needs of growing economic activities (Daly, 1994; Thampapillai, 2002).

These include investing in natural capital to maintain and enhance its stock such as reinvesting a part of the income generated in the economic system in the natural environment to maintain the flow of services from endowments that currently provide services (functional) and to restore the flow of services from endowments which have ceased to provide services (non-functional) (Thampapillai, 2002) or to create new natural capital stocks. For example, periodic treatment of a river which is getting polluted but still provides services to help the river system to continue its services, restoring rivers that have been rendered unusable due to algal blooms; reforestation of areas that had been cleared for long-term open cut mining can expand the set of natural endowments.

Therefore, Jayawickrama et al. (2013) suggested to consider such efforts at the project level through ERSs, because, not only the activities that are minimizing damages but also the activities that are enhancing the natural environment should be incorporated in ERSs to encourage the project stakeholders for more innovative practices.

Daly (1994) explained a notion to finance net receipts of non-renewable resource liquidation in renewable natural capital. For example, extractive projects based on non-renewables can be paired in some way with a project that develops the renewable substitute. This theoretical notion is more relevant in countries like UAE where they earn a larger income from non-renewable energy sources and are able to invest in natural capital. More ways to invest in natural capital in the context of UAE can be explored and incorporated in regional ERSs.

Conserving biodiversity

Although UAE's hot and dry environment limits the country's biodiversity richness, (UNEP, 2015) and the country is being regarded as an unfertile desert, the UAE hosts a unique and remarkably adapted fauna and flora (El-Keblawy, 2009) with 49 mammal species, 382 bird species and 67 amphibian and reptile species identified (UNEP, 2015). Moreover, 311 animal species of the UAE fauna are listed in the IUCN Red Data List, including 63 species classified internationally endangered: 24 bird, 19 fish, 16 mammal, two reptile and two insect species (IUCN, 2006 cited Tourenq and Launay, 2007). UAE has established around 60 protected areas: 38 terrestrial, 21 marine, and 1 coastal including both terrestrial and marine covering an area of 6174 km² which amounts to a 6% of the country surface (UNEP, 2015).

Various artificial forests are being erected to support wildlife populations in the UAE (Ksiksi et al., 2006). The mangrove forests that cover thousands of hectares of land along the UAE shoreline form an integral part of the coastal ecosystem in country and are beneficial as they are providing a rich natural habitat and safe breeding grounds for several fish species, sea snakes and turtles, providing safe nesting and egg laying areas for sea birds, preventing the coastline erosion caused by waves and ocean currents, and playing an important role in reducing carbon emissions, thereby contributing to lessening the impacts of climate change (Abu Dhabi Government, 2014). As a result of the massive forestation programs initiated by the late Sheikh Zayed bin Sultan Al Nahyan, the mangrove forest cover substantially increased over the past decades covering a wide area of the UAE, with Abu Dhabi accounting for more than 75% of the total mangrove forest area in the UAE (Abu Dhabi Government, 2014).

Several causes are threatening the biodiversity in the UAE including natural coastal development and urbanization, as well as over-exploitation of natural resources (over-fishing, over-hunting, overgrazing and water extraction) resulting loss of most of country's fauna over the last few decades (El-Keblawy, 2009). Property developers are urged to protect mangrove forests by giving the environment proper consideration from the early planning stages of their development and also to rehabilitate the affected areas through large-scale mangrove cultivation programs. One example is in Saadiyat Island where the agency partnered with the Tourism Development and Investment Company (TDIC) to plant 750,000 saplings of mangroves on 25% of the island which is currently being developed as a cultural hub of Abu Dhabi (Abu Dhabi Government, 2014). Likewise incorporation of biodiversity conservation in to the construction agenda is important in the UAE and to be considered in ERSs.

Socio-economic barriers to environmental sustainability

The framework developed by Jayawickrama et al. (2013) demonstrates the view that natural environment should be sustained for everything else to be sustained and ERSs are means to promote environmental performance. Although they do not recommend the direct inclusion of economic and social aspects in ERSs, the socio-economic issues which are become barriers to environmental sustainability efforts are addressed in their framework. They stated that project level efforts to mitigate such barriers should be appreciated in ERSs. For example, poverty and non-compliance with environmental laws and regulations are barriers to environmental sustainability efforts in developing countries. Therefore, the project level contributions to eradicate poverty in terms of providing services to the local people and community services as part of the project should be appreciated in ERSs. Similarly, compliance with environmental laws and regulations can be appreciated and non-compliance situations can be de-merited.

The UAE is considered as having a cash-rich government and as maintaining stringent regulations, thus factors such as poverty and non-compliance issues are unlikely to be barriers to environmental sustainability. However, there are other barriers to environmental sustainability in the region such as reluctant to change (Salama and Hana, 2010) and lack of interest by the project developers (Landman, 1999). Salama and Hana (2010) identified that the large majority of construction executives in Dubai have the perception that green buildings are costly to construct and benefits are hard to quantify which poses an important obstacle to the acceptance of sustainable designs. Maguina (2011) stated lack of enforcement as one of the major barriers to sustainable practices in the region and suggested to improve the existing enforcement mechanism. Likewise regional barriers to sustainability practices should be identified and appropriately incorporated in ERSs to encourage mitigating such barriers at the project level where possible.

IV. Further Research and Conclusion

The paper addressed the absence of regional-specific ERSs for assessing infrastructure projects in the UAE. The applicability of a set of factors proposed by Jayawickrama et al. (2013) for the criteria selection of infrastructure-related ERSs in developing countries was discussed in the context of the UAE. Following the discussion, a set of factors and sub-factors are considered as important to consider in ERSs in the context of UAE infrastructure sector as follows.

- Minimizing land use issues (in terms of land area, damages to land composition and site selection)

- Minimizing usage of raw materials (renewable) other than water (in terms of quantity, damages during extraction, and damages during usage)
- Minimizing usage of water (in terms of quantity and source)
- Minimizing usage of non-renewable energy sources (in terms of quantity, damages during extraction and damages during usage)
- Usage of renewable energy (increasing generation and usage of renewable energy with minimum negative impacts if any)
- Minimizing gaseous emissions, solid waste issues and liquid waste issues (in terms of quantity, damages due to harmful quality, and damages due to location)
- Investing in natural capital (to maintain and to enhance natural capital stock)
- Conserving biodiversity
- Minimizing socio-economic barriers to environmental sustainability

The paper provided insights to determine which factors to be included in infrastructure-related ERSs in the UAE considering the existence of natural endowments and the current environmental problems in the country. It provided a set of factors and sub factors that can be considered in assessing UAE infrastructure projects. The applicability of the factors in the UAE infrastructure sector will be tested through field survey and the relative importance of the selected factors will be analyzed through quantitative analysis to make recommendations on the factors to be considered in infrastructure-related ERSs in the UAE.

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