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FOREWORD

Towards the end of last decade, our planet achieved two remarkable feats. First our human population crossed the seven billion mark and for the first time in history, fifty per cent of world's population was living in Urban Areas. By 2050, about 70 per cent of the population will be living in cities, and India is no exception. It will need about 500 new cities to accommodate the influx. Urbanization in India has for the longest time been viewed as a by-product of poor regional planning.

It is in this context that the Government of India has decided for developing 100 "Smart Cities" in the country apart from modernizing the existing mid-sized cities. Japan, Singapore, USA, Russia etc. have already shown their keenness to support India in this vision. The centre has rolled out the plans for some of its proposed 100 'smart cities'. India is probably the only country which needs to not only revitalize some of the densest urban agglomerations in the world but also ensure the delivery of basic services to the lesser privileged in an efficient manner during this urban transformation. The opportunities and challenges are unique to India and therefore the solutions must be transformational, not incremental. Our solutions must embrace and address the imperatives of social equity and inclusive growth in a sustainable fashion.

The country requires a massive investment of over a trillion dollars from the government and corporate sector. There is great potential for technology to be the engine that ensures the optimal use of these investments and there is an urgent need for smart government regulations and strategic public-private partnerships. Most importantly, our approach should be based on sustainability. We call this approach, Intelligent Urbanization enhancing the quality of life of citizens and ensuring social inclusion, boosting economic and decreasing environmental impact.

A basic model of a smart city in india will have to fulfill the set of parameters that define a standard smart city. These include dedicated bicycle lanes, high frequency mass transport, 24X7 water and power supplies to all households, no water logging incidents in a year, 100% internet coverage, 30 minutes emergency medical response time and facilities like parks, retail outlets, schools and recreational areas to be within 400 metres of 95% households. While there is a tendency to focus the entire discussion around technology like sensors, cameras, and software, these are important only because they allow for faster and better use of data to manage scarce resources and improve execution.

It is in this context that IBC has selected the topic "Innovative Concepts in Making of Smart Cities". It is felt that the subject being very topical in the present context would generate interest among delegates and professionals alike and the seminar will come up with useful recommendations for the construction industry.

(Dr. SPS Bakshi)
President, IBC &
Chairman & Managing Director,
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PREFACE

India is going through urban and demographic transition. By 2022, India will overtake China to become most populous nation. Our country is at a point of transition where the pace of urbanization which is presently at 30% level will speed up till it reaches about 60-65%. It is in this context that the Government of India envisages to develop 100 smart cities and rejuvenate additional 500 cities. The objective is that cities which contribute more than half of GDP are key to development and need to provide an ideal environment to be competitive. It is very important that our approach to develop smart cities should be based on social, economic and environmental sustainability.

Smartness in a city means different things to different people. It could be smart design, smart utilities, smart housing, smart mobility, smart technology etc. Thus it is rather difficult to give a definition of a smart city. However, people migrate to cities primarily in search of employment and economic activities beside better quality of life. Therefore, a Smart City for its sustainability needs to offer economic activities and employment opportunities to a wide section of its residents, regardless of their level of education, skills or income levels. In doing so, a Smart City needs to identify its comparative or unique advantage and core competence in specific areas of economic activities and promote such activities aggressively, by developing the required institutional, physical, social and economic infrastructures for it. It also needs to support the required skill development for such activities in a big way.

While there may be many dimensions to a Smart City, at a simple level, it refers to a meticulously planned city that relies on Information Technology as an enabler to solve many of its problems - from the use of sensors to smart grids and data analytics that allow city infrastructure and services to meet city problems and citizen demands efficiently and reliably. Today, buildings in India account for nearly 40% of the total energy consumption, which will reach 50% by 2030. 700 million to 900 million square metres of new residential and commercial space would need to be built every year. Just imagine the increase in energy consumption unless buildings outfitted with intelligent sensors and networked management systems collect and analyze energy-use data. Street lighting today accounts for nearly 1.5% of total electricity consumption in India. Cities that use networked motion-detection lights can save 70-80 per cent of electricity and costs. In India alone, traffic congestion costs $10 billion a year in wasted time and fuel. Drivers looking for a parking space cause 30 per cent of urban congestion along with avoidable pollution. Our cities should embrace technologies that will encourage smart urban governance along with high quality of life with cost effective physical, social and institutional infrastructure such as adequate good quality water supply, 24X7 electricity, clean air, quality education, healthcare, security etc.

All these and other related issues will be deliberated at the length to evolve practical and implementable solutions. The topic of Smart Cities has become important issue due to unprecedented urbanization and has therefore been proposed as the theme for the seminar to be held along with 20th Annual Convention and National Seminar of Indian Buildings Congress at Delhi from September 1-2, 2015. All aspects of Smart Cities shall be discussed in this seminar under the different sub-themes. Naturally, the topic has evoked keen response from the authors and we have received 55 paper of which 37 have been accommodated in this publication for discussion at the seminar.

I would to like to thank my colleagues in the Technical Committee for their contribution in bringing out this publication.

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PLANNING VISION

GOVERNANCE & FINANCING

ENVIRONMENT SUSTAINABILITY

ENERGY MANAGEMENT

INTELLIGENT TRANSPORT

BRIDGING THE MISSING LINKS OF SMART CITY CONCEPT

Uttam K. Roy*, Dr. Madhumita Roy and Arpan Dasgupta*****

Abstract

In India, the concept of 'smart cities' has been envisaged on four pillars. Those are 1) social Infrastructure, 2) physical Infrastructure, 3) institutional infrastructure and 4) economic infrastructure. The policy for making 100 new or existing cities as 'smart cities' in India seems to be futuristic, contemporary and attractive in taking the urbanisation in a global standard. Considering the gigantism and variation of the vast population, India may conceptualise different conceptual benchmarks than the western countries.

The paper attempts a review of Smart City concepts and ongoing debate elsewhere and present a critique on the concept for 'smart city' as envisaged by the government. The global debate on smart city concept and its practice revolve around two different but interconnected segments. Those are definitional confusion and clarity in approach. It identifies the essential links need to be considered in conceptualising the Smart City in Indian context for its sustainability. Two categories of links are indentified which need to be integrated. Firstly three major enabling conditions for developing smart city infrastructures (pillars), which is named as 'City Preparedness Factors'. Three such significant enabling factors are 1) Cultural Heritage and City Ethos, 2) Control on land and natural resources and 3) Organisational empowerment and capacity building. Finally it's linkage or relation with the 'pillars', operational tools and basic framework (employment, quality of life and sustainability) of the smart city is also proposed.

INTRODUCTION

Concept of Smart City is not new and has been coined in multiple contexts and terms globally. In India, the concept of 'smart cities' was envisioned by the present government and allocated a sum of Rs 7060 crores. This concept of Smart City has been envisaged on four pillars. Those are:1) social Infrastructure, 2) Physical Infrastructure, 3) Institutional infrastructure and 4) economic infrastructure. Based on these four pillars, Government of India has indicated benchmarks for each category of services and infrastructures which influences the quality of life substantially. Most of the services are assumed to have deliverable online with higher degree of accountability in terms of time and quality.

However, considering the gigantism and variation of the vast population, India may conceptualise a different conceptual benchmarks than the western countries. It is assumed here that the organically developed metro and mega cities, in India, which has distinct character and ethos, need not be imposed any common framework of 'digitisation' which might have worked in newly built cities. Rather the definition of 'smartness' should be able to embrace the existing character and strength of the city on which it will deliver accountable service for a better habitat and quality of life.

The paper attempts a review of Smart City concepts and ongoing debate elsewhere and present a critique on the concept for 'smart city' as envisaged by the government. It discusses the outcome of preceding reforms in last decades and experience gained at local and state level to assess the local

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context where the Smart City is being planned to be implemented. Finally it identifies the essential links need to be considered in conceptualising the Smart City in Indian context for its sustainability.

HOW INDIA CONCEPTUALISED SMART CITIES

In India smart city concept note has been outlined by MOUD in their publication (hereinafter referred as 'concept note'). It says in the concept note about the overall a) framework, b) pillars, c) bench marks, and d) operational guidelines. In this section those are presented in a cryptic manner for further discussion.

- **Framework**

  The basic framework is based on three components; Competitiveness, sustainability and quality of life. Competitiveness refers to a city's ability to create employment opportunities, attract investments, experts, professionals and people. The ease of being able to do business and the quality of life it offers determines its competitiveness. Sustainability includes social sustainability, environmental sustainability and financial sustainability. Quality of Life includes safety and security, inclusiveness, entertainment, ease of seeking and obtaining public services, cost efficient healthcare, quality education, transparency, accountability and opportunities for participation in governance.

- **Pillars of a Smart City**

  It has been mentioned in section 1 that the concept of smart city in India is based four pillars in terms of essential infrastructures (Fig-1). Those are Institutional Infrastructure (including Governance), Physical Infrastructure, Social Infrastructure and Economic Infrastructure constitutes the four pillars on which a city rests. The centre of attention for each of these pillars is the citizen. In other words a Smart City works towards ensuring the best for its entire people, regardless of social status, age, income levels, gender, etc.

  Institutional Infrastructure refers to the activities that relate to governance, planning and management of a city. The new technology (ICT) has provided a new dimension to this system making it citizen-centric, efficient, accountable and transparent. It includes the participatory systems of governance, e-governance, inclusive governance, the sense of safety and security and the opportunities for creativity.

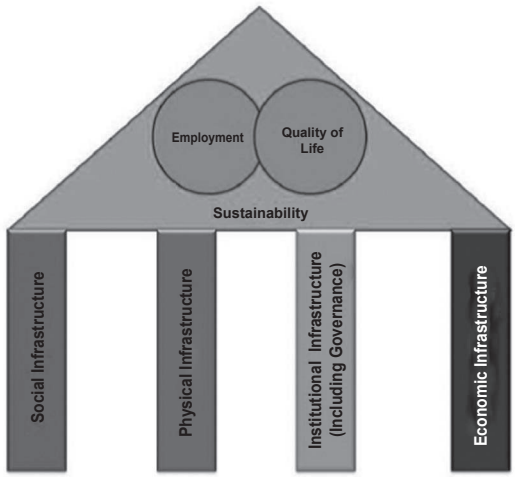

Fig. 1. Smart City Framework as Conceptualised by the Government of India

Physical Infrastructure refers to its stock of cost-efficient and intelligent physical infrastructure such as the urban mobility system, the housing stock, the energy system, the water supply system, sewerage system, sanitation facilities, solid waste management system, drainage system, etc. which are all integrated through the use of technology.

Social Infrastructure relate to those components that work towards developing the human and social capital, such as the education, healthcare, entertainment, etc. It also includes performance and creative arts, sports, the open spaces, children's parks and gardens. These together determine the quality of life of citizens in a city. It is also necessary that city promotes inclusiveness and city has structures which proactively bring disadvantageous sections i.e. SCs, STs, socially and financially backwards, minorities, disabled and women into the mainstream of development.

Economic Infrastructure for a city to attract investments and to create the appropriate economic infrastructure for employment opportunities, it has to first identify its core

competence, comparative advantages and analyse its potential for generating economic activities. Once that is done, the gaps in required economic infrastructure can be determined. This would generally comprise the incubation centres, skill development centres, industrial parks and export processing zones, IT / BT Parks, Trade centres, service centres, financial centres and services, logistics hubs, warehousing and freight terminals.

- **Operational Framework**

  In addition to the above, a Citizen's Reference Framework (CRF) Smart City Development Plan (SCDP) and Environmental Sustainability Plan (ESP) has been envisaged a operational tools for smart city implementations. For each category of infrastructure components, benchmarks have been proposed. However the interrelations between the framework, pillars and bench marks are not clear and need to be linked with each other with solid conceptual basis. Benchmarks seem to be general and common to all categories of cities.

MISSING LINKS

The policy for making 100 new or existing cities as 'smart cities' in India seems to be futuristic, contemporary and attractive in taking the urbanisation in a global standard. Here two categories of links are indentified which need to be integrated. Firstly three major enabling conditions for developing smart city infrastructures (pillars), which is named as 'City Preparedness Factors' and secondly it's linkage or relation with the 'pillars', operational tools and basic framework (employment, quality of life and sustainability) of the smart city. The first three enabling factors (City Preparedness Factors, CPF) are discussed in this sections and its linkage with the overall framework is shown in the next section.

After a close look of the concept note and analysing the ground situation three very significant enabling factors or CPF have been identified. Those are: 1) Cultural Heritage and City Ethos, 2) Control on land and natural resources and 3) Organisational empowerment and capacity building. It is strongly suggested to address these issues before institutionalising the actual programme.

- **Cultural Heritage and City Ethos**

  Most Indian cities are organically evolved with local cultural ethos and heritage. Each city does have unique cultural and social values, which is evident in their life activity, festivals, public spaces, architecture, art etc. The city of Benaras and city of Patna or others are different in nature. The unique characters are inherent in the spaces and people of the city in spite of various local limitations. It is the strength of the Indian cities that they carry such signature in their conduct of daily life and responses.

  Identification of unique city characters is essential to frame any kind of city development plans. This may not be detrimental to improvement of services and infrastructures using 'smart' technology. Rather it is a challenge to integrate and design such technology in right approach. Needless to mention, that this approach will be different city to city. For instance, Singapore, which is an island with minimum natural resources have taken massive programme in application of IT for improvement of their life. They want to be called as 'Intelligent City'. To do that they are also concerned of the adverse effect of IT as well since every technology is a double edged sword and there is price to pay. Following that identity requirement, they exercise strictest censor ship system for IT. Many countries in this region are deeply concerned that the new technologies, most of which are flowing from the West, bring in their wake trends and influences that challenge and subvert long established traditions and beliefs, ways of organisation and governance, and the very culture and ethos of these recipient countries (Mahizhnan, 1999).

  The smart city framework, as envisaged by scholars for European cities, also lacks this parameter. While making the City ranking (Giffinger, 2007) based on smart city principles, the word 'cultural heritage' does not come in the whole parameter set and its scope has been limited to the parameter like the 'attendance in cinema and theatres' only. For India this can't be the only parameter to measure its cultural heritage and ethos. India cannot afford to avoid

cultural heritage in making any city plan. Rather it should emanate from the root. It is not sufficient to identify the cultural heritage only. What to do and how to build upon this cultural heritage is a crucial question that the city stakeholders have to answer. How they are going to utilise the cultural heritage is important. There must be a smart approach to utilise this cultural heritage as an element of their life, socially and economically.

Apart from tourism and other time tested mode for integration of cultural heritage, one possible mode may be to integrate it in the educational and entrepreneurial activity at different levels. For instance, recently created Nalanda University is a contemporary transformation of ancient heritage and will give valuable dividend to the city in terms of local economy and educated community. In the smart city paradigm in the west, it is found that major in migrants in the smart city is due to the pull factor for higher educational facility and overall quality of life enhancement due to that (Winters, 2008). In fact, educated populace make the city more attractive and people coming for higher education stay and live in that city for higher quality of life and higher wages. (Winters, 2008).

It will be pertinent to explain the concept of smart city as envisaged through an architectural lens by Rios. A Smart City is a city that gives inspiration, shares culture, knowledge, and life, a city that motivates its inhabitants to create and flourish in their own lives. A smart city is an admired city, a vessel to intelligence, but ultimately an incubator of empowered spaces (Rios, 2008). A city is felt by the common people by it's built environment. Buildings, roads, other structures, public spaces make city life. Can a city be smart enough without being beautiful? Therefore a strong urban design and place making exercise need to be integrated along with the cultural heritage of the city.

- **Control on Land and Natural Resources**

The concept note on smart cities is silent over the 'land' aspect of city. The classical planning intervention in a city growth is its land use planning and development controls. In India, the land use planning by the urban local bodies was first institutionalised during Constitution's 74th Amendment Act (CAA) in 1992. The act says about eighteen functions for urban local bodies. First two of such functions are 1) Urban Planning including town planning and 2) Land use regulations. The objective of such decentralised function was to enable city authorities to plan and control the haphazard growth. In the process, most of the state government, through it's municipal act, delegated such functions to local level.

Therefore the seed of making city smart in the sense of functionality were embedded in CAA itself. No smart system sustain without the actual available space in the ground. It is possible if development controls, land use controls and land management issues are addressed properly. In India, the car ownership is increasing day by day without increase of road space in the city. The developments of national highways are not the answer for the city traffic. A growing and aspirant city needs new roads and public spaces. The bench marks for transport in the concept notes seems to be theoretical without a clear indication of policy and plan framework for the mobilisation of future land to accommodate the new infrastructures and facilities.

Cities in India have very limited freedom of action. No city can shape the use of the land on which it is built; that right is kept by the state or the Union government for itself (Mukherjee). The decentralisations in isolation or in part are not effective. Except few mega and metros no cities in India have clear land policy, plan and control mechanism. The building bye-laws in place are almost defunct in addressing creating new urban places and only ensure control at one end (during approval). It is near to impossible for a city to augment large project and large investment due to shortage of larger land. Concept of land bank in India is in a very nascent and theoretical stage. The control of land and built environments is not addressed even in JNNURM. Though there has been some reforms repeal of Urban Land Ceiling and Regulation Act (ULCRA) as an optional reform in JNNURM. The so called smart cities in Europe have been exercising integration of development controls towards a sustainable neighbourhoods based on non-motorised transport for achieving multiple benefits towards the quality of life. Therefore,

a strong basis of land banking, land use control and development control mechanism prepared at the building as well as community level is essential for any proactive city growth. That is only possible if efficient land management are in place using participatory approach and advanced technology like GIS and GPS.

Apart from land, many cities are having natural resources which are either deteriorating of getting occupied by unscrupulous urbanisation. As city should recognise its natural resources and utilize in its best for their benefit. For example in India most of the cities are having river banks, canal fronts and lakes. Hardly any city could use those meaningfully for the societal or economic benefit.

- **Organisational Empowerment and Capacity Building**

The essence of the CAA was to facilitate planning and development control at the local level. During JNNURM an assessment based framework was done so that ULBs develop their strength on the strong foundation of 74th amendment. In addition several reforms (mandatory and optional) were envisaged for improvement of urban service delivery and overall improvement of life. Actually the efforts for making Indian cities 'smart' was started during 74th Amendment Act as mentioned above. However the process has been very slow. For example, the concept of 'City Development Plan (CDP)' took more than a year or so to internalise for the ULBs during JNNURM, and other related programmes. The long nurtured outlook towards project and scheme based governance made councillors such delay in understanding the words like vision, plan, strategy etc. Still there was some improvement in terms of understanding the basics of city functions at the local level. The spirit of overall Planning, vision, land use, accounting reforms, e-governance, property tax reform, citizens charter have now been well placed in the activities of urban local bodies (ULB)s. Municipal councillors do talk about these tools. However pluralism of planning exercises indifferent names and themes as applicable in the urban local bodies not only confuses the local government but also violates the constitutional spirit. It is difficult to prepare many development plans like Draft Development Plan (DDP), (CDP), Slum Free City Plan (SFCP), Smart City Development Plan (SCDP) as and when required. Making all city plans by external consultant will only satisfy the requirement for instance to get a specific fund but not improve the capacity and violate the spirit of CAA. What a city of population 2 lakh will deliver with couple of sub assistant engineers if all these reforms are 'imposed' without augmenting its manpower and organisational infrastructure. Many ULBs and cities are lacking in implementing the reforms in full intended scale and dimension. The status of such reforms as published by the government is given in Table 1.

Table 1: Reform Status for JNNURM

Mandatory Reforms for ULBs	Optional Reforms for ULBs/State	Status as on 2014
• Accounting Reform • Citizen's Charter • E Governance • 100% recovery of O/M cost of Water supply and SWM • Property Tax reform • Internal earmarking for funds for basic services for the poor • Provision for basic services for the poor	• Property Title Certification System in ULBs • Revision of Building Bye laws • Earmarking 25% land in housing for EWS/ LIG • Simplification of Legal and Procedural framework for conversion of land • Computerization of Registration of land and Property • Byelaws on Reuse of Recycled Water • Administrative Reforms • Structural Reforms • Encouraging Public Private Participation	Reform scores are varying between 96 to 43 (out of 100) as per government of India. The average reform score across the state is around 77 (calculated by author).

The concept of Smart City in India must be integrated and based on the assessment of cities on the functions and reforms mandated in constitutional reform and reform-linked programmes like JNNURM. Visualising smart city without referring the earlier progress and its continuation will invite more confusion at the city level. ULBs may be given opportunity with the required manpower to make their own plan and schemes. Some handholding at the state level can be given for initial years by appointed consultants. Conceptualising 'smart cites' without enabling ULBs are like a hungry child wearing hired clothes.

DISCUSSION AND BRIDGING THE LINKS

After carefully considering the missing links in CPF as described above, an integrative model showing the linkage between the components, pillars, operational tools and newly proposed enabling factors (CPF) has been recommended. The existing model as in the Concept Note is termed as visible city profile, VCP (Fig-3) while the proposed CPF has been envisaged as perceptible factors (Fig. 4).

In this model CPF has been considered as essential elements like foundation and leading to operational frameworks, pillars and components. The very essence of this model says that we should start its construction from the foundation (CPF). Based on the preparedness of city the essential exercises like CRF, SCDP, ESP forms the basis for the development of four categories of infrastructure (pillars). These pillars lead, at the top, the final objectives/components (employment, sustainability, quality of life) of the model (shelter)

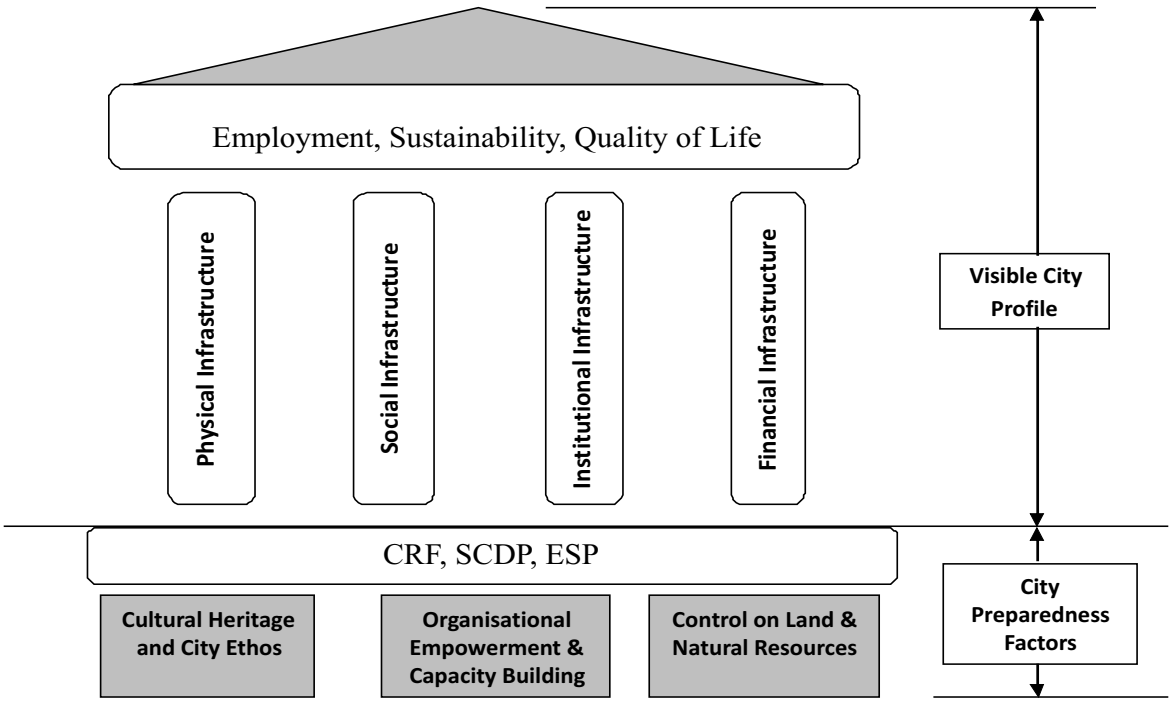

Fig. 2. The integrative Model of Smart City in India

CONCLUSION

This paper attempted to bridge the links which seems to be missing and yet to integrate on the concept. However ample scope is there to work on working model of smart concept for all small and medium cities, differential benchmarks for infrastructure.

The integrative model proposed above shows the similarity of a common house. For a house construction, as the quality super structure depends on the strength of foundation, the preparedness of cities (CPF) will be very crucial in achieving smartness. It is different to city to city and leading to differential condition of infrastructure. Imposing infrastructures projects without improving the essential preparedness and fulfilling the operational tools only lead to adhocism and unsustainability. Therefore it is highly

recommended to undergo contextual detailing of the proposed model before implementing the smart city projects in India.

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SMART CITIES FOR INDIA

Dr. K M Soni*

Abstract

Government of India had announced in the budget of 2013-14 for developing one hundred smart cities to be selected from all over India and developed through Public Private Partnership (PPP) model. At present there are no standard guidelines for planning, construction, maintenance and governance of smart cities in India.

The cost of such cities is likely to be very high unless land is provided at subsidized rates to the developers and the norms of higher FAR/FSI are adopted. In case, land is not provided at subsidized rates, such cities may not be viable even for middle income group and upper middle income group people. Acquiring land at lower rates from the farmers may trigger administrative and political issues.

Operation and maintenance costs of such cities are to be shared by the residents and the cost of such charges is likely to be very high which can be afforded only by affluent and rich. Smart city would also need developing manufacturing and service industries to generate economic and financial resources of earning, both for citizens and the government. These industries are to be located near existing manufacturing hubs and centres. Hence, DPRs should only be prepared after above issues are finalised to avoid the wastage of money and resources.

INTRODUCTION

Smart city concept came in India in 2014 when government decided to develop 100 smart cities. As per the statement of union minister for urban development, concept of smart city is to uplift urban life to a higher level. He emphasized that smart leadership and smart people are essential pre-requisites for making cities smart and effective governance requires smart leadership that is bold, initiative bearing, willing and able to take hard decisions like raising and if required, recovering cost of services, implement reforms in governance, prevent unauthorised constructions besides removing encroachments and take on mafia. As per ministry of urban development report, it is estimated that at present 377 million people are living in urban areas of the country (31%). In the next 15 years, this will increase by another 157 million and by another 500 million by 2050, when more than half of the country's population will be living in urban areas, for the first time. More than 70% of urban people live in 468 cities/towns with more than one lakh population. Hence, cities need to be developed in a planned way, catering the requirements of the future. Hence concept of smart cities has been brought.

The cities having population of more than 1 million, such as Ambala, Panipat, Dehradun, Mussorrie, Dehradun, Gurgaon, Faridabad, Lucknow, Kanpur, Varanasi, Jhansi, Faizabad, Allahabad, Patna, Gaya, Biharsharif, Bikaner, Bharatpur, Jodhpur, Ajmer, Udaipur, Jaipur, Kota, Gwalior, Jabalpur, Indore, Bhopal, Pune, Mumbai, Nagpur, Nashik, Kolkata, Durgapur, Haldia, Ahmadabad, Surat, Vadodra, Chennai, Coimbatore, Madurai, Bangalore, Thiruanatpuram, Kottaym, Cochin, Hyderabad, Warangal, Amritsar, Patiala, Tinsukia, Gopalpada, Bhubaneswar, Cuttack, Shimla, Bishnupur, Ranchi, Gangatok, may be among 100 cities to be declared as smart cities, once the list is finalised by the central government with state governments. From the list,

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it may be seen that most of the cities are existing cities and thus development will be revolving around existing cities or redevelopment of existing cities. It is estimated that 7 lakh crore would be required for developing 100 smart cities in next 20 years but considering inflation rate in the country, the figure may further go up.

Photographs of some models of smart cities developed by the planners are reproduced in Fig.1

Source: www.indiatvnews.com

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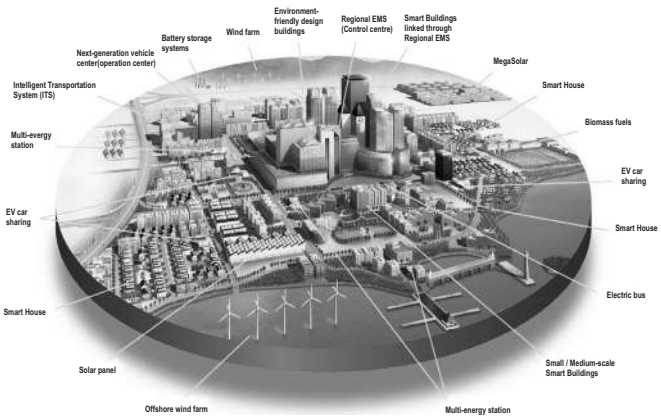

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Source: aajkatajakhabar.com

Fig. 1 Concept of Smart Cities

Fig. 1 shows that planners are going to develop smart cities with skyscrapers having air-conditioned spaces with large usage of glass. These skyscrapers would be required to follow safety norms from earthquake, wind, cyclone, fire and human safety considerations. Today even fire authorities are not having norms and not equipped to fight fire disasters in emergent conditions in such skyscrapers. Thus one has to plan such cities very carefully.

The concept of smart cities is gaining importance where "advanced features" would be developed that are not available even in the existing major cities and thus cost of living and services naturally would go up. The people living in smart cities must have their earnings enough to pay for such services. Thus smart cities would be affordable only by high income group people, which can be termed as "Smart People". In India, we would need a model of smart cities which can be knitted with existing markets, cities, common people and agricultural economy.

DEFINITION

Though there is no standard definition of smart city but it is defined as a city that has sustainable development

and high quality of life by way of economy, mobility, environment, housing, utilities and governance using information and communication technology. Thus the definition has two jargons i.e. "Sustainable development" and "High quality of life".

Sustainable development is defined as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Irony is that maximum natural resources are used and consumed by such smart people only. According to "Worldwatch institute, Washington", people in the US and Canada consume 2.4 times as much energy at home as those in western Europe and an American consumes five times more energy than the average global citizen, 10 times more than the average Chinese and nearly 20 times more than the average Indian. Similarly in India, Delhi has highest per capita energy consumption and Bihar consumes only 7.5% of Delhi. An average citizen of Delhi consumes about 1259 units of energy per annum while national average is merely 156 units and consumption of a person from Bihar is merely 43 units. Thus definition of "Smart city" revolves around the persons consuming high energy and water having high economic status and "Smart People".

In the national conclave of states and union territories on smart cities held on 12.09.2014 smart city was defined as, "A smart city is one that makes urban life comfortable and improves living standards through good governance, efficient health care services and education, 24 x 7 power and water supply, efficient transport, high quality sanitation, employment to the needy and robust cyber connectivity and benefits all irrespective of income, age and gender". This is also mentioned in the draft concept note prepared by the ministry. The definition provides enough space for employment to the needy and benefits to all irrespective of income, age and gender but not the type of employment. It does not state whether smart city would provide space to live to people other than the smart people as it only emphasizes providing employment and benefits which may be direct or even indirect. Thus, there are two possibilities, one; common people (other than smart people) would only be provided jobs of services or two; they would also get space to live in such cities.

COMPONENTS OF SMART CITIES

Thus present definition of smart city includes the following components as per the definition;

- Smart economy
- Smart mobility
- Smart environment
- Smart housing
- Smart utilities
- Smart governance and
- Smart people

Smart economy refers to productivity, entrepreneurship, trade, economic conditions, employment opportunities, international embedment, innovative spirit and ability to transform. Thus smart economy may require lowering of taxes, green collared jobs, and no polluting industries.

Smart mobility includes convenient and safe multimodal travel, speed, accessibility, traffic management, circulation network and efficient use of land. Smart mobility of people and freight is again interlinked to economic growth, environment sustainability and enhancing quality of life for people.

Smart environment includes physical environment, human environment, working environment, atmospheric environment, governing environment and computing environment using information and communication technologies.

Smart housing has a wide but different concept for different persons. Broadly this includes savings of natural resources, functional efficiency, comfort and cultural bindings. Savings of natural resources includes energy, water and material efficiency. Comfort and functional efficiency require proper orientation and indoor air quality of the building.

Smart utilities include various services including water supply, sewerage and drainage, electricity, education, health, safety, security, insurance, telephone, Wi-Fi, business and funeral facilities. The government has been making efforts to create such facilities in the existing cities through JNNURM during last many years but the mission was not successful.

Smart governance is about the decision making and management of the public services with efficiency,

community leadership, continuous improvement, innovation, and efficient technological services. As per Hon'ble minister of urban development smart governance includes smart leadership that is bold, initiative bearing, willing and able to take hard decisions like raising, if required and recovering cost of services, implement reforms in governance, prevent unauthorized constructions besides removing encroachments and take on mafia. This issue is very critical as decision makers are the same and their mind set cannot be changed overnight. The issue is also likely to be flagged with political agenda. It has to be decided whether these cities will have different local bodies or existing corporation laws would be applicable to these smart cities also. Take example of Bandra Kurla complex of Mumbai. If this area is declared as smart city and byelaws of Mumbai Corporation of Greater Mumbai are applicable to the smart city declared, then the corporation will have all the powers of the governance. Therefore, one cannot expect that mind set of authorities would change overnight or they would have two sets of byelaws for governance, one for smart city and another for other area. If they have two sets of bye laws, they may lead to legal repercussions. It is therefore essential that central government and state governments first to decide the governing laws and frame building byelaws before DPRs are prepared otherwise DPRs would not be implementable leading to considerable wastage of money and resources. Another issue would be land acquisition, which is already getting flared up.

Smart People

As defined during the conference on "National conclave of states/UTs on smart cities", smart people are those able to question, pay the cost of services, prevent fellow citizens from violating rules and demand their due and are alert. Thus people living in smart cities are well educated, aware of their rights, and very importantly able to pay the cost of services. Also the government is aware that the cost of services is going to be very high. Such services would include operation and maintenance services. At present service or society charges in many places even now include property tax, water charges, sinking fund, repair fund, maintenance charges for various services, parking charges, common electricity charges, lift charges, non occupancy charges, insurance charges, auditing charges, keeping pet charges etc. As per the report published in Mumbai Mirror on April 12, 2013, "Some of Mumbai's ultra plush residential societies charge monthly maintenance fees that go up to Rs 1 lakh per flat, more than many in the city can afford to pay as rent. Considering the facilities being planned in smart cities, society charges would be more than these charges. It has to be understood that such charges cannot be borne by a person of middle class or even upper middle class income group. Another problem is that shortage of housing is for economically weaker sections and lower income group in the country and for such people, smart cities have no place.

FACTORS ON WHICH SMART CITIES DEPEND

The factors on which smart cities depend are;

- Physical infrastructure
- Social infrastructure
- Economic infrastructure
- Institutional infrastructure

Physical infrastructure includes housing, transport, energy, utility services, solid waste management system which needs to be designed in an integrated and efficient way through use of information technology and smart technology.

Social infrastructure includes education, healthcare, sports, community services, and recreation services. India has a complex social network of various religions, castes, culture, traditions and faiths hence developing social infrastructure is a challenge. In India, decision on reservation in allotment of houses or in allotment of land for education institutes, for socially weaker section like SC/STs, backward castes, minorities, economically weaker sections, farmers whose land would be acquired is to be taken is complex. Such allotment at subsidized rates would lead to hike in the cost of infrastructure developed for others so financial viability would have to be worked out.

Economic infrastructure being backbone of smart cities needs to generate employment opportunities, business activities and income generation activities through industries, commercial centres, information

technology parks, trade and exhibition centres, and financial hubs etc. Even these economical centres may not generate income until business is generated from the outsiders. For example, business activities or commercial centres if are only for the people of that particular city, it would not generate required income until and unless it gets business from outside. If every smart city has IT parks, we would have 100 such parks in hundred cities over already existing IT parks. Therefore, a study needs to be done whether the country needs those many IT parks.

Institutional infrastructure includes infrastructure for various institutions like healthcare, education, administration and management including governance. Again this issue is complex and needs to be planned carefully. For example, today a large number of engineering, dental, medical, and management institutes are existing and probably further may not be required so creating more facilities would mean either new remaining unoccupied or existing not being utilized. Institutional infrastructure would depend upon major usage being planned in each smart city.

ISSUES RELATED TO SMART CITIES

Smart cities are likely to create many issues if not properly planned. These issues may include planning issues for type of buildings required, approval from local bodies, availability of infrastructure to mitigate disasters like fire, earthquake, cyclones, land acquisition, funds requirement, existing vacant inventory and possible vacant inventory after construction of such 100 smart cities, usage of assets created, social issues like allocation of houses, offices and shops to weaker sections of society and farmers, cost of operation and maintenance, administrative and political issues derived from all such issues etc.

Smart Houses

The country needs houses to accommodate large urban population projected as 157 million people in urban area. Even if as an average 5 persons are considered occupying a house, country would need about 30 million units in the country in next 15 years. Thus considering that two third of the population will get accommodated in existing cities as the development cannot be stopped in those cities, 10 million houses will still be required and these 10 million can therefore be planned in smart cities for next 15 years but let us have a look into the inventory already available.

As per the census data, total number of census houses in 2011, 24.7 million houses were vacant out of 330.8 million census houses at all India level. This means that 7.5% houses were vacant at all India level which includes both rural and urban houses. At the national level, maximum utilization of occupied houses was for residential purposes as 79.9 percent while 19.7 percent utilisation was for non-residential; where 5.8 percent for shop/office, 0.7 percent for school/college etc., 0.2 percent for hospital/ dispensary and 11.0 percent for other non-residential use. Thus vacant inventory of 2011 is enough to cater two third requirements of next 15 years. Another interesting figure was that in comparison to census of 2001, an increase of 32.8 percent in absolute number of houses in India has been recorded which includes an increase of 31.2 percent in occupied houses and of 56.0 percent in vacant houses. Therefore, vacant inventory has already increased at an alarming rate, indicating overall supply was more than the demand in the country.

Now let us examine the scenario of urban India only. As per Census 2011 in urban India, there is an absolute increase of 53.9 percent in the number of houses when compared with Census 2001; while increase in occupied houses is 52.1 percent and in vacant houses 72.0 percent. Total number of vacant census houses was found to be 11.09 million against total Census Houses of 110.14 million. Thus inventory of vacant houses in urban area was 10.1% at national level and similar trend was almost in all the states. The use of occupied urban census houses as residences was 76.9 percent at all India level. For non-residential use the figure was 20.0 percent at the national level. From these figures also, there is no requirement of urban housing for next fifteen years.

Now let us examine the figures of ministry of urban development. Secretary (UD) in a conference mentioned during 2013-14 housing shortage of 25 million units (projected during 13-14) in the country, while 11 million homes were vacant as per the census figures of 2011. The centre had projected the total housing shortage in the country at 18.78 million in the beginning of the 12th Five Year Plan (2012-17).

It was clearly brought out that more than 90 per cent of shortage exists for the EWS/LIG section of society. If more than 90% shortage is for weaker sections, should we plan houses for rich or "smart people" in smart cities as there is no demand even today for those people. Let us examine another report from the ministry of urban development.

Till March, the shortage of housing units in urban areas was 18.7 million while over 11 million houses lying vacant, according to a technical group constituted by the Ministry of Housing and Urban Poverty Alleviation (HUPA). If 80 per cent of these vacant houses are made available in the market during 2012-17, the need to build additional houses will come down by over 88 lakh units (Indian express Sep 27 2012). Another report says, "A report released on Saturday by the housing and urban poverty alleviation ministry said of the 17.95 million housing units that came up in the country between 2007 and 2012, 11.09 million houses, or nearly 62%, were either 'vacant or locked up'. And, housing shortage at the beginning of 2012 was 18.78 million. If there is a liquidity crunch, this has the potential to create a sharp fall in housing prices, with destabilising consequences for the rest of the economy, as happened in the US in 2008" (Hindustan times Sep 23, 2012). Even if 6% annual increase is considered in the inventory, inventory of vacant houses might have already gone up from 2011 onwards.

Therefore it has to be examined whether we need residential units in smart cities at all and if by chance liquidity crunch happens in the country, what would be its implications not only in smart cities but all over India in real estate.

Smart Economy

Every city would need the place to work for its residents and the place of work should be near to their residences. Thus there would be need to develop industries, commercial organisations, and business establishments. Commercial and business establishment would only be successful in case the residents have high income. Industry whether manufacturing or service would therefore be main source of income generation. Service industry largely requires only physical infrastructure in terms of buildings but manufacturing industry requires considerable infrastructure. Manufacturing industries are also the source of pollution and from the definition of "Smart city"; such industries may not be viable in smart cities. Therefore load would be on the border of smart cities which also cannot be left for pollution for "other than smart people". One has to be sure that "Smart city" model would be developed for only service industry. If manufacturing industries are planned within smart cities, large workforce would also be required and such workforce would not be able to sustain the cost of living in the smart cities, hence borders of such cities may develop as a "place of living for workforce"; call it slums or residences for economically weaker sections. Another model may be that manufacturing industries are planned separately a little away from smart cities simultaneously.

Smart Mobility

From the definition, in a smart city one would have uninterrupted, convenient and environmentally sustainable transport system. Thus from the present concept, one would not have three wheelers, ordinary buses and taxis, or cycle rickshaws. Air-conditioned buses, luxury taxis, metro, and mono rails may be the mode of transport including private vehicles. Thus the cost of smart transportation will automatically be very high and unaffordable to many. Since smart cities are to sustain the environment, the vehicles of other cities and states may be denied entry to such cities including buses, three wheelers and even private cars. Such conditions though existing in some smart cities in the world may trigger social and political issues in India.

Smart Governance

A decision is to be taken regarding the governance of smart cities. If the developers are to submit development plans and drawings and take various NOCs from existing local bodies, it may take considerable time to get clearance as the local bodies may not be geared up for such development. Therefore, local bye laws are to be framed incorporating master plan, zonal development plans, land use, type of construction, traffic plan, and services. Thereafter only DPRs can be prepared conforming to local bye laws of smart cities.

THE WAY FORWARD

Smart cities are to be developed as business and commercial centres to attract domestic and

foreign visitors for tourism and business to have growth of all the states and local areas. Think, if we have 100 smart cities scattered all over India which have business centres for local population of those states, hotels, apartments for short duration stay and restaurants for the visitors and offices and exhibition cum sale centres for local business entrepreneurs, farmers, businessmen and industrialists, all would be benefited. For example, a smart city near Jalandhar may be a woollen hub, Kurukshetra as basmati rice hub, Saharanpur as wooden craft hub, Varanasi as spiritual hub, Haridwar as ayurved hub, Pune, Hyderabad and Bangalore as IT hub, Surat as diamond hub, Dispur as bamboo craft hub, Moradabad as brass hub, Bhagalpur and Mysore as silk hub, Ujjain as spiritual and Ved vidyapeeth city, Thiruanantpuram as naturopathy hub and so on. These cities can be developed in small areas and would require limited facilities for housing, offices, and governance etc. Since, these can be allocated to individuals, cooperatives and companies, or even can be run by private entrepreneurs on rental basis like exhibition centres, government can also reserve some space for economically weaker sections of the society. The investment required would be limited and also skyscrapers would not be required as the buildings can be planned with local architecture suiting to the climate of the area. Such cities can be developed on the model of "Smart cities" i.e. green cities, with planned traffic and effective connectivity to various existing modes of transports like railways, roads and air. Even such smart cities can be considered for connectivity with other cities by helicopter services and small aeroplanes. All type of facilities need not be created in every smart city and should be need based to avoid increase in vacant inventory of houses, shops, educational and healthcare institutions and offices.

It is said that Indian cities are not smart and good enough to live. When Indians go abroad to cities like Barcelona, Chicago, Boston, Shanghai, they find large difference between such cities and Indian cities. Indian cities, no doubt, cannot be compared to those cities. It is to be examined why the list of smart cities is so less and whether we would really be able to develop 100 smart cities like Shanghai or Barcelona or after some time we would have our own definition of smart cities and still saying that Indian cities are not smart. Also India is a democratic country and as such it is doubtful whether restrictions can be imposed like Shanghai has imposed on entry of workers and vehicles etc. Model like Shanghai has to be examined carefully. If workers have to take work permits to enter the smart city, taxi operators registered outside the city being denied entry, purchase of private cars has restriction, and there is a restriction on creation of infrastructure for economical weaker sections of society, number of issues may arise in India.

Huge investment and development will solve problems of traffic, unemployment, parking, waste generation and pollution but it is to be understood that it is not the investment or development but people of those cities who have contributed largely to smart cities through their discipline. Otherwise also it is said that it is the citizen's behaviour which affects smart housing and ultimately smart cities. Thus India can have its own definition of smart cities suiting to its people and environment embedding international culture.

Hon'ble Prime Minister has announced about developing 100 smart cities in India which is a welcome step. Now the planners are to make a feasibility study about the type of smart cities to be developed. These cities may be grouped if feasible and categorised as say; Type A, Type B and Type C smart cities. Say; Type C cities may require development of physical, social, economical and institutional, Type B may require only physical, economical and institutional and Type A may require only economical infrastructure. Further housing and office requirements can also be worked out in each type of city. A feasibility study therefore is required to be made for every city, with the existing physical, social, economical and institutional infrastructure. It must be kept into consideration that so far there are very few smart cities in the world and reasons of not availability of many smart cities even in developed countries has to be analysed. Thus developing 100 smart cities based on existing model of smart cities will not only require huge financial resources but may not be suitable or may not be essential. All such issues need to be examined carefully and development model and the requirements of infrastructure have to be carefully assessed in each smart city. For example, Delhi being a political city needs different infrastructure than Haridwar being a religious city or Mumbai being a commercial hub. Then economy

of each city is different from other and source is different. Economy of Saharanpur depends upon different sector than Bhagalpur. And then each city has different characteristics based on its social network due to large diversity in the country including in tradition and culture.

CONCLUSION

"Smart city" concept is new to the country. Planning a city requires in depth feasibility study based on business, industrial, commercial, social, economic, infrastructural and citizen's requirements, including environmental considerations. Thus, a master plan has to be developed first for each smart city. Availability of existing infrastructure need be considered before creating new infrastructure.

Cost of living in smart cities would be very high considering operation and maintenance cost of services and thus it would only be feasible for rich people to afford living in smart cities but smart cities in India have to be designed based on habitat sustainability for all sections of the society. Therefore, a new model of smart cities, suitable for India may be essential before DPRs are prepared.

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FUTURISTIC PLANNING FOR SMART CITIES

Dr. Oscar Concessao*

Abstract

Across the world, the stride of migration from rural urban areas is increasing. By 2050, about 70 per cent of the population will be living in cities, and India is no exception. India will need about 500 new cities to accommodate the rapid influx of population into its urban regions. A 'smart city' is highly advanced in terms of overall infrastructure, sustainable real estate, and communications and market viability. Though this may sound futuristic, it is now likely to become a reality as the 'smart cities' movement unfolds in India, "A Smart City needs the integration of technological and social components with the urban development model, within a vision that produces cities more intelligent, more sustainable and more inclusive, not just inputting technology, but generating innovation.

The importance of "place" in futuristic town planning and urban design has come to encapsulate experience from a variety of domains about what makes urban environments successful from the perspective of the people, businesses and communities who use them. It's equally important to use urban life and "place" as our starting points when guiding the application of technology in city systems. In every case, these urban centers are addressing some of the biggest predicaments facing governments, urban planners, architects, and ordinary denizens today. How to accommodate booming populations, increase the efficiency and availability of transport, foster the growth of businesses, support technological innovation, and make the intricacies of government more transparent to citizens.

INTRODUCTION

Smart-cards, smart-phones, smart-watches, smart-markets, and bringing these smart things from the e-domain to the real world – smart cities. Smart cities, a relatively unknown term in India, has suddenly found a place in everyday conversation thanks to the three agreements signed by GOI with the US Trade and Development Agency (USTDA) for developing smart cities in Ajmer, Allahabad and Visakhapatnam. Ever since the ambitious "100 smart cities" project was announced by Shri Narendra Modi led government, it has become a buzzword among city dwellers.

A smart city is an urban territory that provides extremely robust infrastructure, environmental sustenance, economic viability and citizen well-being using innovative services and concepts. According to a report released by The Global Commission on the Economy and Climate in Sep 2014, India's urban population, which has increased from 217 million to 377 million in the last two decades, is expected to reach 600 million by 2031. Large scale urban planning is required to seamlessly integrate this increased population into India's future cities. At present, Indian cities are expanding in a haphazard manner, with basic infrastructure and residential properties being developed with no adherence to city bylaws and codes. This unplanned growth has created 2 challenges for urban planners:

- Leaving municipalities with acute infrastructure shortages.
- Undesirable side-effects that are forced upon residents, such as pollution, traffic, crime, etc.

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Increased consumption of carbon-based fossil fuels is the single most important factor contributing to urban air pollution, which is growingly becoming the top environmental cause of premature mortality. There is an urgent need to create infrastructure that can work on innovative methods that promote sustainability. According to estimates, the cost of environmental degradation, almost entirely driven by urban zones, is reducing India's GDP by 5.7% or USD 80 billion annually.

What defines a Smart City?

Smart Cities are defined by – Smart Energy, Smart Transport, Smart Water and Waste, Smart Social, Smart Buildings (Fig.1)

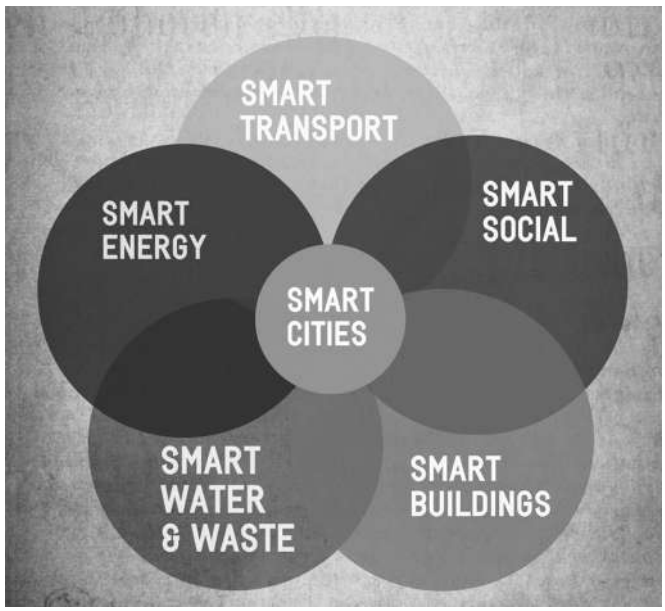

Fig. 1 Elements of a Smart City

The following parameters are designed to adhere and achieve three basic variables:

- A smart city should be environmentally stable by promoting energy efficient processes, low pollution levels and efficient use of resources.
- It should be economically viable by being able to attract long term investments for innovative technologies, thereby creating jobs for its citizens.
- It should ensure wellbeing of its residents. This would include public safety, education for all, health care facilities, social care and safety for children and elderly.

Urban planners and architectural consultants need to put on their thinking caps to help build cities which are future ready and self-sustaining.

RIGHT WAY TO BUILD THE FUTURISTIC CITIES OF OUR DREAMS

'Our Technology-First Approach' has failed the city of the future. So-called "smart cities," powered by technology, carry the promise of responding to the great pressures of our time, such as urban population growth, climate instability, and fiscal uncertainty. But by focusing on the cutting-edge technologies themselves and relying on private companies to move forward, we have lost sight of what we even want our cities to achieve with that entire tech. To date, smart city conversations mostly trade in optimism, focusing on images of cities without congestion and smart energy meters on every building.

At what point do we prioritize the municipality–the actual governance of the city–to make great plans? To help push the industry forward and achieve those trillion dollar market projections, we need to spend as much time and energy creating policy blueprints as we've spent researching and marketing new technologies. Smart policies must match smart technologies.

But where do you even begin that kind of process? Each city is fundamentally a different place with unique collections of industries, rules and regulations and culture. That means there won't be silver bullet solutions to crafting smart city policies. Instead, policy innovators will need to start by sifting through common diagnoses and prescriptions, determining which apply to their specific market.

- **Smart Cities Must Craft an Economic Vision**

  It all starts with cities making a concerted effort to understand who they are and where they want to go. In this respect it makes sense to think of cities like a business. No business can expect to succeed without a business plan, and no city can expect to maximize growth without an economic vision. That means the first step is a bit of self-reflection: smart cities conduct thorough assessments of their strengths and weaknesses, and plan future growth around their key assets

and areas for improvement. Edmonton, Canada is a great example of this, where its City Vision 2040 program is a guide for all major decisions.

- **Smart Cities Must Use Technology to Promote Economy**

  Once a city establishes an economic vision, it's critical that technology address the three drivers of any healthy economy. First, technology must support improved productivity. For example, New York City is using technology to both grow private industries—through major investments like the Applied Science campuses—and to create more efficient government operations. Second, technology must support a more inclusive economy. This means creating opportunities for all citizens and businesses, whether it is through improving digital literacy for underserved populations or promoting open data protocols to foster civic-minded businesses. Third, technology must support a more resilient economy. Cities and their dense populations make them especially susceptible to environmental challenges and technology like advanced storm water management can help mitigate those concerns.

  No industry or household in the world will reach their future potential without access to broadband; it is the electricity of the 21st century. Under this rubric, citywide broadband becomes a required element of any well-mapped economic vision. Rolling out broadband also helps hit all three economic drivers, and creates a critical management asset for smart city executives. It's why future-looking cities like Los Angeles and Barcelona are actively exploring different types of citywide expansions.

- **Smart Cities Must Include an Empowered Municipal Technology Executive**

  A well-designed economic vision will only succeed if it can be implemented. In many cases this will require city governments to realign their internal structures around new or redefined leadership. That means recognizing the importance of smart city executives–whether known as a chief technology, innovation, information, or sustainability officer–and requiring collaboration between their office and others on major decisions, especially regarding physical development. Collaboration includes procurement, too. With these new executives continuing old responsibilities like purchasing equipment and contributing to new citywide economic strategies, procurement rules must be updated to reflect modern business practices. Cities must also ensure their technology executives have access to resources to make investments. As in the case of Toronto's mega waterfront redevelopment, including technology in long-range plans is one surefire way to unlock technology funding.

- **Smart Cities Must Balance Project Size and Risk**

  Smart city marketing tends to focus on citywide investments that will dramatically change how every industry operates and every person lives. And while those kinds of megaprojects are exciting to think about, that kind of scale may be too big for most cities and may overstep the risks city leadership is willing to take. Smart cities will design projects that fit their political and cultural environment. Smaller scale projects that focus on innovative industries have proven particularly attractive opportunities to roll-out smart city technologies. These so-called innovation districts, like in Boston, are able to generate public support, boost local businesses, and serve as a model for future investments. Scale applies to financing, too, where spreading risk across the public and private sector can create stronger support for major tech investments. Thoughtfully designing projects' geographic and financial scale can help reduce sticker shock that may scare away top city leaders.

- **Smart City Executives Need Stronger Networks**

  Considering how fast the technology sector moves, cities need methods to keep up with the pace–both for their own decision-making and in communicating with their citizens. Networking between city leaders is an invaluable way to share information about what worked (and what didn't) in other markets. As it stands, there is no formal city-level network to facilitate this

kind of exchange. Likewise, too many citizens don't know what a smart city means to them, creating a major roadblock to building support for what are often expensive capital projects. Smart city executives and their private sector partners need to create a common language that can communicate smart cities' benefits to the individual.

- **Rebalancing Our Approach to the Cities of the Future**

  Even as a nascent idea, the smart city concept warrants the attention it has received. Urban history is clear on the power of innovative infrastructure to change cities' trajectories. There is no question that digital technologies can continue that trend. But the way we've approached the smart city concept is uneven. Too often, a smart city is whatever each company happens to be selling. That approach can persist because cities are underprepared business partners, looking to get involved either without a long-term plan or the necessary policies to make their vision real. Fortunately, a focus on policy over technology can begin to address that discrepancy. This will not be an easy endeavor. But the sooner cities and their private sector partners recognize this imbalance, the faster the industry can grow.

SMART CITIES AS HUMANE HYBRID CITIES

There are many visions about the City of the Future, sometimes colourful as illustrated in the fig.2. But do they communicate what we are actually looking for? What we need is a vision that reconciles humans and technology and, of course, also ecology. (the latter is very important but is not the focus of the research carried out in this context.)

In short, we argue for a city where people enjoy everyday life and work have multiple opportunities to exploit their human potential and lead a creative life. We call it. "The Humane City". The issues we are concerned with now are (besides the economic, political and social issues)

- How can information technology support people in such a humane city?
- What are the appropriate design goals and how can we realize them?

Fig. 2. Vision of Future City

The application of information technology in the context of future cities is often indicated by notions of Smart Cities or Ubiquitous Cities (u-cities). They are defining a new area for the application of concepts and developments in Ambient Intelligence and Ubiquitous Computing. In a way, it is a natural consequence of extending the scope of work on smart rooms and smart and cooperative buildings to the next level addressing, e.g., public spaces but, in the end, covering comprehensively all activities related to living and working in an urban environment.

