Sustainable Transport Rating Tool via Traffic Impact Studies

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***Abstract*—In the Gulf Countries, rating systems that evaluates sustainable practices in construction and development has proven to have a positive impact in promoting the sustainability agenda to the point that it has become a marketing tool for developers, corporate, and sometimes regions and countries. Realizing that sustainability as a framework needs to be localized in order to achieve maximum effectiveness and attempting to reap such benefits of promoting sustainable transport practices among private sector developers, a sustainable transport rating tool for the Gulf countries was developed and is presented in this paper. This rating tool is novel since must be used in conjunction with the review process of the mandatory impact traffic studies (TIS) which is submitted for every new development. The tool is developed based on the content requirements of the TIS as set by Dubai's Roads and Transport Authority. After defining the objectives, four categorizes under the rating tool were identified, fourteen associated measurable performance indicators were selected by local experts so that the rating tool is practical and fitting to the applicable standards and regulations. Credits were assigned based on resulting weights using Saaty AHP pairwise comparison. At the end, certification levels were defined. Promoting sustainable transport practices, through using this tool and based on the certification level attained, transport agencies can waive some of the impact cost (cost sharing) that the developer is required to pay.**

***Index Terms*—sustainable transport, traffic impact studies, rating system**

I. Introduction

The Gulf Countries Council (GCC) region is one of the world's most naturally endowed and economically prosperous regions that has been characterized by rapid population and economic growth since the discovery of oil in the region more than 40 years ago. This region has undergone a profound transformation from one the least developed areas of the world to modern economies with a high standard of living and per capita GDP on par with those of developed nations. The exceptional growth of the GCC Countries in the last decade has raised concerns regarding the ecological footprint and sustainability of the mega-scale development projects taking place in these countries. These concerns—substantiated by the latest global economic recession—warranted the prioritization of the sustainability agenda in the GCC Government policies and future visions.

Recognizing the high cost of rapid development on the social, environmental and economical sustainability of GCC regions, the governments began launching serious sustainability initiatives with various levels across countries, from introducing ―green‖ legislations, to requiring that all new developments to go through the LEED Rating System, to introducing the impressive MASDAR initiative—the world's first zero-carbon, zero-waste city—to developing ESTIDAMA Pearl Rating System, to hosting numerous international conferences and awards that promote sustainable practices [1].

The transportation sector in these countries has come up alongside with embracing the sustainability agenda from setting up strategic goals to this effect to planning and implementing region-wide integrated transport system (ie, Dubai Metro, the initiation of the 7000-km rail network that would connect the region to Europe) to promotion and endorsement by launching the prestigious "Sustainable Transport Award" by the Roads and Transport Authority (RTA) of Dubai.

This paper will present the research done towards the development of a rating tool that can by employed by the transport agency when reviewing the mandatory Traffic Impact Studies (TIS) of any proposed development in these countries. The tool has the objective of promoting developments that has minimal negative impacts on the transportation infrastructure. It will rate the planned development/buildings with respect to contributing to sustainable transport practices. This Sustainable Transport Rating Tool (STRT) will be independent of whether the TIS will be accepted or rejected by the agency; however, even though this tool is planned to be voluntary for use by the design consultant and the agency review engineer(s), the agency might use the certification levels to offer certain discount on the cost-sharing (or impact costs) that has to be paid by the developer to the transport agency.

The paper will start with a brief review of sustainability concept and sustainable transport definition, then it will discuss selected rating systems that are relevant to this research, after that a brief introduction to how traffic impact studies are implemented in the GCC region. Once the background is explained, the methodology for developing the rating tool (STRT) is presented. At the end, the developed rating tool is presented along with the needed discussion of its categories, indicators, and credits.

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II. Sustainability and Sustainable Transport

The term sustainability has no universally accepted definition; but probably the brief definition of "meeting the needs of the present without compromising the ability of future generations to meet their own needs.." as was defined in the famous Bruntland Report by the World Commission on Environment and Development in 1987 is the most recognized and used definition.

