Enabling Smart and Sustainable Cities through Realestate and City Biodiversity Indices.

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In 2002 Cities have enabled people to advance socially and economically although challenges exist to maintaining cities. In the process to thrive and grow - Common city challenges include congestion, unregulated growth, and a shortage of adequate housing. With around 3.5 billion people living in cities today, cities to be livable in the decades to come requires controlled urbanization with an emphasis to become sustainable living hubs.

Significant amount of the city population still live in slums and the numbers keep rising under the ambit of rapid urbanization. The world's cities occupy just 2 per cent of the Earth's land, but account for 60-80 per cent of energy consumption and 75 per cent of carbon emissions. But the high density of cities can bring efficiency gains and technological innovation while reducing resource and energy consumption. It is in this context quantification of the biodiversity and sustainable housing becomes important to drive the growth of cities towards livability, smart and sustainability.

"A Smart City is a well performing city built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens. The level of interest in smart cities is growing, and the recent literature on this topic (Holland, 2008; Caragliu et al., 2009, Nijkamp et al., 2011 and Lombardi et al., 2012) characterize a city as smart based on economic development, environment, human capital, culture and leisure, and e-governance. Thus, the smartness concept is strictly linked to urban efficiency in a multifaceted way." (Giffinger, et.al 2007).

Quantification of Biodiversity is correlated to environmental health of the region. Since 1992, eleven meetings of the Conference of the Parties (COP) to the Convention of Biological Diversity (CBD) have been held. COP-11 focused on importance of Biodiversity indices to quantify the changing biodiversity maps across the globe.

Quantification of Sustainability in Housing is correlated to Real estate pricing. Real estate indices quantify the liquidity and exposure of transaction data during sale of property. The transaction volumes of sales in real estate influence of the ecosystem health on real estate transaction data depends on several factors.

Although the smartness concept is linked to several factors the scope of this paper is to understand significance of biodiversity and real estate indices in enabling smart and sustainable cities. An effort is made to quantify smartness and sustainable cites as a measure of biodiversity and real estate market indices.

1. INTRODUCTION

The forecast of the global urban population under current trends by 2050 is estimated to be 6.3 billion, nearly double the numbers in 2010. More than 60 percent of the area projected to be urban in 2030 has yet to be built. Most of the growth if happened in small and medium-sized cities, not in megacities could accentuate city challenges that include congestion, unregulated growth and shortage of adequate housing.

With around 3.5 billion people living in cities today, cities to be livable in the decades to come requires controlled urbanization with an emphasis to become sustainable living hubs. The services biodiversity provide to cities are directly part of city planning. The benefits of biodiversity range from water supplies and recreational facilities and indirectly tangible effects of large bio-diverse areas that help in bio resources production and climate change stability. Increase in urban activities would mean increasing demand for commercial and residential properties if the number of residential dwellings and commercial properties remain constant.

An increase in demand for real estate can be actively linked to property prices and subsequently understood as having an adverse impact on biodiversity. On the contrary an improved biodiversity may not lead to decrease in demand in real estate and these are complexities in urban planning aimed at ensuring livability for people. The social networks, cultural attributes and environmental capacities, vies-a-vies ecologies of the intellectual capacities, wealth creation are all part of the participatory governance framework state may have to follow for developing cities to address the growing needs of urban population.

2. INDICATORS OF CITY BIODIVERSITY INDEX

To conserve biological diversity and to ensure the sustainable use of components of Biological diversity the COP meeting in 2008, held in Bonn, Germany proposed the idea of establishing the city biodiversity index (CBI) under the guidance of Convention of biological diversity. CBI comprises three components, that is:

(i) Native biodiversity in the city,
(ii) Ecosystem services provided by native biodiversity in the city, and
(iii) Governance and management of native biodiversity in the city.