A very interesting special case of an urban environment is an "airport" and the way to transform airports into "smart airports" because they show most of the relevant basic issues in a very concentrated and focused manner.

But there is more to it. It reflects the motivation of contributing to finding solutions to the problems we are confronted with in a new era we are living in, called the Urban Age. Already by the end of 2008, half of the world population lived in urban areas and this trend will continue. By 2050, 70 % of the world population will live in cities.

Along this line of argumentation, 'Urban Life Management' was proposed as an umbrella scenario that helps to formulate appropriate research lines in the context of writing the "white paper" on identifying deficits and future research agendas in these areas. As part of this work, the concept of a 'Hybrid City' was proposed by Norbert Streitz. A Hybrid City

consists of a real city with its physical entities and real inhabitants and a parallel virtual city of counterparts of real entities and people. Nevertheless, there will be no complete match between real and virtual entities. Thus, we can state that there will be a continuous dimension with "real" and virtual" as its end points as indicated in fig. 3. The other two dimensions that we find useful are the distinction between "local context" and "global context", on one hand, and between "individual activities" and "group/social activities" on the other hand.

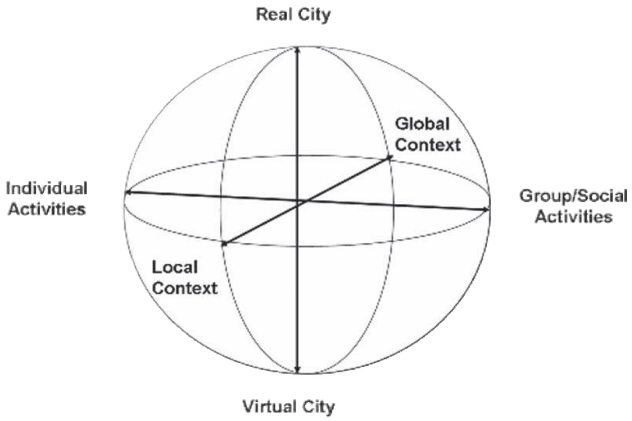

Fig. 3. Key Dimensions of Humane Cities

The three dimensions are in a next step then combined with the property of "smartness" which can be present at different levels resulting in the notion of a Smart City.

The following issues were raised in the first version of the "white paper":

- "How can the realization of a smart hybrid city contribute to reducing and potentially even avoiding some of the problems that are faced by today's cities and in the future?"

  Or in other words:
- "How can ambient and ubiquitous ICT help to contribute to Urban Life Management?

  This can be analyzed and has to be investigated from the following two perspectives:
- How to manage a person's / a group's life in today's and future cities?
- How to manage the urban environment of today's and future cities?

While formulating it as two perspectives, it should be clear that they are not independent; but it helps also to identify the different user needs depending on who are the users:

- People living and working in the city; searching, checking, evaluating and then utilizing the services that are offered by the urban environment with respect to the different aspects of life
- People who are organizing and administering the urban infrastructure so that the services are available for citizens and visitors.

CONCLUSION

Examples of how the smart or hybrid city of the future could operate are: taking care of its individual inhabitants by offering personalized services (e.g. for leisure, shopping, administration but also for security and health), providing optimized opportunities of transportation by combining various sources of traffic information at the same time and integrating different means of transportation, providing opportunities for the involvement of people in the community, e.g., by matching people on the basis of common interests and suggesting common activities or in other words: offering multiple opportunities for social engagement in order to be an active part of society.

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DEVELOPING SMART CITIES IN INDIA

Deepak Narayan*

Abstract

Urbanization has fuelled unprecedented growth of our cities, which has resulted in huge strain on their physical infrastructure. Overcrowding, rampant growth of slums, power cuts, water shortage, high volume of traffic, disparities in living conditions and inequality in access to basic services, have resulted in unplanned development.

In most of the Indian cities the critical infrastructure is woefully inadequate, technologically outdated and fragile, and incapable of meeting even the current needs of its residents. If the country is to improve the quality of urban life and avoid a collapse of the urban infrastructure, we shall have to remedy the situation in the existing cities, re-engineer the old ones and build new smart cities.

Smart city monitors and integrates conditions of all its critical infrastructure such as roads, flyovers, tunnels, rails subways, airports, IT and communication, water, power, and buildings. This can optimize its resources to plan both its routine and preventive maintenance activities and monitor security aspects while maximizing services to its citizens. Smart city is an infrastructure rich city that connects people, information and city elements using new technologies. This helps with competitive and innovative commerce and improved quality of life.

Greenfield cities are developed from scratch with very little utilization of existing infrastructure. This enables the use of state of art technologies, although this requires significantly higher investment in infrastructure. This is more suitable for new city development having private investor based commercial interest and appropriate real estate development model. The other mode is the brownfield model which requires updating and upgrading of existing infrastructure and other facilities to requisite levels. The scale of infrastructure augmentation in brownfield cities is not as profound as in greenfield cities and depends on priorities and extent of financing which can be made available for such development. It is important that brownfield smart cities are developed simultaneously to complement the greenfield smart cities.

INTRODUCTION

With half the world's population living in cities, this is causing lot of strain on energy, transportation, water, buildings and public spaces. Therefore there is increasing need for smart city solutions which are both efficient and sustainable and can generate economic prosperity and social wellbeing. It is the quality and comprehensiveness of city management that monitors and integrates the activities of all its critical infrastructure. The city infrastructure should optimize its resources, plan its preventive maintenance activities, and deal with security aspects while maximizing service to its citizens. Smart city is a high technology and infrastructure centric city that connects people, information and other elements. To create smart sustainable green city, competitive and innovative commerce with proper administration and maintenance system are needed.

In this context, Government of India has decided on developing 100 smart cities in the country, to accommodate the increasing number of people, as the existing cities are already becoming unlivable. Smart cities shall endevour to have smart physical, social, institutional and economic infrastructure and

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shall generate options for all residents to pursue their livelihoods and interests gainfully. Some of the important features of a smart city are:

- High quality of life ensuring safety, security, inclusiveness, entertainment, ease of obtaining public service, cost efficient healthcare, quality education, transparency, accountability and citizen participation in city governance.
- Competitiveness, creating employment opportunities for professionals and people, and necessary climate for investments for institutional growth of the city and,
- Social, environmental and financial sustainability.

IDENTIFYING SMART CITIES

For making the Indian cities modern and internationally competitive, the government has decided to identify and support the development of 100 smart cities in the country. A city can grow on a sustainable basis if there are adequate opportunities for economic activity and requisite wide range of services essential for a modern city. Smart cities are needed be in various parts of the country for encouraging balanced development.

Satellite towns of important cities form a good alternative for such development. Some midsized and some small cities also need to be taken up for such development depending on evaluation of merits of such cities. The government shall have to pick up such cities through a consultative approach amongst all stakeholders. Cities will have to compete on different parameters to become eligible. Some of the criteria stipulated by MoUD are vision, progress under Swaach Bharat Mission, timely payment of salaries to municipal staff, availability of requisite information and also grievance redressal mechanism. Other parameters could be self financing abilities of the cities, existing service levels and track record of general city management.

100 smart cities to be developed shall be generally chosen as per following criteria:

- One satellite city of each of the cities with a population of 4 million or more (9 cities).
- Cities in the population range of 1 to 4 million people (about 39 cities).
- All State/UT capitals even if they have population less than one million (17 cities).
- Cities of tourist, religious and economic importance not included in above (10 cities)
- Cities in the 0.2 to 1.0 million population range (25 cities)

It will be ensured that a comprehensive view is taken in respect of identifying smart cities taking into consideration economic growth, political framework, executive capabilities as well as positive externalities of clusters and urban agglomerations. The state governments shall also be invited to share their views and adequate representation shall be given to various states and union territories in final selection of cities. The smart cities likely to be developed initially are Vishakhapatnam, Ajmer, Allahabad and Varanasi.

PRE-REQUISITES FOR SMART CITIES

Towards the objective of developing an integrated smart city framework, the key enablers are (a) Smart Governance (b) Smart Living (c) Smart People (d) Smart Mobility (e) Smart Environment and (f) Smart Economy. These have been elaborated in the paragraphs below.

Smart Governance

The management of cities comprises of multiple systems all of which are closely inter connected in meeting various needs. A smart city is one where each of these systems work in harmony with others. Institutional infrastructure is very important and refers to the governance and activities of planning and management of a city. The new technology (ICT) makes the systems efficient, accountable and transparent. It includes the systems of governance, e-governance and inclusive governance. Physical Infrastructure refers to items such as urban mobility system, the housing stock, the energy system, water, sewerage and sanitation system, waste management system and the like, which are required to be handled in an integrated manner. Social Infrastructure refers to components such as education, healthcare, entertainment, arts, sports, parks and gardens etc. which are equally important.

For attracting investment and for creating necessary economic infrastructure, we require financial centers and services, trade centers, industrial parks and export processing zones, IT Hubs, logistic hubs, logistics warehousing and freight terminals, skill development centers and the like. These are needed for proper coordination amongst various services for smooth functioning of a smart city. For cities to become smart, all concerned utilities need to make efficient use of ICT's in city administration and achieve proper connect and coordinate between various agencies. This requires new skills and appropriate organizational changes and improved systems and processes.

Smart Living

This pertains to better access to city facilities and re-sources like building and related utilities etc. which lead to improved quality of life. Our cities face severe congestion, deteriorating air quality, increased traffic problems and an increasing energy bill. Public transport has become inadequate and walking and cycling have become unsafe due to inadequate provision of facilities for the same. Proper public transport systems have to be planned along with a well integrated modal system. A smart transport system emphasizes walking and cycling as an integral part of public movement system with discouragement for excessive use of personal motor vehicles.

There is need of adequate ICT systems with requisite internet bandwidth and wide availability of Wi-Fi system. Municipal services like water supply, drainage, solid waste management systems need to be of high quality and available 24 X 7. The smart city should have a city wide sanitation plan. All commercial and residential premises should have toilets with appropriate sewerage and solid waste management system, with recycling of water to the extent practicable. Cities which are clean are considered to be smart, providing healthier environment and better quality of life.

Smart cities need to have continuous access to the electricity which may not be possible with existing supply and distribution system. Energy management and energy efficient practices are therefore needed. Smart grids are required which provide modernized electricity grids that interact with information technology and communication infrastructure to provide transparency in energy use to consumers and to improve quality of energy supply. These also integrate renewable and distribution energy sources into the grid, like solar, wind and co-generation plants.

Enforcing laws that ensure that buildings are built with appropriate insulation and proper HVAC norms are essential. Big complexes can display a daylight harvesting programme that maximums daylight and minimizes the lighting needs. Environmental sustainability is also necessary to create a more livable and healthy environment.

Smart People

Smart cities should have better education levels, skill building, health, lifelong learning opportunities and higher participation at community level. There should be pre-primary, primary, secondary education and higher education facilities commensurate with neighborhood characteristics, population and other relevant factors. There should be adequate number of skill development centers providing opportunities to residents of the city. Education and digital content should be suitably utilized for achieving this objective.

Our country has an inherent weakness in the healthcare system, which is dominated by the private sector. There is need for development of adequate healthcare facility in the form of hospitals, nursing homes, child welfare, maternity centres and hospitals of various categories including general hospitals, specialty hospitals and multi-specialty hospitals to be made available to different strata of society.

A key element in the development of smart cities is inclusion of citizens in the smart city vision. There should be collaboration between local government, municipal department and public utility agencies on one hand and service recipients on the other. There should be a website of the local government wherein the citizens could contribute ideas on improvement of services and other relevant feedback.

Smart Mobility

This pertains to movement of people, goods and information to an optimum level. The smart

transport system emphasizes walking, cycling, public transport system with less emphasis on personal motor vehicles. The goods should move from production centre to consumption centre at optimum cost and high speed. Public transport system should be planned in a manner which could result in proper well integrated multi modal system.

Smart Environment

Smart Cities are required to be environmentally sustainable. This pertains to sustainable development, natural resource utilization, optimum use of water resources and energy, with balance between built and green areas and control of pollution in the environment. Smart Cities should prepare an environmental sustainability plan which would outline the plan and actions to ensure adoption of energy efficient and green technologies and processes.

Smart Economy

Smart city needs to attract investment and to create appropriate economic climate for optimum job opportunities, thus leading to growth in investments. It has to evaluate its core competence, comparative advantages and encourage the generation of economic activities. The economic infrastructure could include industrial parks, export processing zones, IT parks, trade centres, service centres, financial centres and logistic hubs, warehousing and freight terminals. Good quality infrastructure, transparent online business and services processes are needed to establish an enterprise and run it efficiently.

DEVELOPMENT AND FINANCING OF SMART CITIES

The selected cities shall make a proper plan for development consistent with prerequisites of smart cities. There should be a transparent MOU between Central Government, State government and urban local body for modalities and framework of carrying out such development. It will be necessary to have digitized spatial and GIS maps of the lands and relevant master plan should be prepared. All clearances of the competent authorities including all public services shall be obtained. Right of way for laying optic fiber networks, water supply, drainage system, sewerage system and other utilities shall be provided. The master plan should be reviewed and notified by the urban local body. Land in cities is at a premium and existing FARs may not permit necessary density of development. To ensure availability of affordable housing to majority of the population, the existing FARs and bye-laws may be amended and incorporated into in the master plan.

The enabling mechanism shall include establishment of project monitoring unit with proper co-ordination between various department and ministries. At present the different ministries involved are those of Urban Development, IT, Power, Road Transport and Highways, Water Resources Labour and Employment, Human Resource Development, and Consumer Affairs, Food and Public Distribution. Policies at central level are being framed by the Urban Development Ministry and there is need to make them work as a coordinated single point clearing house.

Financing of smart city is the most important aspect which needs to be adequately catered for. A financial plan should be worked out right at the time of smart city development plan and detailed project report. The financial plan developed could include innovative financing such as accessing bond markets, structuring projects on PPP model and obtaining additional resources from private sector, including resources generated both from domestic as well as overseas investors.

The funding could be from central government and state government allocations, borrowings from multi-central and bi-central agencies, and bonds subscribed by national and state level land development agencies such as HUDA, PUDA, DDA etc. Other financing resources could be pooled municipal debt obligation (PMDO) facility in urban areas. There could be Real Estate Investment Trusts (REITS) which could be used as instrument of pooling of investments.

As the central government does not have adequate resources for funding, it is through public private partnership (PPP) that the implementation could be planned out. It will be further necessary to set up a special purpose vehicle (SPV) to manage and fund PPP projects. Centre is expected to provide viability gap funding (VGF) which may be used for

digitization of the smart city. An SPV model may have four equity partners – the central government, the state government, municipal bodies and the private sector. A city may have multiple projects, each headed by an SPV. This would mean devolution of power from municipal commission or MLAs and other government official to the person heading the SPV who will have executive power. SPVs should have powers to plan, develop, execute, implement, operate and maintain. The PPP may go for joint interest in which private sponsors consisting of a consortium of private companies shall contribute equity to the joint venture (JV).

Smart cities call for a new mindset for dealing with private companies. If the private sector invests, there will have to be visibility on returns in the form of payment of higher costs for better and value added services. For example, for buses fitted with GPS system or better quality electricity and water supply, citizens shall have to pay appropriately higher service charges.

A large number of private players such as KPMG, PWC, IL&FS, Accenture, Microsoft, IBB, CISCO, WIPRO, TCS, Infosys have shown interest in playing a major role in developing smart cites and their input needs to be suitably examined and utilized through conferences, workshops and consultations. Events like smart cities India in 2015, Exhibition and Conference, held at Pragati Maidan, New Delhi are extremely helpful in propagating current thinking on the subject to various participants and stakeholder.

CONCLUSION

Smart cities need to concentrate to properly manage various utilities including, transport, healthcare, education and other components of infrastructure. The important parameters which make a city smart are, governance, energy, buildings, mobility, infrastructure, technology, healthcare and citizen participation. No city has all of these. It is expected that by end this year 2015, there will be around 26 global smart cities that will have at least five of above parameters. MOUD have fixed tough performance benchmarks for various services. In transportation, maximum travel time shall be 30 minutes in small and medium sized cities and 45 minutes in metros. The water availability shall be 135 liters per capita per day. Most of the residential areas shall have retail, parks, primary schools and recreational areas accessible within 400 meters. These parameters are somewhat difficult to achieve.

The country plans to have 100 smart cities, both greenfield and brownfield at the rate of about two such cities per state. As per MOUD estimates development of 100 smart cities and rejuvenation and retrofitting of 500 other cities is likely to cost more than rupees forty lakh crores over a period of twenty years. For implementation of this plan, issues related to land, red tape, rules and regulations have to be addressed to enable major investment through private sector. For such city development a large portion of initial investment may be recovered through sale or lease of lands for real estate development of commercial, residential and industrial use. FAR could be increased to allow for higher density of buildings.

Financing of smart cities shall have to be done, apart from private sector, through pooling of funds by central government, state government sources, borrowing from banks, public bonds, pooled municipal debt obligation (PMDO) sources, and real estate investment trusts (REITS). The implementation shall have to be carried out through a suitable PPP framework. Suitable financing options like BOT (Build-Operate-Transfer) may be considered to stagger the initial investment. Tariff structure shall have to be modified to allow for higher cost recovery to meet higher city management costs. We shall have to opt for a cloud based model for information management. This shall enable collection of data from city level, processing it and generating potential responses which could be acted upon by the city level control rooms.

Implementation of smart city solution requires proper coordination between various institutions of central government, state government as well as local municipal agencies and other stakeholders on various matters including financing, sharing best practices and project implementation. A PPP model of working is suitable so that a special purpose vehicle (SPV) could be set up for management of city projects. Private

investment could come through a consortium of companies which could contribute equity to the joint venture for financing. For successful implementation of smart city the government and private agencies shall have to work in a mission mode under the authority of person heading the SPV.

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SMART MATERIALS AND SYSTEMS FOR SMART CITIES

DR. TALAKOKULA VISALAKSHI* AND DR. SURESH BHALLA**

Abstract

The key to the development of smart cities will be the use of smart materials and system with increasing levels of functionality. Smart materials find a wide range of applications due to their varied response to external stimuli. The areas of application vary from day to day life applications to engineering applications such as in aerospace, civil engineering applications and mechatronics to name a few. The most important feature related to smart materials and structures is that they encompass all fields of science and engineering.

This paper presents the application of smart materials mainly piezo electric materials in infrastructure health monitoring of smart cities. Civil infrastructures play an important role in the development of smart cities as well as important long-term investments of a nation which are crucial in supporting the nation's economic and social activities. First, a simple overview of the technology is presented after defining what is meant by 'smart materials' and provides a few examples. This is part of an ongoing work on the use of smart materials for applications in engineering.

INTRODUCTION

A smart system or material is the one which has built-in or intrinsic sensor(s), actuator(s) and control mechanism(s) whereby it is capable of sensing a stimulus, responding to it in a predetermined manner and extent, in a short/ appropriate time, and reverting to its original state as soon as the stimulus is removed (Ahmad, 1988).

The idea of 'smart' or 'intelligent' structures has been adopted from nature, where all the living organisms possess stimulus-response capabilities (Rogers, 1990). However, the smart systems are much inferior to the living beings since their level of intelligence is much primitive.

SMART MATERIALS

Smart materials are new generation materials surpassing the conventional structural and functional materials. These materials possess adaptive capabilities to external stimuli, such as loads or environment, with inherent intelligence. The stimuli could be pressure, temperature, electric and magnetic fields, chemicals or nuclear radiation. The associated changeable physical properties could be shape, stiffness, viscosity or damping. This kind of 'smartness' is generally programmed by material composition, special processing, introduction of defects or by modifying the micro-structure, so as to adapt to the various levels of stimuli in a controlled fashion.

Optical fibres, piezo-electric polymers and ceramics, electro-rheological (ER) fluids, magneto-strictive materials and shape memory alloys (SMAs) are some of the smart materials. Fig. 1 shows the associated 'stimulus' and 'response' of common smart materials. Because of their special ability to respond to stimuli, they are finding numerous applications in the field of sensors and actuators. A very detailed description of smart materials is covered by Gandhi and Thompson (1992).

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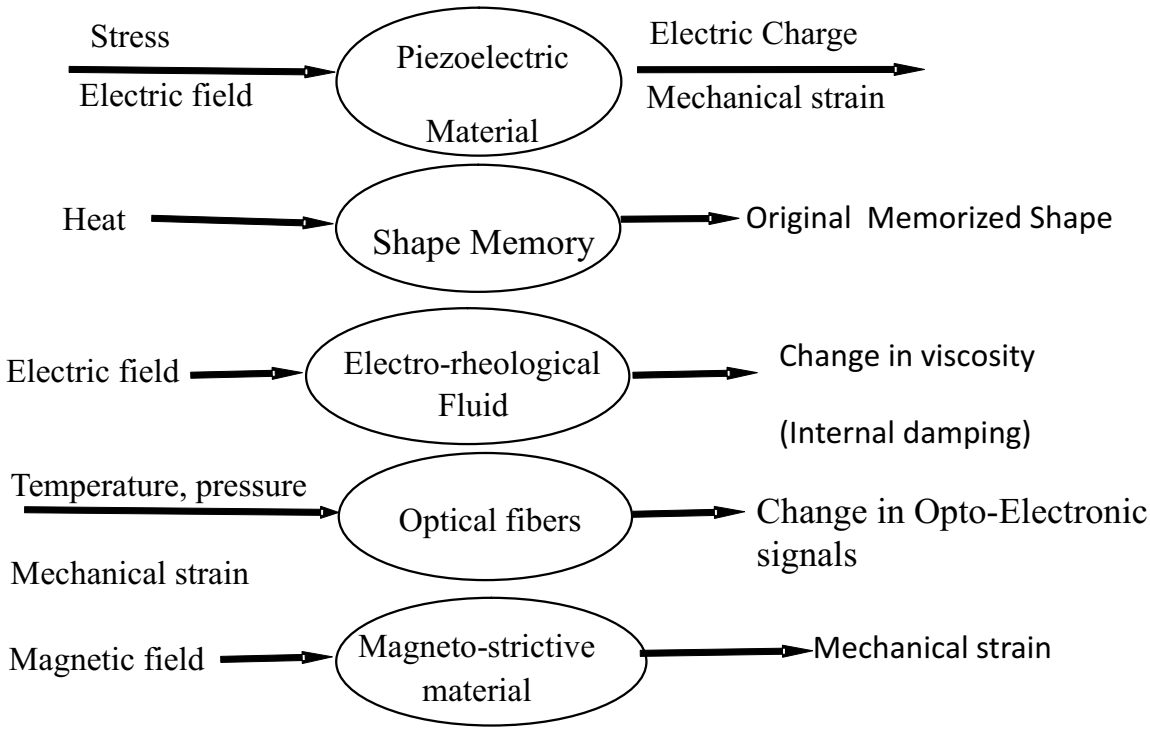

Fig. 1. Common Smart Materials and Associated Stimulus-Response

ACTIVE AND PASSIVE SMART MATERIALS

Smart materials can be either active or passive. Fairweather (1998) defined active smart materials as those materials which possess the capacity to modify their geometric or material properties under the application of electric, thermal or magnetic fields, thereby acquiring an inherent capacity to transduce energy. Piezoelectric materials, SMAs, ER fluids and magneto-strictive materials are active smart materials. Being active, they can be used as force transducers and actuators. Similarly piezoelectric materials, which convert electric energy into mechanical force, are also 'active'. The smart materials, which are not active, are called passive smart materials. Although smart, these lack the inherent capability to transduce energy. Fibre optic material is a good example of a passive smart material. Such materials can act as sensors but not as actuators or transducers.

Optical Fibres

Optical fibres have been classified as the most advanced of the recognized smart materials (Rogers et al., 1988). These are made up of glass and silica, and utilize fibre properties to provide optoelectronic signals, which are indicative of the external parameters to be measured. They have a wide range of applications, including measurements of temperature, pressure, strain, displacement, and chemical composition.

Electro-Rheological Fluids

Electro-Rheological (ER) fluids are typically the suspensions of micron-sized particles in suitable hydrophobic carrier liquids. They have the inherent ability to undergo an abrupt and reversible change in viscosity when subjected to electrostatic potentials. Vibration control using ER fluids has been demonstrated using hollow graphite epoxy cantilever beams filled with various ER fluids (Gandhi and Thompson, 1992). By applying voltage across the beam, internal damping could be increased and vibrations could be suppressed. Viscosity characteristics can also be exploited to create a structure with variable stiffness, which can be effectively used to shift the system's natural frequency away from the frequency of the excitation.

Shape Memory Alloys (SMA)

SMA's has the inherent ability to remember a specified 'memorized' shape. Below a specific temperature (called transition temperature), SMA can

be plastically deformed from its memorized shape. When it is heated above the transition temperature, the SMA will return to its memorized shape, if not constrained from doing so. Typical example of SMA material is the alloy of Nickel and Titanium (Ni-Ti or Nitinol). Nitinol has relatively high electrical resistivity, which lends itself to the easy and uniform heating via the electrical current.

The large recovery force associated with the return to the memorized shape has been exploited to create distributed SMA actuators, which are also used as shape controllers. The SMAs find application in the fields of robotics, active shape control of large antenna reflector surfaces, active vibration control of large flexible structures and also heat engines. For example, shape memory materials could be used in food packaging that automatically opens on heating for people with arthritis (Kamila, 2013).

The present research focuses on the application of piezo electric materials as a part of smart structures and system in the making of smart cities.

PIEZOELECTRIC MATERIALS

The word 'piezo' is derived from a Greek word meaning pressure. The phenomenon of piezoelectricity was discovered in 1880 by Pierre and Paul-Jacques Curie. It occurs in non-centro symmetric crystals, such as quartz (SiO_2), Lithium Niobate ($LiNbO_3$), PZT [$Pb(Zr1\text{-}xTix)O_3$)] and PLZT [$(Pb1\text{-}xLax)(Zr1\text{-}yTiy)O_3$)], in which electric dipoles (and hence surface charges) are generated when the crystals are loaded with mechanical deformations. The same crystals also exhibit the converse effect; that is, they undergo mechanical deformations when subjected to electric fields. Fig. 2 shows a typical piezo electric patch.

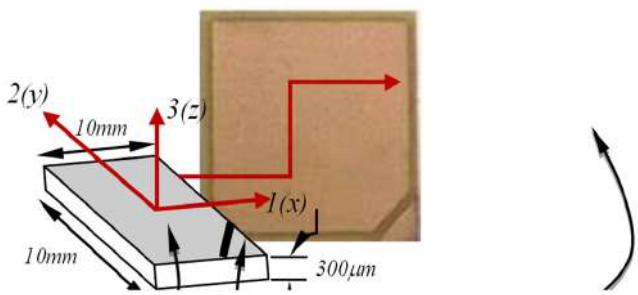

Fig. 2 Geometric Details of a Typical PZT Patch

piezo-electric ceramic (PZT) patches are made up of materials that generate a surface charge in response to an applied mechanical stress. Conversely, they undergo a material deformation in response to an applied electric field. This unique capability enables the material to be used both as a sensor and as an actuator. Smart system applications of these materials range from developing a skin like sensor (with high temperature and pressure sensing capabilities) to robotic applications.

PZT Sensors for Damage Detection

Traditionally, piezoelectric materials have been well-known for their use in accelerometers, strain sensors, emitters and receptors of stress waves, vibration sensors, actuators and pressure transducers. In the last decade, piezoelectric materials, their derivative devices and structures have been increasingly employed in turbo-machinery actuators, vibration dampers and active vibration control of stationary/ moving structures (e.g. helicopter blades). They have been shown to be very promising in active structural control of lab-sized structures and machines (e.g. Manning et al., 2000; Song et al., 2002). Structural control of large structures has also been attempted (e.g. Kamada et al., 1997). Other applications include underwater acoustic absorption, robotics, precision positioning and smart skins for submarines (Kumar, 1991). Skin-like tactile sensors utilizing the piezoelectric effect for sensing temperatures and pressures have been reported. Piezoelectric materials have also been employed to produce micro and nano-scale systems and wireless inter digital transducers (IDT) using advanced embedded system technologies, which are expected to find numerous applications in micro-electronics, bio-medical and structural health monitoring (SHM).

PZT Sensors For Monitoring Of Civil Infrastructures

During the recent years, SHM, employing PZT patches as admittance/ impedance transducers, has emerged as a new non-destructive evaluation (NDE) technique to monitor variations in the structural mechanical impedance caused due to damage. A very detailed review of the various case studies and applications is covered by Park et al., 2003b and Bhalla 2004 who have provided a comprehensive review of the developments in EMI technique since

its invention in1995. Soh et al. (2000) established the damage detection and localization ability of piezo-impedance transducers on real-life RC structures by successfully monitoring a 5m span RC bridge during its destructive load testing. Besides, criteria were outlined for transducer positioning, damage localization and transducer validation.

Recently, the SHM using PZT patches has been extended to monitor the concrete hydration, curing and strength gain. Qin and Li (2008) monitored the hydration of cement using embedded PZT patch, by determining the dynamic modulus of the cement paste through the measurement of the ultrasonic pulse velocity. Shin et al. (2008) used surface bonded PZT transducers for long term hydration monitoring. However, they could not monitor the early hydration as they bonded the PZT patch to the concrete surface only after hardening. Yang et al. (2010) developed a reusable PZT set up to monitor the initial hydration of concrete. Due to repeatable use of the PZT patch, the sensitivity of the PZT signal is observed to reduce. Tawie and Lee (2010) non-destructively monitored the hydration of RC using PZT sensors and used it as an indicator of the bond development at the steel-concrete interface. Quinn et al. (2012) developed an embedded wireless sensing system for monitoring initial curing and health of concrete structures. Providakis et al. (2013) designed a miniaturized wireless EMI based measuring system to monitor the early age strength of concrete. Based on their experimental studies, they found that the EMI signatures gradually shift to the right as the concrete curing time increased. Kong et al. (2013) monitored the very early age concrete hydration using piezoceramic based smart aggregates. Recently the lead authors recently proposed an approach for detecting and measuring the level of chloride and carbonation induced rebar corrosion (Talakokula et al 2011, 2014 and 2015) using PZT patches validated through accelerated corrosion tests on embedded rebars. More detailed description of smart material is covered by Bhalla (2004).

CONCLUSION

The smart material technology has been adopted from the nature itself, hence for a sustainable development it is necessary to utilize and adopt these smart materials in its full capacities. This paper has presented the applications of one of the smart materials namely PZT patches for damage detection and SHM of civil infrastructures. In the present scenario for the development of smart cities, it is very important to utilize these smart materials for SHM so that even a minor damage of incipient nature should not be ignored since it carries the potential to grow and cause failure, either leading to wide scale loss of life and property or halting some revenue earning activity or both.

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INNOVATIVE CONCEPTS IN MAKING OF SMART CITIES

KAMALPREET SINGH*

Abstract

A smart city will have smart energy, smart mobility, smart water, smart pubic services, smart building and homes along with strong integration. However, all planning of the city shall be done in a holistic manner to make new settlement user friendly with best building practices and indigenous technologies as per the climatic conditions of the site. These smart cities have become a need of time because of a paradigm shift in coming times. By 2050, 70% of the population will be living in cities and India is no exception. So it will need many smart cities to accommodate the people coming from villages for better living conditions and lifestyle.

This exercise of designing smart cities is a challenge as well as an opportunity for all the professionals as town planners, urban designers, architects, interior designers, landscape architects, civil engineers, electrical, electronics, IT, mechanical engineers and horticulturists will join together and work in a well coordinated manner and will be able to produce a creative designs for desired working environment to the best satisfaction of the citizens of India. Due care need be taken for all the basic parameters of design like proper integrated layout, orientation, large open spaces with green building best practices as an holistic approach. Sufficient spaces for the supporting class for accommodating them in this city as well. It is possible to prepare very creative designs keeping in consideration all the good aspects of planning as well appreciative skylines as per urban design principles. These will ensure most effective designs for exterior as well as interiors spaces so designed for the better life styles of the citizens of India.

INTRODUCTION

The cities have been planned and developed in India for ages from now; some of them have been growing out of needs for proper platforms for living a better life style, infrastructure with more opportunities for education and learning and with better environment for business as well as recreation for their inhabitants with some core values of business for sustainability. We have learnt making our cities with our previous experience improving upon the conditions in newer settlements. Further if not planned these grew most of the time in an organic manner.

Few cities which were planned well before their execution and development grew on similar lines later taking into account the prevailing needs of the time and also the existing development there. A few to name are Delhi, Jaipur, New Delhi, Gurgaon, Noida, Gandhinagar, and Bhubaneswar.

Chandigarh, the city beautifully planned by a French Architect Le Corbusier, is one of the well planned cities in India which also requires further expansion with pace of time with proper and logical placement of the seat of government i.e. the Secretariat. Sector wise development as per hierarchical needs having planning with self sufficient sectors in addition the business activities, recreational activities and open lungs of the city and neighbourhood for its residents to lead a healthy life with proper town planning principles and linkage of transportation as per vehicular and pedestrian

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needs have been provided. This modern city of its time has started reaching its maturity and started further growth in terms of master plan drawn out for further growth as Greater Chandigarh is in line with the original master plan of the city after development of its suburbs. All this is happening to our so called planned and newer cities. Recently there has been a detailed debate whether Chandigarh is ready to become a smart city. Therefore smart cities have to be planned very carefully.

SMART CITY AND ITS DEFINITION

If we could imagine a city to be interactive, giving status updates on traffic patterns, pollution, parking spaces, water, power and light utilising this information for improving economic health and environment of the city and working conditions and productivity of the people, responsible for maintaining the city, it can be considered a smart city though not exactly defined. These cities are to explore the possibilities of sustainable, equitable and human friendly designs which enhance holistic approach for services required for building smart cities having integration to provide urban environment which is digitally enriched.

As decided by the Hon'ble Prime Minister, Shri Narendra Modi in 2014 India will construct 100 smart cities in near future. These cities shall be developed in entire country i.e. Ajmer in Rajasthan, Vishakhapatnam in Andhra Pradesh and Allahabad in Uttar Pradesh. Land is available for five cities. Prior to this declaration, a smart city named as the GIFT (Gujarat Infrastructure and Finance Tec- City) City Phase I between Ahmadabad and Gandhi Nagar is already under construction.

Smart cites use technology to promote and enhance green development with innovative approach and peoples' participation in a new form. Smart cities enjoy a better status in providing better working and living environment. Technology can help cities to be responding better to the needs of its residents in many ways thus making the urban areas more efficient and green. Smart City is a challenge which uses digital technology for better performance. Common themes emerging for building smarter cities and commuters namely are;

- Integration of energy, transport and infrastructure and communication technologies to be considered parallel for smartness in the urban areas.
- Smart governance through informed decision making and agenda towards communities for overall betterment of the smart cities.
- Innovation and new technologies to enable smarter solutions. Innovation helps better collection, processing and analysis of data through social media methodology.

Government of India (GOI) will develop 100 smart cities in the next 15 years. The current urbanization level is 31%, accounting for 60% of the India GDP. The urbanisation is expected to grow fast in next 15 years therefore there is an ambitious plan of GOI to develop plans for these "Economic growth" using the latest principle for sustainable growth technologies. These cities are proposed to be developed as smart cities with the design as given in the following.

- One satellite city with each of the cities with a population of 9 million.
- All the cities to the population ranging from 1 to 4 million people.
- All state capitals even if having a population of less than 1 million.

The smart cities in India have full scope for the implementation of green buildings norms and practices for air conditioned as well as non air conditioned buildings and considering solar passive architecture, orientation of site, lighting, air conditioning.

SMART CITIES AND GREEN BUILDING CONCEPT

Selective use of materials preferably green materials for construction is required to be used. Elements of water in the form of natural terrain or ground water bodies can be used for air conditioning with spray ponds in the form of water bodies. Use of glass in the buildings should not be all around but on preferred directions of orientation of buildings (with respect of direction of sun movement) if the use of glass is not avoidable part of it can be converted into PV solar cells on the worst side of building orientation

of the building. Thus the glass in facades to be used judiciously in order to achieve best benefits of daylight, view and ventilation and aesthetics.

LED lights to be used extensively except for preserving effects with elements of heritage if any or a specific fact for a desired function. The campus is to be planned with native species of trees/plants and creepers etc with desired form and level of growth with time period. These trees will also be helping to cut off sun on the worst orientation facades as well as screen off dust and sound pollution.

SUGGESTED FRAMEWORK FOR SMART CITIES

In September-2014 President Barack Obama agreed for being a lead partner with the PM Shri Narendra Modi in developing 3 of these cities, Ajmer (Rajasthan), Vishakhapatnam (Andhra Pradesh) and Allahabad (UP). There is a plan for residential colonies and related amenities and facilities in these smart cities.

Five principles that can serve as a framework for US-India partnership on smart cities are:

- Smart city should be economically driven, not technology driven.
- Each smart city should have a Chief Innovation Officer to guide and coordinate investments.
- Smart city development should facilitate India's own technology and innovative capabilities.
- The smart city partnership should result to new state or natural enabling framework for scale innovation for foreign investment.
- India should ensure the smart city partnership, a programme of transparency and citizen engagement.

IMPORTANT FACTORS OF SMART CITIES IN INDIAN CONTEXT

To interpret smart cities in the Indian context the following factors are important:

Energy: It is an urban concern. Fossil fuel feeding mechanized transport is biggest head in energy consumption in cities.

Efficient use of electricity: Fast growing cities of India also consume tremendous amount of energy through real estate construction and infrastructure. Development in urban areas is responsible for energy efficiency in addition to regional responsibility.

Traffic and transport: To build hundred smart cities for its metropolitan city and region is on the agenda of the new government. European Union followed agenda of United Nations and brought clarity in partnership of energy, transport and Information and Communication Technology i.e. ICT in urban areas with the help of applied information, better planning, higher energy efficiency, better transport solutions, intelligent use of ICT along with participatory approach.

Transport is also a major cause for energy consumption and from carbon footprint point of view. Another factor is the time lost due to traffic congestion. Urban economy needs essentially the mobility. Congestion is to be critically managed for essential and emergency services through use of public transport and traffic information and management solutions. Good quality public transport system discourages the use of personal vehicles and the resultant pollution but is also safe and accessible. Use of mobility data help in providing wider connectivity. Safe and accessible corridors-an integrated real database will enable the city to function as smart.

Internet and Communication Technology (ICT): ICT connects cities better to their citizens with feedback and cross productive ideas. Smart urban management and smart governance gives smarter solutions to the cities.

Off late, just a few weeks back one of the dailies in Mumbai mentioned about "Bandra - Kurla Complex" (BKC) of the city to be declared a Smart City in 2017. It is a well planned complex as an important part of the development of the city of Mumbai near the airport having much better connectivity to fall in line with the Smart City. Bandra - Kurla Complex at Mumbai is to connect to a smarter future. There are many salient features of the complex for example provisions of wi fi with free initial time . People in that complex will be provided single window access besides applications like parking. Users in the complex will be able to send SOS alerts to hospitals and family members and yet, information about fuel station,

toilets and hospitals and can file complaints. Parking guides will be available to 3000 parking lots which are presently under construction which will be completed in 2-3 years. System of smart parking will also be available within five minutes with the help of mobile use with which it will become easier to locate parking in this complex. An electric card with minimum fee shall be able to connect to various locations. The BKC will have CCTV surveillance shared by multiple agencies like MMRDA, the development Authority, police station and fire brigade. In case of emergency all the concerned agencies will get an SMS. Wi fi will connect important meters and flood sensors. Smart lighting system will be installed with different voltage and will help to reduce connectivity cost with which lights will be dimmed as per the state of occupancy of a given space but will brighten up as the user enters the space or a room and even the street lights will start brightening with a pedestrian approaching it.

The very concept of "Smart City" is full of challenges in India because the success of such a city depends upon residents, entrepreneurs and visitors whether they become actively involved in energy saving towards implementation of newer technologies. But for a high percentage of end users and their behaviour, we cannot make residential, commercial and public spaces sustainable with new approach and new technology alone. Time is another important dimension in this process of making of smart cities. Such smart cities may take twenty to thirty years for getting built.

Fig. 1. Conceptual Scheme of Smart Cities in India

FIRST SMART CITY IN INDIA

The dream of smart city started with the development of a city like Shanghai. Located between Gandhinagar and Ahmadabad. Gujarat International Finance Tech (GIFT) city is a futuristic design and truly international high tech city in 886 acres of land by the river side is having an easy access to Ahmadabad Airport under first phase of construction. An example of world class technology with seamless and state of art connectivity and expected to attract finest talent with 10-11 billion jobs in the country and as preferred investment destination due to political stability, pro business policy and vast technical pool.

Superior Infrastructure with futuristic buildings-walks with green spaces with large water body well connected with transport system and world class education and health care with smart safe eco friendly and sustainable infrastructure, Diamond Tower with sizable foreground, better orientation with natural light and ventilation, GIFT is an eco friendly city with zero discharge, district cooling system proposed to work on the principles of plan, develop, operate and maintain to the international standards with cutting edge as the Information Communication Technology. GIFT is proposed to be six times larger than the size of Shanghai.

The conceptual scheme is indicated in Fig. 1.

CONCLUSION

A smart city will have smart energy, smart mobility, smart water, smart pubic services, smart building and homes along with strong integration. However, all planning of the city shall be done in a holistic manner to make new settlement user friendly.

This exercise of designing smart cities is a challenge as well as an opportunity for all the professionals as town planners, urban designers, architects, interior designers, landscape architects, civil engineers, electrical, electronics, IT, mechanical engineers and horticulturists will join together and work in a well coordinated manner and will be able to produce a creative desired working environment to the best satisfaction of the citizens of India. Due care need be taken for all the basic parameters of design like proper integrated layout, orientation, large open spaces with green building best practices as an holistic approach.

DEVELOPING SMART AND SELF SUSTAINABLE CITIES - CASE STUDIES

VAIBHAV KUMAR SRIVASTAVA*

Abstract

A Smart city uses technologies to enhance performance and wellbeing, to reduce costs and resource consumption, and to engage more effectively and actively with its citizens. Key 'smart' sectors include transport, energy, health care, water and waste. A smart city should be able to respond faster to city and global challenges than one with a simple 'transactional' relationship with its citizens.

This article consists of case studies of various Smart and Eco Cities planned and under development around the world. Important learning in innovations and ideas about making modern cities Smart can be derived from this study. Though this study deals with brief description of these mammoth projects, but extensive study of design and planning of these, may lead to innovation of much economical and efficient, method and designs.

INTRODUCTION

A Smart city uses technologies to enhance performance and wellbeing, to reduce costs and resource consumption, and to engage more effectively and actively with its citizens. Key 'smart' sectors include transport, energy, health care, water and waste. A smart city should be able to respond faster to city and global challenges than one with a simple 'transactional' relationship with its citizens. Some important ingredients for Smart Cities are below:-

- The overall strategy for smart city development has always been to provide for the needs of the people, while minimizing environmental harm. Recent improvements in human behavior (e.g., recycling and using public transit) benefit the ecosystem even more. And the green economy ensures that people and land prosper together.
- Designs should be made, working hard to maximize the use of natural resources, as sunshine, streams, wind for generating energy, heating homes, heating water, and generating electricity.
- Extensive recycling system needs to be developed which makes use of almost every conceivable waste. Paper, plastics, even tin can can be converted to new raw materials. Energy can be derived from wastes such as landfill gas, wood chips, waste heat, and organic household waste, which in addition provides high-quality compost for gardens.
- Green economy, is important ingredient we may notice in coming future smart cities—community solidarity and pride— and mission like Swatchh Bharat can bring the change.

This paper discusses some of the important Case Studies of Smart Cities around the world.

Case Study:1 - MASDAR CITY, ABU DHABI

Masdar City is an arcology project in Abu Dhabi, in the United Arab Emirates. The city relies on solar energy and other renewable energy sources. Masdar City is being constructed 17 kilometres east-south-east of the city of Abu Dhabi.

Design and Intent

The estimated cost of the city is around US$ 19.8 billion. The city is envisioned to cover 6 sq km.

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and will be home to 45,000 to 50,000 people and 1,500 businesses, primarily commercial and manufacturing facilities specializing in environmentally friendly products. In turn, more than 60,000 workers are expected to commute to the city daily.

Architecture

Masdar is a sustainable mixed-use development designed to be very friendly to pedestrians and cyclists. Masdar City has terracotta walls decorated with arabesque patterns. From a distance, the city looks like a cube. The temperature in the streets is generally 15 to 20°C i.e. cooler than the surrounding desert. The temperature difference is due to Masdar's unique construction. A 45-meter high wind tower modeled on traditional Arab designs sucks air from above and pushes a cooling breeze through Masdar's streets. The site is raised above the surrounding land to create a slight cooling effect. Buildings are clustered close together to create streets and walkways shielded from the sun.

Designers found that these cities coped with hot desert temperatures through shorter, narrower streets usually no longer than 70 meters. The buildings at the end of these streets create just enough wind turbulence to push air upwards, creating a flushing effect that cools the street.

Transport System

The initial design banned automobiles, as travel will be accomplished via public mass transit and personal rapid transit (PRT) systems, with existing road and railways connecting to other locations outside the city. The absence of motor vehicles coupled with Masdar's perimeter wall, designed to keep out the hot desert winds, allows for narrow and shaded streets that help funnel cooler breezes across the city. Public transport within the city will rely on methods other than the PRTs. Masdar will instead use a mix of electric vehicles and other clean-energy vehicles for mass transit inside the city.

Commercial Tenants and Population

As of 2014, Masdar City has sufficient office space to begin attracting a significant number of residents. Masdar City's population is expected to grow from 1,000 to 4,000 in 2015. Masdar predicts that the city's population will hit 10,000 in three to five years. Some important institutes which will be located in city are:

Masdar Institute- The Masdar Institute of Science and Technology is a graduate-level research university focused on alternative energy, environmental sustainability, and clean technology. The institute's building, developed in cooperation with the Massachusetts Institute of Technology, uses 51% less electricity and 54% less potable water than traditional buildings in the UAE and is fitted with a metering system that constantly observes power consumption.

International Renewable Energy Agency- Masdar City will host the headquarters of the International Renewable Energy Agency, commonly known as IRENA.

Siemens- A regional headquarters for Siemens has been built in Masdar City. This building is the most energy efficient in all of Abu Dhabi. The LEED Platinum building makes use of sustainable and energy efficient materials and building techniques. It was designed to use 45 percent less energy and 50 percent less water than typical office buildings. The 130,000 square-foot building is built around the idea of a "box within a box." The structure includes a highly insulated airtight inner façade that insulates from the sun and a lightweight aluminum shading system on the exterior. The plaza beneath the building is funnel-shaped. This shape works to suck prevailing winds underneath the building. Due to the Venturi effect, a breeze flows up to the roof of the building through atria in the buildings structure, cooling public spaces without energy costs. These atria also allow daylight into the centre of the building in order to reduce the need for artificial lighting, further reducing energy consumption

Renewable Resources

Masdar is powered by a 22-hectare (54-acre) field of 87,777 solar panels with additional panels on roofs. There are no light switches or water taps in the city; movement sensors control lighting and water to cut electricity and water consumption by 51 and 55 percent respectively.

Besides photovoltaic, concentrated solar power (CSP) plants are being explored. For example, so-called "beam down" CSP plants have been constructed to test the viability of use in the city.

Water management has been planned in an environmentally sound manner as well. Approximately 80 percent of the water used will be recycled and waste water will be reused "as many times as possible", with this greywater being used for crop irrigation and other purposes.

Case Study:2 - SONGDO INTERNATIONAL BUSINESS DISTRICT, SOUTH KOREA

Songdo International Business District (SIBD) is a new smart city or 'ubiquitous city' built from scratch on 1,500 acres of land along Incheon's waterfront, connected to Incheon International Airport by a 12.3 km reinforced concrete highway bridge, called Incheon Bridge.

The Songdo International Business District will feature the Northeast Asia Trade Tower and the Incheon Tower. Schools, hospitals, apartments, office buildings and cultural amenities are to be built in the district. Replicas of architectural hallmarks, including New York City's Central Park and Venice's waterways, will also be incorporated. This 10-year development project is estimated to cost in excess of $40 billion, making it one of the most expensive development projects ever undertaken.

Ownership and Design

Gale International, holds a majority stake of 61%, Posco 30%, and the remaining 9% is owned by Morgan Stanley Real Estate. The plan was designed by the New York office of Kohn Pedersen Fox. Infrastructure development, labor, and funding are also being provided by the city of Incheon.

Development

Built on 1,500 acres of land reclaimed from the Yellow Sea off Incheon, about 56 km from the South's capital Seoul, Songdo district is the largest private real estate development in history. By its completion date in 2015, the district is planned to contain 80,000 apartments, 50,000,000 sq ft of office space and 10,000,000 sq ft of retail space. Computers have been built into the houses, streets and offices as part of a wide area network.

The Songdo is being developed as a sustainable city with more than 40% of its area reserved for green space, including the park of 100 acres, 26 km of bicycling lanes, numerous charging stations for electric vehicles and a waste collection system that eliminates the need for trash trucks. Also, it is the second city in the world to have all of its major buildings in par or beyond LEED's requirements, after Greensburg, Kansas.

Three additional foreign university campuses are planning to open in 2015. This makes 4 total universities, located within an international business district.

Case Study:3- CHENGDU TIANFU DISTRICT GREAT CITY, CHINA

Chengdu Tianfu District Great City - Outside Chengdu, in central China, a 78 million square foot site has been determined for an unconventional sort of construction project. It will be a city built from scratch, for 80,000 people, none of whom will need a car to get around. The "Great City" is a plan for an ambitious urban center designed to limit its resident's environmental impact by producing clean energy, reducing waste, and promoting public transportation over individual car use. The project is to see the effects of automobile- independent design and to seek better alternatives to urban sprawl.

Transport

It has been called the "Car-Free City," although that is not entirely accurate. The architecture firm notes that the vision is for a city where "cars will be essentially unnecessary," but allowed.

The master plan includes many good ideas. Half the road space will be reserved for non-motorized traffic, and electric shuttles will get people where they cannot or do not want to walk. All homes will be within a two-minute walk of a public park.

Waste Management

An "eco-park" will treat wastewater and solid waste, and generate power. Land outside the city will be reserved for farming. Wildlife habitat will be protected. Buildings have been designed to maximize the use of wind power; the planners decided Chengdu's hazy climate is not conducive to solar power.

City is expected to cut energy use by 48 percent, water use by 58 percent, and produce 89 percent less waste, compared to a conventional development with a similar population. Going beyond environmental impact, the Great City is to provide residents with affordable housing, education, and medical care, all clustered in the city center to encourage a thriving civic life. It's a vision for anyone concerned by climate change and social inequity, and the effectiveness of the power, transportation, and recycling systems will be judged once in place.

Case Study : 4 - MALACCA, MALAYSIA

The proposed Energy Smart Grid City Malacca and the Green Special Economic Zone Malacca projects are expected to be injected with multibillion investment by private public investors and partnerships, is touted to transform the historical state from an agricultural and small industry zone into the first sophisticated and hi-tech smart grid city in Asia. Work on the development of the two smart grid projects, the first of its kind in the country will commence within the first-quarter of next year.

The entire project, which aims to make Malaysia a smart grid nation by 2020 and eventually carbon-free, would be rolled out across the nation eventually. Kicking off at 520 acres of land in Alor Gajah, in collaboration with local and federal government, the projects are poised to prosper into "Malaysia Smart Grid Nation."

Infrastructure

In its first phase, the Smart Grid City, a Green Special Economic Zone (SEZ) is expected to contribute as much as US$96 billion a year to the gross domestic product.

As many as 20 research and development (R&D) centers will be built, creating high-skilled 6,800 engineering professionals in the smart grid industrial, renewable energy and clean technology sectors in that area and up to 300,000 new green jobs.

The Green SEZ will also consist of pre-constructed factory lots with centralized service centre, a commercial hub with retail centers, green product showcase, exhibition hall and grade A offices, a network operation centre, R&D complexes, residential condominium's and homes, smart warehousing and renewable waste treatment centers. The zone will eventually include an international airport and a bridge linking Malacca and Dumai in Sumatera, Indonesia and has been declared tax-exempt for 10 years.

Finances

These projects will be funded with foreign direct investments and private finance initiatives through public-private partnerships and interested partners have been invited to join the project.

Case study: 5 - CLARK GREEN CITY, PHILIPPINES

Called the Clark Green City, the project is a 9,450-hectare master development plan located around the Clark Freeport Zone in Pampanga, a province that is only about 80 kilometers away from Metro Manila. The Clark Green City will see five districts rise in three phases over the next five decades.

The upcoming eco-city is mandated to transform or facilitate the sale of idle military camps and to repurpose former US military bases into productive areas, such as industrial zones. The city's districts will feature, among others, government centre, a central business district, an academic district, an agri-forestry research and development area, and a wellness and eco-tourism district.

Waste Management

It will also be powered by renewable energy facilities and a waste-to-energy plant, as well as enhanced by sustainable modes of public transport like a bus rapid transit system, urban farms, and the use of high-capacity connectivity to support e-governance platforms.

Investment

To encourage business investments in the area, the Clark Freeport Zone has special incentives for investors such as tax and duty-free importation of equipment and materials. Companies can also be 100 per cent foreign-owned for several selected industries.

The Clark Green City master plan is a government response to address the rural to urban migration. It hopes that by developing a new city from the ground up with better urban planning, integrating infrastructure and public services and stimulating the start of new communities outside of Metro Manila, it will provide people with a higher standard of living.

The Clark Green City is expected to become a key contributor to national development. A full completion, the project would create 925,000 jobs and generate about US$36 billion annually, or about four per cent share of the national GDP.

Finances

The initial phase, which covers 2014 to 2019, will require about US$1.3 billion in investment that could be raised through a public-private partnership scheme. The first phase will consist of building the industrial, institutional and mixed use zones, as well as developing the backbone of the eco-city, such as the water supply system, including a water treatment plant; a storm drainage system to help prevent floods; waste management facilities like a waste recycling and biomass recovery plant; and, an organized transportation network prioritizing pedestrians and mass transit over allocating more roads for private vehicles.

Case Study: 6- CLONBURRIS, DUBLIN, IRELAND

Clonburris plan consists of building 15,000 new homes all of which to be designed with the highest sustainable standards. The plans for Clonburris include countless green innovations such as high levels of energy efficiency, mandatory renewable energy for heating and electricity, the use of recycled and sustainable building materials, a district heating system for distributing heat, the provision of allotments for growing food, and even the banning of tumble driers, with natural drying areas being provided instead.

Bio-diversity

One of the key ideas of the plan is to integrate the bio-diverse landscape of the surroundings into the urban landscape. A geographic focal point of the area is the Grand Canal which wraps around the cities limits. Around the canal are countless parks, paths, and scenic views. One part of the plan is to erect 10 new bridges over the canal to connect the environment to the city center with ease.

Transportation

Transportation is also a big part of the proposed plan. When completed Clonburris will have a plethora of public spaces, shopping, housing and community designed spaces. The master plan tries to interlock the different groups of communities with easy public transportation. Part of this new transportation includes 2 new train stations (Transportation hubs) that interconnect with both light rail and heavy rail. Along with this, the integrated transportation hubs will be equipped with a metro system and underground "Dart" or high speed light rail. When all is completed you will not have to walk more than 10 minutes to get anywhere in the city.

Sustainability

Sustainability is another important part of the Master Plan of Clonburris. One of the planner's main goals was to reduce the dependence on cars. Accessibility is key in this, so planners created a central plaza equipped with a library, community spaces, and even a youth café. Another goal was to cut costs by using sustainable alternatives such as: "the use of recycled and sustainable building materials, a district heating system for distributing heat, the provision of allotments for growing food, and even the banning of tumble driers, with natural drying areas being provided instead." With these new improvements Clonburris will have 40% less cost than modern homes and 80% less than Irelands average home.

Power Saving

Clonburris is to have the highest energy efficiency rating and to get 30% of their power from renewable sources. In a draft plan for the Clonburris Strategic Development Zone in Clondalkin, the council propose that 12,000 to 16,000 new homes in eight new neighborhoods be constructed in the area, along with retail and office space, schools and parks.

All new buildings in the zone be constructed with an A grade building energy rating, which means homes will have to use less than 50 kilowatt hours per square metre to cover typical heating, hot water, ventilation and lighting requirements for a whole

year. An average house satisfying current building regulations will have a rating of about 90 kWh per square metre per annum.

CONCLUSION

A perusal of the case studies presented in this paper indicates that smart cities enhance performance and well being of citizens, reduce cost and resource consumption of vital elements like transport, energy, water etc. Though, the case studies presented herein give brief description of some of the major projects but it is desirable that our planners study them extensively to come out with innovative, economical and efficient designs for the Smart Cities being planned in India

THE MAKING OF SMART CITIES: GIFT AND PALAVA

Dr. Asmita Bhardwaj*

Abstract

Smart cities have become the latest buzzword in India's current urban policy post JNNURM. There exist different perceptions regarding what a smart city is in India and abroad. For instance, in Indian case, Prime Minister Shri NarendraModi has stated that smart city development shall be accomplished by creating private- public sector partnerships. Companies like IBM suggest city leaders of smart cities must think holistically about operations insight, law enforcement and emergency management, government and agency administration, and urban planning including smarter buildings. Yet according to NGOs, it is the citizens who lie at the heart of the smart city. According to an international smart city definition, a smart city is a city well performing in 6 characteristics-smart combination of endowments and activities of self-decisive, independent, and aware citizens.