In the 2005 World Summit, it was realized that achieving sustainability requires the reconciliation of environmental, social equity and economic demands – three bottom line of sustainability. Since then numerous programs and certifications based on these three pillars have been introduced for analyzing or evaluating sustainability [2].

As with sustainability many definitions of sustainable transportation have been introduced in the literature. The Transportation Research Board's Sustainable Transportation Indicators Subcommittee recommended the definition selected by the European Council of Ministers of Transport because it has a broad scope and recognizes specific transportation issues. According to this definition, a sustainable transport system:

- Allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations.
- Is affordable, operates fairly and efficiently, offers a choice of transport mode and supports a competitive economy, as well as balanced regional development

Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise [3], [4].

III. Rating Systems for Sustainability and Sustainable Transport

Since the recognition of the importance of sustainability in the mid eighties, numerous rating systems have been introduced such as LEED by the US Green Building Council, BREEAM by the UK Building Research Establishment, HQE rating system in France, Green Star in Australia, etc.

The earlier versions of these systems was developed for assessing new building design but later has expanded to several categories such as renovation, neighborhood or community development, commercial buildings. The majority of these rating systems are voluntary that can be reviewed by external reviewer or through self-assessment. These rating systems are generally developed by identifying the evaluation criteria or categories and then for each of these categories measurable performance indicator(s) are selected. Possible credits are assigned for each indicator based on certain weight that the indicator and its category may carry. Depending on the cumulative credits the project can attain, a level certification is granted.

In the Middle East and GCC countries, realizing that sustainability as a framework needs to be localized in order to achieve maximum effectiveness, the first rating system for sustainability the Pearl Rating System was introduced in 2010 in Abu Dhabi – UAE by Estidama Organization (Estidama is the Arabic word for sustainability). [5] The Pearl Rating System is somehow similar to the format of other rating systems, but the main differences lies in identifying distinctive criteria and indicators that characterize the arid environment of the region as well as the society's characteristics. In addition to weights and credit assigned which should reflect the people's priorities and promote the overall policies. Pearl also has a well-concieved "Alternate Compliance Path". It recognizes that significant industry knowledge and capability has already been created around widely adopted green building programs such as BREEAM, LEED and Green Star. Rather than create yet another set, the Pearl Rating system endeavors to harmonize the criteria that currently exist within these programs. So developers and consultants can work with a program they are already comfortable and familiar with and still achieve a Pearl Rating. Since the Pearl Rating System is connected to this research, it was chosen as an example illustrating the different categories and its credits in Table I [6].

Rating systems for sustainable transportation have been also gaining popularity; the most noticeable in this area are GreenLITES, Greenroads, I-LAST,and INVEST. A difference in these rating systems is the variety of focus. Curz et. Al. presented a comprehensive review and comparison of these systems. GreenLITES implemented by NYSDOT, is a transportation environmental sustainability rating program used to recognize transportation project designs, operations and maintenance practices that incorporate a high level of environmental sustainability, it focuses on transportation operations rather than highway constructions.

Greenroads, developed by University of Washington (UW), is a sustainability performance metric for roadways that awards points for more sustainable practices to help quantify the sustainable attributes of a roadway project.

I-LAST is a rating system developed by collaboration between the Illinois DOT, a consulting engineers council, and road builders, to establish a list of potentially sustainable practices, to establish a simple way to evaluate the sustainability of projects and to recognize the use of sustainable practices in the transportation industry, it mainly examines livability indicators which are partially related to sustainability of transportation projects. Lastly, INVEST developed by FHWA is a self-evaluation rating system geared for sustainable transportation project is tool that measures sustainability over the life cycle of a transportation project or program from system and project planning through design, construction, and operations and maintenance (INVEST 2011). INVEST has three project

types: Project Development, Operations & Maintenance, and System Planning [7].