There were 23 indicators that were considered in the development of the Singapore's city biodiversity index. The indicators for the CBI (COP11, 2012; Lena Chan 2012)

Indicator 1: proportion of natural areas in the city
Indicator 2: connectivity measures or ecological networks to counter fragmentation
Indicator 3: native biodiversity in built-up areas
Indicators 4-8: As this is an index focusing on biodiversity in cities, it is essential that the native flora and fauna diversity be incorporated as indicators.
The 3 core groups are:

- Indicator 4: vascular plants
- Indicator 5: birds
- Indicator 6: butterflies

Cities can select any 2 other taxonomic groups for Indicators 7 and 8 (e.g., bryophytes, fungi, amphibians, reptiles, freshwater fish, molluscs, dragonflies, carabid beetles, spiders, hard corals, marine fish, seagrasses, sponges, etc.)
Indicator 9: proportion of protected natural areas
Indicator 10: proportion of invasive alien species (as opposed to native species)
Indicator 11: regulation of quantity of water
Indicator 12: climate regulation: carbon storage and cooling effect of vegetation
Indicators 13-14: recreational and educational services
Indicator 15: budget allocated to biodiversity
Indicator 16: number of biodiversity projects implemented by the city annually
Indicator 17: policy, rules and regulations – existence of local biodiversity
Indicators 18-19: institutional capacity
Indicators 20-21: participation and partnership
Indicators 22-23: education and awareness

Master planning of the country like Singapore also supported its real estate market representatives to comprehensively in development of real estate pricing index.

Figure 1: Cities which have provided their results for the city biodiversity index
Cities which have agreed to apply the city biodiversity Index (of Singapore)

Figure 2 shows us the comparison of the Biodiversity changes between 2005 to 2012. As of August 2012, more than 70 cities are in various stages of test-bedding as shown in Figure 1. The rate of degradation can be quantified based on the rate of urbanization and in more detail using the CBI as is computed for a score of 192 from the 23 indicators. These indicators can also be linked to urbanization and henceforth the planning for smart city.

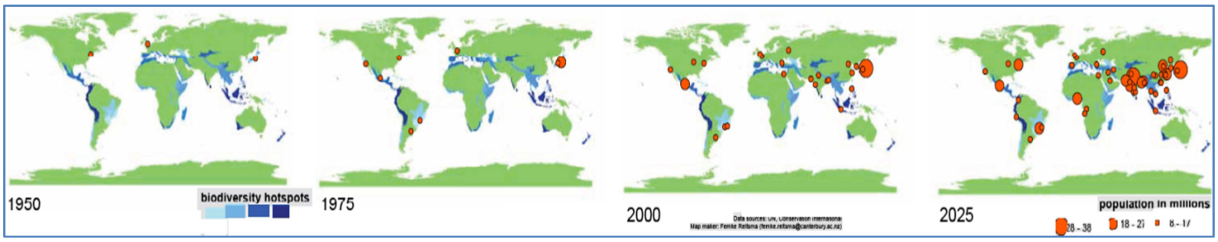


Figure 2: Growth of cities and biodiversity hotspots (City and Biodiversity outlook, 2012)

3. BIODIVERSITY AND REALESTATE

The total economic value of an environmental resource (ecosystem) consists of its use value (UV) and non-use value (NUV). A use value is a value arising from an actual use made of a given resource. Use values are further divided in to direct use values (DUV), which refer to actual uses; indirect use value (IUV) which refer to the benefits deriving from ecosystem functions; and option value (OV) which is a value approximating an individual's willingness to pay to safeguard an asset for the option of using it at a future date, like an insurance value. NUV are usually divided between a bequest values (BV) and an existence or 'passive' use value (XV).

The total economic value of environmental resource:
TEV = UV+NUV= (DUV+IUV+OV) + (XV+BV)

The ecosystem valuation methods that relates to real estate are hedonic methods that consider housing market and the extra amount paid for higher environmental quality. The price of a house is related to the characteristics of the house and property itself, the characteristics of the neighborhood and community, and environmental characteristics. Indicators of CBI that have direct or indirect linkage to real estate prices are Indicator 1 – proportion of natural areas in the city, Indicator 3 – native biodiversity in built-up areas, Indicator 3 - Native biodiversity in built up areas, Indicator 9 – proportion of protected natural areas, Indicator 11- regulation of quantity of water, Indicator 12 – climate regulation : carbon storage and cooling effect of vegetation, Indicator 13-14 : recreational and educational services, Indicator 15 – budget allocated to biodiversity in cities, Indicator 17 – policy, rules and regulations : existence of local biodiversity strategy and action plan.