First, what are the common indicators of smart cities being used in India and abroad, this paper discusses through content analysis of newspaper articles, industry reports and journals. Second, while the definitions are evolving already there are already smart cities developing in India. This paper uses the example of GIFT and Palava city to understand the main features of evolving smart cities to project the future profile of smart cities in India.It concludes by examining the needs of the current urbanisation and analyses whether smart cities are an answer to these problems and what features these smart cities need to have to facilitate such urbanisation.

INTRODUCTION

India has been slow to urbanise in comparison to other countries, however reports such as the 2010 McKinsey's report titled India's Urban Awakening, estimates that urbanisation will rapidly escalate and urban India will house nearly 40% of our population and generate nearly 70 percent of India's GDP by 2030. It is thus imperative that such urbanization be facilitated in order to engage in further economic development. The Eleventh Five-Year Plan argued that urbanisation should be seen as a positive factor in overall development as the urban sector contributes about 62% of the GDP. While India's cities drive economic growth they are grossly inadequate in providing good quality infrastructure and employment to its residents.

To facilitate planned growth of urban settlements in India, the Indian state had made a giant leap from Master Planning of large towns such as Delhi and Chennai to focussing on small and medium towns, to empowering of ULBs, planning a series of new towns, eco-cities, satellite cities. The most recent initiative was to build 100 smart cities in India and allocation of Rs 7,060 crores to facilitate the same in 2014. These cities are presented as the answer to the challenges of rural-urban migration, rapid urbanisation, and sustainable development in India. Examples of such cities include ongoing or proposed projects such Kochi in Kerela, Ahmedabad in Gujarat, Aurangabad in Maharashtra, Manesar in Delhi NCR, and Tumkur in Karnataka. Many of these cities include special investment regions, with modified economic regulations, and tax styructures making it easy for business investments.

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However, there is no single definition of smart cities given that there are numerous stakeholders present in creating smart cities.What are the perceptions of different actors on smart cities? How are existing cities like GIFT and Palava being shaped? Are smart cities an answer to India's urbanisation problem? What should be the shape of smart cities to come? This paper examines.

PERCEPTIONS OF SMART CITIES

Different actors perceive smart cities in different way and there is yet to appear a clear and concise definition of smart cities. The different perceptions are listed below.

Government: Prime Minister Modi suggests that "Cities in the past were built on riverbanks". "They are now built along highways. But in the future, they will be built based on availability of optical fiber networks and next-generation infrastructure". Such cities will not have greater sustainability and accountability, but also deliver jobs and attract new investment.

In terms of financing, according to India's Finance Secretary, a focus on implementation and strong partnerships will be critical in realizing the potential of India's smart cities. Already these plans have spurred significant international interests, but questions such as what supporting interventions and investments are required, areas where the private sector can come in, and what legal frameworks must be addressed.

Developers: Developers play an important role in the shaping of smart cities. Some of the existing smart city projects have been witnessing a growth prospect of 10-15% annual increase with experts suggesting a much better long term investment prospective. The gestation period of smart city development is long, and could take 8 to 10 years to build and even more time to attract businesses and people. The challenges that India would face when it comes to smart cities would be obtaining timely clearances and their financing.

International Bodies: International bodies have also become active in the smart city making race. When Mr. Bloomberg, UN Envoy and former Mayor of New York, met with MOUD he suggested that they will select 'Smart City' applicants who can rise up to the challenges of resource mobilisation with special abilities to carry out urban reforms. Apart from technical elements such as use of technology and intelligent systems, sanitation and affordable transportation, energy and resource efficient, climate resilient, better governance and greater use of integrated urban planning, and in particular better mobilise local resources such as municipal bond mechanisms and public private partnerships (PPPs).

Technology Companies : Most importantly, it is the technology companies who are defining the debate. Technology and consulting firm IBM, for instance, defines smart cities as those that make use of all the information available from city systems, processes and people to use resources efficiently, make better data-driven decisions, and proactively anticipate and resolve problems. Cisco had tied up with ILFS Technologies to jointly develop solutions for digital infrastructure and smart cities in the country. The company had also signed a strategic agreement with Electronics City Industries Association to set up an Internet of Things (IoT) Innovation Hub in Bangalore. Technology could provide a boost up for small and satellite cities which could pool their resources and integrate their management processes. Many of them can compete with those in developed countries on terms of physical and technology infrastructures.

CASE STUDIES: THE MAKING OF SMART CITIES IN INDIA

Already examples of smart cities are emerging in India. The next section presents two case studies- GIFT (a PPP) and Palava (a private sector driven initiative).

GIFT City

Gujarat International Finance Tec-City (GIFT), Ahmedabad, to be developed over 900 acres, is established via a Joint Venture between Government of Gujarat's undertaking Gujarat Urban Development Company Limited and Infrastructure Leasing and Financial Services called Gujarat International Finance Tec-City Company Limited. According to GIFT CEO, "Since the concept of a smart city is that it is essentially a hub for a specific economic activity, each smart city will have to be customised keeping the end user industry in mind". The government's initiative to develop International Finance Services

Centre (IFSC) in GIFT under the SEZ route is a step towards realising India's potential in international financial services.

What is the status of the city? In terms of implementation, one account suggests that upon visiting GIFT only two 28-storey buildings that stand out in the skyline can be seen, beyond which not much going on and city is under construction. Another part that is under construction is the IFSC for which 880 acres of land allotted to GIFT City, and this will be treated as an SEZ the whole project will take 10 years to be completed. However in order to attract market based participants many efforts are required though actors like HDFC, ICICI, Axis, Bank of America, are already interested. Another account suggests that a major part of the GIFT city is yet to materialise which according to its CEO are due to red tape, a technical glitch and a global recession which hit SEZs and other real estate projects. As a result the cost outlay has shot up to Rs 78,000 crore. According to the Industries Commissionerate only 20% of the MoUs signed as part of Vibrant Gujarat have materialised. Yet others specially from private sector claim GIFT City will evolve over a period of time and will play a much larger role in the domestic and international financial services sector and achieve the counter magnet to Mumbai status over time.

There are other concerns such as in terms of the costs and displacements. In terms of costs and cost recovery, funding is an issue that GIFT is and will be facing, and the CEOs demand for Rs. 2,000 crore has been rejected. GIFT has received a loan of Rs. 400 crore from a consortium of banks and financial institutions led by a financial arm of IL&FS out of which Rs.1,000 crore is expected to be spent on data centres and other infrastructure.

Palava- A Smart City

Palava is one of the largest planned city private initiatives in the world. Located in the Mumbai Metropolitan Region, Palava is expected to house over 100,001 families and create approximately 350,000 jobs through its business district and commercial developments. Developed by the Lodha Group in partnership with IBM, as a sister city to Mumbai, the entire city is spread over 4,000 acres. Located as the centre of the economic triangle of Navi Mumbai, Thane, and Kalyan, according to the developers, the city is: a) Planned (From open spaces and cultural zones to the business district and the university, every part of the city is thoroughly planned) b. Potential (a business-friendly city brimming with career opportunities, where it's easy to balance work with family life) c)Place (A short drive away from major commercial and transport hubs, this city is at the heart of the state's business region) d) Pulse (The city will be filled with culture, retail, sports, economic, entertainment and leisure opportunities) and Prudent (Designed to make life as convenient as possible, in an ecologically sustainable, safe and secure environment).

While Palava will have millions of square feet of business space, this has been uniquely planned in phases. Phase 1 will house sectors like IT, ITES companies, financial institutions, small and medium enterprises focusing on trading; Phase II will have significant business opportunities in the fields of retail, hospitality, entertainment, etc; and Phase III which houses the university, will be a focus on symbiosis between start-up ventures and larger companies. By 2025, this plan will result in over 3,50,000 high-potential jobs direct and indirect.

To enable Palava's Smarter City development, IBM will provide a foundation to integrate multiple city agencies and provide a unified view into all city functions, helping all departments collaborate, share insights and information to improve the experience for its citizens. IBM is also creating the business architecture and operating procedures, implementing the technology platform and solutions, and will eventually manage the technology.

Not much information abounds on Palava city apart from delays in construction and infrastructure provision, unlike the case of GIFT city.

ARE SMART CITIES AN ANSWER TO INDIA'S URBANISATION PROBLEM?

While smart cities are being touted as the biggest invention, it still remains debatable whether they can help ease out the urban problems. A couple of problems are highlighted. Urbanisation is increasingly concentrated in the Southern states and concentrated in Class I cities than metropolitan cities.

Indian urbanization is concentrated in four premier cities- Mumbai, Kolkata, Delhi and Chennai.The big cities of India are experiencing ex¬plosive population growth while the small towns are stagnating.

Problems are different in large and small cities. Large Indian cities have created rigidities in the functioning of the market through physical planning controls on location of economic activities and urban land-use, imposed by way of Master Plans, laws and building bye laws, etc. Small cities are experiencing low demographic and economic growth, leading to inability of such towns to attract investors from the national or world market. These need to be supported in their infrastructural projects as their economic bases are not strong to generate adequate revenues for the purpose. These cities have been incapable of absorbing the investments and labour force within the formal segments, creating problems of slums and informal economy.

These are just some of the problems that cities face and it is difficult to say how smart cities will be able to solve them.

The Future Trajectory of Smart Cities

Smart cities have a long way to go, though there are some positive steps. Much needs to be done, given the legislative environment, and consensus amongst multiple actors that are involved in creation of smart cities.

CONCLUSION

In summary, smart cities comprise of the following features: use of Digital technology to provide smart services in transparent manner; smart leadership and good urban governance; self sustained; competitive selection; financing through innovative mechanisms like municipal bonds and PPP etc. In terms of practice, smart cities are emerging, but the character depends on who is developing it. Finally, the problems of India's urbanisation are complex and it is unlikely smart cities provide a complete solution to them. The future trajectory of smart cities will be need to be better defined by the legislative environment, and consensus amongst multiple actors.

MAKING CITIES LIVEABLE: EXPLORING A HOLISTIC APPROACH TOWARDS SMART GROWTH

Sourovee Dutta *

Abstract

The term "Smart Cities" encompasses a vision of an urban space that is ecologically friendly, technologically integrated and meticulously planned, with a particular reliance on the use of ICT to improve efficiency. In India, it is still a question of what, why, when and how, since the new NDA Government has announced to develop 100 smart cities as satellite towns of larger cities and by transforming the existing mid-sized cities and allocated a sum of Rs. 7060 crores for this plan.

With this background, the paper critically relooks the 'Draft Concept Note on Smart City Scheme' by Ministry of Urban Development, Government of India. It attempts to analyze that how "Smart City" is defined, what are the smart constituents creating difference from other cities or whether it is just an agenda of digitalization and generating data from sensors. The main concern is to explore whether this leads towards a nebulous concept like 'smart'. The research explains regarding anticipation of the paradigm shifts, discusses that city-dwellers need city, which are livable. The quality of life is the most important aspect; thus integration of ICT should not be the sole purpose of upgrading Indian cities. The paper concludes with the holistic approach of making cities livable rather than smart ones.

INTRODUCTION

We survive in a world experiencing economic turmoil, climate change, increasing population and rapid urbanization with high-rise and high-density growth. But we also live in the midst of tremendous technological innovations that have the potential to address these emerging issues. There evolves "Smart Cities" – the "booming international phenomenon" and the future reality. The 'smart city' represents a whole-scale rethink of the urban. In recent years, the reach and influence of large-scale planning has tended to be traced on socio-economic grounds as reflected by Saskia Sassen's coining of the 'global city' or in terms of demographics with the 'megacity' label being applied to cities with over 10 million inhabitants (Castle, 2013).

Two major phenomenon are driving changes in the geographical distribution of population and thus in spatial pattern: the migration to cities from dispersed territories and the rapid acceleration of population. With an urban population of 31%, India is at a transition phase where the pace of urbanization will speed up in a rapid manner. Today cities contribute over 60% of India's GDP (Fig. 1) and hence referred as the "engines of economic growth" (MoUD, Govt. of India, 2014). With respect to this, it is necessary to plan our urbanization strategy in the right direction by integrating Information and Communication Technology (ICT) in the spatial development. In this context, the Government has decided on developing '100 smart cities' in the country and accordingly the Ministry of Urban Development, Government of India has defined the concept of smart city, its key parameters and financial mechanisms. The draft proposal has been published as "Concept Note on Smart City Scheme", revised as on 03.12.2014 and the work is under progress.

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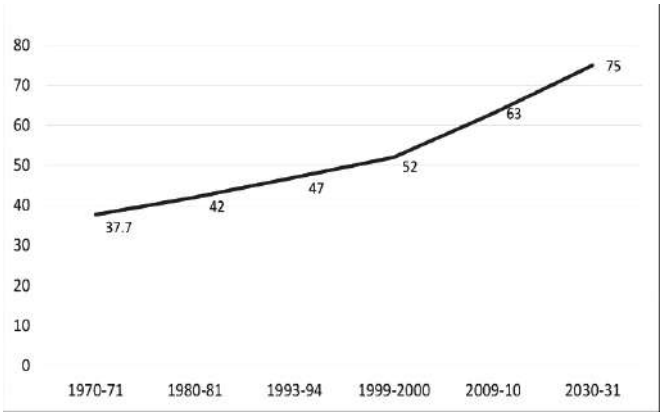

Fig. 1 Urban Share of GDP in India

(Source: 'Concept Note' by MoUD)

With this overview, the paper highlights the appreciable initiative by the government and raises certain concerns which may create future smart cities without distinct difference from others. Accordingly, there is a need to take a holistic approach, which should be thought from citizens' perspectives to anticipate the current paradigm shifts and can contribute towards smart growth through livability.

GOVERNMENT INITIATIVE

The 'Concept Note on Smart City Scheme' provides a broad framework on smart city development in India including the context of developing such idea to plan future cities, its key features, criteria / benchmarks for conversion of any existing city to a smart one, identification of 100 such possibilities and the proposed implementation strategy including finance mechanism and operational procedure. It must be appreciable that the concept note has considered all the planning parameters and covered from its inception to implementation (Fig. 2)

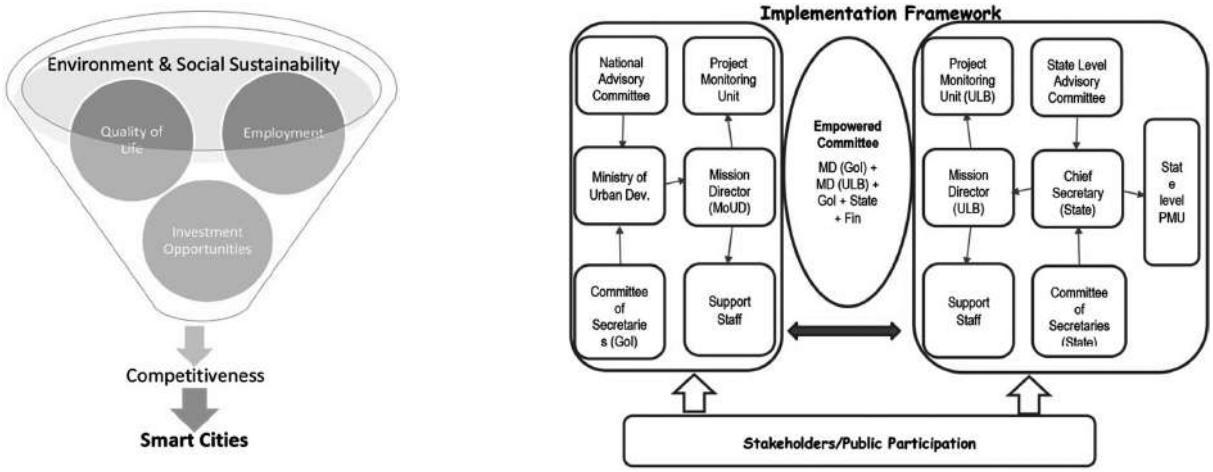

Fig. 2. Smart City Initiative – From Inception to Implementation

(Source: 'Concept Note' by MoUD)

The smart city concept has already gained a lot of attention in the globalized world and it will most likely continue to do so in the coming future. Cities of the developed country are preparing smart development plans, strategies and phasing for its implementation accordingly and through several international benchmarking it is proved that smart technologies can provide solutions for cities by helping them in saving money, reducing carbon emissions and managing traffic flows. But the complexity of the agenda is hindering its progress at many cases (Batty, Axhausen, Fosca and Others, 2012). It involves a large number of stakeholders, each having their own perception of what a smart city should be. Hence, it is extremely important to define "smart" with respect to the context and giving more focus into how to implement those concepts on ground reality. The 'Concept Note' has been relooked and reviewed critically here with respect to that perspective.

A CRITICAL REVIEW OF CONCEPT NOTE OF MoUD

The critical review on 'Draft Concept Note on Smart City Scheme' is mainly focussed on creation of smart city, whether going to be liveable urban space or leading towards a nebulous concept like 'smart'.

Here are some of the major aspects, which may be rethought and revised parameters can be formulated to anticipate the recent paradigm shift.

- The government will not 'create' these cities. The state governments have been asked to recommend a list of cities, which may be converted into 'smart cities'. Unless there is a joint committee / planning body, it may lead towards lack of coordination and hamper the expected faster process of 'smart growth'.
- As the concept is still not defined clearly in the report, it should be questioned and analyzed whether 'smart city' is just a marketing concept or it can be implemented through appropriate framework. However, the concept of 'smart city' first created by technology companies is seeking to sell their sensors, software and hardware. As the definition seemed to be very vague and there is no such effort in clarifying it; it is necessary to judge the concept from citizen's and their usability and affordability point of view. Use of more sensors should not be the focus of development, the benefits out of it and level of efficiency in city management should be the sole criteria before investing for such developments.
- The concept does not really capture what the inhabitants in the crowded, populous and rapidly expanding cities need. A clear definition is thus required and significant to understand its relevance in present context.

  This is important as Adam Greenfield, fellow of LSE Cities, says: "It is worth thinking carefully as it is a $114 billion or Rs. 7 lakh crore issue". This is what these cities will need over a 20-year period, according to a government committee estimate. Thus, before creating a concept like 'smart' without a clear definition and identification of smart components which makes them different from other cities; it should be questioned from a common man's perspective that what exactly do we need?
- Few parameters are required to be researched and described in detail. "A Smart city is one that has the followings: Competitiveness, Sustainability, Quality of Life…" Aren't all cities to be these and more? "The general appearance of the city has to be pleasing and clean…" Is that Urban Design of a city all about? "A 100 Mpbs internet backbone coupled with 100% coverage of all the area by cell phone towers and a high level of telephone penetration will be essential to a smart city as most services will have to be offered online…" It seems that the service providers to people in everyday life (like maids and drivers) are certainly not part of these future cities. "A self healing smart grid is proposed to be developed, which costs to be Rs. 43,386 PCIC (per capita investment cost) for a period of 20 years as per estimation by the High Power Expert Committee…" The goal of minimizing environmental impacts and creating smart urban infrastructure through smart grid against its cost should be reviewed and analyzed in detail. "The guideline benchmark of population density is 175 persons per Ha along transit corridors". Density should be proposed with respect to the context and kind of economic activity performed at that place and therefore, it should be varied from one place to other, instead of standardizing it.
- Buildings as a whole, consume more than 50% of world energy and thus a prime component for energy use reduction initiatives like Building Management System (BMS). Concepts like I (Intelligent) BMS are completely missing in the 'Concept Note' as tool for environmental sustainability.
- "Urban Energy Data Model", by which the overall carbon impact attributed to each building relative to its size, can be understood. Developing smartness by using such tools is entirely missing from the document. The movement towards the digital era can be better utilized through developing 'Online Development Approval System' to bring clarity, transparency in the permission process and to make it faster. Advancement can be brought in the use of technology like regularly updated aerial images; GIS software based informative platform and finally leading towards a 'Smart Development Plan'. Such monumental shift may bring true effectiveness in the futuristic planning process, completely overlooked in the document.

However, from the global initiatives so far, it can be said that being smart can be small or large scale initiatives and range from small movements towards

reducing environmental impact and cost to integrated development hubs. As IBM defines a smart city "one that makes optimal use of all the interconnected information available today to better understand and control its operations and optimize the use of limited resources" (Cosgrove & al, 2011).

The key matter is to have a clear vision of the city planners and decision makers for creating the cities smart. As the concept itself is poorly defined and understood till date in Indian context, smart cities are not coming out with specific parameters for evaluation in terms of livability and sustainability. What could be the preliminary conceptual scheme for an intelligent / smart city that is sufficiently self-aware to synchronize its systems with climatic and ecological phenomena and optimize use of resources at regional and local scale? – Not clear from the report till date.

It should be kept in mind while doing futuristic city planning that city-dwellers need cities, which are liveable. Whether they are smart or intelligent, will not really matter as quality of life is something which is most important and this is deteriorating the fastest in Indian cities. Whether they generate data about mobility, urban land use and governance is important, but should not be the sole purpose for upgrading the cities.

LIVEABILITY – ANTICIPATION OF THE PARADIGM SHIFTS

The concept of liveable cities has lately been getting acceptance in Europe as the city planners and citizens have started working together. It is linked to physical forms like green and pedestrian spaces. For others, it is about the cultural milieu that the city can provide. A liveable city is not possible if it does not offer employment opportunities, it needs to have economic dynamism too. From a futuristic planning perspective, livability is linked with sustainability as it involves consumer resources like food, water, energy and air and related with reduction of carbon generation, use of fossil fuel and efficient fuel management. The degree of livability is determined from the spatial spread of the city as distribution system for supplying a city with food and services with respect to the travel distances. For example, we may take a city like Indore, which is growing rapidly, but has no natural water resource. It is pumped into the city from 60 km away. These consumption patterns arising out of location increase the energy consumption requirement for a city, especially in a country like India, where due to paucity of power, 20 gigawatt is generated using liquid fuel. This includes diesel engines used to generate power or pulling out water from deep aquifers. This is not sustainable and unfortunately, not even part of the discussion on smart cities to provide a smarter solution. One of the principles behind a liveable city is that it is not based on fossil fuels for commuting. Planning such a city means that the local government uses a thumb rule that every citizen can walk for his basic requirement. Education for children, parks or open spaces for leisure and play, basic health care, and entertainment are all within walking distance. The current model of city planning (green field development) is still based on private transport system (Fig.3).

Fig. 3. Automobile Oriented, Polluted, Un-Engaging Urban Planning & Unregulated Urban Sprawl

(Source: IMP Report (Ahmedabad), 2010)

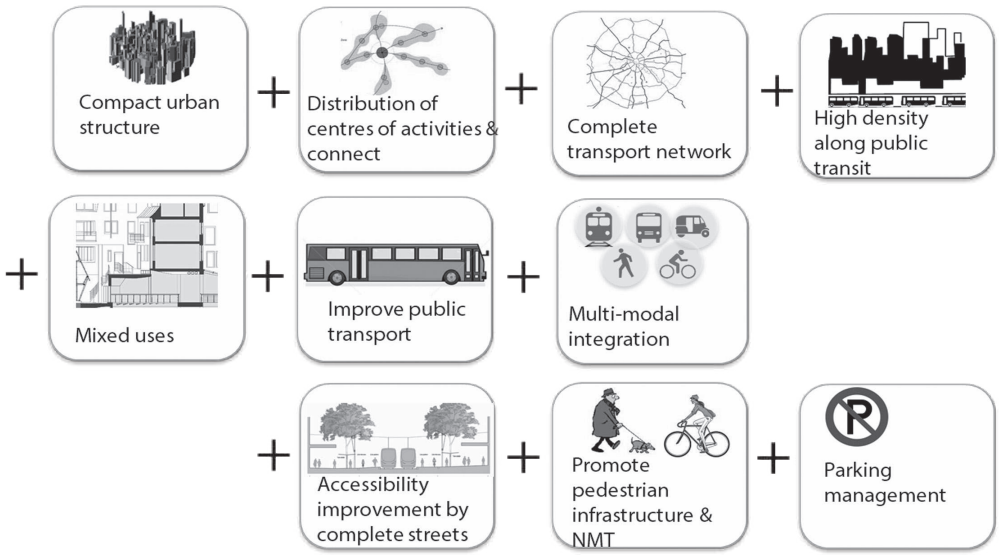

Fig. 4. Elements to make Cities Livable

The concept of pedestrianization, walkability, public transport is still not emphasized as major concern areas. However, small initiatives in India like 'Raahgiri' are catching people's attention as they reclaim the streets from cars for a few hours every week, what if it was part of a city's design? That the streets belonged to people (majorly), and not to cars? A fundamental shift is required even in the way permissions are given for development and integration of public transportation has to be part of city planning. Then only can a city be liveable; it has to be embedded in its planning process and not in its sensors (Smart city discussion blog, 2014).

Now, the bigger issue here is that none of the smart cities are green field projects; the government is looking at reinventing existing cities into smart ones. For instance, Ujjain, one of the cities to be built as a smart city, is a religious tourism-dependent city in Madhya Pradesh. Where we should start from to convert it into smart city? Whether the nature of the city will change? Will it be built on existing fabric of the city? Those detail thoughts are missing till date. The softer aspect of a city and the contextuality, which invite diversity, also encourages sustainability in the long run. Therefore, it will be smarter if we build or focus on liveable cities rather than smart ones.

LIVEABLE CITY: A BETTER OPTION THAN 'SMART' ONES?

With reference of the above discussion, it appears much more relevant at present scenario of rapid urbanization in India, to search for a futuristic urban planning, that responds to the sustainability more than digitalization of everything all around, Frey 1999 defines it as "which results into a city which is people-friendly, having strong living-working relationship, high degree of mobility and access to all basic services to people of all income groups, a symbiotic relationship with its periphery and hinterlands, a structure that enables social mix, self-sufficient communities and generates highly legible and imageable settlement form."

The concept of 'Livability' is much more holistic in its essence than 'Smart'. It is multi-dimensional and multi-layered in nature, which covers local as well as global. The development process to achieve livability responds to a compact spatial pattern, socio-cultural value, environmental balance and economic sustainability. Thus, covers all the necessity of a common citizen and contributes in achieving high quality of life. Utilizing the advancement of digital technology at each of these layers is part of the process, not the sole purpose of development. 'Smartness' as perceived, may discard the economically weaker section from the development process, where livability stands for inclusiveness – "a city for all". As Anderson explained, "what people want are jobs and prosperity, affordable housing, a healthy environment and a city that connects neighborhoods."

CONCLUSION

Cities can only be efficient, if we can integrate and synthesize the required data to perform and measure for efficiency, equity, sustainability and quality of life in cities. Therefore, before implementing this visionary approach of '100 smart cities' in India, it is extremely significant to relook the concept itself and explore, define and evolve planning strategies accordingly, so that the future cities can be liveable. "Distance – stands for walking neighborhoods, Destination – stands for availability of daily needs within that distance and living-working relationship and Density – stands for a balance in-between people, built-form, height and space" (Senville, 2014.) should be the key focus of futuristic urban planning to make cities and their peripheries liveable. To achieve these, the smartness of ICT related advancements can be a tool for faster growth process.

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SMART CITY AS THE ENGINE OF SUSTAINABLE GROWTH

Dr. Arindam Biswas*

Abstract

Cities are responsible for almost 80% of global CO_2 emission. Increasingly, global climate is inherently dependent with the future approach to city development in coming decades. Urban development across the world is not equal. Some cities are more efficient, productive and innovative than the others. Developed cities are more productive in resource utilisation than developing cities. But developing cities are going to experience accelerated pace of urbanization than developed cities. This highlights the challenges in achieving sustainable urban development in 21st century.

This paper discusses futuristic framework in planning of smart city and the evolving challenges to sustainable growth. Patterns of urbanization in developing world today are versions of the modernist city to reflect the ideals of industrialization and to accommodate new automobile technology. Developing cities can no longer enjoy availability of abandoned resources. Four new arrangements of city making are analysed and discussed in this paper as the future to smart and sustainable city growth. Firstly, replace traditional ideas with balancing of complex interrelationships among spatial organization, and travel behaviour; secondly, building cities as economic, physical and social networked environment; thirdly, make city as a platform of innovation; and fourthly, improved organizational management and governance for sustainable city growth and functioning.

INTRODUCTION

Pace and varied pattern of urbanization is uninterruptedly progressing in developing world irrespective of concerns of pollution, climate change. And this rapid urbanization has no sign of abating in the near future. Developing Asia, Africa and Latin America will continuously become more urbanized. Even though policy makers have very limited option to restrict this pace of urbanization, but they can choose to alter the pattern of future urbanization. Resources are limited but with increasing population growth and urbanization the demand is increasing very fast. It can be comprehended that resource per capita will be much smaller with time. But the concern is whether the traditional pattern of urbanization and resource distribution is sufficient in sustainable development of our cities in the future. Existing cities planned and designed in traditional process survives by consuming huge amount of resources can be termed as highly inefficient. Scenarios are similar from developed to developing countries. The amount of development needed to meet this demand will organize patterns of human behaviour, movement, business operations, and urban systems that will persist for decades, if not centuries. Astonishingly, unless new strategies area adopted, much of this growth will be constructed using a pattern of city form invented in the early 20thcentury (Frenchman & Joroff, 2011). The most pertinent question Frenchman, 2011 asks in his literature is about the definition of sustainable cities in the context of 21st Century.

Traditional planning system is deeply engrossed with the ideas of development planning (i.e. Master plan, Comprehensive Development Plan) and its creeping implementation process. This process does not provide any benefit to address the challenge of fast and diverse patterns of urbanization. It does not have the flexibility to adjust with varied dimensions of fast and divergent urbanization process.

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BALANCE COMPLEX RELATIONSHIPS AMONG SPATIAL ORGANIZATION

Traditional planning system practices transit based land function distribution system. It is assumed that this segregated land use planning would be facilitated by freely roaming transit modes. Modern cities are planned with segregated land function between residential, commercial, open spaces, recreation parks, water body, office spaces and industrial land use. This huge uninterrupted space is visualised to link together with a physical network of multimodal transit system. Even our daily activity is heavily dependent on this physical network. Adoption of this planning process is so engrossed with the conventional spatial planning system that developing and developed countries find it hard to identify a replacement of this existing planning mechanism. The scenario is similar for both new greenfield development and infill brownfield development. In recent years, many Indian cities have experienced significant infrastructure improvement with urban renewal program and new town development.

Noida is one of such example of urban development. The city has prepared its Master Plan 2031 by implementing the traditional method of spatial planning (Fig.1). The plan looked beautiful in its creation and its presentation with all the historic planning elements like sectors; wide boulevard roads; segregated usage of residential, office, commercial and industrial spaces; parks, open areas, water-bodies and recreation facilities. But during the course of time the reality of Noida and many cities like Noida is completely different than the planners anticipated. Today the city is widely known for insufficient infrastructure, urban informality (informal settlements, informal transportation, and informal economy), pollution, physical and social unsafe, and crime. Today the concern is to identify the reasons that lead to this grave reality from its original visualisation. But the present trend does not aim for this introspection, rather focusing on multiplication of traditional city development process in varied space and time.

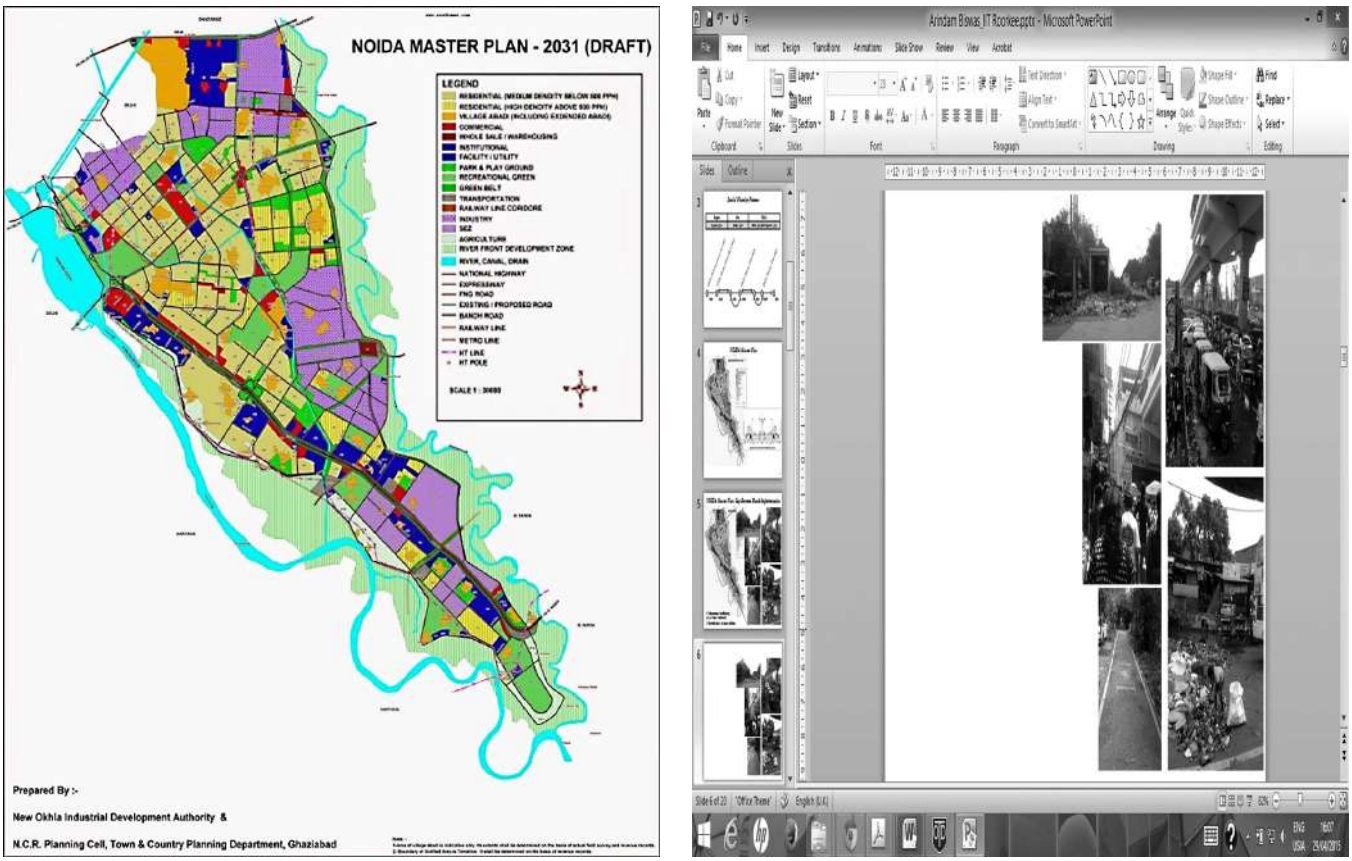

Fig. 1. Noida Master Plan – Visualization and its Reality

Even the recent focus of developing countries on climate change and greenhouse gas reduction is more focused on technological interventions on individual buildings (e.g. green building). Although all these effort are important dimensions but ultimately would reduce energy consumption by just 1-2% (Blok and bv, 2004). Alternatively, urban form, distribution of space, that significantly contributes towards sustainable environment still have not found ample space for discussion in literature and policy domain.

A research argument can be developed to identify that properly functioning cities might be more effective in environmental and ecological sustainability. Newly planned cities in India and other developing countries are grossly non-functional and un-sustainable.

CITIES AS ECONOMIC, PHYSICAL AND SOCIAL NETWORKED ENVIRONMENT

20th and 21st century spatial planning approaches city making by spatial separation of urban functions into districts, which is connected with different hierarchy of roads. This kind of spatial integration requires significant travel to facilitate human functions to perform every day.There is ample evidence showing that distance to jobs is harmful to workers, in particular (Zenou, 2013). City making process considers human activity through urban actions, looked at a bigger scale. But does not detail out human activity by need based detailed analysis. Availability of functions/activities (e.g. physical, economic, social, cultural, and necessary) is not enough and needs to be supplemented with efficiency, financial affordability, quality control and personal satisfaction. Segregation of daily needs from specialised needs require for space planning (Fig.2).

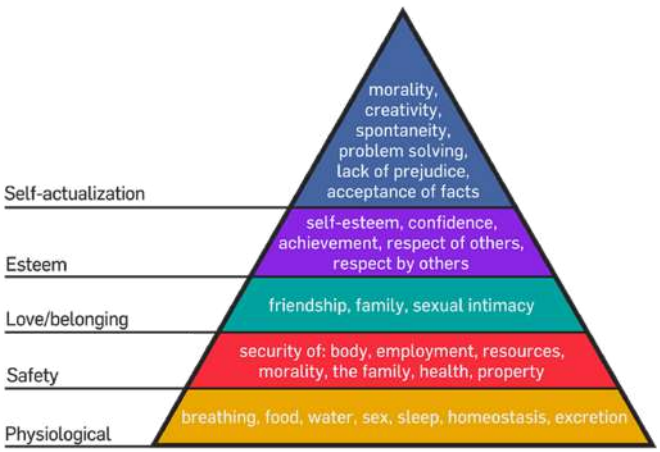

Fig. 2. Maslow's Hierarchy of Needs

Traditional planning process does not provide the scope to detail out local area economic and social networking. Established networking including routes of cost-minimization, to feed the local economies of scale and satisfy survival outputs at the individual community level are the foremost consideration for space planning (Kraus, 2008). Margin of return to supplier of local economic cycle are a cause of concern for developing countries. Wage inequality in trade and services (sometime depend on productivity) are so high that supplier/facilitator (labour) to local social and economic networks (e.g. food supplier, local transit facilitator) often becomes exclusive from the rest of the city and it's functioning. Spatial dimension of labour market networks is particularly important in urban labour markets that are dense with employers and jobs, and in which workers often live in residentially-segregated neighbourhoods (Hellerstein, Kutzbach, and Neumark, 2014). But often land price coupled with various economic externalities force the labours to occupy shelter far from the city or in informal settlements.

Networking and supply of labour is also a cause of consideration. Sometime recently arrived low-skilled immigrants serve as very elastic marginal workers, willing to selectively locate in destinations with better labour market prospects (Cadena, 2014). The situation is very much omnipresence in a democratic country where free movement of labour exists.

CITY AS A PLATFORM OF INNOVATION

Urbanization is taking place rapidly in developing countries, much beyond its capacity of meticulous planning and anticipation. The future is confusing. Countries like India, China, Indonesia, Brazil, and South Africa may choose the options of unconventional city making process accessible due to information and technological innovation. By innovation and networking, cities today can be constituted via relationships of various individual and collective actors (Hadjimichalis and Hudson, 2006).

Ideas such as innovation, learning, knowledge based economy have found its way in modern day city planning process. These ideas seem more robust while discussing smart city. The traditional physical network is increasingly being augmented by wide array of virtual networking system. Fundamental behind this networking process is information dissemination through this virtual network. India has added 20 million mobile phones per month in the past decade. Once mobile become within the reach of every citizen, the quality of service and variety of information dissemination is taking place by technology like smart phone, calibrated with Wi-Fi, 3G and 4G networks.

Innovation, creativity is not only taking place in big industries or high tech laboratories but also in small enterprises in neighbourhoods or households. In Taiwan, 30% of total electronic export comes from household industry which employs almost 70% people in this sector. This creative industry is enabling both boon and challenge to city making process. Increasingly, job location (office, commercial, industrial) may not need to be spatially segregated from housing estate anymore. Residential neighbourhood and housing estate can accommodate innovation industry within its premises. But the challenge is the clustering of creative industry, which in most of the cases fuelled by entry level young entrepreneur seeking lower establishment cost to maximise marginal return and minimise competition. Mostly these industries grow in urban region than city core. Creative workers are specialised in their skills and knowledge. They are highly mobile and thrive in an open, competitive meritocracy and value regions that are tolerant and open (Guimarães, Munn, and Woodward, 2013). Specialised knowledge environment reduce diversification and opportunities for knowledge transfer. Sometime this specialised group of people develop cluster which is nothing but network of companies, their customers and suppliers of all the relevant factors, including materials and components, equipment, training, finance, and so on. It extends to educational establishments and research institutes that provide a large part of their human and technological capital. They are all stakeholders in the end market, influenced by globalisation, commercialisation,skills development, inward investment, start-ups,and trade development.(Carrie, 2000).

ORGANIZATIONAL MANAGEMENT AND GOVERNANCE

At the root of city making process lies efficient organization and management of the city and its region. Administrative boundary does not matches with other forms of city functionaries like housing, utilities and service providers, transit, civic service and taxation. In today's era of privatisation many of these functionaries are constituted with public and private enterprises. Collaboration and co-existence between these collaborators requires interrelation between all these management and governing functionaries. But collaboration between enterprises (public-public, public-private, and private-private) can only take place with information availability in public domain, enhanced confidence building among each other and with greater public participation. Transparency, monitoring and feedback would be the keys to quickly decipher the emerging complication in city functioning.

City planning process needs a different planning approach from the existing approach of visualisation, data collection, analysis, design and implementation. It is not only time consuming but is extremely difficult to implement. Much of the planning remains on paper and does not percolate on ground. City and regional governance system needs to be modified to establish a visionary plan for city, suburbs and region and design the urban/regional legal frameworkin such a way that allow flexiblestrategies to city making process to function perfectly.

DISCUSSION

In the absence of a standard and globally accepted interpretation of smart city; the general functioning of a smart city is often visualised as a city which is connected through multiple data networks that provide movements of people, materials and flow of decisions about the physical and social form of the city. Cities however can only be smart if there are intelligence functions that are able to integrate and synthesise this data to some purpose, ways of improving the efficiency, equity, sustainability and quality of life in cities (Batty, et al., 2012).

City founded on modern is principles, planned today, designed next year, and built over the course of a decade, emerges already a century behind the curve (Frenchman and Joroff, 2011). But today's

urbanization in developing world does not have the liberty to accommodate either the pace and pattern of development. Conventional sequential planning needs to be customized with adaptive and customized approaches. Real time data integrated with real time analysis of physical and virtual city form can reveal complex relationships and interfaces with people. It includes movement pattern of individual and community, traffic flow, utility and service flow, resource consumption, behaviour pattern etc. Digital technology uncovers the multifaceted dinner workings of the city, including the real time behaviour of systems and people, patterns can be recognized, studied, and acted on. Furthermore, diverse scenarios can be modelled to test the impact of alternative development options, using the city, itself (Frenchman and Joroff, 2011).

CONCLUSION

Developing cities emulating the developed counterpart is making cities with the same thought process that originated over a century ago. During this time, technological innovation has altered human life greatly. It is no more the same as it used to be over a century ago. The existing approach cannot be an adaptation of this century old city making process. In this paper I have tried to explain the availability of new paradigm of city making process by discussing four new arrangements of city making. Conventional approach of master plan and its complex implementation needs to be altered with the modern smart capabilities and technological innovation. With this extended capabilities and revision in planning approach, the sequential and frustratingly time consuming planning cycle of visualisation, data collection, analysis, design and implementation is being replaced by flexible strategies that observe, launch and learn. As a consequence, the notion of a fixed master plan is giving way to a set of strategic visions that initiate a gile developments which are continuously monitored, evaluated and adjusted in time and space(Frenchman and Joroff, 2011). Our approach smart city needs to consider opportunities offered with this concept rather indulging in the on-going connotation of digitalization.

On an urban scale, multi-use concepts of city-making are gradually replacing the single purpose districts promoted in 20th century planning. Flexible spaces that accommodate multiple activities can be used more intensively than those dedicated to a single purpose. Masdar is proposed to become the first zero emission city, powered by photovoltaic, and excluding automobiles. The paper display that smart cities of tomorrow can only be visualised with smart implementation of technologies that transform city making for modern cities rather superficial usage of ICT.

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SMART CITIES-A PERSPECTIVE VIEW

DR. PARDEEP KUMAR GUPTA* AND DR. R.K. KHITOLIYA**

Abstract

Cities are facing unprecedented challenges. The pace of urbanization is increasing exponentially. In addition, due to climate change and other environmental pressures, cities are increasingly required to become "smart" and take substantial measures to meet stringent targets imposed by commitments and legal obligations. Furthermore, the increased mobility of our societies has created intense competition between cities to attract skilled residents, companies and organizations. To promote a thriving culture, cities must achieve economic, social, and environmental sustainability. This will only be made possible by improving a city's efficiency, and this requires the integration of infrastructure and services. While the availability of smart solutions for cities has risen rapidly, the transformations will require radical changes in the way cities are run today

INTRODUCTION

It is essentially enabling and encouraging the citizen to become a more active and participative member of the community, for example, providing feedback on the quality of services or the state of roads and the built environment, adopting a more sustainable and healthy lifestyle, volunteering for social activities or supporting minority groups. Furthermore, citizens need employment and "Smart Cities" are often attractive locations to live, work and visit. But the concept is not static: there is no absolute definition of a smart city, no end point, but rather a process, or series of steps, by which cities become more "liveable" and resilient and, hence, able to respond quicker to new challenges. Thus, a Smart City should enable every citizen to engage with all the services on offer, public as well as private, in a way best suited to his or her needs. It brings together hard infrastructure, social capital including local skills and community institutions, and (digital) technologies to fuel sustainable economic development and provide an attractive environment for all. It is a vision which has been developed in consultation with its citizens, creating an attractive environment for business across the city, so that the quality of life of all its citizens is enhanced by anticipating their needs and meeting them, such that firms and people embrace the vision and want to locate and live there.

SMART CITIES AS THE EPICENTRES OF GROWTH

Urbanisation and economic development are two sides of the same coin. In 1800 just 2% of the world's population was urbanised. By 1900 this had risen to 13%; in 2000 the figure had reached 47%; and in 2008 it passed 50%. On current trends it is estimated to be 60% in 2030; 70% or even 75% in 2050; and virtually all this growth will take place in the developing world as it emulates Western Europe and North America. According to the McKinsey Global Institute's extensive study of global cities, 80% of global GDP is generated in cities with 50% in the 380 major cities of the developed world and 10% in the largest 220 cities of the developing world. In 2025, these top 600 cities will still be generating 60% of the growth in GDP but their membership will have shifted East with an estimated 100 new cities entering the rankings from China alone, where the urban population is expected to rise by 200 million, to over 800 million. Some 235 million households earning more than $20,000 pa (at Purchasing Power Parity rates i.e. adjusting for the different cost of living) will live in the emerging economy cities, compared to 210 million in developed region cities. This growth of a global urban middle class, with correspondingly high expectations of public services and the quality of the urban infrastructure and environment, will

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have a profound impact on the market for smart city services. For example, in January 2013, the Chinese Government announced a Green Building Action Plan that sets a national target for 20% of all new buildings to be green by 2015. But it would be a mistake to think that smart urban development is purely a developing world phenomenon. There is a growing recognition among city leaders in the developed economies that smarter approaches are needed to address the challenges which confront society, to improve the efficiency of public service delivery, the sustainability of the urban environment, and the quality of life in our cities. Furthermore, these cities are using smart concepts to enhance their location competitive advantage, promoting their sustainable and smart credentials to attract new business and talent.

However, the value of the smart systems which underpin smart cities and communities is just one element of a potentially much larger market. In its report on "Reinventing the City to Combat Climate Change", Booz Allen estimated that, in real terms, global investment in urban ICT and telecommunications over the next 30 years will amount to over $30 Trillion. Furthermore, there is a much wider set of professional services which are brought into play, as new business models require careful financial appraisal, legal and contracting skills, as well as finance itself, property services and marketing. Even more importantly, the creation of smart communities acts as a "honey pot", as new firms and young professionals are drawn to the area and create growth dynamics based on new clusters of expertise, which spill over into property refurbishment, leisure and entertainment. This, in turn, provides employment opportunities for a much wider segment of the population. Thus, it is not only major cities, such as Boston, Chicago, Stockholm, Barcelona, Copenhagen, Amsterdam, Berlin, London and Manchester which have benefitted from giving a focus to "smart". Smaller communities, such as Friedrichshafen, Aarhus, Santander, Paredes, Peterborough and Bristol are attracting start ups and generating growth on the back of a firm commitment to Smart City concepts.

All cities aiming to develop into smart cities have to be built on three sustainability pillars:

- **Economic Sustainability**

  Cities need to provide citizens with the capacity to develop their economic potential, and attract business and capital. With the global financial crisis, the economic sustainability of cities has taken centre stage. The crisis has unearthed considerable weaknesses in the financial models and planning strategies of public authorities in the provision of services and in their infrastructure investments. Their financial sustainability now depends also on new financial models, as well as more efficient and better-integrated services and infrastructures.

- **Social Sustainability**

  A city's attractiveness for people, business and capital is closely related to the quality of life, business opportunities and security and stability, which are guaranteed by social inclusiveness.

- **Environmental Sustainability**

  Cities face a number of environmental sustainability challenges, generated by the city itself or caused by weather or geological events. To reduce the impact of the city on the environment resource it is important to promote the efficient and intelligent deployment of technology and to integrate infrastructures. This process can also be developed in such a manner as to increase the resilience of the city to environmental shocks. These three pillars have one common denominator, namely the need to achieve more and better with less, i.e. efficiency. Efficiency must also be achieved in a manner that brings benefits and opportunities to citizens, making the city more dynamic and participatory.

SMART TECHNOLOGY SOLUTIONS

Rather than being an expense, smart technology integration can create considerable opportunities for added value in any city. Technology integration helps cities to improve efficiency, enhance their economic potential, reduce costs, open the door to new business and services, and improve the living conditions of its citizens. A key condition for value creation through integration is the compatibility of technologies; which is best achieved through common and consensus-based standards that ensure interoperability. Presently, however, smart city projects concentrate mainly on vertical integration

within existing independent infrastructure and services silos, e.g. energy, transport, water or health. A truly "smart" city requires horizontal integration as well as creating a system of systems capable of achieving considerable increases in efficiency and generating new opportunities for the city and its citizens.

New approaches are necessary to design, implement and finance smart city solutions. Cities are faced with a complex challenge, as the traditional processes of planning, procuring and financing are not adequate for their needs. Smart cities can only exist if fundamental reforms are undertaken. Stakeholders are key drivers to smart city solutions. A smart city cannot be imposed by decree, as the city is shaped by a large number of individual decisions and social and technological changes cannot be fully accounted for. With the present advances in telecommunications, information and communication technologies (ICT) and affordable energy efficiency and energy production tools are changing the relationship between citizens and city services. Citizens are increasingly becoming providers of city services and not only users. A good plan requires the participation, input and ideas from a wide range of stakeholders within the city. This means that city planning needs to allow for bottom-up processes of modernization. The stakeholders are: Political leaders, managers and operators of the local government (city). The service operators – public or private: water, electricity, gas, communication, transport, waste, education, etc. End users: inhabitants and local business representatives. Investors: private banks, venture capitalists, pension funds, international banks. Solution providers: technology providers, financiers and investors. Giving to each of these groups a true stake in smart city development is important to achieve the necessary consensus for the changes. Their concerns need to be carefully considered and acknowledged, and ultimately the direction and next steps have to be collectively approved. In the absence of proper consultation, the authorities will sooner or later face considerable additional obstacles to make their vision a reality.

SYSTEMS INTEGRATION

Without integration rising to the level of a system of systems there cannot be smart cities. The transformation of a city into a smart form presents its stakeholders a wide range of challenges, including benefits and consequences when such a transformation is undertaken. A promising approach to support city planners, but also standards developing organizations (SDOs), is to model a city as a collection of activity domains in an integrated virtual organization (the city), where various groups of stakeholders (local governments, public and private corporations, academia, healthcare institutions, cultural associations, religious congregations and financial firms) participate in operating and sustaining the city as a whole. Modelling the interrelations allows identifying gaps and overlaps in standardization and clarifying the technical needs for integration. While the technologies to develop smart cities are mostly readily available and improving, their deployment is hampered by technical, social and administrative challenges. Horizontal integration of infrastructures through technology is essential to reap the benefits of innovation and the potential and necessary efficiency. Thus, interoperability is essential; without it, city planning is marred by unexpected inefficiencies leading to suboptimal outcomes and higher costs. The planning requirements for city authorities are very complex, as there are thousands of organizations and companies working in parallel to bring on the tools, systems and products that offer potentially affordable/ sustainable solutions. To ensure that smart integrated systems are put in place in practice, internationally agreed standards that include technical specifications and classifications in order to support interoperability (i.e. devices and systems working together) are sine qua non. These include technical specifications and classifications in order to support interoperability. These are metrics against which benefits can be assessed as well as best practice documents that detail controls. Horizontal as well as vertical integration is key to creating value and interoperability. Electric grids, gas/heat/water distribution systems, public and private transportation systems, and commercial buildings/hospitals/homes play a key role in shaping a city's liveability and sustainability. To increase their performance and efficiency, these critical city systems need to be integrated. The successful development of a smart city will require the combining of a bottom-up systems approach with a top-down service development and a data-centric approach. Technology integration includes vertical integration from sensors, to low cost communication, real time analysis and control, and horizontal integration

of historically isolated systems up to citizen based services. Combined, this creates a system of systems.

Today's smart city projects are mainly focusing on improving the integration of historical verticals, i.e. parts of existing utilities, improving e.g. energy efficiency, or reducing water leakage. The next step is horizontal integration. Data from the different sectors can be combined to better manage the city and reduce risks. Interoperability is the key to manage systems of systems and to open markets to competitive solutions. Interoperability is key to manage systems of systems and to open markets to competitive solutions. While we are today experiencing the internet of things (IoT) revolution (driven by the appearance of smart devices, such as wireless sensors, radio-frequency identification tags and IP-enabled devices), different producers are generating technologies using their own communication specifications and data protocols. Future interoperability can only be guaranteed through the existence of international standards ensuring that components from different suppliers and technologies can interact seamlessly. Continued best practice sharing and development of common standards to ensure that data can flow freely between systems is essential, while maintaining the need to protect confidentiality and individual privacy. Common terminology and procedures have to be developed in order to ensure that organizations and businesses can efficiently communicate and collaborate, which can also be guaranteed through standards. Sartorial bodies need to increase collaboration. The large efficiency gains from integration and interoperability can, however, only be realized if city departments and other stakeholders collaborate effectively and agree to share information. Smart services and infrastructures cannot develop without proper collaboration. The lack of exchange of fundamental data on customers, infrastructures and operations is one of the most important barriers highlighted by stakeholders.

There is a need to reform the way standards are developed. The glue that allows infrastructures to link and operate efficiently is standards. Standards are necessary to ensure interoperability of technologies and the transfer of best practices. But standards are not yet adapted to the level of technology integration we are requiring. Standard bodies still operate in sectorial parallel silos, developing standards that are not easy to understand by non specialists, for example city managers. Standards are facilitators for city planners who need to incorporate them in planning and procurement. There is thus a need to reform the way standards are produced and ensuring that they are adapted to the needs of the city planners and other service operators within the city. The systems approach will only work if there is a coherent global approach. There is a need for close collaboration between standard bodies themselves and collaboration with outside organizations, and particularly the city planners. A precondition for the considerable investment in, and successful deployment of, smart city solutions is a substantial worldwide agreement on the what and how decided for and with the key stakeholders. Smart cities stakeholders need to recognize that standardization efforts will involve the development, promotion, and deployment of standards series and conformity assessment schemes that enable the implementation of smart city solutions. In addition, the multiplicity of technologies within a city now demands a top-down approach to standardization. This requires new coordination approaches between SDOs in which all the parts of the city are jointly considered by the several technical committees involved by the different organizations. This methodology is essential as systems level standards will enable the implementation and interoperability of smart city solutions. Guiding principles and strategic orientation for the International Electro-technical Commission (IEC) and messages to other SDOs. Electricity is core to any urban infrastructure system and the key enabler of cities development. As a result, the IEC has a specific role to play in the development of a smart city's set of standards. The IEC shall call for, take initiative, invite, and strongly contribute to a more global and collaborative approach including not only international standardization organizations, but also all stakeholders of the smart city landscape (city planners, city operators, etc.) and specifically the citizens. Technology and system integration are critical to ensure interoperability and the IEC will support active collaboration between the relevant actors as described in the following guiding principles. The IEC shall continue to foster technology integration (electro technical, electronics, digital and IT), and make sure that digital technology is fully integrated in all IEC products in a connect and share data perspective. The IEC shall make sure digital and IT technology suppliers are actively contributing in its work. Data

aspects shall become a key issue in IEC, including IoT, data analytics, data utilization, data privacy and cyber security.

