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Environment and Urban Sustainability

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Abstract— Urbanization is an increase in population of cities over time.This very rapid population growth, proved harmful effect to the city's survival. In this research, a new approach is introduced for evaluating urban sustainability by relating urbanization and urban planning in Tehran. This is based on the assumption that urban planning is a dynamic profession that works to improve the welfare of people and attractive places for present and future generations. Using this definition, Sustainability Index (SI), can be calculated as [1 - (Vu)], where Vu is Urbanization velocity. When SI is equal to 1, the urban development process is considered to be sustainable. Evaluation of the results indicate that Sustainability Index (SI) presents a more rational basis for evaluation of urban sustainability. Hence, the proposed model is an effective tool to help policy makers to understand whether the urban development process is sustainable or need to be corrected.

Index Terms—Urban sustainability; urbanization; urban planning; sustainability index; urbanization velocity.

I. INTRODUCTION

Villages grow into Cities due to improvement in the cultivation, transportation, and preservation of food and other resources. It may be seen that urbanization is the growing number of people in a society living in urban areas, or cities. According to [1], the first stage of urbanization was dependent upon the amount and productivity of the available agricultural land. The second stage of urbanization was the development of sea-river transports and the creation of roads. The third stage, which is still currently in progress, is the shift in the economy to technological advances and population growth. In other words, urbanization has been continued in many countries since the industrial revolution and persisting through the twentieth century. Therefore, it may be noted that urbanization has become an important aspect in promoting urban sustainability or development. Although initially it was considered as an improvement in quality of life this very rapid population growth, proved harmful effect to the city's survival. In recent years, many studies have addressed ways of assessing sustainable performance of urbanization at national, regional, and local levels. Zhang [2] proposed a bi-dimensional matrix model to analyze the performance of environmental, social, and economic dimensions at different stages of urbanization.

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Shen et al. [3] established an elasticity coefficient model for capturing the dynamic nature of the urbanization process by employing two parameters,

namely urbanization velocity (VμR) and sustainable urbanization velocity (VμS). The study by Ramos and Caeiro [4] showed that indicator-based methods can increase the accuracy of evaluation of the sustainable performance of urbanization. Shen et al. [5] assessed the utility efficiency of metro infrastructure projects (MIP) in China from the perspective of sustainability performance by using five key indicator:, Population of city (POP), length of Metro systems (LEN), annual ridership of Metro systems (RID), ticket price (FAR), and gross domestic product (GDP). Weber and Puissant [6] examined the performance of sustainable development of Tunis Metropolitan Area by incorporating the land cover indicators. Weiland et al. [7] presented an indicator system for assessing the performance of sustainable land use in the process of urbanization in Santiago, Chile. Zhang et al. [8] established a quantitative model composed of 19 indicators for evaluating the efficiency of the urban infrastructure from the perspective of sustainable development. Shen and Zhou [9] examined the effectiveness of nine indicator-based systems introduced by the Chinese government, and revealed that the existing indicator systems have limitations when guiding sustainable urbanization in China. Yigitcanlar et al. [10] introduced a multi-scalar indicator system to evaluate sustainable urbanization performance in Gold Coast, Australia. By using remotely sensed data collected with the assistance of GIS, Dewan et al. [11] analyzed the landscape fragmentation in Bangladesh for the period 1975–2005. Jensen [12] demonstrated the sustainability profiles between the districts in Copenhagen city by using a model composed of 20 main indicators across environmental, social, and environmental dimensions. Reddy and Balachandra [13] investigated the sustainable performance of urbanization development in India by using an indicator-based evaluation approach. Byomkesh et al. [14] evaluated the performance of urban green space in Bangladesh by employing a set of indicators.

It may be noted that in recent years, there has been significant development of methods, to guide urbanization towards sustainable practices, but there are still other problems such as environmental degradation, congestion, economic and social exclusion brought about by improper urbanization. It is therefore, necessary a need for properly evaluating the performance of the existing urbanization practices to identify weaknesses and problems so that proper correction may be made.