Two main approaches dominate the literature of real estate price indices: the hedonic regression method and repeat sales method. The hedonic method assumes that house values can be decomposed into bundles of utility-bearing attributes that contribute to the observed heterogeneity in prices. Shiller (2008) argued that the hedonic approach can lead to spurious regression effects in which the irrelevant hedonic variables are significant. A typical hedonic method is represented as follows –

$$\ln p_{it} = \alpha + \beta \ln m_i + \sum_{j=2}^{T} \delta_j D_{ij} + \sum_{j=1}^{l} \gamma_j X_{ij} + \epsilon_i$$

p_{it} = Achieved prices in real estate

X_{ij} = Locational and qualitative characteristics known for all real estate sold

$\alpha, \beta =$ Time dummy variables where $D_{ij} = 1$ δ, γ_j are regression coefficients and ϵ_i is random error

The most updated hedonic methods were recently elucidated in the works of Liang Jiang et al in 2014. The log price can be modeled as the sum of a log price index component, a location effect, an individual house effect, other hedonic covariates, and a time-dependent error term. (Liang, Jiang et al, 2014).

$$y_{i,j,z} = c + \beta_{t(i,j,z)} + \gamma' X_{i,,z} + \mu_z + h_{i,z} + \epsilon_{i,j,z},$$

$\beta =$ time specific effects of house prices μ = location effect is a fixed effect w.r.t location h = individual house effect, with c as a constant intercept, X as the covariates of the i^{th} house in area z, and€ represents the idiosyncratic shocks assumed to be iid$(0,\sigma^2_{€})$The above equation can me modified for houses sold in location z and time t , after applying first differencing, law of large numbers and by eliminating location fixed-effect μ_z

$$\bar{y}_{t,z} - \bar{y}_{t-1,z} = \beta_t - \beta_{t-1} + \gamma'(\bar{X}_{t,z} - \bar{X}_{t-1,z}) + e_{t,z}.$$

$$e_{t',t,z} = \bar{h}_{t',z} - \bar{h}_{t,z} + \bar{\epsilon}_{t',z} - \bar{\epsilon}_{t,z}$$