The system approach shall be accelerated as a top IEC priority taking into account flexibility, interoperability and scalability. Value creation for users (citizens and city infrastructure and service planners and operators) will remain the main driver of standardization work. Smart development requires solutions to be adapted to the specific needs of the city and its citizens, and standards have to be developed with this purpose in mind, removing technology barriers that prevent technology integration. In the system approach, IEC shall consider an architecture framework clarifying the system-of system concept and the basic levels and rules of interoperability and integration. This framework shall be established in collaboration with other international SDOs as well as international organizations such as fora and consortia and shall apply to greenfields and brownfields. The IEC shall also develop work around visualization tools to model the complex interdependency of systems in city simulations. The IEC should aim to liaise with key city stakeholders, encourage and foster their participation and inputs in the standardization work, and create the necessary collaborative working place. The IEC shall challenge the way standards are written and promoted and specifically how the added value of standards, perceived by citizens and city actors, can be increased. These efforts should lead to a wider market with solid standards and interoperability, which will support the expansion of replicable and more affordable technologies globally. Wider collaboration between stakeholders will ultimately lead to more integrated, efficient, less expensive and environmentally benign solutions for the world's rapidly growing urban population.

CONCLUSION

Smart cities are necessary not only to reduce emissions, but to handle the rapid urbanization growth that the world is experiencing. Inefficiencies in urban areas bring large negative environmental and social impacts. City infrastructures are the backbone of the cities, delivering the necessary services to the population and creating the conditions for citizens to develop their professional, social and cultural activities. The participation, input and ideas from a wide range of stakeholders within the city eco-system (city planners, city infrastructure operators, citizen organizations, etc.) are not only critical for solutions acceptance, but as well as a resource to build the most efficient answer to the pain point to solve. The IEC should liaise with these new (for IEC) stakeholders, encourage and foster their participation and inputs to the standardization work.

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EXPLORING THE SMART CITY PARADIGM IN THE CONTEXT OF URBAN INDIA

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Abstract

Exponential growth of urban areas is occurring globally in the past few decades. This expansion has metamorphosed into cornucopia of urban problems. Many researches are trying to find solutions for the same. The Smart City concept is one of them and is widely accepted all over the world.

Indian Cities are experiencing a rapid growth and powerful transformations to adapt to the changing urban scenarios. There is an advantage for India to emulate and choose the right direction to go forward with the idea of Smart Cities, as there are various models available in the world.

Smart city concept is no doubt a revolutionary solution, but nation can only reap its benefits when it is defined in terms of the needs and context of their own lands. The case of India in the context of a Smart City is unique and there is a need to take forward, the idea of a Smart City according to the needs of India. Hence, considering models from Europe, USA, China and Japan, research is carried out in studying various features of a Smart City and to explore features relevant to the Indian context with selection criteria.

INTRODUCTION

Smart city is looked upon as an all-round solution for rising urbanisation challenges globally. When the Smart city concept is adapted in our country, in the process of determining the right features of Indian smart cities, understanding of the Indian needs and context is very important. The advancements in every field and changes taking place all over the world are welcomed and very well received in India. This is the right time for India to emulate and take careful steps. To start with, when we look at the meanings and concepts of smart cities outside India, though there are broad definitions, there are mostly oriented towards technological advancements such as sensors, ICT infrastructure, use of technology and mechanical work for better management of services at every stage. This involves lot of investments and economic stability which is very difficult with in the environment of our country, where the population to be served is huge and the basic necessities are still deficient in many lives. Different models from European Union, USA, China are studied, their characteristics are classified and few are selected for the Indian context on the basis of above mentioned criteria.

FEATURES OF A SMART CITY- THE EUROPEAN MODEL

Boyd Cohen, an urban strategist and researcher developed "Smart Cities Wheel" with the following characteristics: Smart Economy, Smart Mobility, Smart Environment, Smart People, Smart Living, Smart Governance. Since the above characteristics are widely accepted in Europe, all the European models are given in Tables 1 to 5.

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Table 1. Features of a Smart city

(European Innovation Partnership on Smart Cities and Communities, 2013)

Smart Economy	Smart Mobility	Smart Environment	Smart People	Smart Living	Smart Governance
Features	Features	Features	Features	Features	Features
-	Clean technologies for transport	Green buildings	Citizen Awareness & Participation	-	Specific Policy Regulations
-	Mixed-modal access	Energy Efficiency: Energy maps etc	Learning Platforms	-	E- Governance
-	Tools for comfortable travelling.. Apps, Maps, Real time data, online payments etc.	Low residential energy consumption	Events & Workshops	-	Citizen-Government-Platforms: Ideas exchange
-	Schemes for Travelling like carpooling, Cycle stands etc			-	Quantified Assessments: Urban Simulation & Planning
-	Smart Infrastructure: ICT, sensors, cameras, Real time Info in Bus stops etc.			-	Open Data Knowledge sharing between departments, cities, Governments, Citizens
-	Last Mile Logistic			-	Cloud complaints… like Fix my street
					Standardization of Smart city indicators

Table 2. Features of a Smart city (Cohen, 2012)

Smart Economy	Smart Mobility	Smart Environment	Smart People	Smart Living	Smart Governance
Opportunity	Clean technologies for transport	Smart buildings	Education	Culture & Happiness	E- Governance
Productivity	Mixed-Modal access	Sustainable Resource Management	Inclusive society	Safety & Security	Transparent Governance
Local and Global Interconnectedness	Integrated Information and Communication Technology	Urban Planning	Creativity, Entrepreneurship & Innovations	Health conditions	

Table 3. Features of a Smart city (Centre of Regional Science, 2007)

Smart Economy	Smart Mobility	Smart Environment	Smart People	Smart Living	Smart Governance
Innovative Spirit	Last Mile Logistic	Attractivity of natural conditions	Level of Qualification	Cultural facilities	Participation in decision making
Entrepreneurship	International Accessibility	Low Pollution Levels	Affinity to lifelong learning	Health conditions	Public & Social Services
Economic Image & Trademarks	Clean Technologies for Transport	Environmental Pollution	Social and Ethnic Plurality	Individual Safety	Transparent governance
Productivity		Sustainable Resource Management	Flexibility	Housing quality	
Flexibility of Labour Market			Creativity	Educational facilities	
International Embeddedness			Cosmopolitanism/ Open mindedness	Touristic attractivity	
			Participation in Public life	Social cohesion	

Table 4. Features of a Smart city (Tillie) (Karayannis, 2014)

Smart Economy	Smart Mobility	Smart Environment	Smart People	Smart Living	Smart Governance
High employment rate	Public Transport	Low Residential electricity consumption	% of female school aged enrolled	Suicide rate	-
High % of Commercial and Industrial properties of total properties		% of city population with Authorised electrical service	% of students completing primary education	Life expectancy	
Low % of city population living in poverty		Energy consumption of Public Buildings	% of students completing secondary education	Crime rate	
Low Youth unemployment rate		% of Total Energy from Renewable Sources, to Total Energy	Primary Education student/ Teacher ratio	No. of Police officers per 100000 population	
High % of persons in full time employment		Less Power cuts	% of male school aged enrolled	No. of Hospitals per 100000 population	

High No. of businesses in 100000 population		Air, Noise pollution	% of school aged enrolled	Less no. of Homeless people	
High No. of new patents per 100000 population		Green House gases	No. of Higher Education Degree per 100000 population		
		% Change in the native species			

Table 5. Features of a Smart city (Directorate General For Internal Policies, January, 2014)

Smart Economy	Smart Mobility	Smart Environment	Smart People	Smart Living	Smart Governance
E-Business, E-Commerce	Integrated Transport and Logistics Systems	ICT enabled energy grids	E-Skills	Culturally Vibrant	Services Integration through ICT
New business models	Clean technologies for transport	Pollution control	ICT enabled Working	Safe and Healthy	Smart Partnerships between Public and Private
Entrepreneurship	Mixed-Modal access	Retrofitting and Green buildings	Access to Education & Training	Diverse Cultural Facility	
Local and Global inter-connectedness				Quality Housing	

FEATURES OF A SMART CITY- USA MODELS

The USA models have a different set of characteristics when compared to the European models and are given in Table 6 and 7.

Table 6. Features of a Smart city (Mulligan, 2014)

Home/ Building	Transportation	Climate/ Environment	Manufac-turing	Disaster Recovery	Health care	Security	Energy
Convergence of Smart Home and Building Architecture	Applied Robotics for Installation and Base Operations	Enhanced Water Distribution Infrastructure	Smart Man-ufacturing	Event Management for Smart Cities	Closed Loop Health Care	Cyber-secure Syncro Phasers with Security Fabric	Cyber-secure Syncro Phaser with Security Fabric
SCALE - Safe Community Alert Network	Smart Roads	Smart Cities USA	Smart Shape Technology	SERS - Smart Emergency Response System	Connect-ing Smart Systems to Optimize Emergency Neurolog-ical Life Support	Smart energy CPS	Smart Energy CPS

Smart Home/ Business Gateway Platform	Smart Vehicle Communications			Smartphone Disaster Mode	Project Boundary	The Agile Fractal Grid	Smart Power, Smart Light – Made in Detroit
Smart Rooftops	Southeast Michigan Smart Transportation				SCALE – Safe Community Alert Network		Smart Rooftops
Service Enablement Provider							Transactive Energy Manage-ment

Table 7. Features of a Smart city (CISCO, 2011)

Sustainable Socio-Economics	Connected by Sustainable Mobility	Connected by Sustainable Buildings	Connected by Sustainable Energy	Connected by Sustainable work
Active Community & Eco Maps	Smart Transportation Pricing	Homes	Renewable & Co-Generation	Smart Work Centres
Innovative Green Business Models & Sustainability Clusters	Personal Travel Assistant	Office Buildings	Urban Monitoring & Measurement	Digital Swarming & Hub Pavilions
	Connected Public Transit	Public Spaces	Citizens Energy Efficiency	Connected Workplaces
		Public Transit Hubs		Connected Workforce
		Hospitals & Schools		

Features of a Smart City- Chinese Models are Given in Tables 8 And 9

Table 8. Features of a Smart city (Yueh, 2010)

Smart Economy	Smart Service	Smart Environment	Smart Citizen	Smart Government
Enterprises Informationization	Utilities	Infrastructure	Smart Individual	Public Security
IT Industry	Education	Sustainability	Smart Household	Participation
Innovative Economy	Healthcare	Innovative Ability		Governance
	Transportation			

Table 9 Features of a Smart city (Zhang, 2007)

Information Service for Economic Development	Smart City Infrastructure	Culture and Science	Sense of Citizen	Smart City Public Management & Service
Industry development level	Broadband Network Coverage Level:	Level of Citizen income	Life convenient sense	Intelligent government service
% of information service added value in the Gross Domestic Product	Family Fiber access rate	The Per Capita disposable income (RMB)	Satisfaction degree to the network tariff	% of administrative projects approved on website
% of e-commerce transaction value in the total sale value	WLAN coverage rate	Level of Citizen culture and science	Convenience degree of traffic information access	% of the government behaviour electric supervised
% of information service practitioner in the whole practitioner	WLAN coverage rate in Public area	% of Population by educational college or above in the total population	Convenience degree of health care	% of the government public notice published on website
Enterprise Information operating level	Next generation Broadcasting Network (NGB) coverage rate	The rate of city citizen science attainment	Convenience degree of the government service	Interactive rate between enterprise and government network
Integration Index of Industrialisation and Information	Broadband Network Access Level	Level of Citizen Informationisation training	Convenience degree of education resource access	Interactive rate between citizen and government network
The construction rate of enterprise website	Average network access level of Family	% of the related training population per year	Life safety sense	Intelligent traffic management
The rate of Enterprise e-commerce behavior	Average WLAN access level	Level of Citizen life Internetize	Satisfaction degree to the food safety	Intelligent medical system
The usage rate enterprise informationisation system	Infrastructure investment Construction Level	The rate of citizen use internet	Satisfaction degree to the environment safety	Intelligent medical system
	% of network infrastructure investment in the whole social fixed assets investment	The usage % of mobile internet	Satisfaction degree to the traffic safety	Intelligent environmental protection network
	Sensor network construction level (% in the whole social fixed assets investment)	The % of family shopping online	Satisfaction degree to against crime	Intelligent energy management
				Intelligent city safety
				Intelligent education system
				Intelligent community management

FEATURES OF A SMART CITY IN INDIAN CONTEXT

Studying various features of a Smart city from EU, USA and Chinese models, the following selection criteria needs to be adopted in the Indian context.

- Various smart city models proposed by different development authorities, IT Companies etc are more inclined towards high end technology and usage of ICT, apps, sensors etc. But in Indian cities' context where they are still trying to stabilize basic services and infrastructure, the idea is to incline Smart City concept towards the same.
- Features are selected in such a way that they have broader perspective other than focusing on a single aspect.

Smart Economy: Smart Economy is an important characteristic of a Smart city for a developing country like ours, with huge population.

Features:

- Local and global interconnectedness is a strong link that forms the foundation and communicative system for future developments. It helps in the growth of the country to move hand in hand with the global scenario. This is a common feature among various models.
- Encouragement to be given to the young, energetic and talented entrepreneurs and promote smart ideas and entrepreneurship. Entrepreneurship is also a common feature among different models.
- High employment rate is one of the mainfeatures of a Smart city followed globally. Employment is a tool which solves the alarming condition of unemployment in the country and a key for better living.
- Reduction of poverty, increase in standard of living, are some other interrelated features which will change the dynamics of the urban scenario in the country.
- Promotion and growth in the field of E-Business, E-commerce along with increase in the no. of patents and business opportunities, establishments can be quite a boost to the Indian scenario.

Smart Mobility: Considering the vast expansion of urban areas, huge population, increasing numbers of cars, air and noise pollution through vehicles and insufficient infrastructure, this characteristic deals about providing smarter infrastructure of both technical and mechanical, for better and sustainable mobility.

Features:

- Promotion and implementation of clean technologies for transport.
- Increase promotion and use of multi modal and public transport system and access.
- Use of concepts such as last mile logistics, integrated logistics.
- Better international accessibility opportunities along with its affordability.
- Tools for better mobility like apps, maps with real time data, online payments etc., have already been introduced but are available to a very few. These should be made more accessible and affordable.
- Smart infrastructure like ICT, sensors, cameras, real time information in bus stops etc., for better mobility management. These are small modifications and additions to the existing systems which would make it more efficient rather than changing and adopting to a whole new system.
- Schemes for travelling like carpooling, cycle stands etc., should be promoted and planned to decrease the pressure on our resources.
- Smart transportation pricing.

Smart Environment: Awareness about importance of our environment is slowly increasing in the country. Features related to environment should not confine to any urban area but should reach every corner of the country.

Features:

- Enhancement of pollution control system and proper planning to achieve pollution free environment.
- Designing and planning of more green spaces and lung spaces.

- Retrofitting and green buildings.
- Low residential energy consumption, smart designing of the buildings to make maximum use of the natural day light and ventilation.
- Low pollution levels
- Usage of renewable resources.
- Authorised electrical service connections.

Smart People: Smart people refer to citizens of the Smart city. Literacy, spread of knowledge, public awareness etc., are some of the features.

Features:

- High literacy rate and easy access to education
- Due encouragement for creativity, entrepreneurship and innovations.
- High no. of students completing primary and secondary education along with appropriate student and teacher ratio.
- More of students with higher degrees.
- Encouraging programs like distance education, open source online education, age relaxations.
- Provision of learning platforms, citizen awareness programs, interactive and participative programs between varied segments of society, government and citizen interactions etc.
- Adaptation of inclusive society, cosmopolitanism, and open minded approach.
- Intelligent, accessible, affordable education system.

Smart Living: Smart living refers to features for better standard of living, high life expectancy etc.

Features:

- Safe and secure environs.
- Improved health conditions along with basic aid facilities.
- High life expectancy.
- Low suicide rate
- Low crime rate
- Increase in the housing quality and adapting to few new trends in housing.
- Emphasis on the tourism and touristic activity adding to the developments.
- Decrease in the number of homeless people.
- Conservation of traditional and diverse cultural legacy for us and the future generations.

Smart Governance: Smart Governance refers to efficient management of services provided by the authorities to the citizens. ICT infrastructure, e-governance are some of the main features of this characteristic.

Features:

- E-Governance
- Transparency and open data for awareness among the people regarding the government proceedings.
- Emphasis on skill development in government bodies
- Changes in specific policies and regulations for better administration.
- Smart partnership between public and private when necessary.
- Public involvement in decision making.

RELEVANCE OF A SMART CITY IN INDIAN CONTEXT

India is a country with huge population and catering to the needs and basic amenities of them is not an easy task, but to achieve a better quality of living and progress of the country in all spheres this tough task should be made achievable. This can be done only with smart, proper utilization and planning of the available resources in the country. In this regard, the concept of smart city plays a very important role or can be looked up to as a promising solution. In such a situation, Smart city in itself should not become a cause to other problems in the country. Country as a whole should progress forward taking every citizen along but not particular groups. This can be achieved when the solution is accessible, affordable, workable, and adaptable.

Hence, it is very apt to say that smart city is just not use of technology for India. Its definition is far more complicated in the Indian context. Apart from

the implications to be considered such as political, economic and social, there is an important factor to be addressed that is the sustainability. The term sustainability in this context here meant to sustain long term, the very idea of a smart city. The global experience is that a country's urbanization up-to a 30% level is relatively slow but the pace of urbanization speeds up thereafter, till it reaches about 60-65% and with an urban population of 31%, India is at a point of transition where the pace of urbanization will speed up (MoUD, December 2014). Hence, whatever concept India is adapting today becomes very important for the future of the country and should be long term sustaining plan. This factor forms the crux of the concept and it can prevent us from facing the same challenge in the future that we are facing today. Here in Indian context, sustainability also means sustaining and carrying forward the cultural heritage and glory of India parallel to the modern developments and changes in all fronts. Along with it, smarter methods to implement and manage various government services are the need of the hour.

All these factors sum up to define the concept of smart city in the very Indian context demanding an intelligent and efficient plan and re-organization of available resources, considering the present and future constraints.

CONCLUSION

India is a developing country with varied problems in different spheres and at different stages whose implications affect the growth of the country. Different proposed and formulated models of smart cities in different countries and factors influencing them have been studied and analysed. Understanding of components of concept from various models helped in arriving at the base for the introduction the concept in India. Now, basic components have been modified and formulated in the very Indian context to suit the country needs utilising the available resources. This paves a way for the Indian smart city to venture into the field of sustainability.

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INNOVATIVE CONCEPTS IN MAKING OF SMART CITIES

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Abstract

The proliferation of smart city initiatives around the globe is part of strategic response by governments to the challenges and opportunities of increasing urbanisation as the nexus of societal development. As a framework for urban transformation, these initiatives / innovations aimed to harness Information and Communication Technologies and Knowledge Infrastructures for sustainable economic regeneration, social cohesion, better city administration and infrastructure management. However, analysis of Smart City innovations have revealed several technical, management and governance challenges arising from the inherent nature of a city as a "Socio-technical System of Systems". The connotation of a smart city represents innovations in technology, management as well as in policy. Since the context of each city shapes the technological, organisational and policy aspects, it can be considered as contextualized interplay among technological, managerial and policy innovations.

This paper aims to build a comprehensive framework based on sustainable innovations and initiatives available to "Urban System Collaborative" for making Smarter Cities through "Smart City Initiative Design" (SCID) framework.

INTRODUCTION

In recent years, living 'smartly' in a city has become the focus of policymakers and private industry. Millions are being invested in research, development and pioneer projects to construct smart cities. The phenomenal growth in urban population from 250 million at beginning of 20th century, to 2.8 billion at the beginning of 21st century and to about 9 billion by 2050 has resulted in unprecedented level of urbanisation and substaintial growth in size and number of cities all around the globe. The trend of population growth and urbanization, puts increasing pressure on the cities, which indicate lack in basic functionalities of a livable place be it in waste management, natural resources, health care, traffic and adequate, infrastructures. Further to it, social and organisational issues associated with multiple diverse stakeholders, high level interdependence, competing values, social and political complexity make it substantially complicated. Cities play a crucial role for concentration of a large share of highly skilled, entrepreneurial and creative population with diverse pools of knowledge for spurring economic development. The social divisions are often larger within the cities, where slums and business centers are likely to be situated within the same geographical area. To sum up, the saying "Crisis is the mother of innovation" is applicable for sustainable solutions.

The growing demographic, economic, social, and environmental importance creates challenges as well as opportunities. The concept of the 'Smart City' has been under development, as a natural response to the process of urbanization for sustainable living. The concept will seem elusive and vague, till the time the strategies for innovations and initiatives are reflected in applied technologies as well as in the field of management and policy. The actual meaning of smartness in the urban context not only indicates utilisation of cutting-edge Information and Communication Technologies (ICTs), but also management and policy concerns with the following objectives.

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Objectives of Smart City Initiatives: The smart city initiatives in general aim at the following:-

- Carbon reduction and neutrality.
- Achieving energy efficiency.
- Leveraging ICT to develop niche industries (i.e. multimedia or knowledge-based industry).
- Attaining highest quality living environment for residents.
- Developing green areas within the city.
- Developing state-of-the-art information infrastructure accessible to all.
- Achieving economic growth and quality of life simultaneously.
- Developing Sustainable communities.
- Ensuring social harmony.
- Evolving city as living laboratory to foster continued improvements.

The paper attempts to bring out the innovations in technology, management as well as policy as the platform for preparing a comprehensive frame work for making a sustainable smart city.

Smart City Innovation

Innovation denotes "Novelty in Action" and "New ideas that works". We treat a smart city not as a status of how smart a city is but as a city's effort to make itself smart, the connotation of a smart city represents city innovation which supports long-standing practices for improving the operational and managerial efficiency and quality of life by building advancements in ICTs and infrastructures. There are three dimensions of innovation in government bureaucracies i.e. Management, Technology and Administration.

Innovation could be made in product, service, process (new ways in which organisational processes are designed and administrative reorganization into front-office and back-office processes), position (new contexts), strategy (new goals or purposes), governance (new forms of citizen engagement and democratic institutions), and rhetoric (new language and new concepts).

All innovations have opportunities and risks. A smart city characterized as innovation becomes a living laboratory for experiment, which necessarily entails unavoidable risks (generated by new, untested trials). The innovative initiative extends beyond technology, integrating technology by denizens, capability, and global reach into systems that are sufficiently complex. The failure in managing high risks leads to total failure in technology-driven sectors. Common reasons include poor planning, weak business package , lack of top management support, lack of leadership, lack of professional skills, mis-alignment between organisational goals and project objectives, vulnerability to policy swings, too much technology-driven enthusiasm, and political hyper- activism.

TECHNOLOGICAL AND MANAGERIAL ASPECTS

A smart city as an innovation harnesses the transformational potential of smart technologies (i.e. instrumentation with intelligent sensors), mobile technologies, virtual technologies, cloud computing and digital networks. These technological innovations induce technology-related risks such as incompatibility. Interoperability is fundamental to technological innovation in a smart city context and should be readily integrated across systems and organisations. Technological performance is not a logical progression from technological advancement, rather depends on effective management of technological systems and infrastructure. Organisational and policy innovation enables technological potentials and thus technological innovation requires organisational and policy innovation. Advances in technology, city management and policy are therefore necessary for innovation in following terms:

- Technology Innovation: A mechanism to change and upgrade technological tools to improve services and create conditions where the tools can be better used.
- Organisational Innovation: A mechanism to create managerial and organisational capabilities for effective use of technological tools and conditions.
- Policy Innovation: A mechanism to address institutional and non-technical urban problems and create conditions enabling for a smart city.

A smart city can be considered a contextualized interplay among technological, managerial / organisational and policy innovation.

Organisational Innovation

The managerial innovativeness is the most compelling reason to adopt new ICT's in core functions it affects the degree of technological and administrative innovation. A smart city is the application of intelligence to city management. Various strategic approaches are applicable to smart city innovation.

Enterprise Architecture

Enterprise architecture converges to two concepts: business process integration and business process standardization. Thus enterprise architecture is a business issue. Enterprise architecture is not only applied for companies but also to governments, it is considered a requisite for "whole-of-government" collaboration. Thus enterprise architecture is an important capability for innovation toward a smart city.

Cross-Organisational Management

Smart city innovation necessitates advanced levels of sharing and integration of information and knowledge. Governments must promote cross-organisational interoperability as a strategy for maximizing the value of information. Achieving interoperability across boundaries of agencies and levels of government requires leadership for cross-boundary settings, network, and governance.

Roles of Leadership

An important role of both executive and managerial leaders is also the cause of innovation. Leadership in cross-organisational settings represents various capabilities of leaders and managers. Leadership is not only exercised for a single agency, department or team, but extending to a network and enterprise of organisations. Implementation of a smart city initiative needs strong leadership to develop a social infrastructure for collaboration between enablers.

Policy Innovation

While technology is a tool, innovation in policy can lead to use the tool in a smarter way. Innovation in technology can be observed and broadly agreed. So, key policy directions for smart city innovation are:

- Policy integration
- Branding
- Demand-focused initiatives

Policy Integration

Urban policy plays an important role in shaping and changing the regional/ national / global linkages of cities. Coordination of policies-across a variety of spatial scales, across organisational practices and across all levels of governance-is of vital importance. Integration is not merely for technologies, systems, infrastructure, services or information but for policies. "Packages of policies", are essential to successful innovation. The distinctions between types of policy integration are:

- Sectoral integration relates to the coordination of policy fields and sectors (i.e. economic policy, transportation policy, and housing policy etc).
- Horizontal integration denotes the alignment of policies between enablers in an urban area.
- Vertical integration concerns the coordination between different layers of government i.e. typically federal, state (provincial or regional), local or municipal, in international context.

Different visions for a smart city may conflict with each other, but successful modern cities combine multiple visions.

Branding

Policy rhetoric is necessary for city marketing. Innovation in the policy dimension requires a branding strategy. Image making is pivotal for transition to a smart city. Hence marketing is necessary for cities that act as a magnet to attract new talent, resources and investments claiming its differentiating strength.

Demand focused Initiatives

Policies for successful smart cities are demand-driven rather than supply-driven or well-balanced between the two approaches. Smart city policies need to be balanced with more on the demand side and encourage diversity, social networks and cross-sector innovation. Successful innovation is often made by involvement of key stakeholders and demand focused policies may lead to better governance and it should

support collaboration and partnership as a strategy. A smart city becomes a laboratory for collaboration among different functional sectors and among different jurisdictions. Demand-side policies promote and facilitate active citizenship and citizen-centered governance. Citizen engagement has the potential to develop citizens' sense of ownership, awareness of their needs and ultimately reshape the citizen-government relationship.

CONTEXT OF SMART CITY

Any claim about the future of cities is necessarily contextual. Context characterises the innovation to a substantial degree. Each city has unique contexts regarding innovation and the way any city designs its strategy can be unique. So both, innovation and risk should be identified in context.

Physical Dimension

Today's technologies are "space-shrinking technologies", which have enabled a knowledge society and a global community. Geographical concepts matter for innovation of a city. The proximity of people is still a necessary condition for intensive communication and exchange of knowledge. Innovative organisations and people must continue to come together and cluster in specific areas (i.e. financial / industrial / cultural zones). The more concentration of the talents induces more innovative output.

Environmental Context

Urban policies are closely linked and influenced by the larger environmental (i.e. social, political, economic, cultural, and demographic) context. Success of the cities relies upon contextual differences in the relationships among key enablers and the environment of politics and economy. Many cities are concerned with the impact of aging society on technology diffusion. Another environmental context is that of urban competitiveness under international pressure. Hence the intensity of competition among global cities may shape the policies for smart cities.

Level of Interactions

The complexity of innovation and uncertainty of the environment influence innovations. Level substantially of complexity varies with the nature of interaction. Smart city innovative / initiatives can be inter-governmental, inter / intra-organisational. The scope of smart city initiatives can extend beyond city boundaries to multi-jurisdictional context. Objects of interaction include data, information, and knowledge. Activities for interaction will be sharing, communication or integration. Therefore smart city innovation requires the ability to understand the level and nature of the complexity.

SUGGESTED PROPOSITIONS

The smart city initiatives in managerial and policy innovations must create a balanced perspective in technological, managerial and policy aspects. Most of the studies are technology-oriented and optimistic for the smart city initiatives and innovations. But the findings are limited and incomplete. So this is an attempt to offer a more comprehensive view of the smart city phenomena. Conclusively, the following propositions are our suggestions to Urban System Collaborative.

Smart City: a Technological Concept for Socio-Economic Development.

Technology is a necessary condition for a smart city, but understanding of the concept is about the development of urban society for the better quality of life. The adoption of up-to-date technologies per se does not guarantee the success of smart city initiatives. Rather, innovation in management style and policy makes a city more livable.

Smart City is not System-Driven but Service Oriented.

The ultimate goal of a smart city is to enhance the overall quality of city services. Establishing an integrative system is not an end in itself, but a mechanism through which service is delivered and information is shared. Organisational and policy innovation for a smart city is to effectively manage service demands through governance.

Smart City is not only a Municipal Phenomenon but also a National or Global Movement.

World-renowned metropolises now reside in the context of global competitiveness. Smart city innovation initiatives in those cities are building strategies for marketing a city brand. The impact of a

smart city is national and global, beyond the all urban boundary.

Smart City is a Multi-Sectoral Concept

The scope of a smart city initiative goes beyond a single sector or organization. Smart city is a concept of partnership and governance developed through electronic linkage of multi-level, multi-jurisdictional governments and all non-governmental stakeholders (i.e. firms, non-profits organizations and citizens).

Smart City is not Revolution but Evolution

Some commentators derive an image of revolutionary change from a glance at current smart city cases. Considering only technological aspects of a smart city renders its image revolutionary. However, that's partly true Innovation is a long-term strategy and one should track the long-run evolutionary trajectories of innovation. As technology changes rapidly, management changes slowly and even policy evolves more slowly. Considering that, we claim a city can keep evolving to a smarter one through innovations.

Smart City is not a Replacement of Physical Structures but a Harmony between Material and Virtual World

The expectation that a smart city will transcend limitations from time and space is misleading, because the physical context of location and geography still matters for the way of life and the modus operandi of organisations. However, it is true that a smart city has a powerful potential to change our life, in some way and some degree, by shrinking distance and time. A city in the near future should be able to achieve its visions by seamlessly connecting between both the material and digital world.

SMART CITY INITIATIVE DESIGN(SCID) FRAME WORK

This approach may resolve the criticality of lack of a concrete design frame work for smart cities initiatives/innovations. The core aspects of governance for Smart City initiatives and their interrelation are shown in Fig. 1.

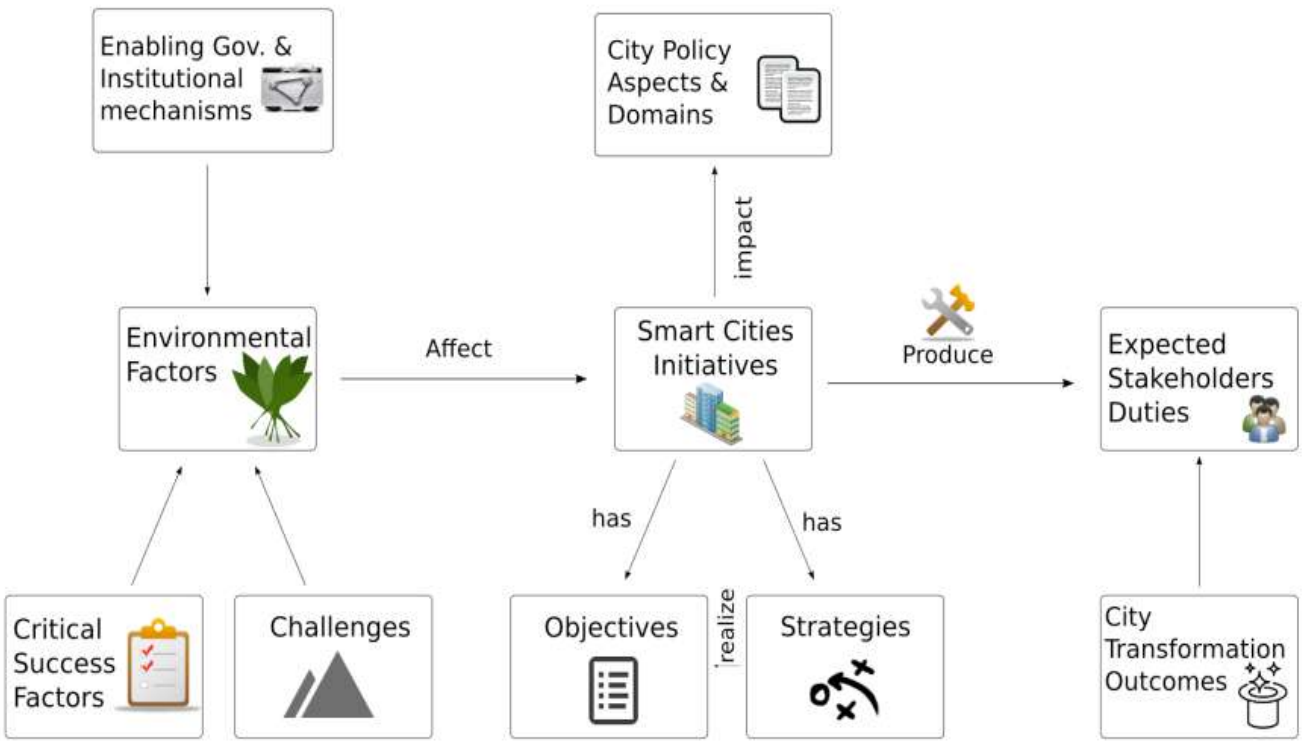

Fig.1 Conceptual Model of Smart City Initiative

Smart City Initiatives need to identified on basis of governance and institutional mechanisms, to address the challenges and critical success factors. The aspects of model establish link between the initiative and outcomes to provide a value-oriented perspective to the sustainable solutions.

Design process

Guided by the research framework and elaboration of the DSR methodology, the design process is proceeded through following steps:

- Identification of problem.
- Defining objectives for the framework.
- Design and development of the SCID framework.
- Demonstration.
- Evaluation of framework.
- Communication of the framework.

Overview of SCID

The elements of SCID framework are indicated in fig. 2 and dimensions needed to be covered in smart city programme are shown in table 1 followed by the strategies indicated in table 2. Components of smart city are show in Fig. 3.

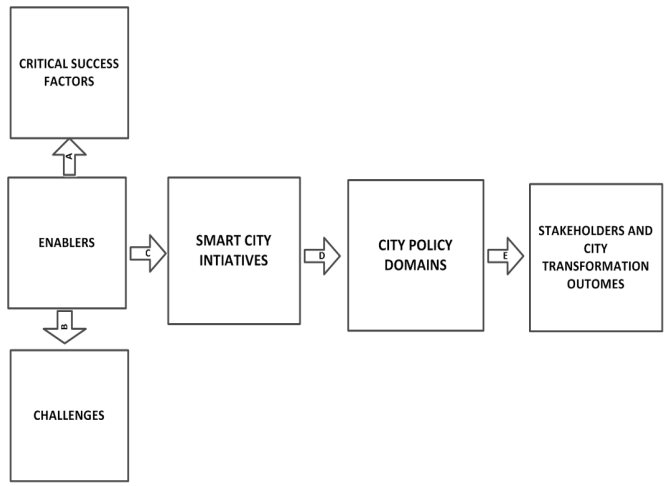

Fig. 2 Elements of SCID Framework

Table- 1 : Dimensions Needed to be Covered in Smart City Programme

Programme	Economy	Economy and environment	Energy	Energy and environment	Environment	Environment & people	Environment & energy	Governance	Life style	Life style & governance	Mobility	Mobility & environment	Mobility governance & environment	Technology	People
City - A	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
City - B															
City - C															
City - D															
City - E															
City - F															
City - G															

Table- 2 Strategies for Environmental Dimensions (from case studies)

Programme/ initiatives	Purpose/strategies
Waste management	• Waste separation into dry recyclables; wet recyclable, residuals & solid waste. • Designed to encourage recycling in low-income areas where it was more difficult to reach by the conventional waste management system. • Involved children in the program by exchanging recyclable garbage for school supplies, chocolates, and food parcel. • Hire retired and unemployed residents temporarily to clean up specific areas of the city. • Minimize the amount of waste, make reuse and recycling possible and enable the use of waste and sewage as an energy source. • Construction of waste separation system in buildings. • Food waste primarily be collected to produce bio-gas for vehicle fuel.
Open and green space	• Build a large green space as the city's centerpiece, which was modeled after New York City's Central Park. • Ensure that all blocks to connect pedestrians to open space, walking/biking corridors and public gathering areas. • Design open spaces and public gathering areas to optimize access to sunlight, views, and open sky. • Provide at least 40% open space to maximize the connection to nature within the city for residents, workers, and visitors.
Material flow and recycling	• 75% of construction waste targeted to be recycled. • Recycled materials and locally produced / manufactured materials be utilized to the maximum extent possible. • Reduced usage of Portland cement through the utilization of flash-content concrete. • Low-VOC (Volatile organic compound) materials be incorporated into buildings.
Environmental Sustainability	• Implement Sustainable city plan targeting: ✓ Reduction in energy intensity level. ✓ Raise overall recycling rate. ✓ Introduce sky rise greenery.
Land use Planning	• Provides land-use plan based on transit-oriented development. • Create centers for each district where local and centralized facilities in each neighborhood. • More land be converted to organic agriculture. Crop-free and pesticide-free zones in the agricultural landscape. • Biological diversity be preserved and developed for protection and management of nature.

Table- 3 : Expected City Transformation Outcomes and Components

Environment	Transportation	Energy	Economy
• Aesthetic value • Recycling take-up by residents and businesses • Green space per residential unit • Recognition - ranking and designation as best practice • Adoption of organic food	• Less congestion • Less CO_2 emission • Self-sustainability • Recognition – ranking & designation	• E-Vehicle adoption • Level of bio-gas production • Use of wind energy • Energy usage reduction • Petrol usage reduction	• Living standard • GDP contribution • Unemployment • Investment friendly environment • Recognition including competitiveness • Employment and job creation • Foreign Investment • Start ups

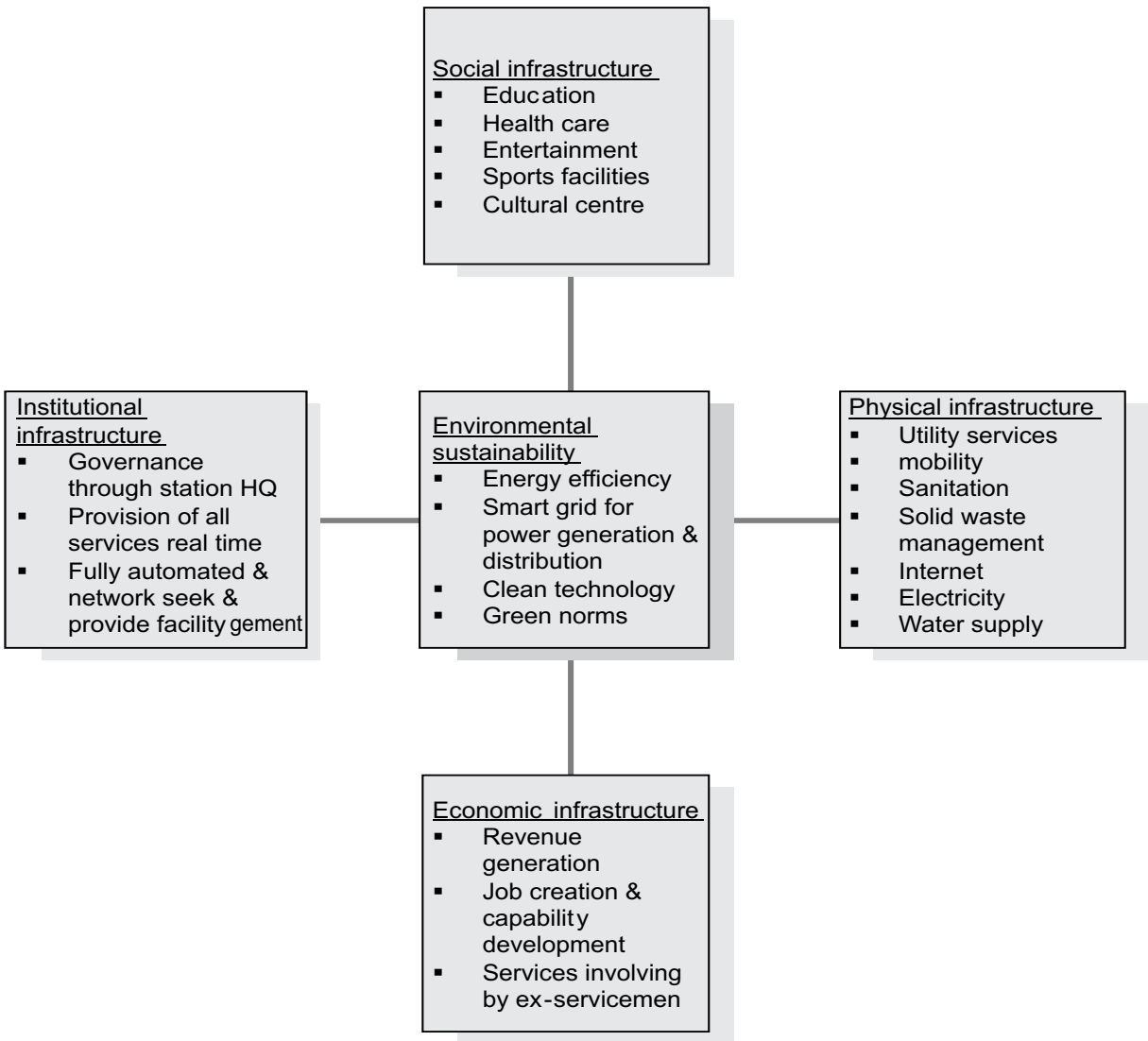

Fig. 3. Components of Smart City

Success Factors

Analysis of the success factors across cases are as follows:-

- Political leadership.
- Adoption of an integrated, holistic and whole-of-government approach.
- Creation of dedicated research and think-tank institution.
- Non-compromise on core values.
- Ensuring creativity and affordability of solutions.
- Comprehensive master-planning.
- Regulations and standards for stakeholders.
- Building stakeholder collaboration and industry partnerships.

Challenges

A number of challenges are as follows:

- Obtaining buy-in from stakeholders, particularly the private sector.
- Inclusion of poor areas in the program.
- Sustaining stakeholders' interests and participation.
- Resourcing and funding the programme considering high development cost.
- Obtaining residents participation.

Enablers / Governance

The types of governance actions have been identified as below:

- Coordination and Integration;
- Service Integration;
- Participation and Co-Production; and
- Policy and Regulations.

Ultimately, policy and regulatory actions include master-planning, institutional development, certification of practices (e.g. buildings), promotional activities (e.g. low carbon growth), and development of framework acts.

CONCLUSION

The knowledge and experience generated from concrete Smart City initiatives / innovations can be harnessed to develop a tool to guide policymaker intending to develop new Smart Cities. In view of the research works, its current form is limited by its existing knowledge-base. Thus, the utility of the tool is partly related to the richness and freshness. We intend to continue work on dissemination of the tool, monitoring and evaluation of its use in more diverse environments and its periodic updation for a novel social strategy for dynamic updation of the smart city design framework.

INTELLIGENT, INCLUSIVE AND INTEGRATED PLANNING FOR SMART URBAN INDIA

A.K.JAIN*

Abstract

India's 7936 cities and towns have a population of 377 million providing nearly 60 per cent of the GDP and 70 per cent of the jobs. It is projected that with a growth rate of 2.76 per cent year, in the next 20 years, India will add about 200 million persons to its urban population. However, poor infrastructure services, mobility, housing, crimes, environmental degradation, health and educational facilities are some of the obstacles in wealth creation and productivity. The government has recently envisioned a smart urban India, with commitment to develop 100 smart cities, infrastructure upgradation in 500 cities, besides rejuvenating 12 heritage and pilgrim cities. The Sardar Patel National Mission for Urban Housing endeavors to provide housing for all by 2022. The Swachh Bharat Abhiyaan (Clean India Campaign) aims to achieve the vision of a 'Clean India' by 2019. These varied initiatives have the potential to transform the canvas of urban India.

The paper documents various strategic interventions required in planning and development process. It also underlines the need for capacity development of urban local bodies in terms of finances, resources and planning. The paper highlights the need for smart urban governance with a closer spatial, institutional and financial integration that facilitates harnessing the resources of both the government and private sector.

INTRODUCTION

India's 7936 cities and towns have a population of 377 million. These provide 60 per cent of the GDP and 70 per cent of the jobs. It is projected that with a growth rate of 2.76 per-cent per year by next 20 years, India will add 200 million urban population, (Table 1). This poses a huge challenge of inclusive and integrated urban housing, land and infrastructure development, especially in the context of poverty and climate change.

Notwithstanding the fact that many Indian cities are abysmally poor, they are still the engines of productivity. However, poor infrastructure services, mobility, housing, crimes, environmental degradation, health and educational facilities are acting as a retardant in wealth creation and productivity. The potential can be enhanced by better infrastructure services, cleanliness, mobility, governance, innovation in technology and better and equitable housing.

Table 1: India's Urban Trajectory

	2011	2031
Population	1210 million	1440
Urban Population	377 million (31.16%)	600 million
Cities and Towns	7936	-
Million+ Cities	47	68
5 Million +Cities	6	10
Housing Shortage	18.78 Million Units	40 Million Units
Slum Population	65.5 million	100 Million

Source: Census of India, 2011 & McKinsey Report, 2010.

Recent policies and key missions envisage a vision of a smart urbanized India. In order to meet the growing aspirations of people and to respond to the

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daunting challenges of urbanisation, it is necessary to provide infrastructure services in all urban centers, with stress on water, sanitation, capacity building, waste management and roads. To address these issues, the Government of India has a vision of a 'Smart Urban India' and a commitment to develop 100 smart cities. These cities will focus on specialized domains and equipped with world class amenities, facilities, connectivity and better environment. Existing cities will also be made smart by development of networked infrastructure, services, digital planning, and e-governance. Wherever possible, twin cities and towns will be developed. For improving the existing cities, the Urban Development Mission focuses on the concepts of digital planning, smart infrastructure services, mobility, Wi-Fi connectivity, public health and hygiene, toilets, and solid and liquid waste management. The Urban Development Mission targets 500 cities, which is estimated to cost Rs. 16.50 lakh crores.

THE CONCEPT OF SMART CITIES

The Smart City intersects between competitiveness, capital and sustainability. Smart city means good governance, providing efficient health and education, 24x7 power and water, efficient transport, high quality sanitation, employment to masses and robust cyber connectivity. A city should provide reliable infrastructure, health care, attract investments by transparent business processes, simple and on line processes for various citizen services. This is possible by invoking smart, computerized services and communication. Standardization, automated production, intelligent services, transportation, information technology, wired buildings and energy efficiency are de rigueur of a smart city. The urban sector in India can't afford to postpone embracing the state of art urban services, such as smart, intelligent and bionic processes, gender safety, simulation, automation and robotics, renewable energy, solar mapping, etc. These are vital in making cities sustainable and inclusive. These also enable a wider public participation, online consultation of citizens in decision making.

Digital Planning: A city plan based on digital and GIS technology should realize full potential of resources, land and skills, while efficiently running daily operations.

Human Resource: A city must provide services that support the social, cultural, health and educational needs of citizens.

Smart Space Design: Integration of various land uses, transport network and physical and social services on a common network helps optimize use assignment and space configurations, eliminating underperforming space, with a significant increase in the productivity.

Smart Infrastructure: ICT (Information and Communication Technology) enabled infrastructure, comprising wireless devices, data centers and digital analytics can make the city and its services more efficient with a low carbon footprint. This needs new ways of planning and infrastructure management. Basic infrastructure services such as water, energy and transportation need to be made intelligent, smart and sustainable.

A blueprint for smart city focuses on intelligent computing infrastructures with cutting-edge advances in cyber-physical systems and innovations support the cities and achieving effective operations and smarter buildings. Energy efficiency, smart grid and renewal energy are integral to sustainable energy. The Government is supporting the 'Development of Solar Cities' that provide impetus to urban and local bodies in creating renewable energy cities. The living pattern should manifest a circular metabolism, replacing the existing linear system of input-output. The buildings have not only to be comfortable, green and energy efficient but also intelligent. ICT can help in improved and speedy repair of the infrastructure and respond to emergencies. The maintenance of the utilities and equipments can be substantially improved, while minimizing "windshield time". Recycling of waste water, rain water harvesting, coupled with waterless toilets will save the environment and avoid impending water crisis.

In a smart city multi-modal public transport comprising metro and rail network, Bus Rapid Transit (BRT) and IPT systems get preference over private modes of transportation. These have to be integrated with the strategies of the transit-oriented development (TOD) that entail clusters of compact, high density, mixed use development that provide housing, employment and recreational facilities, around public

stations or corridors. TOD enables strengthening the ridership and use of public transport among all economic classes. This also needs providing last minute connectivity, integration of multi-modal public transit and smart card. Walking continues to be one of the primary means for travelling for the common Indian. The provision of dedicated walkways and pedestrian safety allow an efficient flow of traffic and reduced accidents.

Clean and Open Defecation-Free Cities: According to National Sample Survey Office (NSSO) data 69.3% of rural and 18.6% urban households do not have toilets. According to the 2011 census, only 46.9% of the 246.6 million households have lavatories while 49.8% defecate in the open. The remaining 3.2% use public toilets. CRY survey report (2012) reveals that 37 percent schools in Delhi do not have functional toilets. Schools and public toilets often suffer from major flaws such as blocked sewerage, broken doors and no water. The Annual Status of Education Report for 2010 confirms the link between providing separate toilets for girls in schools and girls' dropout rates. The Supreme Court of India passed a directive to all the State Governments and Union Territories to provide toilet facility in all schools of the country by November 2011. The deadline has been crossed and yet 41 per cent schools do not have toilet facility for girls.

Liquid Waste and Sewerage: The existing capacity of sewerage system in Indian cities is grossly inadequate, as only about 55% of the population is covered under organised sewerage system and about 15% by on-site sanitation systems. Rest of the population does not have proper access to toilet and sanitation facilities. The increasing pollution in the rivers and water bodies is largely due to lack of sewage treatment facilities.

To improve the sewerage and sanitation, the surface drainage, water supply, waste water treatment and sanitation need to be developed in an integrated manner. This involves appropriate locations for sewage treatment plants (STPs), sewage pumping stations, recycling plants for waste water, common effluent treatment plants and conveyance system. Decentralised STPs with smaller capacities can be provided at the community level. Possibility of recovering energy/ gas from sewage could also be explored.

The sewerage system is designed to handle domestic liquid waste @ 80 % of the water supply. The recycled wastewater and treated sewage effluent can be used for gardening, washing, cooling towers, etc.

Solid Waste: The problem of solid waste management in Indian cities is assuming serious proportions due to increasing population, changing lifestyles and consumption patterns. The garbage from unplanned areas/ slums, Jhuggi-Jhompri (JJ) settlements, etc. is hardly collected which further adds to the environmental degradation. The projected average urban garbage generation in the year 2021 would be 2 lakh MT per day @0.5 kg per capita. Already large cities like Delhi generate about 10,000 MT of garbage everyday @ 0.68 kg per capita per day. Apart from domestic and office wastes, it also includes biomedical waste; hazardous waste from industries; construction debris, fly ash; meat processing, electroplating industry, automobile garages, etc. which require special handling. Major part of solid waste is usually disposed of in sanitary landfills. The rules prescribe the segregation of solid waste in separate bags of green and black colour, however, this is hardly implemented.

Land available for disposal of waste is shrinking fast, which is leading to a very challenging situation. Due to changing lifestyle, the waste material is becoming more complex with increasing plastic film, tetra packs, batteries, chemicals, e-waste, etc. Inert material in the municipal waste has been steadily increasing (30-50%), a majority of which is generated from the demolition and renovation activities. E-waste is a fast emerging issue which remains to be addressed properly. It is time that buy back and similar systems are deliberated upon and put in place. Source segregation, transportation and avoidance of contamination are important issues which are very difficult to achieve in practice.

An alternative is setting up Solid Waste Energy and Recycling Facility (SWERF). SWERF reduces the need for future acquisition of land for landfills by 90 per cent. Odours and health risks are reduced as the SWERF is totally enclosed. There is sterilized handling

of wastes and recyclables as the municipal solid waste is first processed in an autoclave. Greenhouse gases are reduced to the maximum by efficient conversion technology. Some options of Solid Waste Management that can be adapted according to waste characteristics and local context, include the following:

- Recycling, conversion of plastic waste into diesel/LPG, conversion of debris into building / road blocks.
- Energy recovery from waste
- Bio-methanisation technology
- Fuel-pellets
- Incineration technology
- Pyrolysis/Gasification technology
- Composting (aerobic window, an aerobic, tunnel, bio-reactor in vessel, etc.) and Vermi-composting
- Pneumatic waste collection

The rag pickers and kabaris are important stakeholders in waste recycling, who need to be recognized. Pune Municipal Corporation has brought them in the loop and provides them with remuneration, uniforms, gloves, pushcarts and health insurance.

River Cleaning and Regeneration: Almost every Indian city is situated along a river or water body, which is not only the source of water, but also has a social, cultural and religious value. However, with indiscriminate urbanization these have become polluted. River Ganga was ranked among the top five most polluted rivers of the world, with the faecal coliform level in the river near Varanasi more than 100 times the norms. One billion liters of raw, untreated sewage is estimated to flow daily into the river. In Uttar Pradesh out of 742 towns and cities, only 17 have sewage treatment plants. As a result most of the sewage, estimated at 2900 million liters, flows into river. 10,000 dead bodies are thrown into the river each year, besides cremation of 40,000-50,000 bodies on its banks every year. The river stretch from Kanpur to Kannauj is most polluted, mainly due to industries and tanneries. Ganga Manthan organized by the National Mission for Clean Ganga during July 2014 revealed that sewage accounts for 95 per cent of river pollution in big cities such as Varanasi, Kanpur and Allahabad. Encroachments and construction in river bed, illegal mining of sand and water are other major issues.

About Rs. 20,000 crores have been spent under the Ganga Action Plan since 1986 and about 3,000 crores under Yamuna Action Plan since 1993. Both have been abject failures. The conventional sewerage models and techno-environmental approaches have not worked. The issues are closely intertwined with the social, cultural and religious context, whereby the community participation and governance have a key role in the rejuvenation and cleaning of the rivers. This implies coordinated actions, which synergise socio-cultural, environmental, political, administrative, technical and financial aspects. The institutions connected with the river have to be professional and capable of working with the public and understanding the nuts and bolts of social engineering. Without public support and participation, it is not possible to achieve the purity of the rivers.

To ensure the flow of water in the river release of water from upstream barrages and development of reservoirs in low lying areas are necessary. Up-gradation of water quality to prescribed standards needs to be ensured and monitored. By de-silting the existing pondage areas can be enhanced. Construction of micro-dams upstream will help collecting the monsoon excess which can be released in the rivers during lean periods. Natural in-stream elements, e.g. root wads of downed trees provide essential slow-water habitat for fish and insects that will regenerate native wetlands.

Innovative, economical and pragmatic solutions like primary treatment, bio-remediation, oxidation ponds, aeration, etc. can be employed to treat waste water. For treatment of pesticide traces, capping the existing sand bed with bituminous charcoal or coconut shells can be an easy and inexpensive solution. Increasing flocculants by adding powered activated carbon or bentonite clay with doses varying from 25-30 mg/l and the use of granular activated carbon can be effective, subject to its cost. Raw water tanks and rainwater storage can be protected by clay beds, which should be secured from getting washed away during the monsoons. The best way to get rid of

the pesticides and industrial toxins is through "source protection measures", i.e. protect the catchments through methods such as organic or biological farming.

To ensure the conservation of the eco-sensitive nature of the river zone and to take up the removal of polluting and non-conforming activities from it, a legal shield is a must. The agencies dealing with the river, land, water, power, irrigation, drainage and sewerage should work together to evolve coordinated water supply-sewerage-drainage and flood control schemes, and preparation of integrated environment management plans. The regularization of encroachments, religious structures, industries, commercial activities and unauthorized colonies in river zone/flood plain should be avoided and carefully dealt with, keeping in view its eco-sensitive nature and within a comprehensive Watershed & Environment Management Plan.

Rejuvenation and Conservation of Heritage: India's cultural, historical and archaeological heritage assets rank as one of the finest in their diversity and antiquity, they are as varied as they are rich. However, the pressure of rapid urbanization, commercialization, inadequate financing and poor enforcement have put this rich cultural treasure under serious threat of deterioration and decay. The images of smart cities being projected by the consultants are scary, which can be in China, Dubai, Europe or Australia. They do not relate to Indian culture. It is necessary to work out a design vocabulary for smart cities, which retains and respects the Indian culture. The challenge is to design and preserve the whole city and its physical, cultural, social and economic revitalization. This should start with the historic and pilgrim cities and make them smart, clean and sustainable.