II. METHODOLOGY

Existing studies have introduced different methodologies to guide urbanization towards sustainable practices. The application of these methods have contributed to improve environment and urban sustainability. In this research, a new approach is introduced as an alternative model for evaluating urban sustainability by relating urbanization and environment. Urbanization is defined as the urban sustainability that cities could continue without running out of resources. Using this definition, Sustainability Index (SI), can be calculated as [1 - (Vu)], where Vu is Urbanization velocity. When SI is equal to 1, the urban development process is considered to be sustainable. This is based on the assumption that a sustainable city can be assigned one for which the inflow of material and energy resources, and the disposal of wastes, do not exceed the capacity of the city's surrounding environment. In other words, for achieving environmental sustainability, urban consumption must match or be below what the natural environment such as forests, soil and oceans can provide, and the resulting pollutants must not overwhelm the environment's ability to provide resources to humans and other members of the ecosystem [15].

A. Analysis and conclusions

According to [16], the City Development Index (CDI) is based on five sub-indices namely city Product, infrastructure, waste, health and education. The average values of each sub index for the different regions are shown in Table 1. Although the regions are generally ordered from least developed to most developed, there are also particular areas in which regions are relatively weak. Africa has a particular weakness in physical infrastructure. Waste disposal is a problem throughout the developing world.

Table 2. Indicates the natural rate of population growth or urbanization velocity (Vu) by regions in 2014. It may be observed that the rate of population growth vary considerably among less developed regions. General trend shows wide local variations by countries and by cities. Case studies in different regions and countries reveal that policymakers [17] have usually been opposed to accept urban growth and have attempted to avoid it by reducing rural-urban migration.

Further, the values of Vu have been adjusted so that $\sum_{n=1}^{\infty} V_{un} = 1$ incorporating the total population under investigation where n is number of regions. Using the adjusted values of Vu, Sustainability Index (SI) for different regions have been calculated and shown in Table3.

In order to examine the effect of variation of Sustainability Index (SI) ranging from 0.67 to 0.98 on urban sustainability, it may be observed that variations of SI are similar to CDI given by United Nations for different regions as shown in Table 1. It

is further observed that with increase in SI, sub-indices such as city product, infrastructure, waste, health and education also increases. In the other words, Sustainability Index (SI) has the ability to take in to account higher level of urban sustainability as it tends to 1. It may be noted that there is minor variation in the results in Asia and Latin America and Caribbean regions which might be due to published data by different sources. However, it may be concluded that Sustainability Index (SI) present a more rational basis for evaluation of environment and urban sustainability. Hence, the proposed model is an effective tool to help policy makers to understand whether the urban development process is sustainable or need to be corrected.

Table 1. Components of the City Development Index by region

Region	CDI	City product	Infrastructure	Waste	Health	Education
Africa	42.85	49.69	36.17	26.04	50.39	51.96
Arab states	64.55	66.52	66.79	4587	77.18	63.39
Asia-Pacific	65.35	62.90	67.75	44.40	78.27	73.43
Highly Industrialized Countries	96.23	90.60	99.21	100.00	94.26	97.10
Latin America and Caribbean	66.25	62.93	70.42	39.50	82.71	75.68
Transitions	78.59	71.62	90.64	55.93	85.80	88.94

Table 2. Population growth rate by regions

Region	population growth rate (V_u)
Africa	2.50
Arab states	1.80
Asia	1.10
High industrial countries	0.16
Latin Americas and Caribbean	1.20
transitions	0.70
Total	7.46

Table 3. Sustainability Index 2014

Region	population growth rate (V_u)	Adjusted Urbanization velocity (V_{un})	Sustainability Index (SI)
Africa	2.50	0.34	0.67
Arab states	1.80	0.24	0.76
Asia	1.10	.15	0.86
High industrial countries	0.16	0.02	0.98
Latin Americas and Caribbean	1.20	0.16	00.84
transitions	0.70	0.09	0.91
Total	7.46	1.00	

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