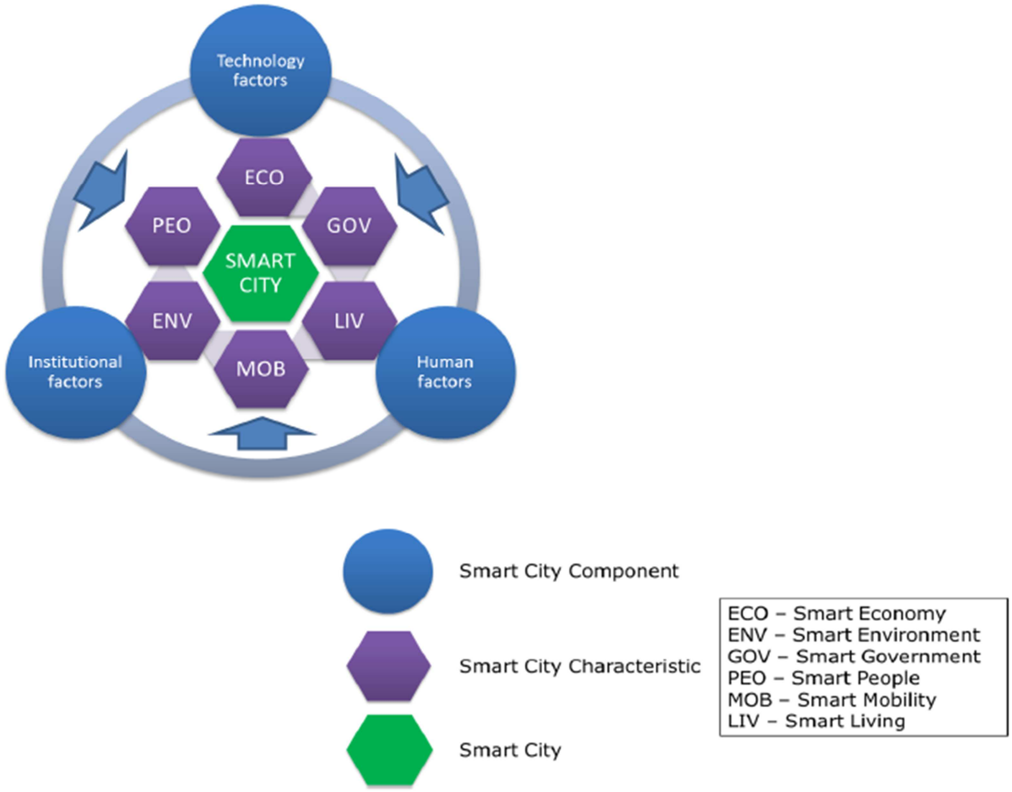
4. SMART CITY

"A Smart City is a well performing city built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens. The level of interest in smart cities is growing, and the recent literature on this topic (Holland, 2008; Caragliu et al., 2009, Nijkamp et al., 2011 and Lombardi et al., 2012) characterize a city as smart based on economic development, environment, human capital, culture and leisure, and e-governance. Thus, the smartness concept is strictly linked to urban efficiency in a multifaceted way." (Giffinger, et.al 2007).

The growing needs of the urban population can be addressed if governance, economy, environment, mobility and living are properly addressed through a systems approach. It involves planning at a city level and thereby making cities as centre of influences for growth models. This clearly emphasizes the development of smart cities - "cities are smart when the ICTs of future Internet developments successfully embed the networks society needs for them to not only generate intellectual capital, or create wealth, but also cultivate the environmental capacity, ecology and vitality of those spaces which the direct democracy of their participatory governance open up, add value to and construct." (Mark Deakin, 2014).

City rankings have disadvantages and advantages - city rankings help draw public attention, stimulate regional development strategies, draw positive changes for regional development outside the city although they may neglect interrelations in regional development and the focus remains on rank. Some of the elaborate city rankings were done in 2007 based on quality of living, sustainability cities for Canada, in 2006 for worldwide cost of living etc.

Figure 3 : The relationship between components and characteristics of Smart Cities



Source: (Lombardi, Giordano, Farouh, Yosef - 2011)

The components to this smartness of a civil society definition are: smart people, governance, environment, economy, mobility and living. These characteristics in turn are seen to be measures of: human and social capital, participative democracy, natural resource endowments, competitiveness, transport & ICTs and quality of life. To quantify the characteristics - several indicators which are directly correlated to subcomponents are to be defined. Globally there are several smart cities are listed across different countries as shown in the Figure 4. Smart cities around the globe are increasing on a day to day basis as governments realize the importance of addressing the needs of growing population. Smartness of city is a widely accepted and growing phenomenon for all cities across the globe. Geographically the definition of smartness may vary. Ranking these cities based on the smartness globally requires quantification of indicators. In the European context, a total of 74 indicators were selected for evaluation (Giffinger, Rudolf et al, 2007) and each of these 74 indicators are grouped under 31 factors and sub classified under the 6 components as shown in Figure 5.

Figure 4: Smart cities across globe.