Effective management of heritage requires its integration with overall planning and development process, which encompasses delineation and listing of historic settlements, zones/precincts and heritage buildings. These can be improved with infrastructure development, safety systems, signage, landscaping, mobility, tourist facilities, information centre, public toilets and rest rooms, dharamshalas/hotels, camping sites, heritage museums, cultural centers, haats, art galleries, training centers for local arts and crafts, heritage institutes, etc.

Housing for All

The social housing shortage, growth of slums and informal settlements, even after 67 years of the Independence is one of the most dismal testimony of the failure of the authorities. The poor and even salaried class have been pushed outside the formal housing market, who are forced to seek shelter in illegal/unauthorised colonies, urban villages or in distant suburbs, due to exorbitant land and housing prices. The housing output of the government sector has been diminishing progressively, which is moving towards market led production. This is resulting in luxury housing and profit-oriented real estate market, which lack community ownership.

The government is committed to provide housing for all by the year 2022. This involves building 20 million houses, and development of about one lakh hectare of residential land. Another one lakh hectare of land is required for LIG, MIG and HIG in ratio of 3:2:1 at average densities of 600 dwelling units per hectare, 300 dwelling units per hectare and 150 dwelling units per hectare respectively. At 300 Floor Area Ratio (FAR) the average dwelling unit size of 50 sqm, 100 sqm and 200 sqm would be available for three income categories. Assuming 50 per cent of city area required for social infrastructure, transport, utilities, parks, playgrounds and work centres, there is a need to assemble, plan and develop about 4 lakh ha or (4000 sq. km) of area during next five years.

To overcome the ever increasing cost of the urban land and its acquisition, it is necessary that existing urban lands are recycled and developed to its optimum efficiency. Also, the slum rehabilitation and social housing projects may be deemed as a 'public purpose' for acquisition of land. This necessitates that the social housing projects are based upon the principle of using land as a resource, with a market sale component of housing (maximum one-third of total FAR and land), part commercial use and are designed with optimum FAR and density.

The delivery of social housing can be accelerated through the implementation of reforms in the land policy, legislative, regulatory and fiscal frameworks. Linked with this is the need to review housing and planning standards which are sustainable, affordable and efficient, and the use of best available construction

technologies. It is equally necessary to take up the improvement of the existing housing stock and rundown public housing areas.

Social housing should also be available on rental basis as many poor families cannot afford the down payments and EMIs. It is necessary that as a rule in any government facilitated housing scheme, at least one-fourth of housing is built/developed by individuals/plot owners, one-fourth by cooperatives/ community groups, one-fourth by government/PSU/ local body and one-fourth by the private sector/PPP.

For housing delivery with speed, quality and economy, it is necessary to adopt state of art, industrialised building systems. The modernisation of Hindustan Housing Factory, New Delhi can be taken as a pilot. The main objective of systems building is to achieve quality, productivity and flexibility, together with reducing time and costs. Automation and robotics give precision to pre-fabricated building components and enable accuracy and customization. Computer-Aided Manufacturing and Computer-Integrated Manufacturing for pre-fabricated components, viz. ceilings, walls, roofs, etc., are integral to the process of industrialized construction. The simulation of construction process enables better control of time, machine, expenditure and the manpower, which could be reduced at least by half to one-third in comparison to the conventional construction. This is also essential for the reasons of ecological sustainability and inclusive growth.

According to the Indian Exclusion Report (2013-14) of the Action Enterprise, Bangalore, 95 per cent of financing in housing sector has gone to middle and high income group from public sector banks and housing finance companies, where the shortage is a mere 4 per cent. Compared to this, only 5 per cent of the financing flowed to weaker sections and low income group housing, where the unmet need is of the order of 96 per cent. This demands a paradigm shift whereby the public sector banks and housing finance companies have to reverse their policy of housing finance. It should be mandatory to give 90 per cent of total housing loans for social housing. This is important if we want to provide housing to all by 2022.

Under the Home Owners Mortgage Equity Subvention Scheme loan limit has been raised from Rs 5 lakh to Rs 10 lakh for EWS and Rs 8 lakh to Rs 15 lakh for LIG categories, along with 5.5 per cent interest subsidy on these loans. To make loans available to the poor a Rs. 1000 crore Credit Risk Guarantee Fund has been established, which will fund around 1.2 million affordable housing units.

15th August 2022 is only 7 years away. delivery of 20 million dwelling units would not be possible without innovations in land assembly and development, planning, design and construction. This is a unique opportunity to introduce state of art processes, such as digital planning, spatial data infrastructure, infill development, building information modeling and single window plan approvals. Intelligent and smart services, especially sanitation, water and energy and recycling of solid and liquid wastes, are necessary for sustainable delivery.

Smart Governance

In any city there are more than 100 citizen services that require engagement with civic authorities. This involve for enquiries, registration, form submissions, payments, maintenance grievances, etc. The availability of Spatial Data Infrastructure, Computerised Land Records, Digital planning and e-gateway for citizen service delivery have attracted much attention in municipal governance and bringing out a silent revolution in urban governance, breaking away barriers of distance, class and gender. The digital systems are increasingly creating an emerging sociology of urban space. It is redefining and imbibing the idea of exclusion and inclusion. The smart card is already being adopted for seamless travel in public transport, access to public spaces, payment system/ gateway and social services. It also makes redundant to travel to local offices, banks or government departments for public services. Digitized revolution is also helping in adopting innovative and eco-friendly urban practices, such as virtual town hall, security, traffic simulation, property registration, taxation, etc. Smart chips and systems can be embedded almost in every urban service and structure, making them smart and intelligent. These enable self-diagnosis and self- repair. The future is already upon us, and with digital chips getting embedded in a city's epidermal and exoskeleton level and also its connective tissues,

cities are increasingly getting digitally scripted and coded.

In view of the growing crimes against women and children, establishing gender sensitive and child-friendly cities has become priorities. Ensuring that women are able to travel safely is crucial for their participation in the overall social and economic development. Through endeavour of proper lighting, surveillance/CCTV identifying and avoiding vulnerable danger points, early warning, insurance provision, disaster resilient infrastructure and appropriate policing can help in safer cities for children, women and all citizens.

So far governance services have been mostly delivered individually and there has not been significant effort at integration. Utilizing the ICT infrastructure for delivering integrated services through web and mobile platforms will metamorphose smart governance.

Financial Resources

The Smart City development involves huge financial investments, particularly for land acquisition, assembly and development. The budget allocation is Rs 7069 crores for 100 smart cities is only symbolic. Gandhinagar GIFT city, covering 700 Ha, involves an estimated investment of Rs 76,000 crores. As per preliminary estimates @ of Rs. 35,000 crores, per city, about 35 lakh crore would be required for 100 cities.

The acquisition of land under the new Land Acquisition R & R Act, 2013 itself can be the reason to put a full stop on the whole scheme. The capacity of government is limited in terms of financial resources. The experience of private sector participation in urban development indicates the marginalization of non-profit sectors such as social housing and infrastructure services for the poor.

Land being the most critical factor, it is essential to optimise its utilization by infill development, redevelopment and redensification, and rationalizing and enhancing the floor area ratios and residential densities. The focus for next five to ten years should be on the brown-field development rather than the green-fields.

Land Pooling and Readjustment can be an alternative to compulsory acquisition of land under the LA & RR Act, whereby the land required for public infrastructure services and social housing can be reserved and retrieved free of cost, against development rights, land use conversion and enhanced FAR for the land owners. This necessitates developing a strategy that ensures social, spatial, financial and infrastructure integration by strategic planning and governance reforms. The IGI Airport, New Delhi, International Airports at Mumbai and Hyderabad, Sports City/F-1 Racing Track, Noida, Yamuna Expressway and Ganga Expressway in Uttar Pradesh are some of the examples of the projects where the cost of infrastructure development is part-funded by the award of land rights, user charges and commercial use.

Integration and Inclusive Planning: City development involves mobilizing the resources of the local, state and central governments and also the private sector. It necessitates horizontal and vertical linkages which integrate spatial, financial and infrastructure planning, while considering sustainability factors. It minimizes the energy use, minimize development on high value agricultural land, avoid vulnerable groundwater resources, optimize use of land (e.g. mixed use areas, redevelopment and redensification, multiple use of buildings, etc.).

The preparation of integrated District Planning Framework covering urban, peri-urban and rural areas, based on a participatory planning and decentralized decision making process, can provide a strategic and effective mechanism that links spatial planning to financial, economic and infrastructure development.

Relatively low and uniform floor area ratio have distorted Indian urban land market by promoting sprawl, increasing transportation and infrastructure overheads. It is necessary that the FARs are rationalised to permit higher density development in the areas with adequate infrastructure and public transportation capacities, both existing and future. Gains in property values can be recouped for social housing and infrastructure development.

MANAGEMENT REFORMS

To make the ambitious Smart City Programme and Urban Development Mission successful, the following management and procedural reforms are necessary:

- Preparation of a land information system, SDI, digitised land data/ ownership details land management program, land regulation and transfer, etc.
- Preparation of Local Area Plans and program for land pooling, infill development, densification, Transit Oriented Development and Redevelopment.
- Government land bank for spot exchange/ adjustment of land with land poolers
- Allocating share of land from land pooling projects for social housing.
- In-situ upgrading slum and squatter settlements
- Working out Infrastructure Service Plans and estimates and their financing sources.
- Action Plan and programmes combining plan funds, EDC, betterment levy, etc.
- Time-lines, action programmes, quality control and monitoring.
- Streamlining approval procedures
- Pre-selection of the experts/consultants/ contractors for award of work on pre-determined approved rates, without the need of time consuming tendering, EOI, etc. for each project.
- Timely recovery of development, conversion, FAR, Betterment/ Service charges, etc.
- Government/ULB to assist PPP/ RWA/ Community/land owners to take up social housing, Redevelopment, conferring land titles/ registration /licenses, and initiate pilots.

Urban management needs simultaneous capacity development and overcoming delays and cost overruns by time-bound action planning and effective monitoring. Technological interface is necessary with respect to standards and specifications, infrastructure, construction and maintenance. There is a need to adopt new contracting procedures for efficiency, quality of service and sustained maintenance. To meet the huge urban targets there is no option, but to optimize and synergize the resources of both public and private sectors. Various models of land assembly and public- private partnerships are being implemented in India. These experiences make explicit the need to evolve a plural, hybrid land policy that responds to urban variety and ensures development of housing, infrastructure and transport networks. This means that a vision of smart cities should encompass the wider canvas of district planning, including their rural periphery. It should integrate with the Urban Development Mission, Hridya Scheme, Clean India Mission, Clean River Mission & Housing for All. However, caution should be exercised that Smart Building and Smart City are two different phenomena. The concept should closely relate to local culture/ heritage, livelihoods, informal sector, ecology, gender sensitivity and security. As a city takes 20 to 30 years to develop and populate, start with transforming the existing cities, like Chandigarh, Dwarka, Narela and Rohini in Delhi, Itanagar, Bhubaneshwar, New Mumbai, Vashi, Nerul, Naya Raipur, etc. Concepts of Infrastructure Bundling, Transit Oriented Development, Land Pooling and Return, Financial SPV can help in resource mobilization. In order to harness the advantages of both the government and private sectors a gradual transition by a hybrid approach can integrate best of the two worlds.

CONCLUSION

India is entering a new era of social and financial inclusion, economic growth and sustainable development. Its success is largely contingent upon intelligent, integrated and inclusive development of cities, infrastructure and housing for all. To take up the new agenda and the challenges of urban growth, there is a need for reviewing the urban planning practices and take a quantum leap in making the Indian cities inclusive, smart and sustainable.

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PLANNING AND DESIGN OF SUSTAINABLE SMART CITIES IN INDIA

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Abstract

India is urbanizing at fast pace and the urban population will cross 600 million by 2031, which will be very critical to the country's sustainable growth and cities will require large scale up gradation to support the future population. For this up gradation of Indian cities, the aim of planning and design of Smart Cities should be to harness IT and Knowledge Infrastructures for better economy, social cohesion, city administration and infrastructure

The objectives of a smart city should be, to achieve spatial intelligence, effectiveness in solving urban problems, competitive services and inclusion. Integration of the new communications potential from sensors on buildings, roads and other elements of the City and the sharing of data between service delivery channels will enable the City to improve services, monitor and control resource usage and react to real-time information.

This paper basically focuses on objectives of smart cities, essential items of smart city, financial and social aspects of smart city, strategic planning for smart city, road map for a smart city, a pilot project for smart city, risk management in smart city.

INTRODUCTION

The term Smart City is widely used, but very little clarity appears in the definition behind it. Smart Cities gained importance as a means of making ICT enabled services and applications available to the citizens and authorities that are part of a city's system. In the recent time, the concept of smart, intelligent, or cognitive cities has gained increasing attention as an approach for addressing the challenges of urban management. It aims at increasing citizens' quality of life, and improving the efficiency and quality of the services provided, city administration entities and businesses. Smart City is a city that uses new technologies to make them more livable, functional, competitive and modern through the use of new technologies, the promotion of innovation and knowledge management. The premise of a smart city is that by having the right information at the right time, citizens, service providers and city government alike will be able to make better decisions that result in increased quality of life for urban residents and the overall sustainability of the city. Information resulting from a smart city implementation has a two-fold impact:

- Bottom-up- It shifts the social behavior of citizens towards a more efficient and sustainable utilization of city resources.
- Top-down- It allows service providers and city government to provide more efficient and sustainable services. Steps required for a smart city are conception, analysis, planning and design, implementation and control.

OBJECTIVES OF SMART CITIES

Planning, design for development of Smart City is a unique initiative which aims at providing a strong sharing platform and offers a unique opportunity for all concerned to get involved in the development of smart cities to exchange ideas and foster the new integrated approaches. It should be objective of planning design and development of such smart

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cities, which are ecologically friendly, technologically integrated and meticulously planned with a particular reliance on the use of IT to improve efficiency. The objectives of smart cities are, to apply ideas, of urban planning, smart mobility, smart utilities, smart energy, safety & security, smart governance and economic development of city by smartening the urban systems with existing circumstances to optimize resource utilization. Other important objectives of development of a smart city are listed as under : -

- Carbon reduction and neutrality
- Achieving energy efficiency
- Leveraging ICT to develop niche industries such as those relating to multimedia or knowledge-based industry
- Attaining the highest quality living environment for residents
- Developing green areas within the city
- Developing state-of-the-art information infrastructure accessible to all
- Achieving economic growth and quality of life simultaneously
- Developing Sustainable communities
- Ensuring social harmony among different groups of residents
- Evolving city as living laboratory to foster continued improvements.

ESSENTIAL ELEMENTS OF SMART CITIES

All smart cities in India must have three essential traits ICT infrastructures, integrated city management framework, and smart users. In order to implement an extensive development of Smart City essential elements are necessary: -

- Power-Smart Cities require clean and continuous supply of energy.
- Infrastructure- Up gradation and maintenance of the existing infrastructure is a necessary.
- Funds- It is essential to develop innovative and viable mechanisms to secure funds for developing smart cities.
- Technology- Smart cities require technology advancements that can support the overall objective of the initiative
- Social infrastructures- Promoting innovations in technology and providing skilled human capital that can create, engage and sustain the future cities will be an integral element
- Transportation- Smart cities provide seamless integrated public transportation that allows efficient and swift mobility across the city
- Smart Buildings- Smart cities will consist of energy efficient buildings that reduce the overall carbon footprint
- Governance- Every citizen will have access to quality social and physical infrastructure.

STRATEGIC PLANNING OF SMART CITIES

Planning and design of a smart city is based on three pillars; infrastructure, operation and people. Strategic planning has to address all three pillars of smart city in details as under :-

Infrastructure -

- Power distribution built on smart Grid technologies like smart meters, digital sensors,
- Services- advance communication system
- Water-intelligent water management using instrumentation and analytics
- Energy-renewable energy
- Telecommunication- fiber optics, digital infrastructures
- Transportation
- Smart lighting- LED
- Assets lifecycle management
- Smart waste logistics
- Intelligent transit
- Real-time optimization
- Integrated fare management
- Parking
- Airports
- Planning and management

Operation-

- Law enforcement
- Smart surveillance
- Emergency management
- Smart buildings and urban planning solutions

- Government and agency administration solution
- Environment

People -

- Social program and healthcare
- Education
- Biometric identification
- Healthcare
- Wellness

DESIGNING OF SMART CITIES

Design teams must operate across the complete project lifecycle, from assessing the physical opportunities and constraints of a site and considering the viability of different development options, to working with planners and developers to design and build the best smart city solution. A design team should focus on following three pillars of design of smart cities.

Infrastructure - A single, 'smart', shared control system would not only avoid duplication, with significant cost savings, but also provide a far richer picture of what is happening; enabling more informed decision-making and more rapid deployment of measures to deal with emerging situations.

Environment and natural resources - It is duty of all those developing smart cities to avoid resource depletion and waste production and to begin to repair some of the damage:

- Identifying approaches to urban development that reduces resource inputs and reduces waste outputs. Using smart technology to create efficient buildings.
- Designing buildings and neighborhoods to re-use or recycle the by-products of heat and recycle water.
- Designing buildings and neighborhoods that consume fewer resources.
- Optimizing generation processes and distribution networks.
- Introducing renewable energy sources. Ensuring demand and supply side matching
- Adopting Integrated Systems Engineering.

Society and community - To accommodate the rising urban population in India, we will need to build more than 100 sustainable smart cities. Important factors for urbanization are access to better education, improved mobility, access to health facilities, greater communal safety, greater individual self-expression, improved accessibility.

Sustainability of Smart Cities - For a smart city, it is imperative to encourage people's participation in social sustainability through an idea of e-participation. This public participation in a smart city can be achieved through some portals for different causes and different movements for betterment of cities and nation altogether. Environmental sustainability also plays an important role as well. Sustainable urban development is achieved only when there is a right balance between growth parameters protecting weak environmental factors. In a smart city every citizen is a user, and a designer. Through integration strategies, the participation of all citizens of smart cities can be accomplished. There is a need to understand the impact of smart cities on urban environmental, social and economic sustainability from a holistic perspective. The main objective of the planning and design of smart city is to develop new scientific methods and tools to support Indian cities in their transformation into smart cities. This will be achieved by the extensive use of low carbon technologies and smart energy management based on innovative design and operation of the entire urban energy system. This will result to reductions in energy demand and greenhouse gas emissions while at the same time creating a liveable environment for residents.

PILOT PROJECT FOR CHANDIGARH AS A SMART CITY

A pilot project can shed light on the processes of e-services design for smart cities. This smart city can be realized in the framework of the people of Chandigarh, which aimed at speeding up the uptake of smart city ecosystems through the rapid implementation, deployment, and uptake of innovative internet-based services. The pilot project can be implemented in strong collaboration with the UT administration. The project should be started with a detailed analysis of both the city environment and the local innovation system. The analysis revealed the spatial concentration of commercial, administrative,

academic, and cultural activities combined with recreation and sports facilities, entrepreneurial, and research premises. However, the spatial proximity of the above mentioned activities does not seem to create enough synergy or some kind of complementarily in order to sustain a vivid commercial ecosystem. In Chandigarh city, despite the large volume of people inflow, local businesses lose market share at the benefit of nearby larger markets and malls. There is some urban problem in Chandigarh like, traffic congestion around the city's main roads, where the heart of the local market lacks street signaling and parking there by creating pollution, and high urban density. Regarding digital infrastructure, although a wireless network is available in the city but it is not free, the digital applications and e-services offered do not correspond to the citizens' and merchants' needs and expectations. These challenges constitute both a weakness and opportunity for Chandigarh to reinforce the commercial city center, improve its attractiveness and quality of environment vis-à-vis nearby markets and malls, through the design and implementation of smart city services and infrastructure. The analysis of Chandigarh city's innovation ecosystem aimed at identifying actors of change: public bodies, public service providers, users, and companies that might guide the design of technological solutions and e-services. The mapping of the city's challenges and actors of change to be followed by a horizon scanning to identify technologies, applications, and solutions that bolster commercial activities and local marketplaces. We should focus on solutions related to mobility, urban information management, and e-commerce. About 20 different applications of intelligent transport systems, e-commerce, and ICT for tourism and leisure can be identified. Based on the conclusions of the survey in terms of challenges, communities, stakeholders, and available technologies and solutions that can make a Chandigarh more sustainable and attractive, a planning scenario to be drawn. This scenario -combining a wide range of digital applications- should be interconnected the different activities that take place in the area and offer a better environment in terms of access, commerce, and environment. The open consultation process should be carried out with the design of a platform composed of following five components.

- **Smart marketplace:** Create a virtual marketplace managed by the local shopping community. It will compose of four interrelated subsystems: a virtual marketplace with numerous individual e-shops; a business directory with description and location of professional and businesses on the map; an application for product offers and promotion; and customer assessment of e-shops.
- **Improve**-my-City enables citizens to directly report non-emergency problems to the public administration and requests about local issues such as discarded trash bins, faulty street lights and broken tiles on sidewalks, illegal advertising boards, and suggestions for improvement and urban renewal. The reported issues are automatically transmitted to the appropriate office of the city administration so as to schedule their settlement.
- **Virtual city tour:** Creates an engaging, interactive, collaborative community map of local sights and attractions. Users are able to submit photos and 360 degree panoramic virtual tours of their favorite points of interest and attractions.
- **Sense the city Chandigarh:** A network of sensors that receives, collects, and visualizes air pollution data from sensors distributed around the city.
- **Parking spaces availability:** Informs about free parking space in premises and open parking areas located in the city center. The parking inventory is updated regularly and delivered to users through web and Variable Message Signs. Number of hardware installations also to be established at places, including: four environmental pollution monitoring stations; one car park at capacity counting station; three outdoor electronic displays showing the available parking spaces in real time; and four interactive information terminals (info kiosks). The combination of hardware infrastructure and software applications creates a layer of smart city services that helps to improve the physical environment of the city center, enhancing its attractiveness and functionality.

INFORMATION MANAGEMENT IN SMART CITIES

The goal of a digital city is described as "creating an environment for information sharing, collaboration, interoperability and seamless experience for all its

inhabitants anywhere in the city". Cities require accurate and real-time information about the status of urban services in order to improve public safety and provide adequate infrastructure-based services such as safe drinking water, reliable electricity, and sustainable, safe and reliable transportation and communication. However, traditional cities cannot optimize this provision of services due to constantly changing conditions. Important officials are not able to access the requisite information for decision-making in the right form, and at the right time. The utilization of IT for decision-making by citizens, service providers and city government has given rise to the general notion of a smart city. Any information-centric city features three mutually connected dimensions: technology, human and institutional. Combining software and telecommunication networks, sensors, and identifiers creates intelligent cities.

FINANCIAL AND SOCIAL ASPECTS OF SMART CITIES

Financing smart cities requires integrated solutions to ensure energy efficient urban development. Grids, energy supply systems, energy efficient buildings, transport and the behavior of citizens will lead to considerable energy savings and green house gas reductions. Barriers to financing smart city technological solutions can be summarized as follows: -

- Perception of high risk when investing in innovative solutions and energy efficiency measures;
- Uncertain energy price policies and uncertainty about fossil fuel prices
- Large volumes of investment required
- Long-term delays before reaching maturity/ profitability.
- Limited capacity for public funding: high public deficits in municipalities and incapacity to raise funding from capital markets.

SUGGESTED STRATEGIES FOR SMART CITIES IN INDIA

Suggested strategy planning, design and development for smart city in India is as under:-

- It should be ensured that smart devices are available to all citizens.
- A smart city should have Wi-Fi network for administrative functions, CCTV network enabling exchange of video data and U-service network for connecting the websites of all the public offices. Smart city should have web site for sharing of information like, General administrative work , Welfare, Culture, Tourism, City management, Environment, Safety/ security, Education, Health, Industry, Economy, Transportation.
- Within these categories, public information systems and different datasets should be included to provide information on child-care services, public-transportation routes, bus arrival times, parking availability, and weather conditions by region.
- Information should be available for recommended restaurants; all accompanied by maps, internet links, graphs or statistics.
- Smart city should share almost all information in its original form with the exception of citizens' personal information.
- Comprehensive research of smart cities need a combined approach for accommodating state of the art, sustainable and broad rationale with insights into sustainable transportation, green energy, environmental quality, smart building, affordable housing, resilience for risk, availability of potable water and food and many other different domains.
- Enhance application of geo services, geospatial data in the form of projects which should be majorly driven by government departments. In addition, in terms of online maps and other software applications.
- In India, there is already an onset of the usage of ICT in most of the Indian cities but the comprehensive social structure that is induced by information and communication technology can be established through urban planning using GIS.

CONCLUSION

The approach of planning design and development of smart city ranges from a complete city solution covering infrastructure, transport, governance, business, economic and land use

planning and digital master planning to individual projects whether building, campus, district or public realm. The common thread is an acute understanding of how professional services are interrelated, bringing them together to work most effectively whilst at the same time creating greater opportunity for efficiencies through the application of technology. There is a need to create layers of smartness of a city not just resource efficiency but health, sustainability, a sense of shared community and an ability to adapt to future challenges. In addition to link these layers to harness data to enhance efficiencies of city operations and urban living even more. Smart cities are thus capable of altering the environmental and social behaviors of citizens, whether this means providing information about mechanisms for reducing energy consumption, or updates on travel routes.

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ANALYSING, PLANNING AND IMPLEMENTATION TRENDS FOR SUSTAINABLE SMART CITIES

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Abstract

India is gaining a technological impetus under the present Government. A healthy work life balance is key ingredient for increased efficiency and comprehensive growth. Indians are today on the cusp of a critical paradigm shift in how to approach in our professional and personal lives. Abundant appliance of innovation is absolute tool leading to favoured growth of region. Significantly redevelopment of the urban areas inclusive of regional long-term projection of upcoming growth is principal challenge for Planners and stakeholders. Objective may be achieved by upgrading mindsets, skills and competence at all levels leading to prosperity. Brave trends across the sectors are helping us interpret what lies ahead for our speedily transforming nation.

An attempt is being made through this paper by analyzing varied attributes and their methodologies in urban planning of smart city. Objective of paper is to put forth unique parameters for smart developments and achieve adequate strategies for advancement.

INTRODUCTION

Urban Planning, rethinking with concepts of Smart in Indian context combines sustainability. The merit of sustainable with smart may not vary. Sustainable in smart city has turn into a traditional wisdom. India is put up with multitude canvas of colors, vibrancy, culture and events with a tag of unity in diversity. This scene further lays prominence on an influential swing to the inclusive paradigm in development scenario. A smart formula needs to be applied with its adaptive theorem of addressing existing situation in equilibrium with new initiative of urban intervention. The epitome of smart cities is not in the inception but in addressing current scenario of Indian cities with urban population .Rate of urbanisation is on edge to augment by cities contributing to 75 % of GDP in next 15 years. The smart city venture needs a stylished approach in true Indian flavour embodied remarkable yet complete underlying an unusual genus.

The India lifestyle spells an ordered chaos, as in realistic with jerks and brakes, push and pull features. The cities should aim at branding underlying sustainable everyday urbanism against smart futuristic globalism. Showcasing potentials, addressing the contextual reality against the global frame poses the challenge in realizing smart city.100 smart cities in India from visionary dream to reality needs the path to etched, directions drawn, socio-economic foundations laid and raised on pillars of regional strength.

COMPONENTS OF A SMART CITY FROM PART TO WHOLE

The indicators of a smart city are largely outlined on general terms of Infrastructure, economic incubators and ICT networks. The specific dynamics, resource evaluation and management, societal connotations and the contextual concern needs inclusion. Frameworks created by the Planning Communities of the developed nations target global economy leadership through the advent of smart cities. Race is to create hubs of technical expertise pooling that would be shared at a price through consultancy domain; India has to now spearhead smart revolution by evolving its ethnic potential indicators from the field.

Traditional Wisdom of Planning-Sustainable is Smart

Traditional practices of evaluating the site with climate responsive options hovered with primary markers of green, energy efficient and sustainable cities. These have been dictating global paradigms.

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On the other hand ancient planning principles of form, scale and density of towns inclusive of skyline regulation outlined urban morphology with the development context. Public spaces were extension of social life and participation in fostering natural assets. These were classic forerunners to sustainable living, being intelligently redefined to achieve smart targets. Revisiting roots is not being caught up in a time warp but rather analyzing innate cultural strengths in the everyday Indian urbanism. The spectrum in planning fraternity with current scenario has swing back and forth in time. Practices,compositional organization and civic aspirations synchronous to both Indian and Western context as the dictum has moved on from think globally act locally to the fusion trend of global.

Whereas per se with the planning modality of whole to part and part to whole, pertains planning community to go further in depth. At this juncture area to regional development may rise in context of smart building, neighbourhood and region etc. A smart building is one that uses technology and processes to create space that is safer and more productive for its occupant's. It is more operationally efficient for its owners. In such a building, a network of electronic devices monitors and controls the mechanical as well lighting system to reduce energy and maintenance costs. Air-handling units mix outside air to regulate temperature in various parts of the building. Sensors are placed in rooms and air-ducts to monitor temperatures. Such buildings have hot water system to cool its air and equipment, with sensors maintaining temperatures at optimum levels. Smart Intelligent buildings also have alarm capabilities. While fire and smoke alarms are common, other types of alarms for reporting critical faults in the mechanical and electrical system are also increasingly coming into use. Lighting is controlled with a system based on sensors. It can detect presence of occupants and relative darkness ensuing modulate lights.

The soul-searching continues today, as planners and professionals to promote the use of technology to justify the creation of sculptural contortions. As the field is vast, scope of paper is restricted to analyzing certain attributes as a guiding principle for further developments from this sector. At the outset adequate options may be derived for technological advancement in the route ahead of Smart Cities and their development.

Amongst earliest intelligent buildings in India is the India- Habitat Centre in New Delhi. The Engineering Design and Research Centre (EDRC) of Larsen and Toubro Engineering Construction and Contracts Division in Chennai is another such building. It has fully automated energy management, life safety and telecommunication system .It is possibly the first building in India without any light switch. All cabins are equipped with infra-red detectors to detect occupancy. Entry is only through smart with built-in antennas.

URBAN REGENERATION IN JAPAN

Japan has been depopulating since 2005 .As per the projections by Town Planners, population of cities of all sizes will start to decrease after 2015. Due to this demographic change, focus of urban planning and development in Japan has shifted from growth to reorganization. More attention being paid to turning cities into more compact and sustainable places with a high quality of life.

Further, in line with global and national environmental concerns, much can be expected from urban regeneration in transforming Japanese cities into more sustainable and low-carbon urban environments in the era of depopulation. As an experimentation methodology two urban regeneration initiatives namely "project-based" and "plan-based" approaches were being adopted.

- The first case was the Minato Mirai 21 project (MM21) located in the central quarter of Yokohama City in the Tokyo Metropolitan Area. Although initiated in the mid-1980s, the project is still in progress. MM21 was built on 186 hectares of Brownfield's and reclaimed lands and is currently a mixed-use district, including offices, malls, residences, hotels, cultural centres, a hospital and parks. The main objective of the project is to increase the self-sufficiency of Yokohama by strengthening its central business district (CBD).
- The second case was Kanazawa City in Ishikawa prefecture in eastern Japan- a mid-sized historical town with a population of 462,361 people. Kanazawa has been encountering problems caused by urban sprawl, such as decline in the city centre, high reliance on automobiles and an increase in carbon emissions. Since the 1990s, the city government has been addressing these

problems through several means, including urban regeneration. The "City Centre Revitalization Plan", which covers an area of 860 hectares and includes actions to regenerate the city centre, is the primary component of urban regeneration attempts in Kanazawa.

The analyses of the impacts of these two initiatives were made to tackle climate change by breaking them down. The important basic aspects played a key role. These were: economy and work, buildings and land use, transportation and mobility, infrastructure for resource efficiency, energy consumption and efficiency and community-based issues.

In addition to the scope and extent of their climate benefits, both cases presented a series of lessons on transforming urban regeneration projects into opportunities to reorganize cities in climate-friendly manners as described below.

Participation and Political Commitment

In order to benefit from community engagement, participation mechanisms need to be supported with political commitment and the two should complement each other. Only then can have a balance between technical top-down and participatory bottom-up approaches be achieved throughout regeneration practices. This issue had an impact in overall outcomes.

Coordination between City Divisions and Policies

A sectoral approach dominates policymaking in both cities. Different city administration divisions are in charge of different sectors regarding urban development and environmental management. However, coordination between them seems to be insufficient.

Binding and Structural Measures

A main factor that limited the positive impacts of the revitalization plan in Kanazawa is the reluctance of the city's government to introduce binding measures. Instead, it chose to adopt "soft" measures aiming to achieve behavioral change in the long-run. For instance, the plan avoids restricting car use, although it aims at decreasing the use of private cars for inner-city trips. Such an approach seems to have prevented the plan from being supported by strong and complimentary measures. Likewise, the limited capacity of the city government to introduce structural measures in certain policy fields resulted in similar outcomes. As Kanazawa's bus system is run by the private sector, the city government couldn't introduce structural regulations on the system, and soft policies have been ineffective in overcoming the structural deficiencies in the system. This illustrates that binding and structural measures should be introduced as part of regeneration projects, particularly to ensure compliance and behavioral change.

The Lessons Learnt

As a cross cutting potential these case studies demonstrated that urban regeneration is an instrument of urban policy. It has potential to facilitate preface of spatial policies to address climate change. Intervention inherent to the regeneration process could be used to upgrade existing urban environments and hence change the form and land use structure of cities in climate-friendly manners. Of course, achieving this is not straightforward and hindered by multiple challenges, as quoted above. Overall, there remains need to understand conceptually, and in practice, how urban regeneration could help to both tackle climate change and achieve its main objectives of revitalizing certain areas in the urban fabric.

ANALYZING ICF'S NOMINATED WORLD'S SELECTED SMART CITIES

The Intelligent Community Forum (ICF), a New York-based think tank, prefers to focus on Intelligent Communities, defined as "cities and regions that use technology not just to save money or make things work better, but also create high-quality employment, increase citizen participation and become great places to live and work."

Every year since 1999, ICF has been naming world's most intelligent community. In January 2015 forum announced list of finalists for 2015, which included 7 cities and towns from 8 different nations: three from the United States, one from Australia, one from Brazil, one from Canada, and one from Taiwan and Rio de Jeneiro from Brazil. Huge conglomerates like London, New York, Tokyo or Mexico City, did not make it to the top seven; rather, the cities are mainly mid-sized cities that have found in the "broadband economy" a way to rethink themselves. The overall

winner will be announced at the ICF's annual summit in Toronto this year.

The brief of only few examples are analyzed due to limitation. The basic aim is to understand the aspects responsible in making the city smart.

Columbus, Ohio, USA

Columbus is a city of sharp contrasts. It is a key metropolitan focus of fortune 1000 companies in America. It is also a hub of low-income population stranded by decline of low-skilled factory employment; hence it is trying to bridge the gap between these two worlds through collaboration among government, education, business and institutions. It is a creditable movement to incorporate acceleration programs, business mentoring, seed funding and capital attraction.

Brain Gain explores the most important issue facing cities today, whether they are technology centers or in the middle of agricultural lands. The issue is how to attract and retain talented people who provide the energy of modern economy. Lessons it offers, based on experience of leading cities around the world, are of great value. Columbus has been one of a landmark from U.S. metros that turned a brain drain in 2005-2007 into brain gain in 2007-2009. Employment growth in skilled manufacturing has exceeded 35% over past decade .Subsequently in 2013, Columbus was named one of the top 10 cities in US for new college grads. A route to success may be ascertained by the Education Institutions role with Govt and society. Educators meanwhile are collaborating to improve the chance that low-income students can afford higher education also succeed at it. The Central Ohio Compact unites K-12, community college and undergraduate institutions to guide low-income students into higher education. Preferred Pathway is one program that guarantees community college graduates a university placement, which lets them turn their 2-year degree into a 4-year degree at a fraction of the normal cost. City government supports this effort with programs including Capital Kids, which provides after-school digital literacy programs for K-12 students, and APPS, which works to give at-risk youth positive alternatives to being on the street, including computer labs funded by Microsoft.

Ipswich, Queensland, Australia

Ipswich is appearing on Top7 Intelligent Communities of the Year list for the first time. In 2011, Ipswich published a 20-year economic development plan designed to combat its challenges and prepare for the ones to come. When the Australian government's National Broadband Network was announced in 2009, Ipswich partnered with local communities to create what they called the Western Corridor National Broadband Network and attract national investment. A Digital Hub project and Digital Enterprise program are equipping citizens and business with digital skills, while Ipswich begins a major redevelopment of its city center, where digital technologies will be used to attract tenants and to improve public safety. Green standards will make the center one of most sustainable in Australia. It estimated the addition of 292,000 new residents and 120,000 jobs. The percentage shall be so much so that when plan is completed, in 2031, it will mark emergence of one of Australia's model smart cities.

New Taipei City, Taiwan

New Taipei City was originally a county known as Taipei County before 2010, which surrounds Taipei. After the county's population overtook that of Taipei, it was decided that the county should be upgraded to city status. However, it could not simply rename itself as "Taipei City", because Taipei City already existed. However for second time in a row in the top seven, New Taipei City (NTC) is developing a knowledge-based economy to power its future. The focus has been mainly on broadband: the household penetration rate is at 91% with 87% on 100 Mbps service.NTC has also connected more than 300 schools, placed tablets and computers into classrooms and has facilitated the installation of more than 10,000 Wi-Fi hotspots in convenience stores. Massive investment went into high-speed roads and rails to unite the doughnut-shaped city, while broadband advances coupled with a Knowledge-Bridge project has driven industry-university collaboration projects and provided talent and jobs.

Rio de Janeiro, Brazil

Probably best known of the pack, Rio is more famous however for its beaches, Carnival spirit and gavels than for being a vibrant business hub. But preparation for the 2014 World Cup and the 2016 Olympic Games have given the city chance to revitalize itself, create a better transportation system

and deal with long-standing infrastructure problems. ICT programme such as the Rio Data mine (an open-data system that makes available vast amounts of city information) are also playing an important role in giving a boost to the economy. The municipality has built Knowledge Squares in nearly 40 low-income, crime-ridden neighborhoods, and 32 digital facilities which have provided digital literacy training to 69,000 citizens. Appreciation also in the direction of discovery of vast offshore oil fields; Rio is now receiving twice the foreign direct investment of Sao Paulo. In the equivalent manifestation of Tourism the authorities are focusing consecutive smart development in addition boost the existing.

Surrey, British Columbia, Canada

Surrey is a city in the province of British Columbia, Canada. It is a member municipality of Metro Vancouver, governing body of the Greater Vancouver Regional District. It is the province's second-largest city by population after the city of Vancouver. Surrey is third fastest-growing city. On the path to foster development, is focus on a project called Innovation Boulevard. Project is monitored by Mayor's Health Technology Working Group by comprising 50 representatives from universities, a health authority, nonprofits, business associations, government and developers. City universities and business associations are building clusters in health technology, clean tech and advanced manufacturing. Project comprising a range of smart-city systems are civilizing livability and better appealing with citizens. Goal is of boosting local employment by almost 50%.

LESSONS LEARNT

From the above analysis, it is evident that the unique character of the city not only depends on only infrastructure development but subsequent process of job creations and quality living standards has certain impact. The study also reveals the impact of existence of the institutions and landmarks along with the Government and public support certainly supports in building the Intelligent and Smart Cities.

Every one of us dreams for better living areas, digital sanctity, natural environment. A Time has already arrived to wake up. It's the time now for our mind sets makeup and move ahead living the unwanted barriers breakup. In the race of sustainable life we must join our hands in making our mother India the brightest of all. So the justified solution is to have a Smart City in all angles and then only the challenge can be met. However, the land dynamics for undertaking of a smart city targets the urban rural hinterland, the fringes, peri urban areas or vast tracks of agricultural land near the proposed industrial and investment corridors. The displacement of the people and livelihood is a cause of concern. The attributes discussed in the paper appeal the path for the planners and professionals to lead in a balanced pattern.

CONCLUSION

- Community participation with the local bodies in development of smart options is the defined solution.
- To encourage such developments maximum elaboration in the field through the training and interactions at all levels may be encouraged.
- Lessons at global scene may be learnt while encouraging the developments of Smart city concepts in Indian Scenario.
- The cases of Japanese regeneration speaks in volumes, these concepts may be applicable in case of development in Indian context.
- Every case has its unique history and parameters, encouragement shall be for viewing our developments in relation to balanced growth. Rather copy and paste formula may not work but the ideas and lessons in positive fashion shall be viewed.
- The databank shall be maintained as per the development activity.

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SMART CITIES : NEED OF INDIA

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Abstract

Mckinscy global Institute has declared alarming scenario of cities in India by 2030. 590 million people will live in cities (twice the population of USA). Cities will account for nearly 75% of India's GDP. There will be 68 cities of one million plus population contributing to 40% urbanization. 13 cities will be with four million plus population and six mega cities will be with ten million plus population. Indian cities need $1.2 trillion of additional capital investment. 70% of new employment will be generated in cities. By 2050 it is anticipated that 70% populations will be living in cities. 500 new cities are required to accommodate this influx.

Therefore having smart cities is need of India. Smart cities are based on mainly on information and communication technology (digitized setup), innovative financing and smart Governance including PPP setup. Smart cities are growth engines. Cities are central to Indian economic future. Smart cities should be safe, healthy, protective, sustainable with smart urban infrastructure, efficient energy management and environmental sustainability, innovative economy and empowerment opportunities. Govt. of India has vision of developing 100 smart cities as satellite towns of larger cities and by modernizing the existing mixed sized cities in next 15 years with investment of $1.2 billion.

INTRODUCTION

According to McKinsey Global Institute 2010 report, 590 million Indian people, almost 50% of the population of India will live in Indian cities by 2030. This would be equivalent to almost twice the population of the US today. Today the urban population is currently around 31% of the total population and contributes over 60% of India's GDP. It is projected that urban India will contribute nearly 75% of the national GDP in the next 15 years. It is for this reason that cities are referred to as the "engines of economic growth" and ensuring that they function as efficient engines is critical to India's economic development. An estimated investment of $1.2 trillion will be required to meet the projected demand in urban cities and about 700-900 million sq. metre of land space needs to be built.

As per census definition, towns with population of one lac and above are called cities. Cities are developing fast and are growth engines. This will be clear from following facts at national level.

- Decadal growth in urban areas from 2001 to 2011 is 31.8%. Whereas at rural level it is only 12.3%.
- Urbanization as per census 2001 - 24.89%. Urbanization as per census 2011 - 31.16% Projected urbanization in 2030 - more that 50% (as per MCKINSCY Global Institute Report)

Year	2001	2011	% Increase
No. of Cities	394	497	26.74%

Scenario of cities with respect to population:

	2001	2011	2030	% age increase w.r.t. 2011
Cities with one million plus population	40	46	68	48%

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Cities with one to four million plus (metro cities)	5	7	55	685%
cities with ten million plus population (mega cities)	1	2	6	200%

Other important features of MCKINSCY Global Institute Report as on 2030 :

- Cities will be central to India's economic future. Cities will also be critical for inclusive growth.
- Cities will account for nearly 70% of India's GDP.
- Urbanization in cities will be 40%.
- In 2008 as per report, 340 million population was residing in cities. In 2030 population of 590 million people will live in the cities (Twice population of USA).
- 68 cities will be with population more than 1 million. Out of 68 cities, 13 cities will have population more than four million and 55 cities will have population 1 to 4 millions.
- Out of 68 cities, 6 cities will be mega cities (population more than 10 millions).
- India's current approach is insufficient for mammoth task to satisfy housing infrastructure and therefore this approach will lead to urban decay.
- Indian cities need $ 1.2 trillion of additional capital investment.

Anticipated Scenario By 2050 : 70% population will be living in cities. 500 new cities are required to accommodate the influx. Due to increasing urbanization and load on rural land, the government has now realized the need for having smart cities that can cope with the challenges of urban living and also be the magnets to investment.

Pattern of urbanization and Mackinscy global institution report of 2030 has led the need to have smart cities in India. The global experience is that a country's urbanization up to 30% level is relatively slow, but pace of urbanization after 30% speeds up, till it reaches 60-65%. Therefore, India is at transition point where pace of urbanization will now speed up.

Therefore, there is a need of cities to get smarter to handle the large scale urbanization. We need to plan our urban areas well and let us take advantage of information and communication technology (ICT) and sensor works, creation of more employment opportunities and economic activities for improving life sustainability. Therefore, smart cities will be binding ways to manage complexity, increase efficiency, reduce expenses and improve quality of life. India's current approach will lead to urban decay with respect to quality of life and standard of living.

DEFINITIONS OF SMART CITY

The term smart city is still quite a fuzzy concept and is used in ways that are not always consistent. Smartness in a city means different things to different people. It could be smart design, smart utilities, smart housing, smart mobility, smart technology and employment to wide section of society etc. Here are some definitions of different bodies.

Smart Cities Council : A smart city is one that has digital technology embedded across all city functions.

Indian Government : Smart City offers sustainability in terms of economic activities and employment opportunities to a wide section of its residents, regardless of their of education, skills or income levels.

IEEE Smart Cities. (European Society) : A smart city brings together technology, government and society to enable the following characteristics : smart cities, a smart economy, smart mobility, a smart environment, smart people, smart living, smart governance.

Business Dictionary: Smart cities that creates sustainable economic development and high quality of life by excelling in multiple key areas; economy, mobility, environment, people, living and government. Excelling in these key areas can be done so through strong human capital, social capital and/ or ICT infrastructure.

According to above definitions there are four pillars of smart cities as given in Fig.1 Major fields of intelligent city activation are given in Table 1.

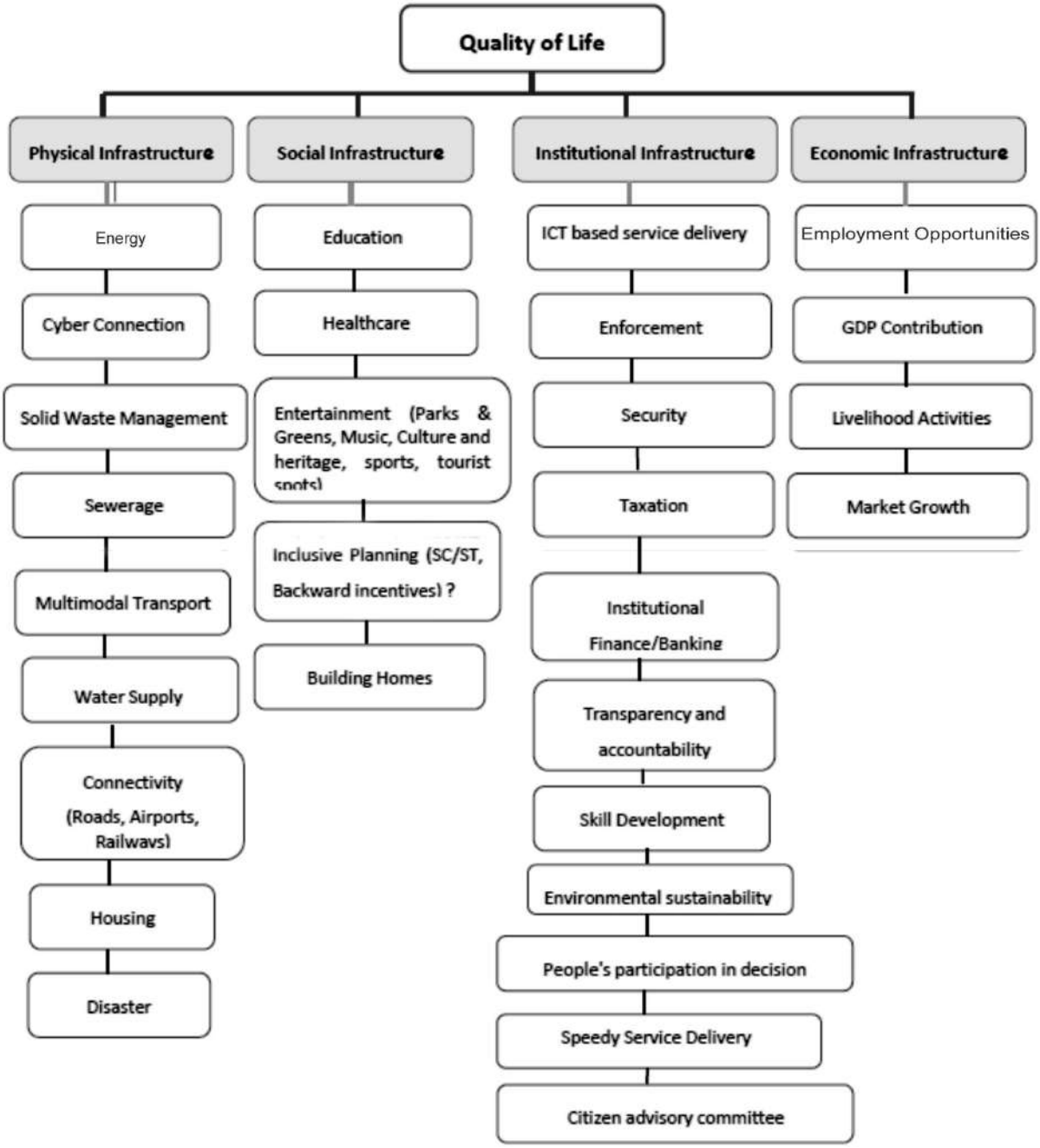

Fig. 1. Pillars of a Smart City

STRATEGY FOR SMART CITIES

The following strategy should be adopted for smart cities.

- Aim for smart cities.
- Policy guidelines for smart cities.
- Role of UN Agenda 21 for having smart cities.

Aim for Smart Cities: Our cities must be places where we have human being dignity, safety, happiness and hope. Cities should be safe, healthy, protective and sustainable places with respect to smart infrastructure, digitized set up, environmental sustainability and employment opportunities.

Therefore standard of living and quality of life are main factors for safe cities.

Table 1: Major Fields of Intelligent City

Innovation economy and Employment opportunities	Smart Urban infrastructure	Smart Governance
- Innovation in industries, clusters/ Creation of knowledge intensive companies/ Knowledge workforce/ Education and employment	- Intelligent urban Transport - Mass Transport (Metro/ Rail/ Bus/ Airbus/ Monorail/ Bus rapid transport system), dedicated bicycle tracks and continuous unobstructed footpaths	- Futuristic Urban planning - Administration services to the citizens
Construction of smart buildings which are "smart" in terms of saving our resources i.e. these buildings are named smart because they will save up to 30% of water usage, 40% of energy usage and the maintenance of these buildings will go down by 10-30% in cost. (Green buildings)	- Reliable Utilities-Water Supply and use of waste water, Sewerage, Drainage, Waste Management, Communication System, Wireless/ Sensor Networks/Health Care -Efficient Energy Management Note - Bench marks have been specified for all.	- Participatory and direct democracy
Innovative Financing including, FDI, PPP and Municipal Bonds	- Environmental sustainability and Safety	- Services to the citizens - Quality of life

Policy Guidelines for Smart Cities :-

- Information technology and telecommunication setup.
- Creation of employment opportunities towards wide section of residents, regardless of education, skill or income levels.
- Proper regional level infrastructure planning and development and infrastructure up gradation works are to be done.
- Water engineering and water management.
- Energy management in clouding, sufficient lighting setup in cities.
- Sustainable development (social, environmental and financial).
- Attraction for investments, experts and professionals etc.
- Clean cities.
- Well planed parking in every area of city.
- Proper drainage of entire city as whole.
- Cost efficient health care
- Proper tourism attraction and heritage of ancient monument.
- Shelter for all.
- Involvement of NGO's/CBO's.
- Public private partnership to be encouraged.
- Ease in doing business
- Safety and inclusiveness
- Entertainment
- Ease of seeking and obtaining public services
- Quality education
- Special attention to be given to not to have urban violence, crime and insecurity among citizens around the globe.
- Development of new construction techniques along with proper methodology.
- Handling increasing volume of human waste and its treatment.
- Solid waste management (proper attention to collection, segregation, transportation disposal and treatment).

- Development of eco-friendly engine, based on fuel cell technology for replacement of conventional petrol and diesel internal combustion engines (to combat pollution).
- Total quality management concept
- Proper sewerage treatment.
- Vehicular pollution control (maximum air pollution is due to vehicles).
- Preventive measures should be taken to reduce air pollution from industries by installation of pollution control equipments.
- It is necessary to have a clear cut policy on noise pollution.
- In order to protect vulnerable groups like senior citizens, school children, women, handicapped and pedestrians from road accidents, it is necessary to have a policy for producing safer vehicles to control speed and design of road geometrics and avoidances of encroachment of footpaths and road sides.
- Awareness campaign for school children, senior citizens and women should be launched to make them aware of the ill effects of pollution, traffic hazard and importance of road safety.
- Keeping abreast with changes coming up in other sectors like administration and new innovative materials, which have effects on urban development.
- Integrated economic development process including development of rural areas.
- Better transport system. Mass rapid transport and ring road system will have to be developed in all metro and mega cities.
- Encroachments free roads, foot paths and other open areas.
- Settlement pattern.
- Integrated development of other city area including urban poor areas.
- Financial setup (Govt., semi govt., FDI, PPP setup and municipal bonds etc.)
- Women's rights and peace in society.
- Accountability and opportunities for participation in governance.
- Encourage development polices that reduce vulnerability to distress such as;
  - Land use
  - Risk assessment
  - Disaster impact assessment
  - Design, construction and maintenance
  - Integration of projects, polices, vulnerability to disaster and urban planning
- Prepare city managers to cope with emergency situation such as
  - Emergency management planning
  - Institutional strengthening
  - Communication channels and warnings
- Prepare community members to address emergency situation
  - Public awareness and educational.
  - Community based programmers and solutions.
- Special programmers for high risk situations priorities include
  - Informal settlements
  - Essential facilities
  - Cultural treasures
- Transparency

UN Agenda 21: Un agenda 21 on sustainable development is main tool for having smart cities. We can have safe cities by improving human settlement management (Chapter 7 of UN Agenda 21.)

SMART CITIES SCENARIO IN INDIA

At present there is no smart city in India. Govt. of India has allotted ₹ 72 billion for developing following 100 smart cities as satellite cities of larger cities by modernizing the present following cities in 15 years:

- Maharashtra Pune, Mumbai, Nagpur, Nasik, Aurangabad, Bhivandi (6 Nos)
- West Bengal Calcutta, Durgapur, Haldia, Habra, Jangipur (5 Nos.)

• Gujarat	Ahmedabad, Surat, Vadodara, Rajkot, Bhavnagar, Junagarh, Gandhi Nagar (7 Nos)
• Madhya Pradesh	Bhopal, Indore, Gwalior, Burhanpur, Jabalpur (5 Nos)
• Tamil Nadu	Chennai, Coimbatore, Madurai, Tiuruchirappali, Selam, Tirunelveli (6 Nos.)
• Karnataka	Bangalore, Gulbarga, Bidar, Bijapur, Badami, Pattedakal, Mahakunta (7 Nos.)
• Kerala	Trivendram, Kollam, Kottayam, Tiruvalla, Ernakulam, Cochin (6 Nos.)
• Telangana	Hyderabad, Warangal, Karim Nagar, Nizambad, Malgonda (5 Nos.)
• Andhra Pradesh	Guntur, Vijaywada, Karnool, Chittoor (4 Nos.)
• U.P.	Kanpur, Allahabad, Lucknow, Jhansi, Faizabad, Varanasi (6 Nos.)
• Rajasthan	Jaipur, Ajmer, Bharatpur, Bikaner, Jodhpur, Kota, Udaipur (7 Nos.)
• Punjab	Ludhiana, Amritsar, Jalandhar, Patiala (4 Nos.)
• Bihar	Muzaffapur, Patna, Gaya, Bhagalpur, Bihar Sharif (5 Nos.)
• Haryana	Faridabad, Gurgaon, Ambala (3 Nos.)
• Assam	Guwahati, Tinsukhia, Obalguri, Tangla, Goalpara (5 Nos.)
• Odisha	Bhubaneshwar, Cuttak, Rourkella, Sambalpur, Balasore (5 Nos.)
• Himachal Pradesh	Shimla (1 No.)
• Uttrakhand	Dehradoon, Haridwar, Roorkee (3 Nos.)
• Jharkhand	Jamshedpur, Dhanbad, Ranchi (3 Nos.)
• Sikkim	Gangtok, Pellina, Yuksam (3 Nos.)
• Manipur	Bishupur, Chandel (2 Nos.)
Total	100 Nos.

Top 10 Smart Cities of World

At world level with respect to information and communication technology, resulting in cost and energy saving, improved service delivery, quality of life and environmental setup etc., following are top 10 smart cities.

Vienna	Toronto
Paris	New York
London	Tokyo
Berlin	Copen Hagen
Hong Kong	Barcelona

Source - As per BOYD COHEN (International urban strategist)

CONCLUSION

Smart city is the intersect between competitiveness, capital and overall sustainability (social, environmental and financial sustainability) and smart cities will prevent future urban decay in India and standard of life and quality of life will improve.