TABLE I. CATEGORIES OF PEARL RATING SYSTEM AND ITS ASSOCIATED CREDITS

Credit Section	Credit Points Available
IDP - Integrated Development Process	13
NS - Natural Systems	12
LB - Livable Buildings (indoor and outdoor)	36
PW - Precious Water	43
RE - Resourceful Energy	44
SM - Stewarding Materials	28
IP - Innovating Practice	3
Total	**170**

TABLE II. COMPARISON OF SUSTAINABLE TRANSPORTATION RATING SYSTEMS [7], [8]

System	Green LITES	Greenroads	I-LAST	INVEST
Rating method	Point system	Point system	Weighted two scoring steps leading to a percent	Point system
Major category	sustainable sites water quality materials/ resources energy & atmosphere innovation/ unlisted	Project requirement environment & water access & equity construction activities materials & resources pavement technologies custom credits	planning design environmental water quality transportation lighting materials Innovation	system planning & processes project development transportation systems management O&M
Max. Point	60 points	credits 118 points	233 points/ 153 items	68 criteria ranging 1-10
Certification level	Certified, Silver, Gold, Evergreen	Certified, Silver, Gold, Evergreen	Point System	Bronze, Silver, Gold, Platinum

IV. IMPLEMENTING TIS IN THE GCC

In general, Traffic Impact Studies are specialized studies which assess the effects that a particular development's traffic will have on the surrounding transportation network. Traffic Impact Studies can vary in range and complexity depending on the type and size of the proposed development. Increasingly and in many countries in the world, traffic impact studies are becoming an essential part of the development review process to assist developers and public agencies in making landuse decisions, where the proposal may have a significant negative impact on traffic and transportation operations.

Traffic Impact Studies are one of the most important tools that can help in:

forecast the traffic impacts created by new developments based on accepted practices, not perception, determine improvement/upgrading needed to accommodate the new development, relate landuse decision with traffic conditions, evaluate access strategies and its alternatives, update traffic data, provide input for metropolitan transportation planning, and from the developer's perspective the TIS helps in identify problems which could affect the developer's decision on pursuing the proposed project.

TIS have proven to be a very important tool especially in the GCC countries were the development rate was unprecedented due to its large oil revenues and government efforts which have permitted rapid advancement through these stages, especially in United Arab Emirates (UAE) and Qatar. In some of these countries the population growth rate in the last two decades was reaching 10-12% annually with continuous influx of skilled and non-skilled immigrants arriving from all over the world introducing their local techniques and standards to the market. In parallel, the development rate of new projects was phenomenal. Catching up with such a growth by providing bylaws, standards, guidelines or legislation for regulating this growth was not an easy endeavor by the governments.

In the year 1998, Dubai, a member emirate of the UAE, was the first to require Traffic Impact Studies (TIS) for every development generating more than 100 trips/peak hour through its Roads and Transport Authority (it was still under Dubai Municipality then). To this effect, Dubai's Traffic Impact Studies Guidelines was published along with "Dubai's Manual for Trip Generation and Parking Rates". This manual contained locally-regressed

trip generation rates for ninety different landuses (codes) categorized in seven categories. These rates are the basis for all TIS in the GCC. Other guidelines were later introduced by different transport authorities in the region; nevertheless Dubai's guidelines remains the most referred.

Dubai's TIS Guidelines is comparable to many other available guidelines worldwide except that it is fitting to applicable local standards and regulations.

V. Methodology for Developing STRT

In this section the methodology that was followed for developing the STRT is presented. seven main steps were carried out

1) Determine goals and objectives that are related to TIS and sustainable transport

2) Identify categories of the different indicators

3) Develop sustainability performance indicators

4) Define how each indicator is evaluated

5) Determine weight for each indicator based on AHP pair-wise comparison

6) Allocate points

7) Develop rating scale

The first four steps were carried out after comprehensive review of literature on sustainable transport indicators and rating systems in which various categories and indicators were listed and then focus groups of practicing traffic engineers and transportation planners in the region were help were appropriate transport sustainability indicators were identified. [2], [4], [7].

Assigning weights was done through Saaty AHP of two-levels. AHP was selected based on its strengths of assigning weights, use of pairwise comparisons, and determination of survey consistency [2].