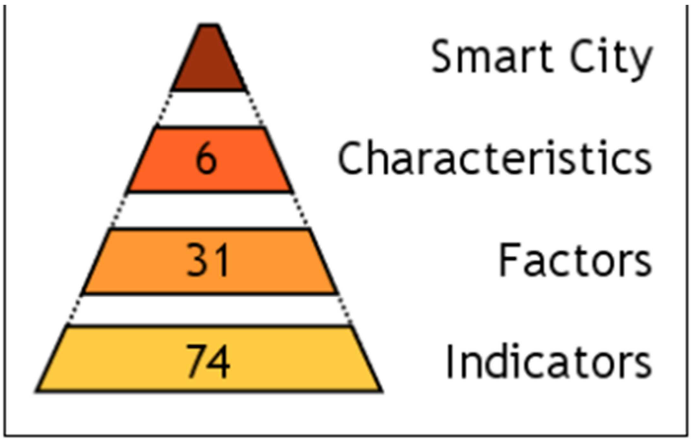


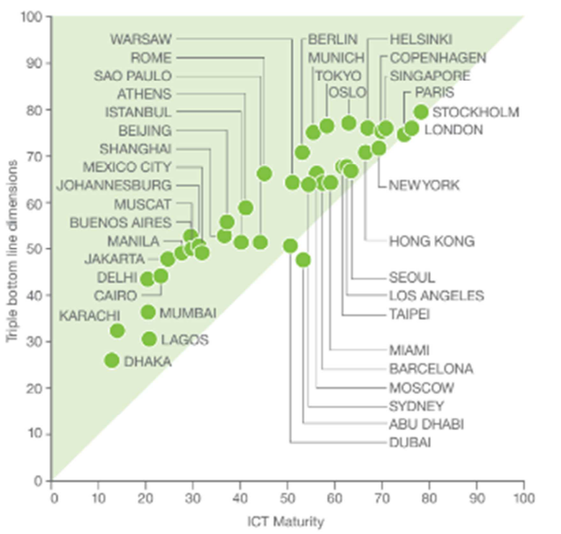
Figure 5: Structural classification for smart cities. (Source: Giffinger, Rudolf et al, 2007)

From the literature the 6 factors can be categorized to 31 characteristics out of which the scope of this paper is focused towards factors that are in direct relationship to real estate prices and biodiversity of the city. Medium-sized cities as cities often also understood as “second cities” on a European scale, cities which are mainly not recognized very well on a European scale but often of crucial importance on a national and regional scale. As a starting point we chose to focus on cities with a population between 100,000 and 500,000 inhabitants. The most comprehensive overview of cities or functional urban areas (FUA) in Europe provides the Espon 1.1.12 study incorporating almost 1,600 entities in Europe (Nordregio et al, 2004).

From different available data sources in Europe – 31 factors are further classified using 74 indicators based on analytics of the available data. (Giffinger, Rudolf et al, 2007):

In this current study, the scope is to analyze only those above indicators that relate to city biodiversity index and the real estate index. So the scope of this paper is indicators that contribute to smart economy, smart living, smart environment and ICT infrastructure.

5. SUSTAINABILITY VS ICT RANKING:



RANK	CITY	RANK	CITY
1	STOCKHOLM	21	ROME*
2	LONDON	22	DUBAI*
3	PARIS	23	ABU DHABI*
4	SINGAPORE	24	ATHENS*
5	COPENHAGEN	25	SAO PAULO
6	HELSINKI	26	BEIJING
7	NEW YORK	27	ISTANBUL
8	OSLO	28	SHANGHAI
9	HONG KONG	29	JOHANNESBURG
10	TOKYO	30	MEXICO CITY
11	LOS ANGELES	31	BUENOS AIRES
12	SEOUL	32	MUSCAT*
13	TAIPEI	33	MANILA
14	MUNICH*	34	JAKARTA
15	MIAMI	35	CAIRO
16	BERLIN*	36	DELHI
17	MOSCOW	37	MUMBAI
18	BARCELONA*	38	LAGOS
19	SYDNEY	39	KARACHI
20	WARSAW*	40	DHAKA

Comparison of ICT maturity to triple bottom line performance for all index cities. Newly added cities are marked with stars in the ranking list.

Figure 6: Ranking of City as per ICT maturity, source: networked city index 2014, Ericsson

Smartness of a city encompasses sustainability of a city, facilitated by the fourth pillar of sustainability – “Technology, interchangeably used with ICT”. In 2014, a study by Ericsson ranked the cities with ICT maturity against the Triple bottom line a measure of sustainability. From Figure 6, the list of cities or regions that participated in City biodiversity index also have been ICT ranked further drawing a linkage to sustainability of the cities. The component smart mobility of the Smart city directly is linked to ICT and thereby explains the correlation between smartness and sustainability of the cities.

Figure 7: Inter-linkage between smartness and sustainability facilitated by ICT

SMARTCITY

SMART ECONOMY - (competitiveness)	SMART PEOPLE - (social and human capital)	SMART GOVERNANCE (participation)	SMART MOBILITY (transport and ICT)	SMART ENVIRONMENT (natural resources)	SMART LIVING (quality of life)
Innovative spirit	Level of qualification	Participation in decision making	Local accessibility	Attractivity of natural conditions	Cultural facilities
Entrepreneurship	Affinity to life long learning	Public and social services	Innternational accessibility	Pollution	Health conditions
Economic image & trademarks	Social and ethnic plurality	Transparent governance	Availability of ICT	Environmental protection	Individual safety
Productivity	Flexibility	Political strategies & perspectives	Sustainable, innovative and safe transport systems	Sustainable resource management	Housing quality
Flexibility of labour market	Creativity				Education facilities
International embeddedness	Cosmopolitanism				Touristic attractivity
Ability to transform	Participation in public life				Social cohesion
	CBIndicator 20,21,22,23	CBIndicator 17,18,19		CBIndicator 1,3,7,9,10,11,12,13,15	CBIndicator 14, 16