MAKING OF SMART CITY OR LIVEABLE CITY

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Abstract

This paper focuses on the concept of smart city originated at the time when the entire world was facing one of the worst economic crises in 2008.It is a marketing concept, first created by technology companies wanting to sell their sensors, software and hardware. A smart city is just a term for better cities. A 'smart city' is an urban region that is highly advanced in terms of overall infrastructure, sustainable real estate, communications and market viability. Countries like South Korea, UAE and China began to invest heavily into their research and formation.

The concept of liveable cities has lately been getting acceptance in Europe as city planners and citizens have started working together. It is linked to physical forms like parks and green spaces. For others, it is about the cultural milieu that the city can provide. A liveable city is not possible if it does not offer career opportunities to succeed; it needs to have economic dynamism. There is need for detailed planning. Among the challenges to getting new cities built or existing cities transformed is the lack of experts who can make such huge projects work and attracting private finance .The paper also ventures to find out whether we should focus on developing liveable city or smart city.

INTRODUCTION

The concept of smart cities originated at the time when the entire world was facing one of the worst economic crises. In 2008, IBM began work on a 'smarter cities' concept as part of its Smarter Planet initiative. By the beginning of 2009, the concept had captivated the imagination of various nations across the globe. The trouble is that 'smart city' is a marketing concept, first created by technology companies wanting to sell their sensors, software and hardware. Also, the definition of a smart city is very vague and the government does not seem to be making any effort in clarifying it. Thirdly, it does not really capture what inhabitants in crowded, populous and rapidly expanding cities need.

Other nations have put up smart cities like Barcelona, Chicago, Boston, and Shanghai etc. Now if India comes up with such initiative, it should not be criticized. One of the major problems in setting up a smart city or making a current city better for living would be managing the extreme population. Our cities have more population than other nations like Singapore etc. Countries like South Korea, UAE and China began to invest heavily into their research and formation. Today, a number of excellent precedents exist that India can emulate, such as those in Vienna, Aarhus, Amsterdam, Cairo, Lyon, Málaga, Malta, the Song do International Business District near Seoul, Verona etc. There is the iconic Tianjin Knowledge City, which got replicated into Suxhou, Guangzhou and Sichuan in China.

INDIAN SCENARIO

India's attention is focussed on urbanisation and the smart city concept is gaining ground rapidly. The Indian urbanisation agenda is in three parts:

- Urban Renewal of 500 cities;
- Rejuvenation of Heritage cities, and
- (c) The implementation of 100 "Greenfield" and "brown field" Smart Cities.

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Existing cities like Dholera and Surat in Gujarat and Visakhapatnam in the east have already begun work to transform into smart cities with help from companies such as Microsoft Corp (MSFT.O), IBM Corp (IBM.N) and Cisco Systems (CSCO.O).

India's push to accommodate a booming urban population and attract investment rests in large part with dozens of "smart" cities like the one being built in Gandhinagar, on the dusty banks of the Sabarmati river in Gujarat. Gujarat International Finance Tec-City (GIFT), as the smart city is called, will double up as a financial hub, with tax and other breaks to lure banks, brokerages and other businesses. A bird's eye view from atop one of the two office buildings on the 886-acre GIFT site, a venture which began when our present PM was chief minister of Gujarat, shows little sign yet of the 9 billion rupees spent on the first phase. But the sandy plain hides infrastructure including an underground tunnel for utilities, a first in India. The plan, however, is for a meticulously planned metropolis complete with gleaming towers, drinking water on tap, automated waste collection and a dedicated power supply - luxuries to many Indians.

Beyond GIFT, green field projects are likely to face hurdles including land acquisition rights and lengthy approval processes, as well as finding the right location. GIFT has the advantage of being flanked by a river on one side and a national highway on the other and also sits between Gujarat's political capital of Gandhinagar and its business hub of Ahmadabad, with a large International Airport.

At a cost of about $1 trillion, according to estimates from consultants KPMG, the plan is also crucial to Govt's ambition of attracting investment while providing jobs for the million or more Indians who join the workforce every month. The grand scheme, still a nebulous concept involving quality communications and infrastructure, is beginning to take shape outside Gandhinagar, capital of Gujarat; with the first "smart" city the government hopes will provide a model for India's urban future. So far, it boasts modern underground infrastructure, two office blocks and not much else.

SMART CITY VERSUS LIVEABLE CITY

Smart City

The concept paper of Govt. includes various suggestions on operational procedures, approval process for proposals, nature and extent of Central Government support on financing, capacity building, which would be useful for further discussions.

First of all, the government will not 'create' these cities. The state governments have been asked to recommend a list of cities that they want to be converted into 'smart cities'. The ministry of urban development has already started working on the details of how these smart cities will work. It is worth thinking carefully as it is a $114 billion or Rs 7 lakh crore issue. This is what these cities will need over a 20-year period, according to a government committee estimate. The government has allocated about Rs 7,000 crore so far for the creation of smart cities. This is likely to go up as and when investors, both domestic and international, pour in more money. The government has come with an investment of $1.2 billion for 100 smart cities in the next 15 years.

The several facilities that would be developed in smart cities including reliable utility services, efficient social infrastructure and a smart transport system, which would restrict the travel time within the city to 30 to 45 minutes, 100 per cent coverage of road network with storm water drainage network and 100 per cent access to toilets. All smart cities will need to have a master plan valid for the next 10 years in addition to having digitised spatial maps, regularly updated open data platforms, amongst other benchmarks specified in the Annexure of the concept note.

Physical infrastructure such as the urban mobility system, the housing stock, energy system, water supply system, drainage system, solid waste management and sewerage system etc will have to be integrated through the use of geospatial technology. Universal access to electricity and water 24 X 7 will be provided. The municipal offices will have to be fully automated so that citizens have the ability to seek and the municipal offices the ability to deliver services in real time, through IT based facilities.

In terms of social infrastructure, good and high quality education, healthcare and entertainment

services are essential. Adoption of energy-efficient and environmentally benign practices in the use of building material, transport system, sewerage and water supply systems, street lighting, air-conditioning systems and energy consumption in buildings will be non-negotiable.

The document also states that a city having a population of up to 40 lakh or more, cities of tourist and religious importance and select cities which have a population of less than 10 lakh and all state and union territory capitals will get an opportunity to nominate a satellite city for the "Smart City" project.

In Delhi, it is being proposed that DDA will develop a new smart city through the land pooling scheme and the NDMC area may be considered for demonstrating all the components of smart cities.

The cities with ongoing or proposed smart cities include Kochi in Kerala, Ahmadabad in Gujarat, Aurangabad in Maharashtra, Manesar in Delhi NCR, Khushkera in Rajasthan, Krishnapatnam in Andhra Pradesh, Ponneri in Tamil Nadu and Tumkur in Karnataka. Many of these cities will include Special Investment Regions(SIR) or Special Economic Zones(SEZ) with modified regulations and tax structures to make it attractive for foreign investment. This is essential because much of the funding for these projects will have to come from private developers and from abroad.

With increasing urbanisation and the load on rural land, the government has now realised the need for cities that can cope with the challenges of urban living and also be magnets for investment. The announcement of '100 smart cities' falls in line with this vision.

Liveable City

The concept of liveable cities has lately been getting acceptance in Europe as city planners and citizens have started working together. It is linked to physical forms like parks and green spaces. For others, it is about the cultural milieu that the city can provide. A liveable city is not possible if does not offer career opportunities to succeed; it needs to have economic dynamism. This is possible if it also offers reasonable safety within which to raise a family. From a planning perspective, liveability is linked to sustainability as it is to consumer resources like food, water, energy and air. It generates carbon and other gases along with waste in enormous quantity. This determines the spatial spread of the city as distribution system for supplying a city with food and power travel distances.

CHALLENGES

If our cities are not developed then in coming years the living conditions will get worse due to rapid urbanization .Most of the cities in India face common problems such as traffic, average police activities, unemployment, parking problems at public place and the cities are not clean.

The concept is not without challenges, especially in India. For instance, the success of such a city depends on residents, entrepreneurs and visitors becoming actively involved in energy saving and implementation of new technologies. There are many ways to make residential, commercial and public spaces sustainable by ways of technology but a high percentage of the total energy use is still in the hands of end users and their behaviour. Also, there is the time factor — such cities can potentially take anything between 20 and 30 years to build.

The government of Singapore has sought clarity on India's concept of smart cities, even as it expressed keenness to invest in Prime Minister's grand plan of creating 100 such cities across the country .It is still in the process of "understanding what the (Indian) government actually means by a 'smart city', as in whether they want a city to be information technology (IT)-enabled or having a state-of-the-art connectivity".

A state-of-the-art city is a much larger concept than being IT-enabled, as the former addresses social, economic and environmental concerns as well. IT-enabled services would comprise only five per cent of a smart city of the kind being debated in India. Singapore is globally regarded as a smart city but the government believes it to be a "garden city".

National Institute of Urban Affairs is helping the Government of India to set guidelines for the new developments. According to Mr.Jagan Shah, Director of the Institute, "Most (Indian) cities have not been planned in an integrated way. To get the private sector in, there is a lot of risk mitigation that needs to

happen because nobody wants a risky proposition." He stressed the need for detailed planning. Among the challenges to getting new cities built or existing cities transformed is the lack of experts who can make such huge projects work and attracting private finance.

To address India's urbanisation challenge, we have to start looking at our existing cities. India needs to address the basic fundamentals of so-called smart cities in terms of sustainable and clean environment, a sound regulatory framework and a robust land bank.

OLD OR NEW CITIES?

A smart city is just a term for better cities; cities in India are not that good enough to live. We adapt to one situation very easily and start getting used to it. It brings up smart buildings which are "smart" in terms of saving our resources i.e. these buildings are named smart because they will save up to 30% of water usage, 40% of energy usage and the maintenance of these buildings will go down by 10-30 %(in cost). We all want our cities clean so that it can provide better lifestyle and attract business as well. "Smart" city are a need to be established in our country.

Pressure on India's existing urban centres is already intense, with cities like Mumbai gridlocked by traffic and hampered by poor infrastructure and a lack of amenities like parks and effective public transport. Yet some experts believe that building new cities may not be the answer to India's swelling urban population.

India has built planned cities in the past, including Chandigarh, designed by French architect Le Corbusier and Gandhinagar itself. But the scale of its current push is unprecedented.

Indore is growing rapidly, but has no natural water resource. It is pumped into the city from 60 km away. On an average, electricity transmission travels 200 miles and food travels 1,200 miles. These consumption patterns arising out of location increase the energy consumption requirement for a city, especially in a country like India, where due to paucity of power, 20 giga watts is generated using liquid fuel. This includes diesel engines used to generate power or pulling out water from deep aquifers. This is not sustainable and unfortunately, not even part of the discussion on smart cities. One of the principles behind a liveable city is that it is not based on fossil fuels or commuting as a way of life. Planning such a city means that the local government uses a thumb rule that every citizen can walk for his basic requirement. Education for children, parks or open spaces for leisure and play, basic health care, and entertainment are all within walking distance.

Ujjain, one of the cities to be built as a smart city, is a sleepy, religious tourism-dependent city in Madhya Pradesh. Where will the policymakers start from? Will they change the nature of the city? Will they build on existing economic drivers of the city?

One of the purposes of building a smart city is to attract people to live there, and people will go where there are opportunities. The softer aspect of a city that invites diversity also encourages creativity and sustainability in the long run. Therefore, it will be smarter if we build or focus on liveable cities rather than smart ones.

Delhi is a most polluted city in the world. Under the 'smart city' plan, focus will be to build an Electrical Transit System by using facilities with total electrical transport (Metro, BRT, Monorail, Trams, Electrical Cars, Electrical rickshaws, Electrical scooters etc.), very short distances between office and residential for using electrical rickshaws, scooters, cars, cycles etc., all residences area will provides solar energy (own), promoting best energy efficient items and installing LED streetlights, Broadband(wifi), Intelligence Transport System etc.

CONCLUSION

The belief that the solution to key urban problems lies in better technology is attractive for both politicians as well as foreign donors of 'smart technology' since it incorporates the promise of a quick-fix. Technophilia is also appealing to a gnawing sense of inferiority regarding 'advanced' nations and our own 'backward' State.

Cities are made up of fragile egos, aspirations, historically embedded inequalities and constantly jostling social identities. The best — smartest — cities are those that address these aspects as well

as one other crucial aspect of urban life. The latter has to do with dealing with strangers: A city consists of residents, the vast numbers of whom will never know each other and yet must deal with one another. However, we have no idea regarding how to deal with strangers except with hostility and violence. It is entirely disingenuous to think that the problems of urban life in India can be solved through 'smart parking' and greater CCTV surveillance.

Technology contributes towards social good only if social contexts are addressed at the same time as technological ones. Smart cities are not those with high-speed Internet but ones whose residents have the capacity for humane behaviour towards each other and the ability to deal with differences.

No amount of efficient public transport — such as the Delhi Metro — will convince large sections of the population to forego the status symbol that is the motor car. When cars brush each other or motorcycles scrape cars, it is not metal that is damaged; it is the urban ego. The other aspect has to do with aggressive masculinity. Urban violence of different kinds — road rage to neighbourhood brawls — are linked to perceived offence to 'manhood'. We live in cities of feudal mentalities and it is spurious to think that faster Internet connections will change this.

These may be excellent opportunities for greater profits for companies that make parking and surveillance equipment, but they have little to do with the social good. The latter is only addressed if we take up the messy topic of urban social relations. It is only then that we will resuscitate the urban imagination of genuinely liveable cities. Should the government focus on creating liveable spaces versus a nebulous concept like smart?

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SMARTER SOLUTIONS FOR DEVELOPING SMART CITIES IN INDIA

NARENDER SINGH*

Abstract

The trend of migration of people from rural to urban areas is putting a thrust on the cities throughout the globe. As India's population continues to grow, it is predicted that about 25-30 people will migrate every minute to major cities from rural areas in search of better livelihood and better life style. It is estimated that by the year 2050, the number of people living in Indian cities will touch 843 million. To accommodate this massive urbanization, our country needs to find smarter solutions to manage complexities, reduce expenses, increase efficiency and improve the quality of life. Therefore, the city components viz. engineering (buildings, road network, energy, water and waste management and ICT), administration (governance, education and transportation), health (healthcare facilities and environment) and citizens needs to be smart for developing smart cities.

A smart city is one that has digital technology embedded across all its components to enhance performance, to reduce costs and optimize the resources. The concept of a smart city has no end point, but rather a process, or series of steps, by which cities become more livable and resilient and, hence, able to respond quicker to new challenges. In this paper, efforts have been made to elaborate drawbacks of the components of existing cities along with finding smarter solutions to achieve the target of future smart cities in India.

INTRODUCTION

The people are migrating continuously from villages to cities in search of better opportunities and thus putting burden on the existing amenities in the cities. This compels the technocrats to evolve smarter solutions to develop smart cities to accommodate the influx. With the increasing urbanization and load on agricultural land, the government of India has now planned to develop 100 new smart cities and allotted Rs. 70.60 billion in budget year 2014-15 for their development. Therefore, it is desirable to revolutionize the existing approach of developing cities with smarter solutions so as to optimize the available resources.

A smart city uses digital technologies to enhance performance and well-being, to reduce costs and resources, and to engage more effectively and actively with its citizens. There are four main components of a smart city as shown in fig. 1.

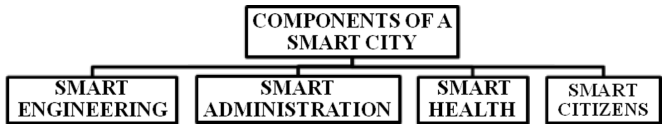

Fig. 1. Components of a Smart City

There is strong evidence that appropriate engineering intervention can significantly increase the efficiency and reduce the resource consumption of a city. The smart engineering has five main components as shown in fig. 2.

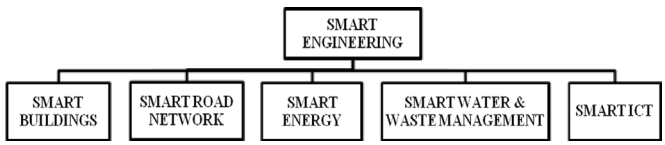

Fig. 2. Smart Engineering Components

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SMART BUILDINGS

India is expected to emerge as world's third largest construction market by 2020, by adding 11.5 million homes every year. Therefore, smart buildings have to be designed to optimize the water, energy usage and reduction of the building maintenance. The current practice is to construct the buildings without taking consideration of design aspects and thus unsafe and uneconomical. The government should promulgate the zoning ordinances and building codes so as to design the buildings smartly and making them cost effective.

Recent advances in data gathering and analysis are opening up new possibilities for smart building technology. The various tools and technologies that make the buildings smart have been discussed below.

Sensors and the Internet of Things

By 2020, there will be an estimated 50 billion networked appliances and sensors worldwide, constituting a vast global network of data-generating devices such as sensors and their uniform resource locators (URLs), known collectively as the 'internet of things'. Sensors are increasingly being installed in buildings to gather data about movement, heat, light and use of space. This information allows BMS to make reactive and even anticipatory and personalized real-time alterations to a building's environment to suit its occupants.

Building Management System (BMS)

BMS is a computer based control system that has the capability to control and monitor the building's mechanical and electrical equipments such as ventilation, lighting, power system, fire system and security system (Fig. 3).

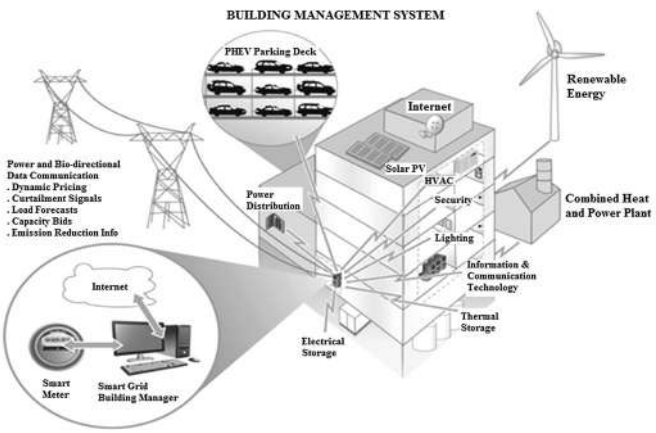

Fig. 3. Building Management System

The ongoing expansion and upgrading of wireless networks and leaps in computing power mean that today's smart building designers possess the tools to use data to make the built environment more comfortable while reducing our carbon footprint.

Building Information Modeling (BIM)

BIM is a process involving the generation and management of digital representations of physical and functional characteristics of places. The various software packages like ArchiCAD, Tekla Structures, Autodesk Revit, Bently AECOsim Building Designer, Vector works, etc. differ from architectural drafting tools such as AutoCAD by allowing the addition of further information (time, cost, manufacturer's details, sustainability and maintenance information, etc.) to the building model. Through 3D computer modeling, BIM has become an information repository for the geometry, spatial relationships, quantities and properties of the whole building and its components, allowing architects, engineers and designers to work on the same platform.

SMART ROAD NETWORK

The existing road network of an Indian city is not well planned and different utilities like optical fiber cables, electric poles, water and sewerage pipe lines, etc. are coming in the middle of roads, causing inconvenience to the road users and leads to accidents as shown in Fig. 4.

Fig. 4. Sewerage Manhole Coming in the Midway of a City Road

A smart road network uses new and emerging technologies to reduce congestion, save money, improve safety and reduce environmental impacts. Despite many technological advances made to vehicles, mobile devices, and cars, we see little change to roads. There are many things we can do to roads that can help to innovate and improve the driving experience, particularly when it comes to road safety. The future road technologies that make the road network of a city smart are discussed below.

Glow in the Dark

Rather than spend a large budget on road lighting or other lighting options that span across thousands of miles of roads, the idea to use glow in the dark road markings is a better and more adoptable alternative. Such markings are already made available on the road in the N329 highway in Oss, Netherland (Fig. 5a). The markings are made using paint that contains photo luminising powder that charges up during the day and will glow for up to 8 hours during night.

Fig. 5. Glowing Road Marking

Solar Roadways

In solar roadways, the solar panels complete with light emitting diodes (LEDs) and microprocessors could be installed on glass roads (Fig. 5b). Glass is renewable, environment friendly, and its strength can be improved to be even stronger than steel. Despite being glass, the surface can be engineered for cars to be able to stop safely even when travelling at speeds of up to 80 mph. The solar panel roads can even melt snow during winter and of course the solar energy harnessed can be used to power electrical needs.

Wind Powered Lights

The wind powered lights will power up itself using pinwheels to generate electricity. It works by harnessing wind drafts from passing cars into electric. The electricity will use to light up the lights on the pinwheels, basically lighting up the road path (Fig. 5c). Since it requires wind to power up, these wind-powered lights will only light up as cars pass by the area.

Electric Priority Lane

The electric priority lane is the path where electric vehicles (EV) user can charge up their vehicle on the go. The induction priority lane will have embedded magnetic fields that can charge the vehicle while it is on the go. This is especially useful in countries like Netherland, where there are a lot of EVs on the road (Fig. 5d).

SMART ENERGY

The transmission and distribution (T&D) losses in India during 1995-96 were about 22 percent which has increased to about 23.7 percent by 2010-11. During 2010-11, the state which has highest T&D losses is Jammu & Kashmir (62%) and the state having relatively low T&D losses is Himachal Pradesh (11%) as shown in Fig. 6.

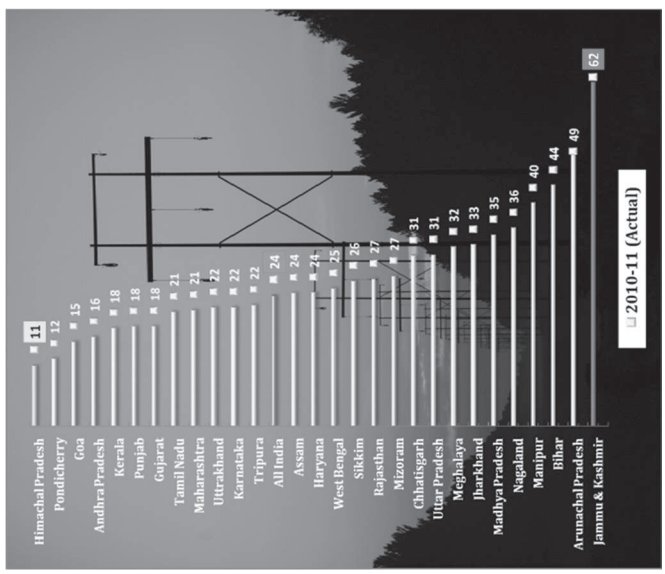

Fig. 6. T&D Losses across Different Indian States in 2010-11

Smart meters are the first step to create a national smart grid, where electricity will be delivered to customers on the basis of responding to dynamic demands using data and help to reduce the T&D losses up to great extent. The ability to produce smarter, lower-consumption energy based on renewable sources such as hydropower, solar, wind, biomass and bio-fuels, geothermal, and ocean and tides represents a fundamental step towards a sustainable energy and offers special opportunities for cities. The advanced techniques like pyrolysis process could be used to produce fuel oil from tyre and plastic waste to substitute the conventional energy resources.

SMART WATER AND WASTE MANAGEMENT

Reducing water consumption and improving water efficiency in buildings is a major step towards sustainable water management. We can all contribute towards saving water in our homes with actions that are simple yet efficient. Installing water efficient fixtures in toilets and kitchens could be the first step to save the water as discussed below.

Dual Flush Toilets

A significant way to save water in buildings is to replace existing single flush toilets with dual flush toilet. The dual flush toilets use 4.5 liters on full and 3 liters on a half flush than the normal flush toilets which use 9 to 12 liters of water in every flush.

Sensor Operated Urinals

These detect the presence of people through movement sensors or door switches combined with an electronic delay to stop flushing for a set period after flushing.

Sensor Taps

Sensor taps with a flow rate of 2 liters per minute can also be installed. These taps cut off water supply when the hands are removed from under the tap, or when the preset timing of 30 or 60 seconds is reached, whichever is earlier.

Waste Water Recycling System

In this system the waste or gray water is collected from bath tubs, showers, bathroom sinks and washing machines and drained into storage tank, where it is filtered and disinfected. The treated water is then pumped to supply the toilets with water for flushing as shown in Fig 7.

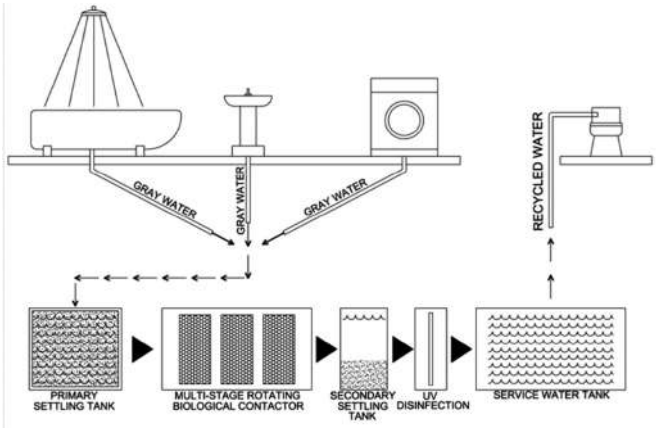

Fig. 7. Waste Water Recycling System

Waste water from the toilet and kitchen sink is connected to the building drain, which connects to the municipal sewer of the city. For managing solid waste generated from a smart city the various techniques preferred are composting, gasification, pyrolysis, etc. than land filling, incineration, co-combustion, etc. to recycle the waste and to minimize health hazards and environmental problems.

SMART INFORMATION AND COMMUNICATION TECHNOLOGY

The information and communication technology (ICT) is a tool which enriches the users with the worldwide information at any time and at any place. The utilization of ICT for decision making by citizens, service providers and city government has given rise to the general notion of a smart city. The ICT system should be smart enough to meet the daily requirements of the citizens (Fig. 8). The e-surveillance system of a smart city need to be centralized for controlling illegal activities (like terrorist activities) by the police authorities to safe guards the citizens.

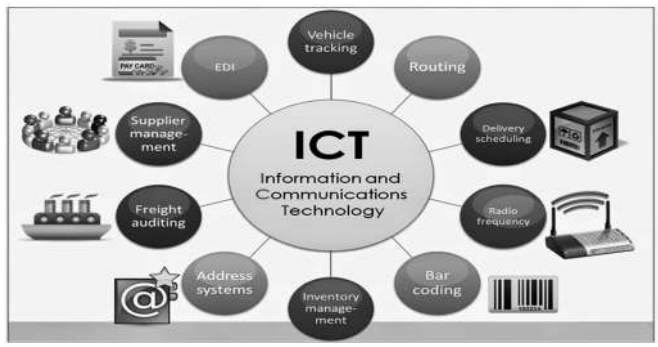

Fig. 8. Smart Information and Communication Technology

SMART ADMINISTRATION

The smart administration has three main components viz. smart governance, smart education and smart transportation as discussed below.

Smart Governance

In order to achieve urban sustainability, government employs information technologies, including internet and mobile computing, to enhance its relationship with citizens, businesses, and other governmental sectors. This enables the delivery of more services to citizens, improved interactions with businesses, and more efficient governmental management.

The 'Digital India' campaign launched by the government in 2014 with the idea to facilitate the citizens to connect with all departments digitally or electronically while reducing the paper work is a big initiative towards e-governance. The benefits of e-governance include less corruption and cost along with greater transparency, convenience and revenue growth, which leads to smart governance.

Smart Education

Students want to learn in the classroom the same way they interact outside of it. Smart technology makes exploring lessons and collaborating on solutions a simple, easy experience that students immediately recognize and adopt. The concept of edusat, online learning, digital textbooks, cloud computing, etc. has revolutionized the existing education system. Advancement and successful use of all forms of modern interactive technology depends on smart usable systems that are adaptable, do not require expensive training, accommodate the needs of diverse users and are low cost. The utilization of interactive technology in education specially has an impressive impact on introducing and advancing a more flexible and innovative smart education.

Smart Transportation

Smart transportation is a network for industry and services, which acts as an engine and catalyst for growth and prosperity. Several dimensions of sustainable development may benefit from an improved transportation system. Clean and highly eco-performing public transport can be the backbone of sustainable urban transport services. Public transport represents an acceptable alternative to cars, only when it is safe, clean, reliable, fast, frequent, noiseless, flexible, easily accessible, well designed, environment friendly and economically viable. A smart transportation system allows for an integrated view of real time traffic data through the use of devices installed on roads such as traffic signals, cameras and sensors (Fig.9). This data is processed with the purpose to establish an intelligent and adaptive traffic management system that empowers drivers through dynamic messaging and other methods, to choose optimal routes and avoid accidents or street problems, thereby increasing safety.

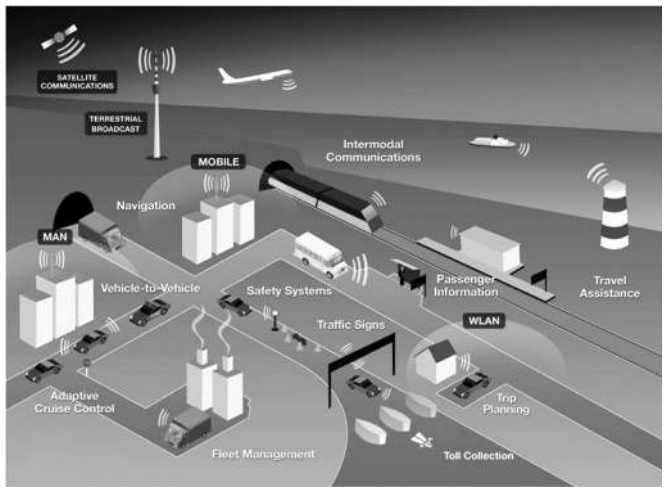

Fig. 9. Smart Transportation System

SMART HEALTH

The smart health has two main components viz. smart healthcare facilities and smart environment as discussed below.

A cost-effective and sustainable healthcare information system relies on the ability to collect, process, and transform healthcare data into information, knowledge, and action. The electronic health records (EHR) are expected to improve healthcare of patients. The EHR contains personal data along with payment information and help the patients to track their record easily at any time and at any place (Fig.10). The demand for ICT in healthcare services is a reality that is steadily increasing. With adoption of smart healthcare systems it is possible to provide cost effective quality healthcare services with less ICT set up costs and reduced risk.

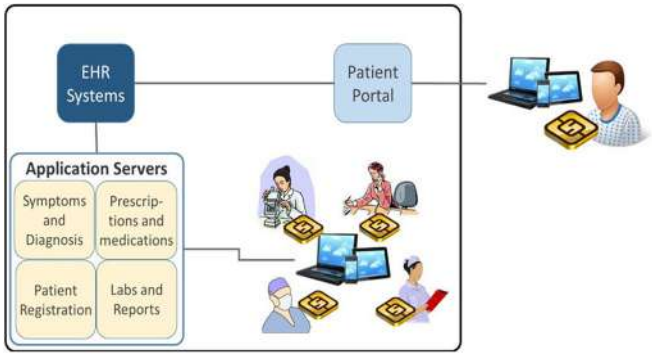

Fig. 10. Smart Healthcare Facilities

The emergence of environmental issues such as climate change has greatly augmented the need for robust, cheap, operationally adaptable, and smart monitoring systems. The fiscal investment historically needed to achieve high resolution temporal and spatial environmental data has prevented the collection of data sets adequate for both the detection of critical environmental change and the development of more reliable predictive models and tools. The digital technologies help to monitor the various climatic changes like rainfall, snowfall, storm, cyclone, earthquake and pollutants' level in the atmosphere and make the city administration informed to cope with the climate changes well in time. The concept of smartness of buildings, roads, energy, water and waste management and transportation of a city will reduce the depletion of natural resources, reduce the waste generation and minimize the emission of pollutants and thus make its environment smart.

SMART CITIZENS

'MyGov' is an innovative platform launched by government of India in 2014 to make the citizens smart enough to share their views and ideas on key issues through internet and engage them in making decisions. Thus digital technology makes citizens more informed; we all in turn make better informed decisions. As smart citizens, our changing behaviors, more efficient practices and smarter social norms are helping to develop cities into the kinds of place where we want to live.

To be smart, the citizens need to follow the building codes/ norms during construction, use the water, energy, etc. smartly to conserve the available resources, use the public transport rather the private vehicles, prefer jute, paper or cloth bags than plastic bags, grow more and more plants in the areas available with them and elect the public representatives without any personal benefit or fear to make the city smart in a real sense.

A smart city which mainly uses the digital technology is prone to cyber security threats like hacking, viruses attack and misuse of personal or government data by the illegal agencies. Therefore, it is highly desirable to advent a strong and safe technological mechanism to avoid its misuse.

CONCLUSION

The migration of people from rural to urban areas is becoming a crucial issue for the cities. To accommodate the influx, it is highly desirable that city components viz. engineering, administration, health and citizens need to be smart for developing smart cities. A smart city with the help of digital technologies enhances its performance, reduce costs and optimize the resources for the well being of citizens. The government should implement the advanced technologies in all the elements of a city to achieve the vision of smart cities in real sense.

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RELIABLE UTILITIES- SMART WATER : A CASE STUDY OF TOWNSHIP FROM HINJEWADI, PUNE

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Abstract

A city can be defined as smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life with a wise management of natural resources through participatory action and engagement. For a city to be 'smart', all individual components of the city should be smart in the sense of making of a smart city. These components may involve Smart Buildings, Smart Water, Smart Integration and Grid, Smart Environment, Smart Energy, Smart Transportation and Mobility.

This paper includes the innovative concepts implemented by author in making of a smart city and as a part of academics. Case study involved the implementation of all smart city components on a site located at Hinjewadi area, Pune city. The study focused on issues such as urban sprawl, traffic, infrastructure, water bodies, economic potential, supplies, construction activities, escalating land values, informal sector, environment. The study encompasses analysis using primary and secondary data from various sources. The detail of components of smart city focusing on the Reliable Utilities- water supply, sewerage, drainage, waste management and communication system

INTRODUCTION

More than half of the world's population now lives in urban areas. This shift from a primarily rural to a primarily urban population is projected to continue for the next couple of decades. Ensuring livable conditions within the context of such rapid urban population growth worldwide requires a deeper understanding of the smart city concept. The urgency around these challenges is triggering many cities around the world to find smarter ways to manage them. These cities are increasingly described with the label Smart City.

One way to conceptualize a smart city is as an icon of a sustainable and livable city. Although there is an increase in frequency of use of the phrase "smart city", there is still not a clear and consistent understanding of the concept .Only a limited number of studies investigated and began to systematically consider questions related to this new urban phenomenon of smart cities. This paper attempts to start filling this gap by identifying important trends and suggesting research agendas about cities as they invest in new ways to become "smart."

WHAT IS A SMART CITY?

A city can be defined as smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life with a wise management of natural resources through participatory action and engagement. Main components of smart city are: (Fig.1)

- Smart buildings
- Smart water network
- Smart integration and grid
- Smart environment
- Smart energy
- Smart transportation and mobility

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Fig.1. Smart Components

(Source: google images)

Smart Buildings

The smart buildings are the one which are constructed using smart building material and sustainable design in order to be eco-friendly and economical. The main building material to be used in construction of all buildings in township are:

Smart Concrete: Concrete is core building material but even concrete starts to crumble when it comes face to face with water, wind, stress and pressure. The current method of dealing with structural instability in concrete has been to replace or repair it but what if all you had to do was add a little water? A new type smart concrete contains dormant bacteria spores and calcium lactate in self-contained pods. When these pods come into contact with water they create limestone. Filling up the cracks and reinforcing the concrete. Self-healing concrete is estimated to save up to 50% of concrete's lifetime cost by eliminating the need of repair.

Smart Self Heal Coating: New to the market and already in use are self-healing coatings, sealants and adhesives. The coatings are made with polymers that innately react with one another when they rupture, creating a process of self-healing.

Shape Shifting Metals: Shape shifting metals can undergo great stress and temporarily change shape, but they are designed to 'remember' their original form and revert back to it if altered in some way. Used in the construction of a bridge, for example would help the bridge against damage from a hurricane or earthquake. Other than the above, many other sustainable building materials can be used such as glass , steel and mainly maywan shuttering, clc bricks, fly ash bricks, artificial sand etc.

Smart Water Network

Especially for the township, a Smart Water Network will be provided. The smart water network includes treatment, supply and management of water from the river itself. With the help of jack wells and a dedicated treatment plant of required capacity the water can be treated and distributed along the smart grid.

Smart Integration

The smart integration consists of a large series of wireless data network which consists of a grid of ICT's. The smart integration takes into care the optimum use of advanced Information Technology along with safety, affordability and easy usage facilities. For safety; CCTV cameras, automated fire alarms, integrated security system which includes IT advanced debugged circuits for automated protection are installed. The smart grid covers all the infrastructure and services provided and joins it with a series of wireless network. The smart grid also is intelligent as it helps us to save a lot of energy and reduces the losses of frequency of electricity mainly at the time of fluctuation.

Smart Environment

Smart environment mainly constitutes an eco-friendly, sustainable and longtime intact environment. This can be achieved in the township Fig. 2 by the following proposals:

- Use of renewable energy resources in the form of rainwater harvesting, solar street lights and solar panels for limited use.
- Conversion of used energy into renewable one.
- Planting trees and landscaping of eco trees which are oxygen provider and heat insulators for the township.

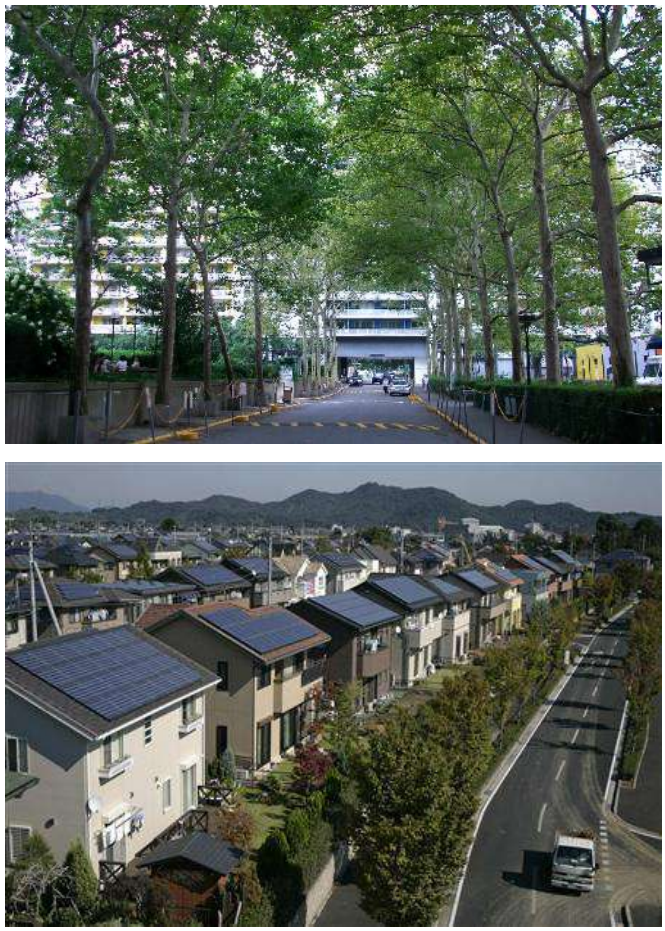

Fig.2. Green Area; Renewable Energy

(Source :google images)

Smart Energy

The Atlas Copco ER range of energy recovery systems can recover up to 94% of the electrical energy used. This means users are able to use their compressor energy more than once. When electricity is distributed, they generate a lot of heat. The major portion of this heat up to 94% remains in the compressed air and lubricating oil; the remaining 6% is lost to the environment through radiation losses. The design of Atlas Copco screw compressors, coupled with their ER energy recovery system, fully captures all the available heat generated during the compression process. The recoverable heat can be used in a variety of ways to offset general industrial heating requirements. This recovered energy can be used to preheat water feed to boilers or steam generators; other applications include space heating and even the heating of water for washing hands and for showers. Recovered heat reduces the amount of energy required from traditional energy sources which, in turn, reduces CO_2 emissions.

Smart Transportation and Mobility

The road network to be used is Grid Iron Pattern. The advantages of grid iron pattern are:

Financial Cost: Grid street patterns are generally considered to be less expensive than a street hierarchy plan because fewer road miles are needed to serve the same population. The pattern minimize disputes over lot boundaries and maximize the number of lots that could front a given street. John Randal said Manhattan's grid plan facilitated "Buying, selling and improving real estate''.

Pedestrianism: Pedestrians have an easier time connecting to other parts of neighboring neighborhoods and commercial business. Obstacles such as cul-de-sacs and busy intersections with high speed traffic that hinder or discourage pedestrianism are rarely present. The grid also enhances pedestrian access to mass transit.

Safety: Recent studies have found higher traffic fatality rates in outlying suburban areas than in central cities and inner suburbs with smaller blocks and more connected street patterns. It is clear that the lower speeds encouraged by the frequency of intersections decrease the severity of accidents occurring on streets within a grid plan.

Mobility

Electronic Vehicle System (EVS) is a desirable option. The advantages of EVS are as follows:

- No pollution

- Low maintenance
- Eco friendly and economic
- Easy to use

IMPLEMENTATION OF SMART CITY CONCEPT: CASE STUDY – HINJEWADI, PUNE

The site is in Pune's largest IT sector – Hinjewadi. Thus it complements the presence and all the technical needs can be fulfilled by the SEZ itself. It collaborates with the sense of the people, turns out to be smart city for smart people. We need to follow MIDC rules for the site which mainly stresses on the safety of the township; the smart grid used for the township will be more than safe for it. Smart City concept makes the township self-reliable and self-sufficient by providing all the services through a smart network.

Fig. 3 gives the Master Plan of our site showing the land use. The concept we have used is Smart City Concept. Smart buildings, Smart Integration, Smart Transportation, and Smart Environment etc. are the main aims of this concept.

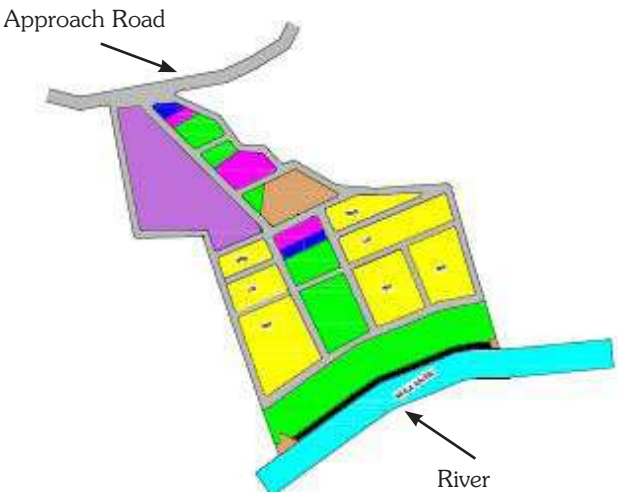

Fig. 3. Master Plan

At the entrance, we have the SEZ, commercial, public semi-public and other amenities so that not only the township population but also the outside population can enjoy. They are positioned accordingly that the people can enjoy them and have equal access to all the amenities according to their income groups.

The main advantage of this site is the presence of the Mula River. The river is the main source of the water and using Smart Water Network and dedicated water treatment plant the water is supplied to the entire township.

Smart Integration where each sector, each building, each tenement is smartly connected to the control centre and other utilities and thus giving safety, enjoyment, and work power.

The LIG, MIG and HIG are positioned so as that they are not too away from each other and LIG-MIG-HIG chain is followed parallel to each other.

Smart Environment constitutes for about 20% area of Open Spaces and Recreational Space which are well connected to the smart grid and smart resources.

Smart Buildings with smart materials, Smart technology and less work-home distance makes township life easy for its residents where they can enjoy amenities , go to work and still don't have to travel much.

Smart Transportation implies to the Grid Iron Pattern. The road hierarchy to be followed is 36m-24m-18m-15m respectively.

SMART WATER NETWORK

A smart water network is a fully integrated set of products, solutions and systems that enable water utilities to:

- Remotely and continuously monitor and diagnose problems, pre-emptively prioritize and manage maintenance issues, and remotely control and optimize all aspects of the water distribution network using data-driven insights.
- Comply transparently and confidently with regulatory and policy requirements on water quality and conservation.
- Provide water customers with the information and tools they need to make informed choices about their behaviors and water usage patterns.

The following sections explain how smart water network require people and technology to help utilities benefit from implementing these solutions.

Global Savings due to application of Smart Water Network is given in Table 1

Table 1: Global Savings due to Smart Water Network

Category	Savings as percentage
Leakage and pressure management	2.3 – 4.6
Strategic capital and expenditure prioritization	3.5 – 5.2
Water quality monitoring	0.3 – 0.6
Network operations and maintenance	1.0 – 2.1
Total smart water savings opportunity	7.1 – 12.5

The following technologies are used in Smart Water Network Solutions

- Measurement and sensing devices, such as smart water meters and other smart endpoints, are the physical hardware within the water distribution network that collect data on water flow, pressure, quality, and other critical parameters. This foundational layer includes electromagnetic and acoustic sensors that can help detect potential leaks and abnormalities within the distribution system.
- Real time communication channels allow utilities to gather data from measurement and sensing devices automatically and continuously. This layer features multiple communication channels that are used for two way communications to instruct devices on what data to collect or which actions to execute (e.g., remote shutoff).
- Basic data management software enables utilities to process the collected data and present an aggregated view via basic network visualization tools and GIS, simple dashboards or even spreadsheets and graphs. This layer can also include data warehousing and hosting, cyber security of computer systems and basic business function support tools (e.g., work order management and customer information system)
- Real –time data analytics and modeling software enables utilities to derive actionable insights from network data. This layer serves as the central source of the economic value of smart water networks for utilities. Dynamic dashboards allow utility operators to monitor their distribution network in real time for hazards or anomalies. At the same time, network modeling tools can help operators understand the potential impact of changes in the network and analyze different responses and contingencies.
- Pattern detection algorithms can draw on historical data to help distinguish between false alerts and genuine concerns and predictive analytics allows operators to consider likely future scenarios and respond proactively and effectively.
- Automation and control tools enable water utilities to conduct network management tasks remotely and automatically. This layer provides tools that interface with the real time data analytics and modeling software, leveraging communication channels and the physical measurement and sensing devices within the network. Many utilities have existing SCADA systems that can be integrated with smart water networks to further enhance their control over the distribution system.

Water Distribution Grid is shown in Fig. 4. The following two systems can be used for distribution of water.

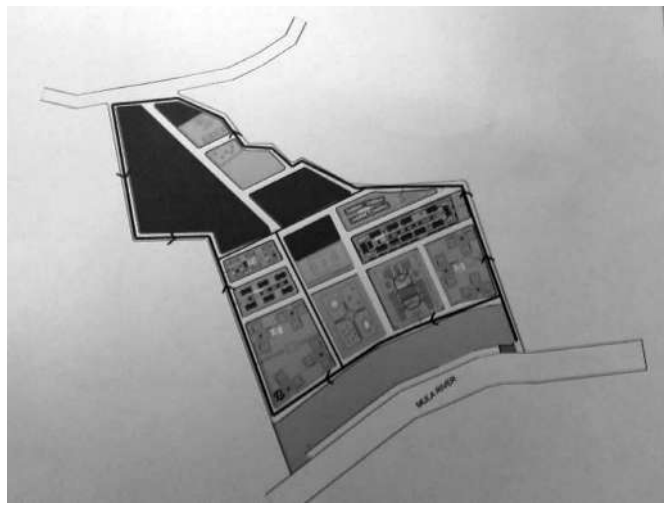

Fig. 4. Water Supply System in Township

Dual Distribution System

This is also known as combined gravity and pumping system. The pump is connected to the mains as well as to an elevated reservoir. In the

beginning when demand is small the water is stored in the elevated reservoir but when the demand increases the rate of pumping, the flow in distribution system comes from both the pumping station as well as elevated reservoir. In this system, water comes from two sources one from reservoir and second from pumping station, it is called dual system. This system is more reliable and economical, because it requires uniform rate of pumping but meets low as well as maximum demand. The water stored in elevated reservoir meets the requirements of demand during breakdown of pumps and for firefighting.

Advantages of dual system of distribution are:

- The balance reserve in the reservoir will be utilized during fire. In case the fire demand is more, and if required the water supply of few localities may be closed.
- This system is overall the best system. It is economical efficient and reliable.
- This system has the advantage that during power failure the balance water stored in the water tank will be supplied to the township.
- The pumps have to work at constant speed, without any variation in their speed. This increases the efficiency of the pumps and reduces the wear and tear of pumps. The supervision, operation and maintenance of these pumps is much less as compared with the pumps is much less as compared with the pumps working at variable speed.

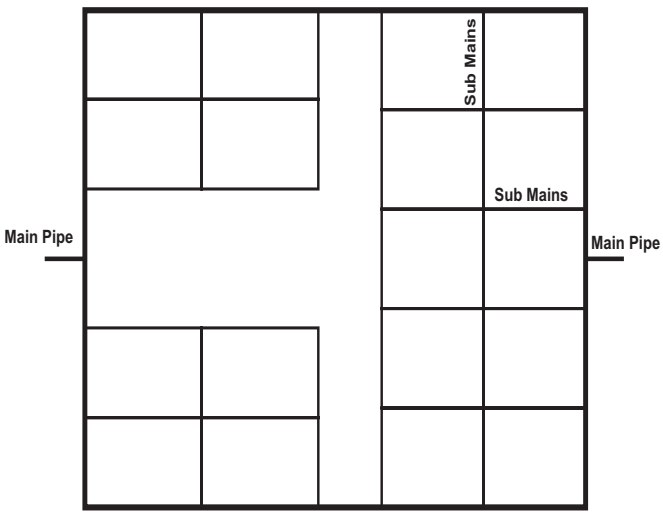

Fig. 5. Ring System

Circular or Ring System

This system (Fig. 5) can be adopted only in a well planned locality. In this system each locality is divided into squares or blocks and the water mains are laid around on all the four sides of the square or round the circle. The branches, sub-mains etc. are laid along the inner roads as well. All the sub-mains and branches are taken off from the boundary mains and are inter connected. In this way every point receives its supply from two directions. This system is more suitable for the township with well-planned roads.

Dug Well Recharge

In Alluvial as well as hard rock areas, there are thousands of dug wells which have either gone dry or the water levels have declined considerably. These dug wells can be used as structures to recharge (Fig.6). Ordinary dug wells or bore wells and tube wells can be used as recharge wells, whenever surplus water is available. In such cases recharge takes place by gravity flow. In areas where water levels are declining due to over development, using available abstract structures for recharging aquifers is the immediately available option. In this township such type of dug well is done on the side of entry gate.

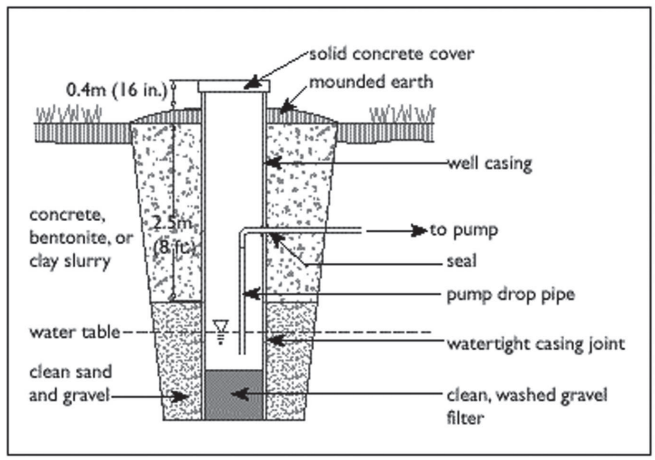

Fig. 6. Dug Well Recharge

(Source: google images)

CONCLUSION

- By automating processes, improving operational efficiency and making use of the distribution systems like dual distribution system and circular distribution system, the smart water network reduces costs, saves water, optimizes security

and compliance, and provides better service to all stakeholders.

- It is easy to save water from a large residential area by using smart water technology which involves dual water distribution system and circular or ring distribution system.
- They can upgrade and extend the system easily without costly configuration and are not constrained by existing technology in their future for making it on a large scale.

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SMART URBAN GOVERNANCE

Dr. Ponni M Concessao*

Abstract

Building 100 new smart cities is high on the agenda of the new government. However, the concept of "Smart Cities" must be seen in the Indian context and without the bias of techno-centrism and one-size-fit-all solutions. A smart urban governance system consists of five elements: rules and norms, actors/ participants, interactions, ICT enactment, and outcomes. Governance needs an overhaul – newer strategies that work, realistic plans, rationalization of governance structure, creating incentives, newer governance models based on new-age thinking, technology and innovation that can support development, which not only give new definitions to city value, but can rediscover the city and which can promote CSR's.

A smart city vision for India thus needs to acknowledge the roles, and address the needs, of both the above-mentioned stakeholders in order to gain wider acceptability as well as have a better chance of becoming a reality. A well-articulated smart city vision has a potential to transform city making and urban citizenship paradigms to ones that involve greater use of technology for gathering, visualizing, analyzing and patterning data for informed urban planning and making relevant data available in a consumable format to the citizens for greater transparency and informed decision-making.

INTRODUCTION

India's Prime Minister, is a leader with an urban vision. Before becoming prime minister, he was chief minister of Gujarat, where he transformed the state capital Ahmedabad with an award-winning sustainable bus transit system and a "world-class" riverfront recreation space. Today, his most ambitious projects in the region are two planned new "smart cities": the Gujarat International Finance Tec-City, on the outskirts of Ahmedabad, and Dholera, an industrial hub on the Delhi-Mumbai corridor. Still in inception, these cities are at the heart of the new administration's ambitious plan to transform the crumbling and chaotic image of Indian urbanization by building a hundred new smart cities.

China is an inspiration for us both in its larger push for modernization through urbanization, and its state-of-the-art new developments like Tianjin's famous "Eco-city". For urbanizing countries like India and China, smart cities are an opportunity to turn urban growth into sustainable development. The new policy has generated excitement amongst business leaders and urban elites tired of living in "third-world" environments. But whether India's smart city policy will translate into the desired outcomes – more sustainable, more productive and better-governed cities – is debatable. Both smart and traditional cities need strong and effective local institutions to flourish. In India, that simply isn't the reality.

India's Megacities lack autonomous governments with the power to shape their own affairs. Instead they're controlled by provincial administrations, and managed by a patchwork of state, city and municipal bodies, public and private corporations and village panchayats (a sort of parish council). But if smart cities are to have any impact on planning, coordination and governance, there needs to be a centralized metropolitan governing structure,

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accountable to city residents. If city governments do not have the incentives and resources, the trappings of a smart city – cyber highways, digital sensors, smart cards and computerized management systems – will remain just trappings: like the city development plans and environmental policies Indian cities regularly prepare but rarely implement.

City and local governments, responsible for basic public services, have the most direct impact on well-being, particularly that of the poor. In India, however, there is a glaring mismatch between their functions and capabilities. Moreover, most so-called "smart city" or "new city" projects underway in India are happening outside official city boundaries. Most aren't new cities at all, but self-contained commercial, residential or industrial enclaves adjacent to major cities. The revenues from such policies typically go to provincial levels of government, which are in charge of urban development policy; municipal and local authorities are left holding the costs. This pattern undermines the potential of city governments to grow into effective, well-resourced and democratically accountable institutions that can effectively improve urban conditions. China is politically centralized, but administratively and fiscally it is far more decentralized than India. Its local governments account for half of public expenditure and 25 percent of revenue. They have the tools and resources to plan and manage growth; they can annex surrounding rural areas, and use land revenues to fund urban development. This strategy has allowed China to urbanize rapidly, with infrastructure and services keeping pace with or preceding urban population growth. India will struggle to follow suit.

Urbanization, historically, has been a time where public institutions are built and strengthened, from utilities to regulatory institutions, social welfare services to libraries and hospitals. So the current fragility of India's civic institutions will have a serious impact on its ability to deliver improvements in wellbeing to its rapidly growing urban population. Rural urbanization accounted for nearly 30 percent of urban growth in India over the past decade. It's created hundreds of newly-urban settlements which don't have the municipal institutions required to collect taxes, plan development or deliver public services. As a result, slums and informal settlements, once a big city problem, are becoming more widespread. By 2040, India's urban population will be over 600 million. Amartya Sen describes India as a place where "islands of California" exist amidst a "sea of sub-Saharan Africa". To mitigate, rather than entrench, inequities India needs an urban agenda that is more wide-ranging, inclusive, sustainable and locally-driven than one centered on new smart cities.