The prioritization process begins with conducting a pairwise comparison of the fourteen identified sustainability indicators. Another focus group was formed of five key experts in sustainability, urban planning, environment, development economist, and civil engineering university professor. AHP and pairwise comparison was explained briefly and each expert was asked to compare each of the indicators based on their importance with respect to sustainability using an AHP scale of importance from one to five.

Expert Choice Software was used to calculate the weights for each of the indicators based on the pairwise comparison results. Also overall consistency ratio of the results was checked.

Based on the weights obtained, points were allocated such as the lowest possible credit for any indicator is larger or equal to one. Once that is established, by linear interpolation of the resulting weights, credits were calculated for each indicator and the total credits resulted was 57 credits.

VI. The Sustainable Transport Rating Tool (STRT)

After implementing the methodology outlined in the previous section, the STRT is presented in this section. Table III next illustrates the STRT categories, its associated indicators, the objective of evaluating and giving credit or not for each indicator, and the strategic goal that can be achieved from this positive performance. The STRT categories are four landuse, smart location, infrastructure, and transport system. The main objectives were to:

- Encourage mixed-used development
- Reduce urban sprawl
- Encourage transit-oriented development and increase public transport share
- Promote alternate modes of transportation (ie, walking, biking)
- Efficient transportation system management and resource allocation
- While the main strategic goals that will be served by these objectives are:
- Reduce vehicular travel, car-dependency and related carbon footprint
- Reduce the development carbon footprint
- Promote safer, healthier living and better quality of life

The next step in developing the STRT was determining the how to evaluate each indicator. Table IV below describes how to evaluate each indicator were the evaluation consist if the development under review is fulfilling the requirement. For example for the development to achieve the LU1 six credits, the development must be proposed as a mixed-use with least two landuse codes contributing to the trip generation calculation with any code representing at least 30% of the total area, while if three codes were used, then any code must represent 20% of the total area and so forth.

One indicator which carries by itself the larger number of credits is the impact of the transportation system on the surrounding transport network.[9] This indicator evaluates the change in the average time delay for the four most impacted intersections in the study area (as agreed by the RTA reviewer). The sixteen possible credits are thus divided into four for each junction. As listed in Table V below, depending on the impact of the development by looking at the status of level of service LOS, and its corresponding allowable change in the average delay in seconds, the credit can be granted.

The last column of Table IV presents the number of credits that can be granted if the development can fulfill the requirement. Also, the credit for each category is listed below it. The landuse category can attain 10 credits, smart location 15 credits, infrastructure 13 credits, whereas the largest number of credits can be attained under the impact on transport network with 20 credits.

TABLE III. STRT CATEGORY, INDICATORS AND ITS OBJECTIVES AND STRATEGIC GOALS

Category	Indicator	Objective	Strategic Goal
Landuse (LU)	Site Proposed Landuse	Encourage mixed-use developments	Reduce vehicular traffic
	Study Area (off-site) Landuse	Encourage developments within mixed-use communities	Reduce vehicular traffic
	Study Area (off-site) growth	Encourage developments within existing communities and reduce urban sprawl	Reduce development footprint and urban sprawl
Smart Location (SL)	Site Location with respect to existing infrastructure network	Encourage developments connected to infrastructure and reduce the development footprint	Reduce development carbon footprint
	Site Location with respect to metro stations or park-and-ride facilities	Encourage developments that are transit-oriented	Reduce vehicular traffic, employ integrated transport system
	Site Location with respect to public bus stops	Encourage developments along transit bus routes and transited-oriented	Reduce vehicular traffic, employ integrated transport system
	Site Location with respect to Freeways and Airport	Discourage developments within noise and air polluted environment due to air traffic and vehicular traffic	Reduce transport-related negative impacts on population
Infrastructure (IN)	Bicycle Facilities	Encourage alternate modes of transportation	Promote healthy, environment-friendly societies
	Pedestrian	Encourage alternate modes of transportation	Promote healthy, environment-friendly societies
	Parking	Discourage car-dependency	Less cars, less fuel consumption
	Water Management	Encourage sustainable drainage management solutions	Safety, preserving natural resources
Transport Network (TP)	Impact on Junctions	Allow balanced trips assignment by encouraging smart access strategy	Efficient transport demand management
	Access Strategy	Encourage safe responsible access strategies	Safety, efficient management
	Smart access management	Reduce traffic bottle necks, congestion and have efficient traffic management	Safety, reduce travel time