ICT maturity (7 variables)		
Infrastructure	Affordability	Usage
broadband quality	tariffs	technology use
availability	IP transit prices	individual use
		public and market use.

SUSTAINABLE CITY

Triple bottom line (8 variables)		
Social	Economy	Environment
health	productivity	resources
education	competitiveness	pollution
social inclusion		climate change

City biodiversity index relevant
Real estate index relevant
ICT networkindex relevant

TECHNOLOGY AS FOURTH PILLAR OF SUSTAINABILITY

6. LINKAGE OF REAL ESTATE INDEX, CBI TO SMART& SUSTAINABLE CITY INDICATORS

Smart living and smart economy components of the smart city are a direct correlation to the real estate index pricing. While the smart mobility component is a direct correlation to sustainability as Technology facilitates the drive to Triple bottom line of the City. Smart governance and Smart people are related to the Institutional capacity of the city biodiversity index and so is the smart environment component. The inter-linkage of 23 indicators of city biodiversity index to sustainability is evident as safe-guarding environment is one the key component of the triple bottom line.

7. SMART CITY PROJECT WORK and INITIATIVES

Some of the smart city initiatives in EU and Industrial initiatives are listed below -

EU Policies and Initiatives

• European Smart Cities Project

• The Smart Specialization Platform established by the European Commission to assist Europe’s regions exploit their full potential and become competitive on a global scale.

• European Initiative on Smart Cities This project provides a framework for those cities and regions wishing by 2020 to progress towards a 40% reduction of greenhouse gas emissions, through increased take up of energy efficient and low carbon technologies.

Industrial Initiatives

IBM Smarter Planet initiative emphasizes the importance of capturing, analyzing and utilizing data as part of what they call the Decade of Smart.

• Cisco Smart Connected Communities initiative provides the ICT infrastructure and service delivery platforms to support smarter working, in new and existing cities.

• GE Ecomagination brand captures a variety of smart and sustainable innovation across its product and service range.

• Siemens Infrastructure and Cities division looks at supporting sustainable solutions for the Smart City, and will be launching the Siemens Crystal (Urban Sustainability Centre) in London in 2012 to showcase their products.

8. CONCLUSIONS AND FUTURE WORK

Smart city projects are growing in number across different cities since 2012. Developing countries like India also adopted a massive smart city project approach to transform 100 cities to smart cities since 2014. While geospatial data is the key for the disseminating the data for a smart city, the typical approach for smart geospatial data to smart cities involved combining smart data services with geospatial data. However many developing countries are not in a position to use the qualitative aspects of geospatial data including India. With an urban population set to rise by more than 400 million people to 814 million by 2050, India faces the kind of mass urbanization only seen before in China. It was in May 2014 national government of India, promised 100 so-called smart cities by 2022 to address the growing urbanization issues.. At a cost of about US$1 trillion, according to estimates from consultants KPMG, the budgetary allocations of many smart city plans are behind requirements.

While this paper has only elucidated the inter-linkages between real estate, biodiversity and smart cities. Some of the critical components like smart governance issues plays a pivotal role in defining property rights and living of the future generations.

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BIOGRAPHICAL NOTES

Manohar Velpuri served four years for commission 9 as delegate and secretary for the previous chair of commission 9 (2011-2015). Mr Velpuri was introduced to commission 7 in 2009 and later worked for related research areas in other commissions of FIG with active participation in the annual meetings and conferences of FIG since 2009. Mr Velpuri was actively involved in research work after his relocation to Asia - Hong kong, Singapore, Malaysia in 2010 and ever since also received outstanding leadership award from Stanford who's who. Mr Velpuri works as executive director for Absolutum consultancy pvt limited

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