SMART CITIES

Building 100 new smart cities is high on the agenda of the new government. However, the concept of Smart Cities must be seen in the Indian context and without the biases of techno-centrism and one-size-fit-all solutions. After analyzing the initiatives globally, certain common themes do emerge for formation of smarter cities and communities, namely:

- Integration: Energy, transport and information and communication technologies (ICT) seen as parallel and interdependent factors for smartness in urban areas.
- Smart Governance: This aspect is the backbone of smart solutions. Smarter governance is enabled through more informed decision making and participation of disparate opinions and agendas towards overall betterment of cities and communities.
- Innovation and Technologies: World over, technologies are enabling smarter solutions. Technology innovation is helping better collection, processing and analysis of data through conventional and crowd/social media methods. Interpreting 'Smart Cities' in the Indian context, following prima-facie impressions emerge:
- Energy: Although not within the urban local jurisdiction, energy is very much an urban concern. While fossil fuel fed mechanized transport remains the biggest head in energy consumption in cities. Increasing and inefficient electricity usage is also a cause of concern. Moreover, the fast growing cities of India also consume tremendous amounts of energy through real estate construction and infrastructure expansion activities. Cities, globally, use more energy than the industrial and rural hinterlands, implying that energy efficiency is not just a regional but also an urban responsibility. Particularly in India we all suffer from scheduled

and unscheduled power cuts. Contributing to peaking of grid loads and fossil fuel needs is our erratic usage pattern where a few hours of use trumps the overall consumption across a day. This impacts the overall urban economy, having direct impacts on the revenues of any city and its potential for growth.

- Traffic and Transport: As discussed above, transport is a major concern from energy and carbon perspectives. Moreover, mobility is the basic need for any urban economy. Time lost due to traffic congestion has a direct impact on the overall efficiency of any city, including that of the businesses and economic activities. Congestion management is also critical for provision of essential and emergency services. Good quality public transport system not only helps curb the use of personal vehicles and the resulting pollution but also has benefits in terms of safety and accessibility.
- Internet and Communication Technologies: ICTs help cities connect better to their citizens, enabling better feedback and cross fertilization of ideas. Technological solutions help model and analyze urban issues, incorporating multiple factors and generating solutions that have multiples co-benefits. However, pursuing technologies for the sake of technology introduction is never fruitful. Technology is merely the means towards the desired ends and not the other way round.
- Smarter Urban Management for Smarter Cities and Communities: The key link in enabling smarter solution of cities and communities is smarter governance. With the advances made in the last decade, most cities have a combination of above.

PUBLIC TRANSPORT AND TRAFFIC INFORMATION AND MANAGEMENT SOLUTIONS

While mass transport solutions come with a back bone of information collection and management systems, they work in silos and are more or less limited to efficient running of such a system. This is particularly true for the BRTS systems being adapted in India where up to 5 vendors deal with data pertaining to ticketing, tracking, information display and maintenance of rapid transport systems. Wider availability and use of mobility data can help in providing wider connectivity, safer and accessible corridors and efficient use of mobility stock across the city. An integrated real time database will enable the city to respond to changing settlement and usage patterns while maximizing resource use through management.

- Municipal Administration and MIS Systems: Such systems include to varying degrees the municipal services and internal administrative protocols. The MIS systems exist with varying levels of cross integration and data reliability. Geo-referenced maps exist in most cities, either at the municipal level or with several parastatal agencies. Good quality spatial, socio-economic and service efficiency data can help decision makers make better decisions. But for that the data is to be made widely available, devoid of legal bottlenecks and with the flexibility of constant improvements (e.g. Wikimapia enables users to customize maps, and add and edit information)
- Better Energy Use: There exist varying levels of detail on the energy use at city and municipal levels, energy and fuel bills and major consuming heads e.g. vehicle fleets, water and sewerage pumping etc. However, an overall energy management system with real time assessment of energy consumption across the city does not exist. This limits the ability of cities to react to energy trends and achieve efficiency. E.g. the green roofs initiative in New Delhi mitigates the peaking loads during day time by feeding in solar energy into the grid. Similarly, dynamic energy efficiency can be achieved in municipal service delivery by monitoring the energy trends.
- The smart urban management solution: It is not difficult to observe that the solution to above is all locked in interdependencies and multitude of actors, institutions and specializations. Energy and resource efficiency is dependent on technology and innovation. While governance brings it all together through collective decision making. The smart city solution remains an integrated database and decision making system that incorporates innovative ICT technologies to simultaneously generate, process and analyze spatial, transport, energy, municipal services and socio-economic data, the capability and resource base to enable holistic decision making and finally

a governance system that encourages informed and prompt decisions. It is the urban managers' ability to interpret such data in all its complexity and holistic scope, monitor trends in the above mentioned sectors backed by experience and intuition, to run scenarios for energy efficiency, cost efficiency and financial feasibility and use them all for efficient economy, safer and well performing spaces, effective governance and responsive mobility that would truly drive us to smarter cities.

The increase in economic growth in India has caused an escalating rate of urbanisation, the unfortunate part being that 'the quality of life' has taken a backseat – to put bluntly, for many of us staying in Indian cities is 'no less than a mess'; there seems to be the absence of power, the intellect, the systematic functioning of the authority that will direct India on a path where 'living everyday especially in metros becomes at least satisfactory, and not chaotic'.

In a country that recently celebrated its 68th year of independence, the question remains – are we all independent and liberal in the sense that we, as the users (read stakeholders) are allowed to take decisions and express our opinions for a country we are citizens of? Does Governance still have to be in the hands of a few, who might be the best leaders for running a central power but not an ideal authority to comprehend the direction cities and urban planning have to take? The most ideal situation has to be definitely one where the framing of policies has to involve more of stakeholders, communities, urban thinkers and scholars, and where we have to steer clear of getting caught in cobwebs of rules, time consuming – permissions and delays that in reality, hold no significance.

Master plans of cities are today being chalked out with the final decisions being taken by politicians and bureaucratic bodies, and sometimes-international experts present on the panel. Does it not undermine the role of planning and planners in our country? There are many urban designers and architects in the country who have initiated proposals for urban improvements – this needs to be acknowledged at a higher level.

The smart city concept holds an array of opportunities for future of cities and city-making in India. However, it is critical that urban planners in India acknowledge technology as merely a tool and engage with it in a way that affirms values and addresses the most pressing goals.

This idea supports a vision to create highly networked, environmentally sustainable, energy efficient and seamlessly managed Indian cities; cities capable of attracting investments and supporting a high standard of living while also being self-sustaining.

The idea of smart cities thus creates an urban utopia where technology comes to the rescue of every challenge. What could not be solved through decentralization and a series of urban sector reforms, can now be solved by inculcating 'smartness' into our cities.

Most of the existing imagery of smart cities is being propagated by industry-led consortiums. The imagery focuses on highly technical and specialized solutions like smart-grid; GPS based land record-monitoring, intelligent transportation systems, and so on. The dialogue focuses on use of available solutions, rather than assessment or articulation of needs by urban planners and managers.

Although not deliberate, these imaginaries and dialogues may result into alienation of two crucial stakeholders from the process of city making: the citizen and the urban planner. The concept note highlights the urban challenges prevalent in Indian cities and the use of technology tools to address the same, however little is elaborated in terms of empowering the citizenry through use of these tools. The lack of a benchmark on citizen participation further makes the inadequacy of the vision to address the creation of empowered citizenry, apparent. Further, by advocating and emphasizing the technology solutions available, the plan of action is laid out and the role of an urban planner is almost made redundant. There seems to be no need for identifying contextual challenges and specific needs along with understanding the best-fit technology that can be integrated seamlessly into the existing urban fabric of the cities. Thus, the focus on solutions de-emphasizes a rather complex process of urban planning and ignores the potential of utilizing smart city technologies for capturing and using data for evidence-based planning.

CONCLUSION

A smart city vision for India thus needs to acknowledge the roles, and address the needs, of both the above-mentioned stakeholders in order to gain wider acceptability as well as have a better chance of becoming a reality. A well-articulated smart city vision has a potential to transform city making and urban citizenship paradigms to ones that involve greater use of technology for gathering, visualizing, analyzing and patterning data for informed urban planning and making relevant data available in a consumable format to the citizens for greater transparency and informed decision-making.

It is critical that urban planners in India acknowledge the role of technology as merely a tool and engage with it in a way that affirms the most contextual values and utilize it to achieve the most pressing goals. The smart cities framework should not aim to simply strengthen the consultative participation through use of technology for monitoring urban services, but also to empower citizens by providing them consumable data derived out of smart city tools, enabling them to play a substantial role in the city making itself. The smart city concept holds an array of opportunities for future of cities and city making in India. However, it is the articulation of a well-rounded and contextual vision that shall set us on the path of realizing and making most of these opportunities.

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CHALLENGES OF INFRASTRUCTURE FINANCING IN INDIA

K R Ramana* and Dr. P Hanumantha Rao**

Abstract

Infrastructure is the vital element for the growth of any economy. India is certainly no exception to this. No economy can think of growing without sufficient and necessary infrastructural facilities. It is like a base on which the building has to stand. The stronger the base, the stronger will be the building is the rationale behind the need of sound infrastructural facilities. Indian economy has been facing the challenge of inadequate infrastructural facilities like energy, transport, communication, education, health, housing etc. As per an estimate, Government of India needs a massive provisioning of Rs 26 lakh crore for the next five years beginning 2015 to finance infrastructure projects to help the economy attain 7-8 per cent growth. Further it is forecasted that out of the estimated Rs 26 lakh crore amount required for infrastructure projects, almost 80 per cent will be required for power, roads and urban infrastructure. In power, generation will account for the largest share of investments whereas in roads, investments would be driven towards building national highways and state roads. In urban infrastructure, municipal bodies would need significant investments for constructing urban roads, expanding its transport and revamping water supply and sewerage infrastructure.

The article aims to explore the various sources, along with their respective merits and demerits, which can be used to overcome the congestion and meeting the demand for services of rural and urban infrastructure requirement and the challenges of financing of the above related infrastructure projects for upcoming smart cities in an emerging and speedily developing nation i.e. India.

INTRODUCTION

India is the fourth largest economy in the world and the the lack of world class infrastructure is one of the most significant factor which is obstructing its further growth and development. As per an estimate, this lack of adequate infrastructure is adversely affecting India's GDP growth by 1-2 per cent every year. Rapid growth of the Indian economy in recent years has increased stress on physical infrastructure, such as electricity, railways, roads, ports, airports, irrigation, water supply, and sanitation systems, all of which already suffer from a substantial deficit. Government of India needs a massive provisioning of Rs 26 lakh crore for the next five years beginning 2015 to finance infrastructure projects to help the economy attain 7-8 per cent growth. Out of the estimated Rs 26 lakh crore amount required, almost 80 per cent will be required for power, roads and urban infrastructure. Further, for developing Smart cities, India needs significant real estate investment, which globally is structured and regulated differently than infrastructure investment.

A Smart City needs to have fully integrated infrastructure and would be a place where there are long-term core jobs available and a vision for sustained growth. If we use an average figure of 1.0 million people in each of the 100 proposed smart cities, the total estimate of investment requirements for the services covered by High Power Expert Committee is around Rs.7.0 lakh crores over 20 years. This translates into an annual requirement of Rs.35,000 crores. However these estimates have to

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be analyzed for the purpose of funding by the Central Government. Moreover, it is assumed that most of the infrastructure will come either as complete private investment or through Public Private Partnerships. The contributions from the Government of India and the States/ULBs will be largely by way of Viability Gap Fund. Implementing Smart City solutions has become increasingly complex and financially challenging. In order to fulfill the vision for Smart Cities, the Ministry of Finance had already allocated Rs.7060 crores in the Union Budget for the year 2014-15. In this context, financing of infrastructure projects is of utmost importance for India. If careful thought is not given to this aspect, we may not be able to grow at the desired rate. Financing of smart cities needs integrated solutions to ensure energy efficient urban development. Grids, energy efficient buildings, energy supply systems, transport and the behaviour of citizens will need to lead to considerable energy savings and green house gas reductions, which is the final aim. Strategic planning, integrated municipal departments and procurement processes have to be backed up by innovative financial mechanisms to leverage the necessary private funding to support the large-scale and to some extent radical transformation in energy use. The government has a plan to develop 100 cities into smart cities over a period of five years. Converting a city into a smart city needs huge amount of investment. The government of India intends to provide visibility gap fund only. The remaining funds are expected through the public-private partnership (PPP) model. As per an estimate, the Central Government will spend around Rs 48,000 crores and an equal amount of money will be spent by the states Governments. Some of the sources which can be used for financing infrastructure needs in India are discussed below:

Debt Funding

One of the important sources of financing infrastructure needs of the country is debt financing. There was not much of demand from the financial system till 2005 to fund infrastructure investment as it was very low – (around 3-5% of GDP) and was financed mostly by budgetary allocations and the internal resources of public sector enterprises engaged in infrastructure. But it was during 11th five year plan when infrastructure spending picked up substantially with an important role played by the private sector and greater recourse to the financial system. Most of the debt financing come from banks, non-bank finance companies and External Commercial Borrowing followed by insurance companies. Debt instruments include bonds, which are debt securities issued by companies or governments. They entitle the lender to claim the investment over a certain period (usually long term) with interest. Bonds provide the borrower with external funds to finance long-term investment. These are similar to loans, but are easy to trade. If bonds are issued by project companies to raise funding from the markets for a specific project on a non-recourse basis, they are often called 'project bonds.

Commercial Banks

Commercial banks in India play an important role in funding infrastructure Special Purpose Vehicles (SPV's) but their exposures was limited on account of asset liability mismatch, narrowing interest margins, inadequate capital and redistribution of risk associated to other funding entities. The problem is more alarming at the initial underwriting stages were banks do not have necessary expertise to evaluate the underlying technical and financial risks that are usually associated with such long term projects. Regulatory norms like ceiling on exposures and provision of a higher capital further have limited their contribution to such social cause as infrastructure development. Also, there is an absence of organized securitization mechanism where a bank's balance sheet exposure on infrastructure can be converted to paper based securities. In spite of this entire drawback, commercial banks have done a great job in infrastructure financing in one way or the other. Most Banks have smartly diversified its role from being a fund provider to pure advisory services.

Infrastructure Non Banking Finance Companies

Non-bank finance companies (NBFCs) also increased their lending sharply as the credit demand for power, telecoms and roads expanded. The major Infrastructure Finance Companies considered are PFC, REC, IDFC, IIFCL, L&T infra and IFCI. The outstanding credit from IFCs to infrastructure sector has increased from Rs 1,10,549 Crs. in FY08 to

₹ 1,81,595 Crs. in FY10 at a CAGR of about 28 per-cent . The PFC and REC which together constitute about 80 per cent of the lending by IFCs have had their outstanding credit growth at approximately 27 per cent per annum.

Insurance Companies

Life insurance companies are expected to invest 15% of their Life Fund in infrastructure and housing. The share of Infrastructure investments in the Life Fund has come down to 10 per cent in financial year 2010-11 vis-a-vis 15 per cent in financial year 2006-07. For Non life insurers, the Assets Under Management increased at a rate of 9.62 per cent p.a. from ₹ 50,383 Crs. in FY2006-07 to ₹ 66,372 in FY200910 whereas the share of infrastructure investments increased continually from 12 per cent in FY2006-07 to 16 per cent in FY2009-1010. Insurance penetration is expected to continue to rise, with the insurance premium growing from the current approximate 4% of GDP to 6.4% of GDP by the end of the Twelfth Plan. Investment in infrastructure by the insurance sector has been estimated based on the past few years average investment by insurance companies at about 63% of premium income after deducting commissions and expenses, and the infrastructure investment as a share of the total insurance investment flows (of 6.2%). Though there is much greater scope for channelizing insurance funds for infrastructure (which needs long-term funding) there are various prudential and regulatory constraints in the sector precluding this.

External Commercial Borrowing (ECB)

Infrastructure companies also explored external credit markets. The share of infrastructure investments in overall ECB borrowings has declined over the past few years. The estimates of the external borrowings during 12th Five Year Plan are based on the five year averages (FY 07-11) of the actual external borrowings.

Equity and Foreign Direct Investment (FDI)

The equity/ FDI has been approximately 14 per-cent of the total investments made towards the infrastructure building during the first three years of 11th FYP whereas the overall debt contribution was around 41 per cent which implied a debt equity ratio of 2.93:1. If the proposed infrastructure spending is funded in the same ratio, the equity/ FDI available is expected at ₹ 4,55,414 crs. However, it is important to note that Equity funding will be a key constraint going forward – possibly even bigger than debt funding. A large part of equity investments will depend on foreign investments with domestic investment institutions not coming in majorly at primary level for taking equity in Infrastructure projects. Regulatory changes to make projects commercially attractive are needed to draw adequate equity capital to infrastructure sectors. Also other changes like pension/PF regulations amendment to allow investments in equity markets will be critical. Foreign investment is permitted in infrastructure companies in Securities Markets, namely, stock exchanges, depositories and clearing corporations, in compliance with Securities and Exchange Board of India (SEBI) Regulations and subject to the following conditions:

- There is a composite ceiling of 49 per cent for Foreign Investment, with a FDI limit of 26 per cent and an FII limit of 23 per cent of the paid-up capital;
- FDI will be allowed with specific prior approval of FIPB; and
- Foreign Institutional Investment (FII) can invest only through purchases in the secondary market.

100% FDI is allowed under the Automatic Route in Development of townships, Housing, Built up infrastructure and Construction Development Projects but does not include real estate business.

Public Private Partnership (PPP)

The PPP is defined as "the transfer to the private sector of investment projects that traditionally have been executed or financed by the public sector" (IMF, 2004). According to Ministry of Finance Government of India the PPP project means a project based on a contract or concession agreement, between Government or statutory entity on the one side and a private sector company on the other side, for delivering infrastructure service on payment of user charges. The PPP model will help government

to implement its schemes in partnership with the private sector. Typically these are set up in a form of a Special Purpose Vehicle and are engaged in financing, operating and maintaining of the assets and project. This is going to be one of the most important sources for infrastructure financing especially for proposed Smart Cities in India.

Foreign Institutional Investors Investment

As per an estimate by the planning commission, there is a gap of $100 billion in infrastructure funding that has to be bridged from foreign sources. To speed up the flow of funds to the infrastructure sector, the FII limit for investment in corporate bonds, with residual maturity of over five years issued by companies in infrastructure sector, has been raised by an additional limit of US$ 20 billion taking the limit to US$ 25 billion. As a result of this, the total limit available to the FIIs for investment in corporate bonds is raised up to US$ 40 billion. As most of the infrastructure companies are organized in the form of SPVs, FIIs would also be permitted to invest in unlisted bonds with a minimum lock-in period of three years. However, the FIIs are allowed to trade amongst themselves during the lock-in period.

Infrastructure Bonds

The infrastructure bonds have a maturity of 10 years but a lock-in period of five years and the investor will have the option to sell the bonds back to the issuer. Alternatively, the bonds can be traded on the stock exchanges. What makes these bonds lucrative for investors and issuers is :

a) Section 80CCF, any individual or Hindu undivided family can invest up to ₹ 20,000 in infrastructure bonds and avail of tax benefits

b) These provide fixed returns and are reasonably safe and

c) The amount raised by issue of infrastructure bonds by Infrastructure Finance Companies, u/s 80CCF of the Income Tax Act, 1961, shall not be treated as „public deposit as provided in the Non Banking Financial Companies Acceptance of Public Deposits (Reserve Bank) Directions, 1998

Infrastructure Debt Funds

The concept paper on creation of a Debt fund for Infrastructure PPP projects was for the first time presented by Shri Gajendra Haldea, Adviser to Deputy Chairman in a meeting of experts and stakeholders which was held on May 12, 2010 under the chairmanship of Deputy Chairman Planning Commission. This paper suggested the creation of the India Infrastructure Debt Fund that would raise low-cost long-term resources for re-financing infrastructure projects that are past the construction stage and associated risks.

Further the Report on India Infrastructure Debt Fund, under the Chairmanship of Mr. Deepak Parekh made recommendations on setting up of Infrastructure Debt Funds for ₹ 50,000 crore ($ 11 billion) to meet the needs of long-term debt for infrastructure projects that are set up through Public Private Partnerships (PPP).

Takeout Financing

Takeout finance is a new product emerging in the context of the funding of long-term infrastructure projects. As per this agreement, the institution/ the bank financing infrastructure projects will have an arrangement with any financial institution for transferring to the latter the outstanding in respect of such financing in their books on a predetermined basis. In view of the time lag involved in taking-over, the possibility of a default in the meantime cannot be ruled out. The norms of asset classification has to be followed by the concerned bank/financial institution in whose books the account stands as balance sheet item as on the relevant date. If the lending institution observes that the asset has turned NPA on the basis of the record of recovery, it should be classified accordingly. The lending institution should not recognize income on accrual basis and account for the same only when it is paid by the borrower/ taking over institution (if the arrangement so provides). The lending institution should also make provisions against any asset turning into NPA pending its take over by taking over institution. As and when the asset is taken over by the taking over institution, the corresponding provisions could be reversed. However, the taking over institution, on taking over such assets, should

make provisions treating the account as NPA from the actual date of it becoming NPA even though the account was not in its books as on that date.

CONCLUSION

If the financing pattern is taken care of, India's Smart Cities will become a favoured destination for foreign investment across jurisdictions and asset classes. Smart Cities need smart financing that gets the mix of returns, risk, stability, and venture just right. As huge investments will be needed, innovative methods of raising revenues will have to be developed by the States and Cities, taking into account some of the possibilities outlined earlier. The financing of infrastructure needs of the country is no doubt a huge challenge for India in the time to come. All the above sources should be fully explored to fund the financial requirement for infrastructural growth with a focus on smart city concept.

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INNOVATIVE FINANCING FOR DEVELOPMENT OF SMART CITIES

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Abstract

The need for creation of smart cities is increasing continuously. The reason behind this is high rate of migration from rural to urban areas, which is giving rise to increase in the urban population and urban sprawl. The government is realizing the need for creation of smart cities, which is a very big project and thus requires high level of skills and huge amount of investments. However it is very difficult due to high level of financial risk and lack of skills within the govt. On the other hand, when we talk about small local level projects, a need for financial participation is always felt from both the side i.e., local bodies and the people.

These type of situations can be handled easily with the help of methods of innovative financing which include public private partnership (PPP), municipal bonds, state guarantees, insurance, and other market based innovative. This paper discusses about some of these major innovation that can be used for development financing. It also explains about the key issues related to it and their possible solutions. It also focusses upon how these innovative financing methods can be helpful in the making of smart cities.

INTRODUCTION

There are various challenges associated with development which are mentioned in the United Nations millennium declaration. The millennium development goals are the agreement of various world countries to focus on various challenges and for the development of the world. The seven millennium development goals focusses on various challenges like poverty, education, women empowerment, health etc. whereas the eighthmillennium goal recognizes the need for providing support to developing countries from international environment (United Nations Development Programme, 2012)[1].

The developing countries have made various efforts in itself for finding the various innovative sources of financing to meet millennium development goals (MDGs). However these efforts have been found to be ineffective due to lack of skills and support from international environment.One more reason for this failure was the lack of financial support from the private sector. These efforts of developing countries are appreciable; however the need for innovative financing for the development cannot be ignored, as it is the only method which can support the world in finding the millennium development goals.

The millennium development goals were first addressed in 2002, after that there has been a lot of discussion on it. Now when we are coming closer to the end of the period decided for it, a lot of efforts are required so that at least some of these or part of these can be achieved. The second main point which is important to note down here is that various efforts from the developing countries are coming in the form of development of smart cities, so it is very important to note down here that methods of innovative financing should be used in these projects so that these efforts can help in the development of these countries and can also contribute in achieving the millennium development goals.

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INNOVATIVE FINANCING

There is no exact definition of innovative financing, however it can be understood with two terminologies. These are the source of funding and the uses supported by them. The source of funding may be from new resource, private investors etc. And the uses they support are related with development, as they provide financial solutions for various developments problems. It has mainly three type of functions. These are (Elisabeth Sandor, 2009)[2]:-

- New approaches for pooling private and public revenue streams: partnership between public and private sector like PPP projects for financial support.
- New revenue streams: new tax, charge, voluntary contribution schemes, fee etc. to support development activities.
- New incentives: financial guarantees, insurances, other rewards etc. to scale up ongoing development activities.

There are two different dimensions of innovative financing. The first focusses on innovative financing as a source of capital. The second dimension focusses on innovative financing as a deployment or use of capital. (Global Development Incubator, 2014)[3]

We can easily understand these two dimensions. The source of capital means that innovative financing provides various new sources of capital investment from various sector which may be public or private. Deployment or use of capital, describes the mechanism of innovative financing by which it can make development initiative more effective. It helps in redistributing risks, increasing liquidity, and matching the duration of investment with project needs.

So if we incorporate these two definitions, we can define innovative financing as the mechanism by which we can achieve capital investment and use these capitals for development of various projects which will give rise in the effectiveness of the projects and also in their validity. We will now discuss about the reasons for the need of innovative financing and how innovative financing can be helpful in development of various projects especially in case of smart city projects.

INNOVATIVE FINANCING: WHY?

There are various reasons for need of innovative financing in development projects. Finance is a very important asset in any project, as it is responsible for working and outcome of the project. With the change in the technology and innovation in the field of development, it is very difficult to use traditional financial techniques. Here comes the need for innovative financing, so that development projects can be incorporated with the emerging technologies. Second reason governing the need for innovative financing is the need for financial incorporation between public and private sector. As there is requirement for a lot of finance for the national level projects like smart city project, hence the need for investment from the private sector is felt, which can be fulfilled with the help of innovative financing.

Third, when we talk about private projects or local level projects, there is also a requirement for finance which cannot be managed by the private body itself, so this need is fulfilled with the help of innovative financing ideas like municipal bonds, state guarantees, insurance etc.

METHODS OF INNOVATIVE FINANCING

There are various methods of innovative financing. The usefulness of these methods differ with the type of project. However, these methods can be very helpful in case of development of smart cities and can also contribute to the development of the country. Some of these methods have been discussed here, which can be used in case of smart city projects

Public Private Partnership

Public private partnership is a funding model for development projects in which there is a partnership between public and private sector. The project is funded and operated through this partnership. The public private partnership is a medium to long term arrangement for the project financing and operating between public and private sectors. There may be more than one private partners in any PPP project.

There are various benefits of PPP project, to both public and private sectors. These benefits include

- Makes projects affordable
- Risks are allocated to the party which is best suited to handle it

- Innovation and increased efficiency from private sector.
- Public budget could be used in other sectors.
- Better management of the projects.

There are various types of PPP projects like built, operate, transfer (BOT), built, own, operate & transfer (BOOT), design, built, operate & transfer (DBOT), design, built, finance, operate & transfer (DBFOT), design, built, maintain & transfer (DBMT), built, own, operate, maintain & transfer (BOOMT) etc. However their efficiency depends upon the type, scale, and location of the project.

PPP project can be used in the development of smart cities. As it is a very big project, so it can provide financial support to the project. Smart city project is a long term project, so it requires better management and operation techniques, which can easily met from PPP model. Smart city project also requires a lot of skills and innovations, which will only be possible when there is a partnership between public and private sector.

Municipal Bond

These are the bonds issued by local or state governments. These are the debt securities issued to finance general government activities or special projects. Municipal bonds are generally used to meet capital needs of infrastructure projects and other aspects of municipality. The interests that investor receives is exempted from income tax.

Municipal bonds can be used for small local level public projects like development of highway, bridges etc. the biggest advantage of investing in municipal bond is their tax-advantaged status. There are mainly two kinds of municipal bonds, general obligation bonds and revenue bonds. General obligation bonds are repaid by the taxes which is collected by the issuer, while revenue bonds are repaid by the revenue which is generated from the project, for example a toll road.

Municipal bonds cannot be very successful in projects like smart city projects, as these are very big projects. However these can be used in the operation and maintenance period of the project. Also for use of municipal bond technique there is a requirement of strong local body. Due to these constraints it is very difficult to use this technique in developing countries like India. But once we are able to remove these constraints we will be able to use this technique very effectively.

State Guarantee

State guarantee fund is a fund which is administrated by the state or national government, to the policyholders in the state in case any insurance company found to be default or insolvent. These are given to the policy holders of only those companies which have license to operate in a given state. It means that if any insurance company has license to operate in a state, policyholder of that company within the state are protected, because if the company defaults on its payments or became insolvent, the state guarantee fund will pay him instead.(financial dictionary: State Guaranty Funds, 2012)[4]

The state guarantee fund are financed by these companies itself. They pay a small percentage of their revenue to different states to fund state guarantee funds. These funds are managed by state governments. A good example of state guarantee funds system is United States of America.

There are various benefits of state guarantee funds. They provide finance security to policyholders like an insurance company. They promote private bodies to invest money in various companies and projects. These are very helpful and effective for private bodies and private projects.

State guarantee funds cannot be used in case of smart city projects, as these are central government projects and are large level projects. However, this technique can be used in collaboration to other techniques, like PPP where it may be helpful to private bodies as they will have finance security, which will promote them to participate in the smart city projects. This will also help to government as there will be more private choices for partnership.

Frontloading and Debt-Based Instruments

Frontload initiatives makes public funds available earlier for development. It does this through insurance of public bonds at international capital markets. Other debt-based mechanisms include debt conversions, which can be defined as the exchange

of debt, at a substantial discount, which reduces the amount of debt and debt services payable, thereby providing additional resources for development expenditures.

Diaspora bonds, which are the debt instruments issued by a country to raise financing from its overseas diaspora and socially responsible or green bonds which are provided to investors, who are interested to invest in development and environmental initiatives, therefore charging lower rates of return on their investments (United Nations Development Programme , 2012)[1].

These methods can be helpful in providing innovative finance mechanism at national and international levels, for the development of large scale, national and international projects like smart city projects. These can also be helpful in providing the financing support to various private bodies from national and international financial supporting bodies.

BENEFITS OF INNOVATIVE FINANCING

There are various benefits of innovative financing. It will secure maximum development impact, promote progress towards the millennium development goals and improve global governance framework. It will become more effective if it (Elisabeth Sandor, 2009)[2]:-

- Avoids discouraging countries from raising domestic funds and from development of equitable and fairly policies.
- Complies with various declarations which focusses on strengthening the countries ownership, alignment within their policies, budget, priorities and frameworks.
- Take account of advantages and disadvantages of specific financial instruments.
- Is simple and transparent, which is very important when calling for private partnership.
- Follow good public financial management techniques.

There may be also some other benefits. These may vary from case to case. Also these benefits show how important are innovative financing methods in case of development projects in development of countries.

SMART CITY PROJECT, INDIA

The government of India has announced to develop 100 smart cities in the country, to meet the various concerns arising out of the unregulated growth and urban sprawl in present cities of the country. It is focused on recasting the urban landscape of the country to make them more livable and inclusive besides driving economic growth. Efficiency and sustainability will be the major focus areas of the smart cities. Whereas the accountability will be the most important factor in the fund disbursal to the states. The cost of the project is estimated to be around ₹48,000 crore.(Smart Cities - Transforming Life - Transforming India, n.d.)[5]

As this project is a very large scale project, both in terms of finance and time period of operation, so there is strong need for use of innovative financing methods to be incorporated in the project. Government of India has identified this need and has announced that project will be developed under active private participation. This project of smart city is under consideration for public participation. The government has proposed the PPP model for the project in the working committee.

Although the government has taken initiative but still there is need for incorporation of various other techniques for successful financing and operation of the project. The methods like frontloading, diaspora bonds, green bonds, state guarantee, and municipal bond should be incorporated with PPP model to make project more successful and viable.

CONCLUSION

From the above discussion it can be concluded that innovative financing is a tool that can be used for engaging the private sector and international agencies into the development programs. It is very important in the current world scenario with day to day changing technologies and with coming of new skills and innovations in the field of development projects. Also to achieve the millennium development goals of the United Nations, it is very important to use the methods of innovative financing in various development projects.

The use of innovative financing cannot be successful in development projects without the help

of public and private sectors. There is a very strong need for various steps to be taken towards innovative financing from both public and private sector. This coordinated effort will help in enabling the methods of innovative financing and in building the global network of investors and entrepreneurs to expand the development sector in the whole world.

And finally when we talk about the smart city projects, it is very important to note here that innovative financing is very important for the success of this project. This project can only be started with the financial cooperation between public and private sectors or funding from any global agencies and it will also require an insurance of financing technologies to erase the financial risk.

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ENVIRONMENTAL SUSTAINABILITY FOR SMART CITIES

KANIKA BANSAL*

Abstract

There are diverse criteria to term a city as 'smart' and various cities use different criteria to earn the tag of 'smart city' like the level of innovation in the cities, quality of life of the people of the cities. Some may say that a smart city is a city which is technologically advanced, using information and communication technologies for service delivery to its citizens. But then, there is another view, a more comprehensive one which looks at 'Smart Cities' as cities which use information and communication technologies to efficiently and intelligently make use of the existing resources of the city which could reduce the cost of energy of the services provided while delivering a good quality of life, keeping in mind the environment. The latter can be called sustainable smart city.

A city which meets the goals of present development without sacrificing the ability of future generations to fulfill their development needs is sustainable. The city should be designed with due consideration of environmental impact inhabited by people and should be dedicated to minimization of required inputs of energy, water and food, and waste output of heat, air pollution - CO2,methane, and water pollution. The present paper gives the various strategies for building an Environmental Sustainable City.

INTRODUCTION

As the global population continues to grow at a steady pace, more and more people are moving to cities every single day. Experts predict that the world's urban population will double by 2050 – which means we're adding the equivalent of seven New Delhi Cities to the planet every single year. Urban areas also contribute a higher share of GDP. In India, the urban population is currently 31% of the total population and it contributes over 60% of India's GDP. It is projected that urban India's contribution to the national GDP will increase to 75% in the next 15 years.

Cities are accordingly referred to as the engines of economic growth. There is, therefore, crying need for the cities to get smarter in order to handle this large-scale urbanization and finding new ways to manage their complexities, increase efficiency, reduce expenses, and improve quality of life.

SMART CITY

There are diverse criteria in order to term a city as 'smart' and various cities use different criteria to earn the tag of 'smart city' like the level of innovation in the cities, quality of life of the people of the cities etc. Some of them are illustrated in Table 1.

Some may say that a smart city is a city which is technologically advanced, using information and communication technologies for service delivery to its citizens. But then, there is another view, a more comprehensive one which looks at 'Smart Cities' as cities which use information and communication technologies to efficiently and intelligently make use of the existing resources of the city which could reduce the cost of energy of the services provided while delivering a good quality of life, keeping in mind the environment. The latter can be called sustainable smart city.

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Table 1: Smart Cities across the Globe and their Smart Initiatives

City Name	Why are they Smart?	Targeted Sectors	How are they Environmentally sustainable?
Vienna	• Incorporated the concept of green cities, improved quality of life and included digital governance. • Involved stakeholders and consulted them in the building and execution of carbon reduction, transportation and land-use planning	• Governance • Environment Improvement	• Carbon reduction
Toronto	• Essentially is working on the transition of cities to low-carbon economy. • Use of natural gas from its landfills to power the garbage trucks. • Smart Commute Toronto initiative.	• Energy • Transportation	• Cleaner Fuels • Promotion of pedestrianization
Paris	• Incorporated the green city concept and digital governance. • It also as a successful public Bicycle sharing system called Velib	• Transportation • Governance	• Green city (city with effective measures in carbon footprint reduction)
Tokyo	• Solar panels, storage batteries and energy efficient appliances all connected to a smart grid	• Energy	• Renewable energy
Copenhagen	• Most resilient city globally • Sustainable innovations • More than 40% of the citizens are using bicycles for their daily commute	• Environment • Transportation	• Carbon Measurement & Planning

Compilation Source: TOP 10 Smart Cities of The world

Therefore, we can define Smart City as "city which enhances quality and performance of urban services to reduce costs and resource consumption, and to engage more effectively and actively with its citizens." Sectors that have been developing smart city technology include government services, transport and traffic management, energy, health care, water and waste management. A smart city would therefore be more prepared to respond to challenges than one with a simple 'transactional' relationship with its citizens. The city could use digital technologies or information and communication technologies (ICT) to achieve its aim of being Smart.

Smart city should include applied innovation, sustainable planning, a more participatory approach, higher energy efficiency, cleaner transport solutions with intelligent use of technological innovations and Information and Communication Technologies (ICT), etc, with the goal of improving the management of urban flows and allowing for real time responses to challenges.

Major technological, economic and environmental changes have generated interest in smart cities, including climate change, economic restructuring, current trend of online retail and entertainment, ageing populations, and pressures on public finances.

KEY FEATURES

"The key features of Smart City is the intersect between competitiveness, Capital and Sustainability."- (MoUD). In order to achieve the key features of smart cities as specified above, the smart cities should be able to provide:

- Better Investment opportunities and simpler approval processes
- Transparency in governance to make it more user friendly
- Infrastructure provisions, Better utility services and health care facilities

Contrary to common belief, urban systems/ cities can be more environmentally sustainable than rural or suburban living. With people and resource located so close to one another, it is possible to save energy and resources by smartly incorporating environmentally sustainable concepts.

HOW TO MAKE A CITY SUSTAINABLE?

A city which meets the goals of present development without sacrificing the ability of future generations to fulfill their development needs is sustainable. The city should be designed with due consideration of environmental impact inhabited by people and should be dedicated to minimization of required inputs of energy, water and food, and waste output of heat, air pollution - CO_2, methane, and water pollution (Fig.1).

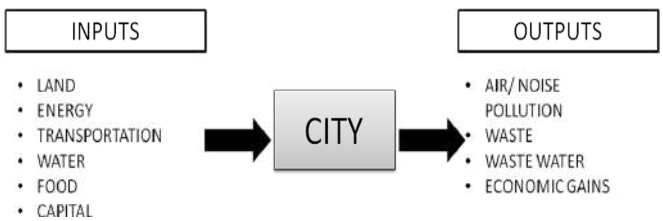

Fig. 1. City System

Minimally a sustainable city should firstly be able to feed itself with a sustainable reliance on the surrounding areas. Secondly, it should be able to power itself with renewable sources of energy. This is to create the smallest possible ecological footprint, and to produce the lowest quantity of pollution possible, efficient use land; recycle the waste, or convert waste-to-energy, and thus the city's overall contribution to climate change will be minimal, if such practices are adhered to, making it a smart sustainable city.

In order to perceptively assess functions and performance criteria of sustainability, it can be classified under as per the systems required for a city as described in table 2.

There are many sustainable concepts from Infrastructure specific solutions like SUDS (Sustainable Urban Drainage management) to a Landuse specific concept like Eco-Industrial Development to a comprehensive concept like Green city.

SUSTAINABLE CONCEPTS TO MAKE CITY SMARTER

Sustainable Urban Drainage Management System

Sustainable Urban Drainage Management System (SUDS) could be defined as "Collective group of approaches which are used to manage surface water that take account of water quantity (flooding), water quality (pollution) and amenity issues". SUDS are technically regarded a sequence of management practices, control structures and strategies designed to efficiently and sustainably drain surface water, while minimising pollution and managing the impact on water quality of local water bodies. It mimic nature and typically manage rainfall close to where it falls. SUDS can be designed to slow water down (attenuate) before it enters streams, rivers and other watercourses, they provide areas to store water in natural contours and can be used to allow water to soak (infiltrate) into the ground or evaporate from surface water and lost or transpire from vegetation (known as evapo-transpiration) (Fig.2).

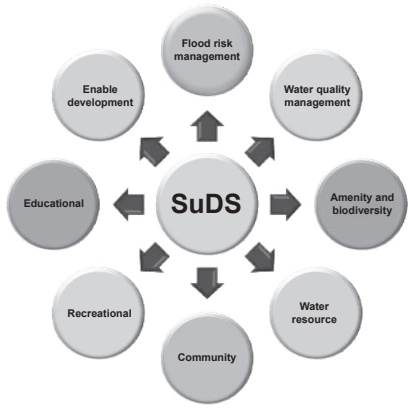

Fig. 2. Functions of Sustainable Urban Drainage Management System

Table 2: Performance Measurement Criteria

	Functions	Performance measurement criteria
Social system	• Interaction • Recreation • Inclusion / equity • Commerce / work	• Physical & psychological well-being • Economic activity • Food security
Circulation system	• Pedestrian mobility • Transit mobility	• Transportation GHG reductions • Accessibility & travel costs • Pollutant removal • Health impacts of fuels • Vehicle miles travelled
Energy system	• Energy production & consumption • Material production • Recycling & reuse	• GHG production • Air quality • Recycling rates • Per capita energy consumption • Local food availability
Biological system	• Climate moderation • Ecosystem restoration • Wildlife habitat	• Biodiversity • Health of indicator species • Habitat connectivity
Hydrologic system	• Water retention • Groundwater recharge • Water quality • Water reuse	• Quantity & quality evaluation • Hydrologic connectivity • Pollution abatement & removal • Amount of water retained / detained
Geologic system	• Support for all the other systems • Soil and surface drainage • Natural hazard mitigation	• Slope and soil type • Seismic activity

Green spaces, parks, open spaces and green infrastructure has the ability to infiltrate rainwater runoff and should be enhanced to protect the water quality by taking steps to increase an urban area's tree canopy, mandating the buffering of streams with trees and plantings, and making sure that both redevelopment and new development meets high storm water management standards. SUDS techniques include green roofs, permeable surfaces, infiltration trenches, filter drains and filter strips , swales - shallow drainage channels , detention basins, purpose built ponds and wetlands etc (Fig.3). SUDS works on the principles given in Table 3.

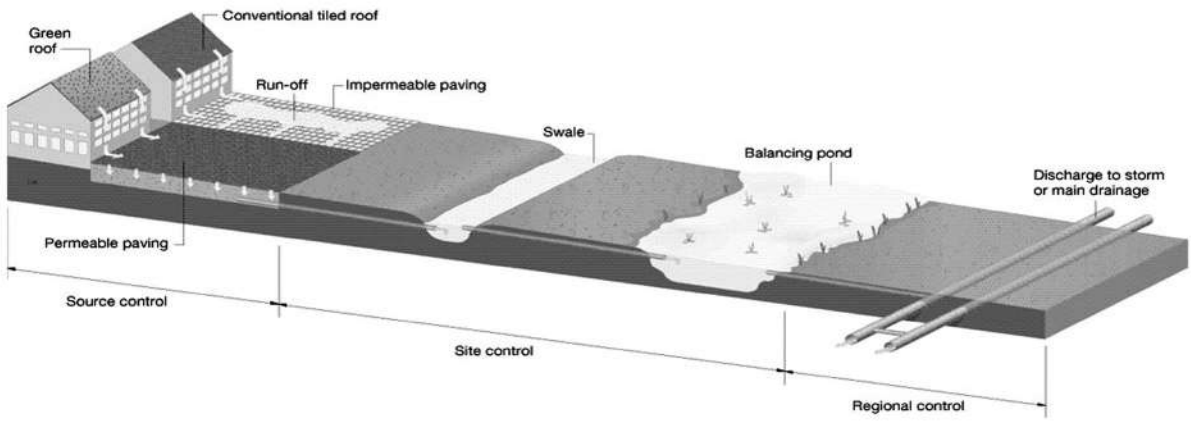

Fig. 3 SUDS Management Train

Table 3: Principles of SUDS

Prevention	• Good site design and effective housekeeping measures • Included within the site management plan
Source control	• Achieved with features such as green roofs, soakways, rain gardens and permeable pavements • Harvested water can be reused for non-potable uses
Site control	• Planned management of water in a local area or site • Approached include routing water from building roofs and car parks to soakway or infiltration areas and then to storm tanks or a detention basin • Attenuate the flow of water entering the system after a storm event
Regional control	• Provides a natural method of handling excess water thereby reducing the risk of flooding events by collecting the water in a balancing pond or wetland

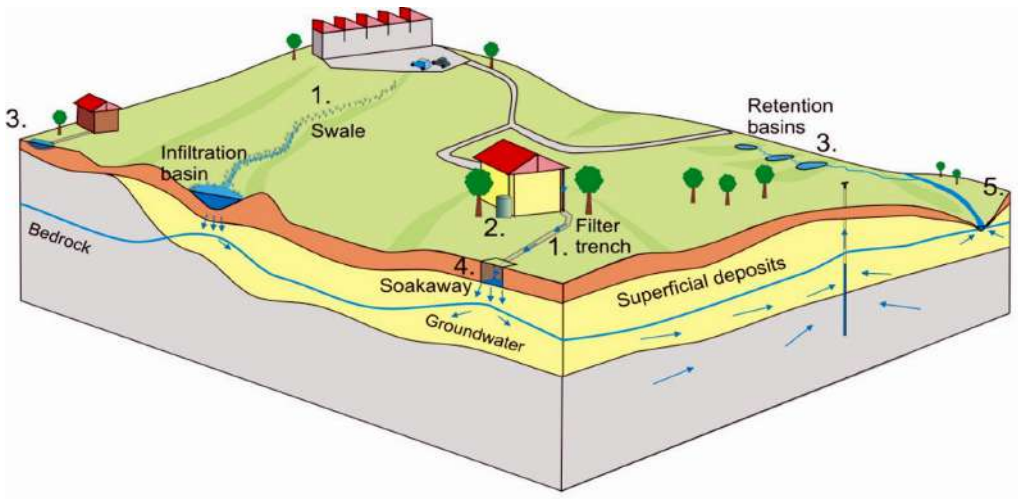

Fig. 4. SUDS Model

As illustrated in (figure 4), during a storm, storm water management across the city is done by the following strategies:

- Surface water moves through Swales and filter trenches that remove entrained pollutants
- The peak river discharge is delayed and reduced with incorporation of retention basins, enabling storage of water for re-use.
- Storage in retention/ detention pond manages flood as well as enable ground water recharge
- Infiltration of water to ground through infiltration basins and soakways improves the quality of water in river and decreases peak river discharge as well as enable ground water recharge.

Eco-Industrial Development

Eco Industrial Development (EID) could be defined as"… a promising strategy to promote sustainable industrial development tackling environmental, economic and social aspects in a balanced manner." 'Eco' in the 'eco-industrial development' echoes the simultaneous concern for the economic gains and the environmental excellence. An eco-industrial development may be viewed as a dynamic system with integrated infrastructure flows and the objectives of sharing resources, enhancing productivity, and reducing / removing the waste stream.

It focuses on developing new local and regional business relationships between the private sector, government and educational institutions in order to use new and existing energy, material, water, human and infrastructure resources to improve production efficiency, investment competitiveness, and community and ecosystem health. It is considered as win-win-win approach (Table 4).

Table 4 : Sustainability in Eco-Industrial Development

	SOCIAL	ENVIRONMENTAL	ECONOMICAL
ECO-INDUSTRIAL SYSTEMS	• Social responsibility • Stakeholder cooperation • Community participation • Dialogue • awareness	• Physical flow of material and energy • Incorporation of non-renewable energy options and optimal use of renewable energy available • Waste and emission generation • Pollution control	• Reduction in material cost • Capital investment in terms of additional infrastructure requirements and efficient processes and technology.

Forming interconnected networks of natural systems with tangible ecosystem services in a city (wherein smaller and concentrated projects would form part of a bigger overall plan) would be a slow process and not easily implementable. At the same time any development project should also be comprised of an ecological and sustainable framework. Eco-industrial Development is one such concept which makes even an environmentally non-suitable landuse as Industrial to be planned in an environmentally sustainable way.

Industry is related to a greater or lesser degree to all environmental impacts. Global ecosystems are intimately intertwined with our economies; through the feedback loops so established, the degradations of the ecosystems will also have growing impacts on industry. As one of the main focuses of even the Smart city Initiative by Govt. of India is creation of jobs and economic enhancement, Industrial Landuse would form an indispensable part of the Smart city landuse distribution (Fig.5).

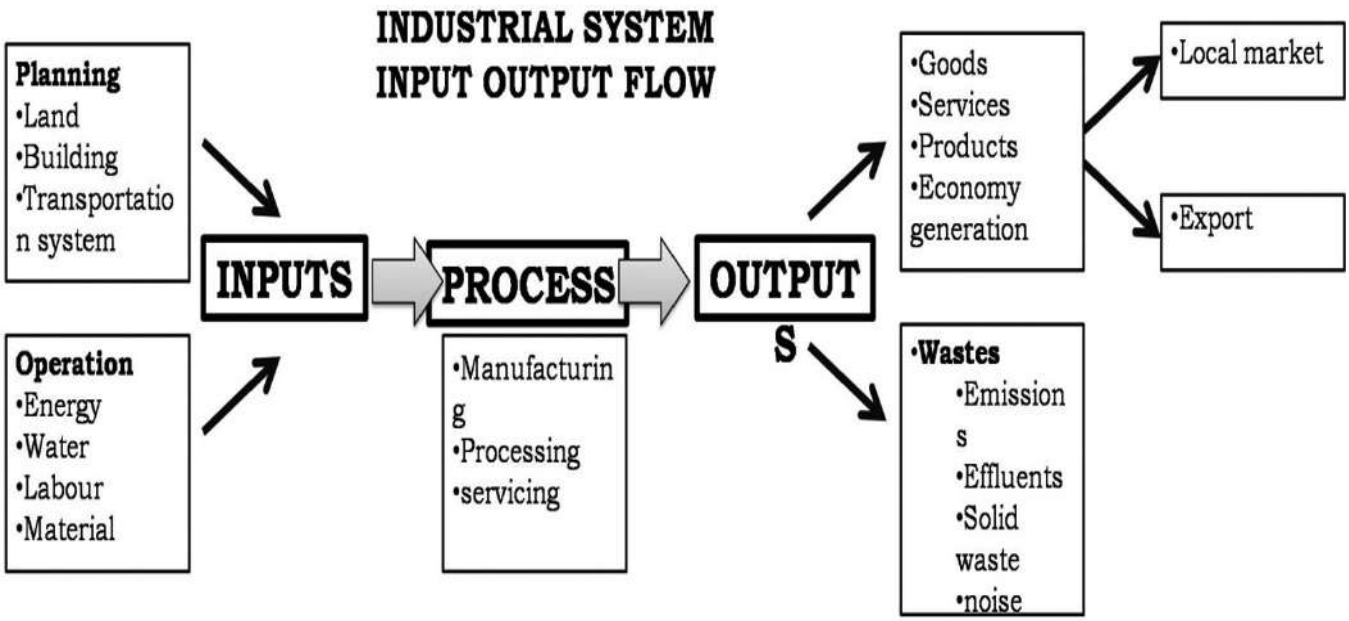

Fig. 5 Industrial System

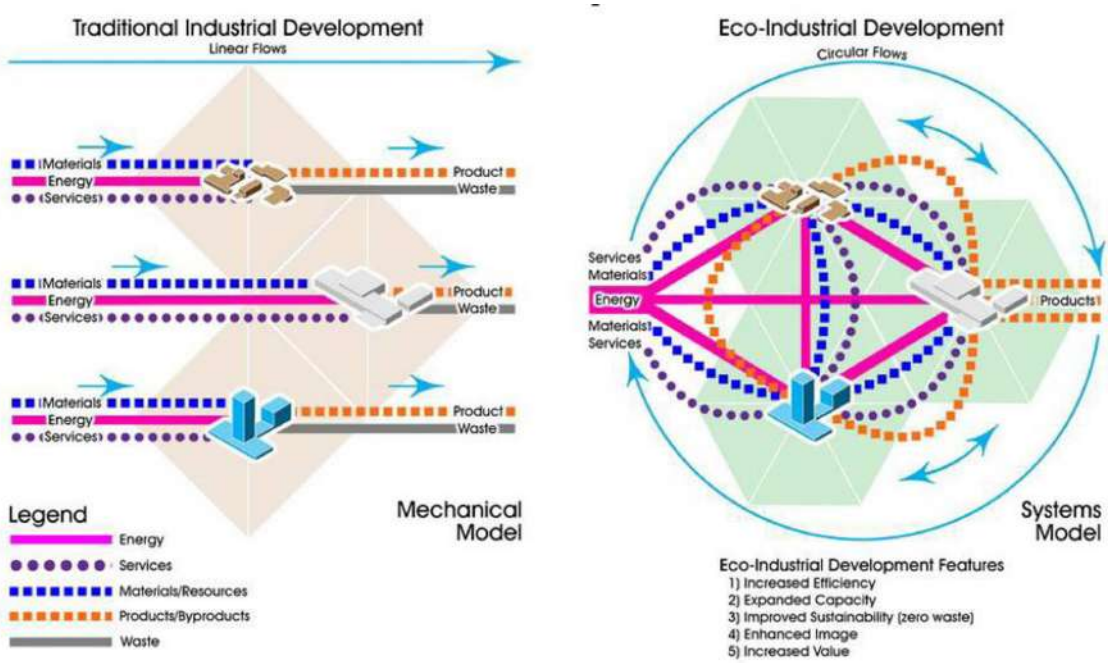

Fig. 6 Traditional Industrial Development Vs Eco-Industrial Development

Source: (Stephens, 2010)

The following are the Strategies for Eco Industrial Development (Fig.6)

1. Integration into Natural Systems:

- Minimize local impacts on environment by integration into surrounding landscapes, hydrologic settlings and ecosystems
- Minimal contributions to GHGs

2. Energy Systems

- Maximize energy efficiency through:
- facility design or rehabilitation,
- co-generation,
- energy cascading
- Extensive use of renewable energy
- other means like Inter-plant energy flows

3. Material Flows and Waste Management

- Emphasize pollution prevention especially toxic substances
- Ensure maximum re-use and recycling of materials among EIP entrepreneurs
- Reduce toxic material risks through integrated site level waste treatment
- Link the enterprises to companies/ industrial areas in surrounding regions as consumers and generators of useable by-products via resource exchange and recycling networks

4. Water

- Design water flows to conserve resources and reduce pollution through strategies like recycling, water cascading, water harvesting etc

5. Effective EIP Management

- Maintain mix of companies needed to best use each other's by-products as companies change
- Supports improvement in environmental performance for individual companies and the development as a whole
- Operates a site-wide information system that supports intercompany communications, informs members of local environmental conditions and provided feedback on parks performance

6. Construction/ Rehabilitation

- To follow best environmental practices in material selection, site planning and green building technology.
- Incorporation of building automation systems

- Use of recycled/ reused materials/ Consider life cycle environmental performance of materials and technologies

Green City

A green city is pollution free with adequate green cover and trees. The city will have low environmental impact with conservation of resources and reduction of waste. The city uses clean and efficient energy along with renewable electricity generation; has clean, accessible and safe transportation system along with sustainable infrastructure provisions. Green city is more healthier, more affordable, and more pleasant place to live.

Green city is defined as "….a city that has the cleanest and most efficient energy, transportation, and building infrastructure possible." - Green Cities campaign. As per report published by Asian Development Bank, Green cities are cities that have already achieved, or are moving toward long-term environmental sustainability in all of its aspects. For a city to be considered "green" measures must be undertaken in a comprehensive, planned manner that not only positively impact the city but also contributes to environmental sustainability at the global level. Initiatives for improving planning, transport, energy efficiency, industrial metabolism, and water supply and sanitation facilities should be taken up along with governance and awareness-raising actions.

Strategies for making Green city are :

1. Water:

- Conserve water resources by maintaining the water flow, water quality and water quantity.
- Reduce demand by incorporation of ICT and smart fixtures like waterless urinals to demand based water meters.
- Recycling and reusing of waste water at all levels from site to city depending upon the amount of technological interventions required
- SUDS as discussed earlier

2. Urban Nature:

- Habitat protection-existing river/ lake ecosystems or urban forests which act as habitat to a variety of urban biodiversity should be protected.
- Increase in green cover through creation of green roofs at the site level to green pavements, green ways, and green infrastructure provisions at city level.
- Management of varied scales of green spaces in an appropriate way to get the recreational as well as the ecological benefits. Mandatory green area in every landuse.

3. Sustainable Transport:

- Transit-oriented development zoning regulations
- Mixed development policies and incentives to reduce the need for travel
- Creation of Eco-blocks
- Road space rationing in city centre (CBD), or district
- Developer incentives and land-benefit levies; as per the polluter paid principle
- Public transport and multi modal transport
- Promoting non-vehicular modes of travel by making green ways, bike ways

4. Waste

- To make a city green, one needs to go further than gathering cans and bottles, by adding electronics and food waste to the list of items recycled and composted, and by instituting larger-scale programs to recycle water for industrial use.
- De-centralised Treatment should be enforced
- Facilities for reuse- recycling should be incorporated.

5. Energy

- Use of renewable energy and mandating efficiency measures
- Green decentralized generation
- Reducing need by proper site planning, and use of greener devices

CONCLUSION

The cities are indeed large communities which provide both challenges and opportunities for environmentally-conscious developers, and there are distinct advantages to defining and working towards

the goals of sustainability. The solution can be SUDs, Eco-industrial development or Green city or many others, the need of the hour is to explore and apply appropriate options to enable cities to keep up with the global pace in future without compromising on environment. Smart cities should be developed on the principles of sustainability to minimize the environmental impacts of the development which will result in enhancement of quality of life (as desired) as well as would make the cities resilient to the effects of increasing threats of climate change.