TABLE IV. STRT PERFORMANCE INDICATORS, EVALUATION METHOD & POSSIBLE CREDITS

Category	Performance Indicator	Indicator Evaluation	Credits
Landuse (LU: 10 cr.)	Site Proposed Landuse	The development is mixed-use with at least two Trip Generation Codes with at least 30% for each code (if two codes) and at 40% (if > two codes)	6
	Study Area (off-site) Landuse	The landuse within the at least 70% of the study area is zoned as mixed-use	3
	Study Area (off-site) growth	The developed plots within the study area are at least 50%	1
Smart Location (SL: 15 cr.)	Site Location with respect to existing infrastructure network	The site is within 400 m of an existing infrastructure network	2
	Site Location with respect to metro stations or park-and-ride facilities	The site is within 500 m of an existing or planned metro stations	6
	Site Location with respect to public bus stops	The site is within 250 m of an existing or planned bus stop	3
	Site Location with respect to Freeways and Airport	The site is at least 500 m of an existing freeway or major arterial, and at least six km from the tip of the airport runway	4
Infrastructure (IN: 13 cr.)	Bicycle Facilities	Bike racks are provided (at least10% of the required car parking spaces).Bike racks are located in protected, shaded and visible spot)	3
	Pedestrian Facilities	Facilities for supporting pedestrian activity within and around site (ie, safe shaded trees, dedicated pathways)	2
	Water Management	Use of pervious surfaces in out-door areas in the development along with appropriate drainage system	5
	Parking Facilities	Parking spaces provided should not exceed the bylaws required number by more than two spaces	2
Transport Network (TP: 20 cr.)	Impact of development on junctions in study area	Changes of LOS and average delay are within acceptable range as in Table VI	16
	Access Strategy	Access points located at light-traffic roads	3
	Access Management	Use of smart technologies for entering and exiting	1
		TOTAL	57

To promote sustainable transport practices among developers which will be reflected in its turn on users and society, through using this tool and based on the certification level attained, transport agencies can waive some of the impact cost (cost sharing) that the developer is required to pay. A proposed scheme is presented in Table VI next.

TABLE V. CHANGES IN AVERAGE DELAY (SECONDS) AT INTERSECTIONS

Condition	Full Credits	NO Credit
When LOS A→B	≤ 5.0	> 5.1
When LOS B→C	≤ 5.0	> 5.1
When LOS C→D	≤ 6.0	> 6.1
When LOS D→E	≤ 7.0	> 7.1

TABLE VI. CERTIFICATION LEVEL & PERCENTAGE WAIVER OF COST SHARING FEES

Credits	Certification Level	Percentage waiver
52	Gold	15%
46	Silver	10%
40	Bronze	5%

VII. CONCLUSIONS

The development process worldwide is embracing the "Geening" or "Sustainability" agenda thanks to the numerous programs in raising awareness regarding the negative impacts of irresponsible old practices and policies. Introducing rating systems for evaluating sustainable practices in the construction industry has proven to have contributed positively in promoting sustainable practices among designers, engineers and consultants. Despite the fact that transportation activities has a major share of the overall carbon footprint, the current sustainability agenda does not focus as much on the transportation sector. Therefore, introducing a sustainable transport rating tool that can be used concurrently by the designer, the planner, the traffic engineer, and the transport agency official alongside reviewing the mandatory traffic impact studies can contribute to bridging the gap that relates landuse and transportation in practice and ensure the focus on sustainable transportation practices at all level of the society.

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