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SUSTAINABLE URBAN DEVELOPMENT : AN INTEGRAL ELEMENT OF SMART CITY

HARJOT SINGH*, AKARSH DWIVEDI*, SACHIN JOSEPH VERGHESE* AND SIDDESH K PAI**

Abstract

The concept of smart city does not have an absolute definition but it is rather a process, or series of steps, by which cities become more liveable and resilient and therefore, able to react quicker to new challenges. However, in order to understand the concept of smart city, it can be defined as a city which uses concepts of information and communication technologies (ICTs), internet of things (IoT), intelligent and zero-energy building and other means to create sustainable economic development and high quality of life by excelling in multiple key areas such as economy, environment, governance, infrastructure, mobility and people.

Smart city should be built on sustainable urban development pattern in order to meet the needs of present and future generations with respect to economic, social and environmental aspects. The objective of this paper is to analyse the characteristics of sustainable and smart city in order to merge the features of both in to single entity. This paper studies and analyze the concept of smart city from sustainable urban development prospective and its viability in Indian conditions. This paper also review various concepts related to intelligent and green city that can be applied in smart cities by taking case studies of existing smart cities.

INTRODUCTION

The idea that a city could be smart was a science fiction that was pictured in the popular media but suddenly with the rise of computerized devices across many scales with artificial intelligence, the idea that a city can become smart, becomes a new reality. Today, cities are becoming smart not only in terms of the way we can automate routine functions serving individual persons, buildings, traffic but in ways that enable us to monitor, understand, analyse and plan the city to improve the efficiency, equity and quality of life for its citizens. However, cities can only be really smart if there are intelligence functions that are able to integrate and synthesise this data to some purpose, ways of improving the efficiency, equity, sustainability and quality of life in cities. The term smart city in fact has many faces - Intelligent cities, virtual cities, digital cities, information cities are all perspectives on the idea that ICT is central to the operation of the future city.

We are facing drastic environmental problems caused by mass consumption of energy and natural resources as a result of economic growth. In order to solve those problems, we must continuously make efforts to change the way we live and work in our daily lives and economic activities as well as develop sustainable smart cities.

SITUATION OF INDIAN CITIES

After economic reforms of 1990, rapid urban growth in India has occurred, this has led to the problems of urban sprawl, unregulated ribbon development, increasing problems of inadequate urban infrastructure and deteriorating quality of urban liveability. The lack of planning that characterizes most suburban growth has resulted in higher transportation costs in terms of money, time and inconvenience for suburban residents, in higher public sector costs, in undesirable land use patterns and in the inadequate supply of open spaces, recreational facilities and other amenities. Over all, the unplanned and uncontrolled

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rapid growth has resulted in serious negative effects on the urban dwellers and their environment.

India has a population of almost 1.2 billion people. 55% of this population (nearly 600 million people) has no access to toilets. Most of these numbers are made up by people who live in urban slums and rural areas. A large populace in the rural areas still defecates in the open. Slum dwellers in major metropolitan cities, reside along railway tracks and have no access to toilets or a running supply of water. India is still lagging far behind many countries in the field of sanitation. Most of the Indian cities and towns are characterized by over-crowding, congestion, inadequate water supply and inadequate facilities of disposal of wastewater and solid wastes. Besides this, proper waste disposal and sewage treatment plants are missing in many of the cities (Dr. Mohammad Akram, 2013). Government of India has taken many steps to improve this situation but situation of India is still same.

CASE STUDIES OF SMART CITIES

Curitiba, Brazil.

Curitiba is a city located in Parana State of Brazil and it is considered as one of most greenest as well as smartest city in Brazil. Cuiaba has developed and implemented several innovative systems to create jobs, improve public transportation, low cost housing and waste management. The city has integrated a radial linear branching pattern to protect density by diverting traffic from city centre to protect green areas by encouraging industrial development along radial axes. Curitiba also has strict environmental regulations (Sustainable Urban Planning (Curitiba City, 2011). Some of amazing features of Curitiba are as follows.

- Curitiba is a transit oriented city, it has very advanced bus rapid transit system which serves some 60% - 70% of its residents (Curitiba's Urban Experiment, 2013). The city also has 100 km (62 mi) of bike routes for bicyclers.
- Curitiba's waste management and recycling program is also marvellous. 90% of residents recycle 2/3 of their trash daily, which provides the citizens with a cleaner city as well as jobs. Curitiba initiated a garbage exchange program in an effort to minimize the amount of waste and litter on the streets in poorer neighbourhoods. People are given bags of food or transportation tokens in exchange for bags of trash.
- With all this development Curitiba does not neglect the need of its poorest citizens. The Public Housing Company of Curitiba has build low-income housing near the centre of the city instead of far away from the centre, which is common practice around the world. The incorporation of public housing within the rest of the city has created socially integrated neighbourhoods that provide public health, education, and recreational services.
- Curitiba has 55 m2 of green space per inhabitant and has over 1,000 parks. Many of these preserved areas are located near river streams and lakes, acting as buffers against flooding, development, and pollution.
- Curitiba's 'Open University' provides an education for a modest fee, and the city's inhabitants are taught about environment protection. Clapped out old city buses are used as mobile schools which teach the population about sustainability (Curitiba: The Green Capital).

The whole plan behind Curitiba's success reveals how a careful balance between nature and society can be acquired.

Songdo International Business District, South Korea

Songdo International Business District (SIBD) is a new city built from scratch on 1,500 acres (610 ha) of reclaimed land along Incheon's waterfront, 65 km southwest of Seoul, South Korea and connected to Incheon International Airport by a 12.3 km reinforced concrete highway bridge, called Incheon Bridge (Christopher Henry, 2011). It is considered as most smartest and greenest city in the world. Songdo have several unique and novel features because of which some people also think that it is a city of future. Some of it's amazing features of Songdo are as follows.

- All the buildings within Songdo are intelligent and LEED certified. Forty percent of its area is dedicated to outdoor spaces. The city is offering its inhabitants green space for leisure. The city also has 16 miles of bicycle lanes.

- Songdo have very unique waste management system, all of the household waste sucked directly from houses through a vast underground network of tunnels, to waste processing centres, where it is automatically sorted, deodorized and treated. In the future, some of this waste will be used to produce renewable energy, this plan is currently under progress Songdo, South Korea Aims to be World's Greenest City.
- Every inch of the Songdo has been wired up with fibre optic broadband which keeps people connected and sends a constant data stream to computer processors that keep city operating. For example, street lights can be switched off in deserted streets to save energy or brightened in busy ones. The city also have hi-tech as well as novel Tele-Presence systems all over the place, it is an advanced video conferencing technology that allows residents of Songdo to access a wide range of services including remote health care, beauty consulting and remote learning, as well as touch screens that enable residents to control their unit's energy use (James Day, 2012).
- The traffic within Songdo is measured via radio frequency identification (RFID) tags on cars. These sensors send the geo-location data to the central monitoring unit that signal black spots or congested areas. Also the public transportation is completely wired and all locations are always known (Cities old and new get smart, 2013).

There are many more hi-tech technologies for Songdo which are either under development or under testing phase.

CONCEPTUAL MODEL

From above cases of the smart city , it is clear that it is not possible to develop a hi-tech smart city without sustainable urban development and that's why it not wrong to say that smart city only exist in science fiction and in realty what we called a smart city is actually a sustainable smart city.

Another important factor which affect smart city is the behaviour of the citizen of city. No matter how good, hi-tech, smart and sustainable city is designed, if its denizens do not have proper smart behaviour, then city is only as good as normal city.

Model in Fig. 1 shows the impact of social, economic and environmental sustainability on smart city. As shown, to achieve multidimensional sustainability, both citizen's behaviour and official decision-making must become more efficient, effective, and sustainable. Citizens behaviour can only be controlled by means of rules and regulation. In addition to this a smart city is also affected by sustainable planning through changes of infrastructures (energy, land-use, and transportation systems), and the structure of governance. Official policies on land use, energy and transportation impact the amount of pollution, which in turn has a pronounced effect on environmental sustainability. On the part of citizens, changes in consumption, travel and energy behaviours reduce demand which in turn positively affect environmental and economic sustainability. Social, environmental and economic sustainability are also affected by changes in political behaviours and accordingly by participatory governance.

Planning enhances the capacity of government agencies to deliver public services while involving citizens in decision-making processes. Social sustainability will be enhanced as a result of this broad participation of citizens in their political system. Planning also play important role in development of smart infrastructure which in turn enhances the economy. In short, urban sustainability is realized when questions of social, economic and environmental sustainability have all been taken into consideration.

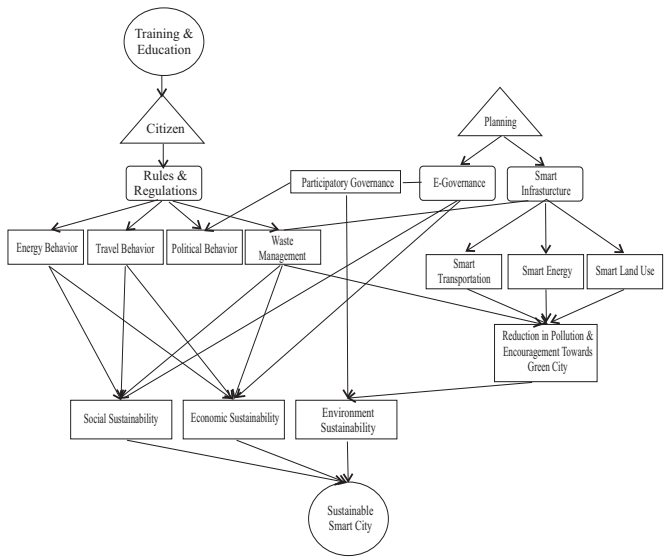

Fig. 1 Model of Smart City

CONCLUSION

Sustainable urban development is important factor for a developing a smart city. Curitiba is a proof that a smart city is not all about use of hi-tech solutions but combination of proper utilization of economic and innovative solutions, social development and environmental perseverance. For example, Curitiba could have chosen a number of hi-tech solutions to its urban problems. Curitiba can develop a metro rail transit system to deal with the problem of congestion. However, Curitiba has chosen a different path to solve this problem, the choice of transportation technology was simple economics, a metro rail transit system would have cost around hundred million dollars per kilometre while the bus rapid transit costs around hundred thousand dollars per kilometre.

Unlike Curitiba which is a smart city totally focused of sustainable urban development, Songdo International Business District is a smart city based on cutting edged technological advancement as well as sustainable urban development. However, Songdo is not a city which can accommodate Lower Income Group and Middle Income Group strata; it's a city for the rich people to live.

In Indian condition, it's not viable to construct a network oriented city like Songdo, in one go. Even though, if it is viable it will require a huge amount of capital as well as time. In addition to that, it won't satisfy the definition given by government of India, that is, "Smart City offers sustainability in terms of economic activities and employment opportunities to a wide section of its residents, regardless of their level of education, skills or income levels". Moreover, unlike South Korea, India requires more than one smart city and this requirement of India reduces the fusibility of a city like Songdo in India in one go.

So, it is better to divide development of sustainable smart city into two phases, they are primary phase and secondary phase. Primary phase should be consisting of development of a green, compact and transit orientated city and more emphases should be given to environmental development and waste management. Secondary phase should be consisting of implementation of state of art technology based on ICT and IoT into the city. Also, secondary phase should be continued process to make city more smarter.

Following recommendations should be considered for developing sustainable smart city.

- Sustainable smart cities should be developed in such a way that it encourages its denizens to live near transit services in sufficient density to make public transport feasible and attractive to decrease their dependence on driving. Also high capacity, high speed, multi-modal and multi-level transport system corridor should be developed to connect cities with each other.
- Sustainable smart cities should give great emphases to waste management system. Waste management system should be developed in such a way that it should be able to dispose waste without polluting water, soil or air.
- Education and training programs should be induced to create awareness among the people regarding environmental problem and urban sustainability.
- Sustainable smart cities must be made in such a way that it can provide variety of housing types at affordable choices for individuals and families of various socioeconomic classes without compromising with living quality of its resident.
- Sustainable smart cities should be designed in such a way that it can provide pedestrian and bicycle friendly environment to its denizen. If possible bike-sharing programs should be induced within the city.
- Sustainable smart cities should also create economic opportunities for the people of Lower Income Group and Middle Income Group strata by facilitating and integrating informal sector activities at sector and city levels.
- Sustainable smart cities should be build in such a way that at least 25% of it should be covered with green trees. Also there should be strict norms and regulations regarding cleanness of the city.
- Government should involve higher educational and research institutes and universities for research and development of technology and software required for development of sustainable smart cities and power generating technology based on utilization of renewable

sources of energy. This initiative will not only provide required technology but also increase the research value of involved institutes and universities.

- Sustainable smart cities should have high speed internet connation throughout the city. Moreover city should also contain charging stations.
- Sustainable smart cities should contain enough sensors to collect all kind of data associated with city and city should have an artificial intelligence system which can process these data into useful information. There should also be a cloud storage system to store this information. This information should be accessible to every denizen of city, so that they can make better decision when required. Smart city should also provide its administrative services through internet.
- Sustainable smart cities should also have cutting edge surveillance and security system within the city to keep check on the crime.
- Futuristic and innovative transportation facilities, sensors and other technology based on ICT and IoT should be developed on Public Private Partnership (PPP) bases.
- Consumption of electricity in sustainable smart cities is going to very high and solution of this problem is the maximum utilization of renewable sources of energy. Solar roofing system should be implemented in the city and solar parks should be developed. Besides this, if possible airborne wind turbine should be used for power generation.
- A Sustainable smart city should have a single administrator, like a Mayor. This system is very successful in United States of America and other advanced countries. Also Government should use financial instruments like bonds in order to fund the development of sustainable smart city projects. In addition to this government can also attract FDI by introducing lucrative polices.

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SMART CITY- SUSTAINABLE CITY: LEARNING FROM TRADITION

Deependra Prashad*

Abstract

With large hoards of population migrating to cities in every country across the world, the world is already primarily urban. Urban areas are being developed, redeveloped, revitalized, adapted for different usages and are subject to a range of pressures on their form and character. A large no.of people and organizations are trying to understand cities and improve the incumbent living conditions. These include a range of city improvement movements including the "compact city movement", "sustainable city movement", "heritage city movement" etc. The latest to join the list is the "smart city movement". But how is a city smart?

Urban Strategists have tried to understand the aspects in the running of a city which could be needing improvement. One way to understand "SMART" is a city, which has all actions from its development perspective are "specific, manageable, actionable, responsive and time bound", ie. S-M-A-R-T. If all actions, whether in policy, or in projects conceptualization and delivery and finally in terms of technology used were to be S-M-A-R-T, it would automatically result in an interactive and responsive administration.

INTRODUCTION

With large hoards of population migrating to cities in every country across the world, the world is already primarily urban. Urban areas are being developed, redeveloped, revitalized, adapted for different usages and are subject to a range of pressures on their form and character. A large no.of people and organizations are trying to understand cities and improve the incumbent living conditions. These include a range of city improvement movements including the "compact city movement", "sustainable city movement", "heritage city movement" etc. The latest to join the list is the "smart city movement". But how is a city smart?

A definition of the city being smart has developed wherein through its various instruments, infrastructure, urban services and their delivery, the city interacts in a better and reliable manner with its occupants , whether temporary or permanent. But how can we comprehend a smart city better ?

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In the Indian context, we understand that our country has a widely acknowledged infrastructure deficit (Fig.1). This includes overcrowded roads, aging rail lines, and port systems using antiquated technology all slow down the flow of goods and people and create bottlenecks in economic growth. Infrastructure projects are frequently conceptualized late, are quite over budget, and frequently short of specifications. Newer technologies have the potential to make a difference in certain areas. So for e.g. smart highway systems and electronic tolling can reduce road-

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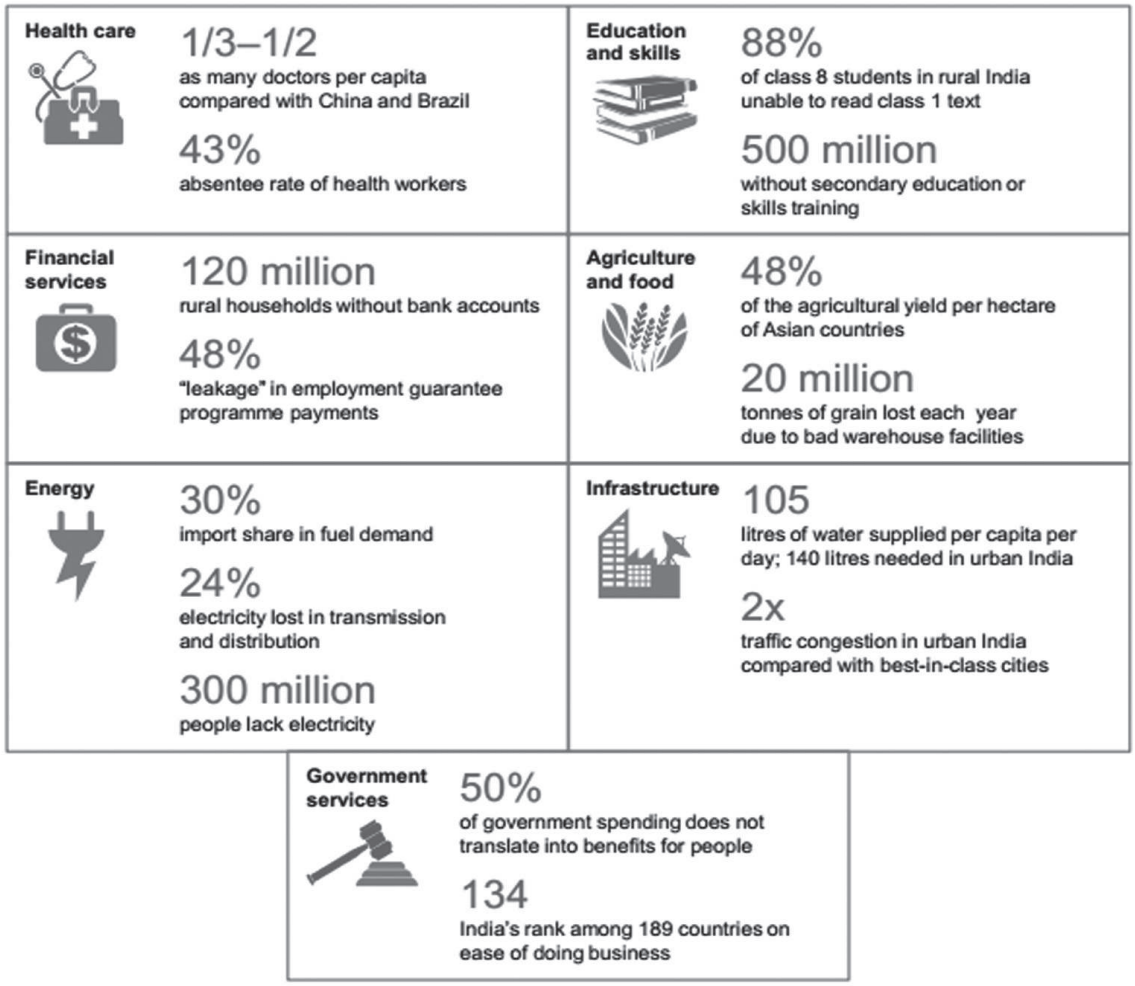


Fig.1 India's Challenges, Low Productivity and Inadequate Access to Basic Services

(Reference: World Health Statistics 2011 by Jishnu Das et al).

travel times by 10 to 15 percent. Automatic water sensors can help systems to cut leakage by 15 to 20 percent, helping reduce water shortages. Automated technologies in green buildings help in responding to the changing populations within a building and commensurately help reduce air conditioning energy requirements.

But a no.of the smart city initiatives remain sector specific, area specific or organization specific. How can a broad based program like that of the smart cities engineer large scale change in the quality of life of cities.

In addition, the Smart Cities programme also includes the provision of a smart grid. Although our power system is the 4th biggest in the world (230 GW of installed capacity in July 2013) our consumption is only 1/4th per capita of developed countries. This is slated to grow 900 GW by 2032 and we need to ensure that this remains controlled. The question which arises is whether just an explosion of green (read sustainable) buildings be able to deliver a sustainable city, or does a sustainable city need much more?

SMART CITIES PROGRAMME AND FUNDING

The Smart Cities programme as recently approved by the cabinet seeks to supply 100 cr to

every such city per year for 5 years. The total budget outlay therefore is 48,000 crores and a matching grant is expected from the state in question / municipal bodies, other urban local bodies and the private sector. The corollary program of AMRUT (Atal Mission for Rejuvenation or Urban Transformation) seeks 50,000 crore for 500 cities, i.e. 100 crore per city. Investment likely predominantly from private investment of PPP's contribution from central / state / ULB will be largely by way of viability gap support (VGF).

Smart Cities are planned either as satellite cities to existing large cities, or by modernizing existing mid-sized cities. Urban planners have felt that for a small city like Vizag, Ajmer, Kochi, Varanasi, this might make some visible changes, but for the metros, this would be a small amount and would just add an insignificant figure to the humongous amounts required. Secondly, an important fear is that the money shall not be used only for new real estate developments, but be directed towards improving existing urban life, urban areas and urban services.

Funds of Central Govt. are planned as 60% on infrastructure, 10% for e-governance, and the rest on equity contribution towards 2 integrated township projects, one greenfield project, one redevelopment project. As mentioned before, new projects obviously are profitable for everyone, but whether the existing area redevelopment projects, which are direly needed,will ever take off.

SMART CITY IMAGING

What is the image of a smart City? What is the image of a smart urban area. If we were to analyze responses across a group, one were to imagine a range of technologically advanced, glass buildings, which might be connected to the information superhighway, but could be quite disconnected to the ground. Why is this the impression, especially in the Indian context.One reason would be that keeping in mind the crying lack of basic urban services in Indian cities, the lofty, western imagery based ideals might seem disconnected and elitist.

LESSONS FROM TRADITION

As mentioned before, the image of a smart city usually seems that of a glazed tall building or a group of buildings, which are connected to the information superhighway, but seem quite disconnected to the ground. Is that the only image of a smart city that we grasp? What happened to essential elements of a good and liveable city? Are Smart Cities also to be happy cities? Is being Smart only being tech savvy? Or does a sense of place, space, a sense of walking around the city, a sense of knowing the neighbour still important? What are those essential aspects which can still be borrowed from walkable, intimate and compact traditional cities which will really complete the definition of a smart city in the real sense. Looking at it from the environmental perspective, it is these aspects which can really complete the loop on making a smart city, truly sustainable.

Traditional city planning was based on the principle of efficient usage of limited resources. For. e.g., even for cities planned adjacent to rivers or water bodies, the planning focused on elements needing water being nearer to the water. No motorization, meant that settlement and utilities had to be accommodated in a close mix, where all kinds of usages overlapped. These tend to work as a natural ecosystem, as compared to the modern concept of exclusivist zoned areas. A smart city could learn from the traditional pattern in reducing its ecological footprint. These and other criterion cement the "smart" or "Sustainable" lessons that modern cities can receive from traditional cities Let us look at some of these logical lessons in light of our current urban environmental situation.

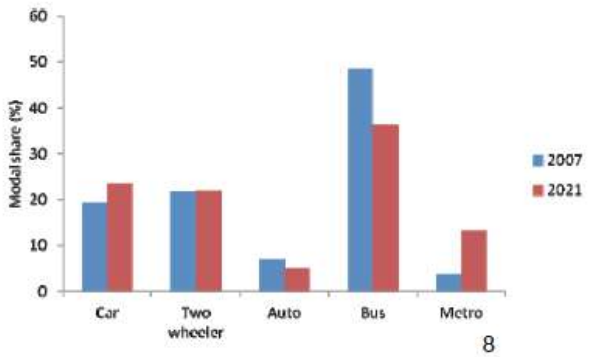
A) Walkability

Current Indian Cities have completely ignored the need for walkability, (Fig.2) despite a major part of our current population being walkers. Data from all our cities, points to the fact that besides developing the information superhighway, most city authorities have been busy building roads and highways for ostensibly improving transportation, completely ignoring real and present needs of walkers and cyclists.

Fig.2 Walkability is a Primary Need of the Physical Structure of a City

Despite building more roads in Delhi, Road space per vehicle has effectively shrunk (Fig.3). In Delhi, roads occupies 21% of the city space, Parking occupies 10% of space. Mumbai Roads occupy12% and in Kolkata only 6%. In Delhi, AurobindoMarg, which is a major arterial road, cars take up 50% of the road, but are responsible only for 17% of the commuting trips.

(Reference: Anumita Roy Chowdhury, Centre for Science and Environment).



Trend in Model Share 2007-2021

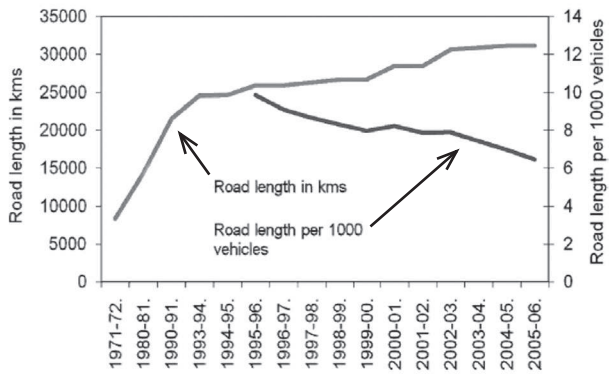


Fig. 3. Data of Roads Availability in Delhi
(Source: on the basis of Economic Survey, Delhi Govt.)

A traditional city, in comparison, tries to compact facilities and utilities within walking distance or accessible by public transport. Many forms of non motorized transport (NMT) were also utilized. A combination of "Promoting Walkability", "Curtailing usage of private vehicle usage" and "Promoting NMT's" lends a healthier air quality to traditional cities and would certainly be a smarter way of developing and expanding newer cities as well.

B) City Expansion Vs Compaction

Fig. 4. Dispersed City
(Reference: Department of Urban Design, SPA)

Fig. 5. A Suburb on Outskirts of a City
(Reference: Dept. of Urban Design, SPA)

The design of a city matters and our traditional cities lead by example by creating compact city, multi activity – mixed use, intense streets and public spaces. (Fig. 4,5,6 & 7) Commercial areas are readily accessible from residential areas and are based on a mixed –use approach. The city is designed, not for the vehicle, but for the human being and lends itself to a highly reduced environmental footprint. Whilst in some cases, traditional cities face inadequate service provision, the compaction due to more people occupying lesser space leads to a vast reduction in the required service lines, reduces vehicular commuting trips and compacts the usage of water and energy for maintenance and upkeep of common spaces.

Fig. 6. A Compact City: Jaipur.

Fig. 7. Before and After Pictures of a City Space through the Introduction of Innovative Usages.

(Reference: Walkable and Livable Communities Institute)

C) Provision for Mixed Landuse and Mixed Neighbourhoods

Traditional Neighbourhoods (Fig.8,9,10) thrived on the concept of mixed landuse, which created a mix of residential, commercial, recreational and utility within accessible distances and allowed a predominance of walkable facilities.

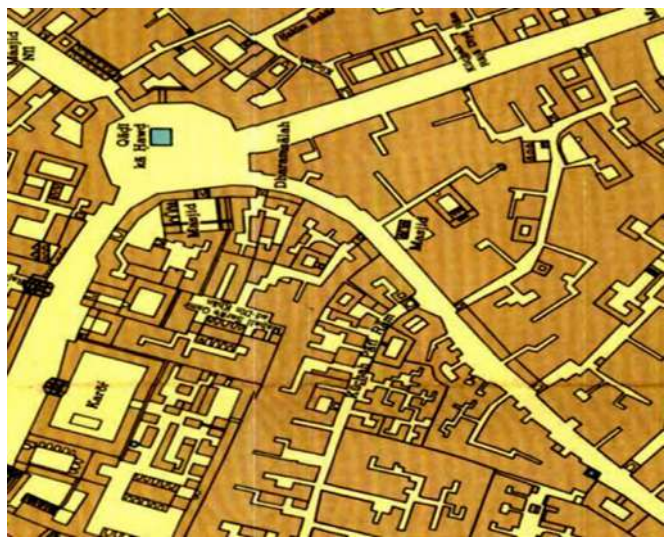


Fig. 8. The Urban Pattern of a Traditional Neighbourhood. Showcases the Importance of Smaller Blocks and Fine Grain Network, which creates a Porous Network of Streets.

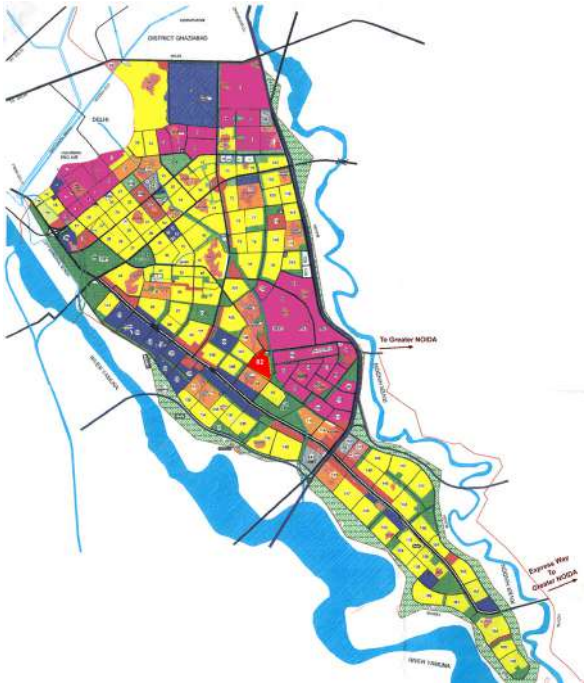


Fig. 9. Urban Pattern of New Areas being Developed as per Zoning.

This leads to longer travel times, dispersed communities and a lack of identification with your neighbourhood. This is one of major reasons for a transportation overkill and congestion in the city. Instead priority is given only for large highways.

Fig.10. Lack of Proper Distribution of Roads as Part of the Need of a Fine-Grain Structure of the Neighbourhoods.

Reference: Dept of Urban Design, School of Planning and Architecture, Delhi

D) Provisions within the City for "Density vs Height"

Smart cities imagery as currently being developed tends to look primarily at vertical development. Traditional cities and buildings (also due to limitations of technology at that time) stuck to the low rise-high density paradigm (Fig.11). From the environmental perspective, certain cities prefer to go vertical as it is felt that this will free up valuable space for greens. Whilst this may be true, tall towers actually take people so high up that they get disconnected from the ground disabling the use of such freed-up ground as a social space. Secondly, the embodied energy spent in making tall building and the running energy spent in providing services like water, sewage, lifts makes it extremely energy intensive. A middle approach of medium rise, high density allows a balance between horizontality and verticality, while allowing sufficient greens. Urban rooftop gardens and rooftop farming also helps reduce the food footprint of a city, while also mitigating the urban heat island effect which increases due to non-green and non-reflective roofs.

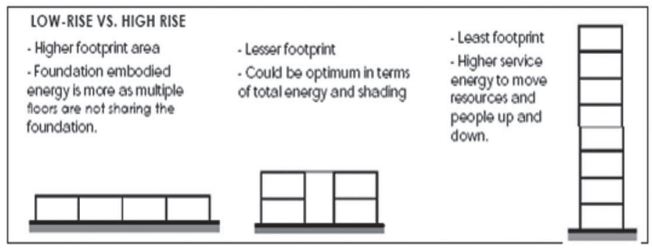


Fig.11. Low Rise Vs High Rise

(Reference: IGD Booklet for Green Design, CPWD, Author: Deependra Prashad)

The design of the community neighbourhood also affects its usage. A large number of organizations all across the world are experimenting with how urban design affects sustainability of cities. In the adjoining graphic (Fig.12) from the Walkable and Liveable Communities institute, the city quarter which is "automobile focussed primarily develops direct parking access for the automobile and pushes the built environment into the centre. In comparison the "people focussed" or "pedestrian focussed" option allows the building to stick to the street edge, creates a street elevation and allows for possible shading of the road depending on the orientation. It accommodates mixed use with shopping below

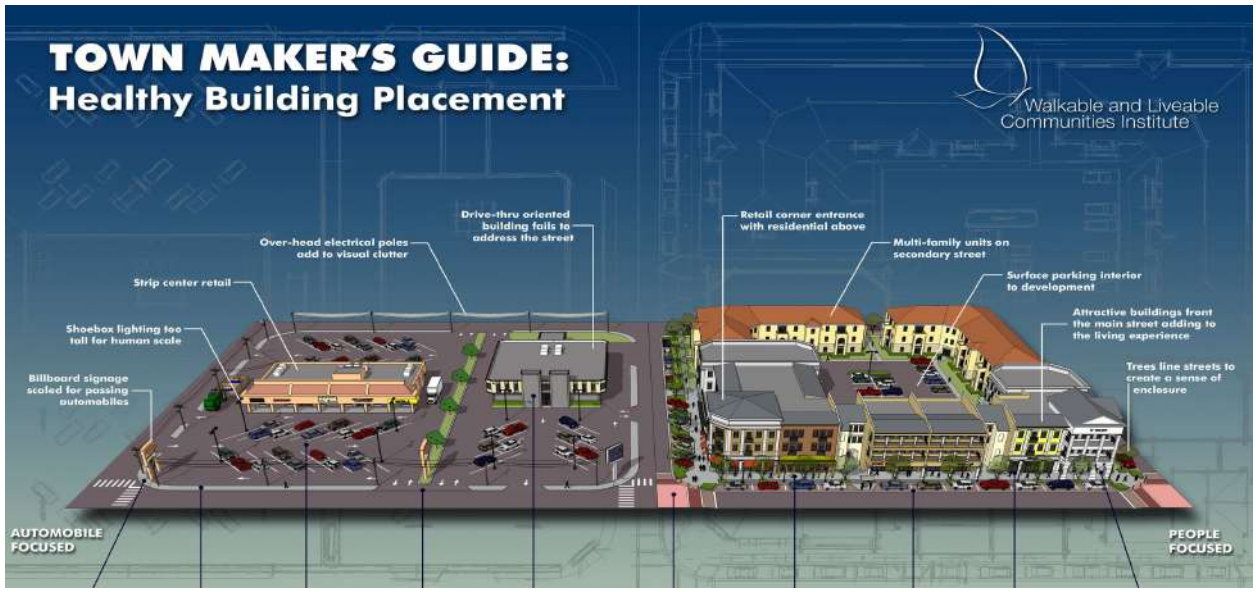


Fig. 12 Town Maker's Guide: Healthy Building Placement for Sustainable Cities

(Reference: Walkable and Livable Communities Institute)

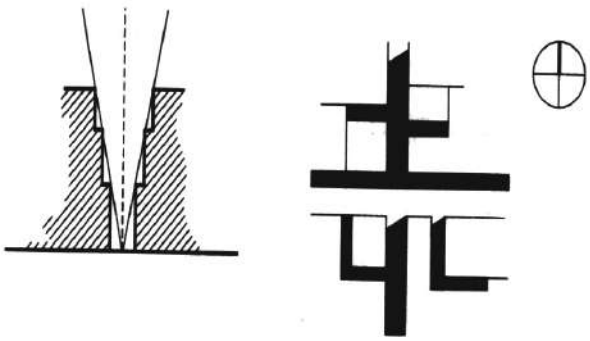


Fig.13. Road Orientation for Sustainable Cities- Street Widths in hot climates: Narrow North-South street minimizes eastern and western radiation.

(Reference: Manual of Tropical Housing, Otto Koenigsberger)

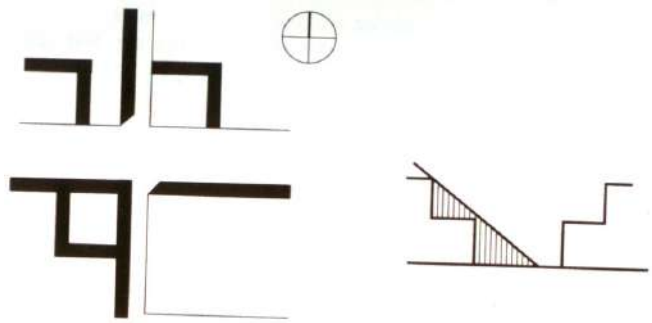


Fig.14. Road Orientation for sustainable cities - Street Width in Cold Climates: Wide east west streets maximize the scope for south winter sun

(Reference: Manual of Tropical Housing, Otto Koenigsberger)

and possible residential above. Parking areas, which could contribute to the urban heat island and pushed into the centre and are shaded themselves from the surrounding buildings. Such a space should be in any case about 2-3 degrees lesser in terms of ambient temperature as compared to the "automobile focussed" option.In looking at the plans of various traditional cities, one notices that street and network plans have been developed or have naturally evolved accordingly and work with the climate (Fig. 13&14).

CONCLUSION

It is nobody's case that we return to our historical state. But there are certainly lessons not to be forgotten if we really have to leave our cities livable for the future generations. As part of the smart city movement, cities are being asked to prepare documents like the citizens reference framework, smart city development plan and the environmental sustainability plan. In creating the last, the "Smart - Sustainable City" can learn a lot from the traditional city.

ENVIRONMENTAL SUSTAINABILITY: THE ESSENCE FOR FUTURE SMART CITIES

Dr. Sushma*

Abstract

Sustainability is the ability to continue a defined behavior indefinitely. There are three main pillars of sustainability (viz. social, economic and environmental) those are responsible for making the cities smart in true sense. Of the three pillars, the most important is environmental sustainability which involves making decisions and taking action that are in the interests of protecting the natural world, with particular emphasis on preserving the capability of the environment to support human life. If the environment of a city is not protected, then no matter how hard we try; the other pillars cannot be made strong because they are dependent on the greater system they live within. Environmental footprint analysis is an accounting tool that measures human demand on ecosystem services required to support a certain level and type of consumption by an individual, product, or population. Carbon footprint is the most developed method to measure the direct and indirect greenhouse gas emissions caused by a defined population, system, or activity.

In this paper, efforts have been made to find different solutions to make the environment sustainable for developing future smart cities.

INTRODUCTION

The world's cities occupy 4 percent of earth's land area, yet they are home to more than 50 percent of world's people. By 2030, that percentage will swell to 60 percent and cause troubling trends, like increased traffic congestion and smog. As a result, cities make up a large part of the world population where around 70 percent of the global CO_2 emissions derive from and an unprecedented level of consumption among the inhabitants. A large number of cities face significant energy, environmental and climate related challenges now and in the future. The need for smart urban solutions has never been greater. Urbanization leads to a growing demand for sustainable solutions, stable energy, fresh and potable water, efficient transportation, and resource management. Cities contribute to climate change and are in turn affected by its consequences. To solve these challenges, it is desirable to become more energy efficient, consumer focused and technology driven.

PILLARS OF SUSTAINABILITY

There are three main pillars of sustainability viz. social, economic and environmental those are responsible for making the cities smart in true sense as shown in fig. 1.

Fig. 1 Pillars of Sustainability

Social Sustainability

Social Sustainability is the ability of a social system, to function at a defined level of social well being indefinitely. This is the ability of a community

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to develop processes and structures which not only meet the needs of its current members but support the ability of future generations to maintain a healthy community.

Economic Sustainability

Economic sustainability is the ability of an economy to support a defined level of economic production indefinitely and helps to identify various strategies that make it possible to use available resources to their best advantage to provide long-term benefits.

Environmental Sustainability

Environmental sustainability is the ability to maintain things or qualities that are valued in the physical environment. Environmental sustainability programs include actions to reduce the use of physical resources, the adoption of a recycle everything/ buy recycled approach, the use of renewable rather than depletable resources, the redesign of production processes and products to eliminate the production of toxic materials, and the protection and restoration of natural habitats and environments valued for their livability or beauty.

DIMENSIONS TO A SMART CITY

Whether developing new cities from scratch or rebuilding existing cities, the challenge is to ensure that the city becomes more livable, economically successful, and environmentally responsible. A smart city is a city that performs well in six dimensions as discussed below.

- Smart economy: High productivity, entrepreneurship and ability to transform.
- Smart mobility: Strong ICT infrastructure and sustainable transport systems.
- Smart environment: Sustainable resource management, pollution prevention and environmental protection.
- Smart people: Diversity, creativity and participation in public life.
- Smart living: Cultural facilities, housing quality, health and safety issues.
- Smart governance: Political strategies and perspectives, transparency and community participation in decision making.

SUSTAINABLE DEVELOPMENT

Sustainability is about continuity and development is about change (fig. 2). There are many things about life that we want to sustain/ maintain and many that we want to change. So it makes sense to create the notion of 'sustainable development' that combines desired change and desired continuity, e.g. we might change exploitation, unhappiness, poverty, destructiveness, etc. and sustain the rest of nature, trust, tolerance, honesty, happiness, health, etc.

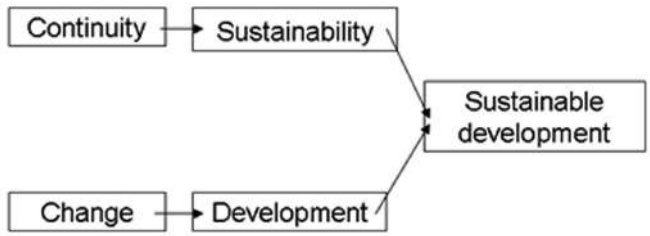

Fig. 2 Sustainable Development

Treated in this way sustainable development doesn't have to be an oxymoron (a combination of conflicting terms). While theory says that sustainable development does not have to be an oxymoron, it can sometimes take quite a bit of negotiation before a whole society can be comfortable with a shared definition of what should be maintained and what should be changed. Thus, sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

ENVIRONMENTAL FOOTPRINT ANALYSIS (EFA)

Footprint methodologies estimate life-cycle environmental impacts from a narrower view point than traditional life-cycle assessment. The environmental footprint methods described below can be classified into two broad categories of analysis: streamlined life cycle assessments that use a single unit indicator (e.g. carbon dioxide equivalents) and location specific analysis (e.g. ecological footprint of a city). A single unit indicator does not mean that only one source or one piece of data is used. Typically, many different data are used but are converted to a single common unit, such as carbon or nitrogen. In this manner, single indicator environmental footprint analysis is similar to economic tools that use currency as their single unit indicator. Assessing environmental

footprints may help frame and inform sustainability discussions by providing a better understanding of the limitations of local resources to support social, economic, and environmental systems. The EFA comprises of five main methods as discussed below.

Ecological Footprint

Ecological footprint measures the amount of land and/or ocean required to support a certain level and type of consumption by an individual or population. This measurement is estimated by assessing the total biologically productive land and ocean areas required to produce the resources consumed and mitigate the associated waste for a certain human activity or population. Through the ecological footprint analysis, it is possible to estimate the fraction (or multiples) of land/ ocean area required to support a specific lifestyle within a specific geographic area (country, state, city, etc.).

Materials Footprint

Materials footprint uses material flow analysis to estimate the total material and waste generated in a well-defined system or specific enterprise. This method provides several useful indicators for measuring the mass of materials entering and leaving a defined system boundary, including domestic material consumption (e.g. per capita material consumption), total materials requirements (e.g. the measure of all of the material input required by a system, including direct and indirect material flows and imports), and material intensity (e.g. the ratio of domestic material consumption to gross domestic product).

Carbon Footprint

Carbon footprint is the most developed form of the footprint methods. It is a measure of the direct and indirect greenhouse gas emissions caused by a defined population, system, or activity. Carbon footprints can be calculated by taking an inventory of six greenhouse gases [carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO), sulfur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs)] as identified in Kyoto Protocol. Each of these greenhouse gases can be expressed in terms of the single-unit indicator, carbon dioxide equivalents (CO2e) or in normalized terms (e.g. CO_2e per sales dollar, land area, or production unit). CO_2e is calculated by multiplying the emissions of each greenhouse gas by their respective 100 year global warming potential.

Carbon footprints are categorized into scope 1 (direct greenhouse gas emissions from fuel combustion in vehicles and facilities), scope 2 (indirect emissions from purchased electricity), and scope 3 (other indirect greenhouse gas emissions, e.g. waste disposal, outsourced activities, business travel, emissions from leased facilities).

Nitrogen Footprint

Nitrogen footprint is a measure of the reactive nitrogen (e.g. NO, NH3, etc.) associated with a population or activity through agriculture, energy use, and resource consumption. Nitrogen footprints are typically expressed in terms of mass loading per time (e.g. kg/year).

Water Footprint

Water footprint measures the total volume of fresh water that is directly or indirectly consumed by a well-defined population, business, or product. Water use can be measured by the volume of water consumed (e.g. the amount evaporated and/or polluted in a given period of time) and is indicative of the water volume required to sustain a given population. The water footprint of a region is the total volume of water used, direct or indirect, to produce goods and services consumed by inhabitants of a region. An internal water footprint measures the consumption within a region for goods and services, while an external water footprint measures the embodied water used outside the region for goods and services.

ROLE OF TECHNOLOGY IN MONITORING ENVIRONMENT OF A SMART CITY

There are many organizations in the world that currently carry out ambient air quality monitoring in major cities. For example, the UK air quality archive has pointers to several monitoring networks that produce daily or hourly data on different pollutants. Likewise, Indiastat, the India environment portal, reports statistics that reflect the pollution levels in India. The commonly used gas analyzers for monitoring include diffusion tubes and infrared sensors. Geographic information system (GIS) and wireless sensor network air pollution monitoring system (WAPMS) is a wireless sensor network (WSN)

air pollution system in Mauritius with focus on the development of a data aggregation algorithm.

Mobile environmental sensing system across grid environments (MESSAGE) is a collaboration project between five UK universities to develop a pervasive sensing system for monitoring and displaying online information about traffic and traffic related pollution for traffic management and route planning purposes. The project's scopes include system architecture and infrastructure design, data processing and mining, transport system modeling, user interface development of pollution maps and sensor modules development. On the information webpage, four of the pollutants are specifically mentioned, NO, NO_2, CO_2 and CO.

STEPS TO MAKE ENVIRONMENT OF A SMART CITY SUSTAINABLE

As the green movement continues to gain momentum, cities across the globe are asking what they can do to become greener and more sustainable. There are many ways to define a sustainable city, but it is up to each community to create its own vision of what sustainability means to the people who live there and which specific goals they wish to achieve as discussed below.

Create a Sustainability Plan

The first step to become a sustainable city is establishing a plan with specific goals and a long range vision that are tailored to the unique characteristics of each individual community (fig. 3). This process should involve a considerate amount of public input and participation of government departments.

The city government needs the keys to sustainability planning as discussed below.

- Hire a sustainability coordinator to develop the plan
- Form teams that build bridges across city departments and beyond city hall
- Develop a greenhouse gas emissions inventory
- Define clear, relevant and measurable goals
- Get regular people to tell you what sustainability goals are important to them
- Develop implementation plans within your plan

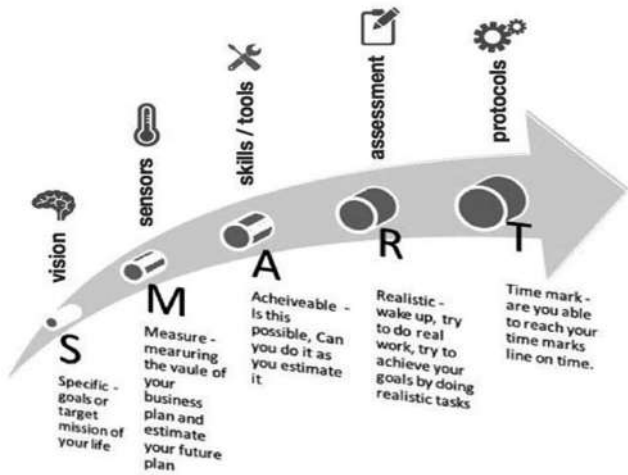

Fig. 3 Smart City Planning

- Take a deep breath and release a draft plan for public comment
- Obsessively track the implementation status of your measures
- Remain accountable to the public

Increase Civic Participation and Community Involvement

Citizen participation and support is important in all aspects of the planning process. Strategies should be developed to solicit greater input from all economic and social groups throughout the entire community. Furthermore, communities should encourage the collaboration of stakeholders in making development decisions. Communities should also strive to increase awareness and engage citizens in the sustainability movement by making information available such as online resources, convenient access to green policy documents and guidelines, community briefing sessions, and informed staff available to answer questions.

Preserve and Enhance Natural Resources

The natural resources available to every community should be preserved to protect native species and support biological imperatives for clean water and air, food, shelter and public safety. When communities are unable to prevent development from breaching important natural ecosystems, at a minimum, an effort should be made to preserve linear, connected greenways so wildlife can attain the resources vital to their existence without the interruption of roads/ fences.

Support Local Agriculture and Food Production

Communities should support and encourage viable, environmentally sound and socially equitable food systems at local and regional levels. The improvement of physical and economic access to farmer markets, organic markets, super markets and other places that sell fresh product will all contribute to a healthier and more sustainable community. Smart cities can support local farmers and encourage healthy eating habits by removing barriers to and providing incentives for urban farming and by providing opportunities for all residents to grow their own food.

Encourage Healthy and Active Living

Healthy people make healthy communities; therefore, communities should encourage individuals to remain active by preserving public access to open spaces, both formal and informal, including parks, playgrounds, town greens & bodies of water, forests and mountains. Greenbelts that connect parks and outdoor destinations with bike trails and open spaces are a great way to promote outdoor activities, and in some cases can serve as an alternative commuter route for residents (Fig. 4).

Reduce Carbon Footprint and Greenhouse Gas Emissions

City governments have the power to affect the main sources of pollution directly linked to climate change: energy use, transportation and waste. The city govt. should have adoption of building energy codes as a fundamental means for achieving higher efficiencies and lower energy use intensities in new residential and commercial construction. Policies that demand energy use disclosure is an increasingly recognized means for enabling market forces to drive demand for energy efficient real estate.

Support Green Buildings and Green Infrastructure

Buildings account for 38 percent of CO2 emissions and 70 percent of the electricity load in a city like Delhi. Communities can dramatically reduce the amount of greenhouse gases they produce as well as their consumption of electricity by establishing policies that encourage building beyond minimum national efficiency standards. Retrofitting existing buildings to improve energy efficiency and healthy indoor environments is equally important. The preservation of historic buildings offers huge energy savings when considering the embodied energy of an existing building and the amount of energy it takes to replace it with a new one, with additional benefits of helping to maintain a community's connection with its past and attributing to the community's sense of place. Innovations in lighting technology now allow communities to cost-effectively convert public facilities and infrastructure to use smart and efficient lighting strategies, such as LED and QL lighting.

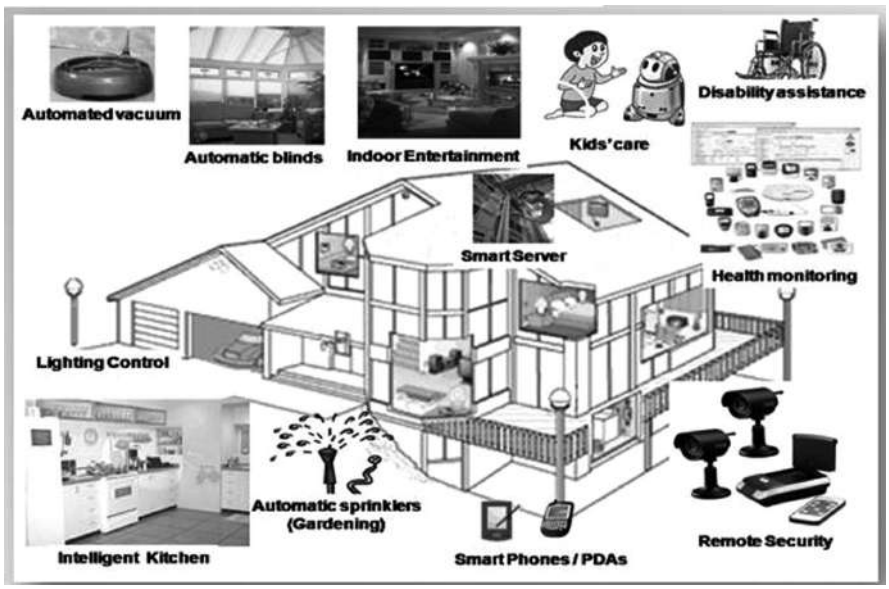

Fig. 4 Smart and Sustainable Urban Environment

Develop an Efficient Transportation Network that Reduces Vehicle Use

The combination of limited public transportation options, inefficient road networks, and separated land uses creates an auto-dependent environment that increases vehicle miles traveled (VMT) and adds to overall infrastructure costs. One way communities can encourage public transportation is through the development of a multimodal transit hub that connects local and regional transit systems. This makes using public transportation options more appealing, and also provides an opportunity to create a central focal point for the community, aiding in the establishment of a sense of place.

Intelligent Transportation Systems and Services (ITS) can be integrated into existing infrastructure, and in vehicles themselves, which can relieve congestion, improve safety and enhance productivity. Typical types of ITS strategies might include traffic management centers, coordinated traffic signal systems, real-time traveler information systems, automated vehicle location devices, emergency response centers, automated fare and smart cards, and advance vehicle control and monitoring systems.

Reduce Waste

The easiest way for communities to reduce waste is through a comprehensive recycling program. These programs should include pick up services for standard recyclable goods, as well as drop off locations for hazardous materials like oil, paint, anti-freeze, batteries and electronics. Part of this includes educating the public on how and what can be recycled. The composting is the most eco-friendly method to manage the organic wastes and proved as best initiative to inspire and educate state and local jurisdictions on the importance of getting compostable organics out of the landfill.

CONCLUSION

The sustainable environment is essential for the true development of smart cities. The urbanization leads to a growing demand for sustainable solutions, stable energy, fresh and potable water, efficient transportation, and resource management. The technological advancement helps to eliminate all carbon waste, to produce energy entirely through renewable sources, and to incorporate the environment to make the cities smart and more livable. The government should strictly enforce law to sustain the smart city environment in future.

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HARMONIZATION OF GHG AND AIR POLLUTION EMISSION INVENTORIES IN SMART CITIES

SHAKTI PRAKASH*

Abstract

Green House Gases (GHG) reduction and Air Pollution Management (APM) are among the inherent major objectives of proposed smart cities in India. The development of emission inventories, is usually carried out separately for GHG and APM. A harmonized approach may help fulfilling afore-mentioned objectives by identifying appropriate strategies and clean technologies for GHG emission reduction and APM . So far, GHG emission accounting (emission inventories) have been carried out for 40 cities, out of 100 smart cities proposed. Emission inventories act as databases which help in the implementation of climate change action plans and in predicting the extent of air pollution for up to 72 hours in advance and in detecting its source, issuing warning about potential impacts on public health due to any exceedance in air pollution and intensity of ultraviolet radiation..Harmonization of GHG and Air pollution inventories will go a long way not only in addressing climate change but also protecting public health in proposed smart cities.

In fact, There is a need that Government of India should provide support to practitioners on air quality and climate change action plans and provide local authorities with better information on how to deal with both challenges. The preparation of harmonized emission inventories will enable proposed smart cities to monitor the implementation of both air quality management and climate change action plans.

INTRODUCTION

Majority of définitions of Smart Cities still lack detailed ecological and environmental pollution perspectives. Focus Group on Smart Sustainable Cities (FG-SSS-2013) after a detailed analysis of around 120 définitions of Smart Cities provided a commonly acceptable définition involving key words signifying environmentally responsible and sustainable approach and having far reaching implications for goals and objectives of environmentally sustainable development i.e. "A smart sustainable city (SSC) is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects". Thus, a Smart City must be sustainable in its functioning for the present as well as future generations.

Prime Minister of India and Ministry of Urban Affairs have developed .the concept note for Smart Cities programme which involves benchmarking for parameters such as … transport, spatial planning, water supply, sewerage and sanitation, solid waste management, storm water drainage, electricity, health care facilities, education, fire fighting etc. Achieving these benchmarks while developing and operation of smart cities have serious implications for ensuring a required quality of different components of environment as far as environmental pollution management is concerned. There is a widespread awareness and recognition that the air quality related public health problems has assumed such a grave shape that Ministry of environment and Forest (MoEF) has launched new Air Quality Index for Cities Programme , as part of Prime Minister of India's - Clean India Mission' to help citizens understand complex pollution data and its implications for their health. However, MoEF and CPCB , both are still

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in dispute with a World Health Organization (WHO) study of 1,600 cities released in May 2015 which found New Delhi having the world's dirtiest air with an annual average of 153 micrograms of small particulates, known as PM2.5, per cubic metre. Thirteen of the dirtiest 20 cities worldwide were in India. The MoEF has now planned that this air quality index project would be extended to 20 state capitals and 46 million plus population cities over the next couple of years.

It is a well established fact that climate change exacerbates air pollution; air pollution also exacerbates climate change. Incomplete combustion of fossil fuels, biofuels, and biomass produces black carbon, also called soot or particulate matter. The impact of these air pollutants on global temperature is very complex. Some climate scientists assert that their overall impact is to heat the atmosphere. Air pollution and climate change share causes and solutions. Reduction in fossil fuel consumption reduces both pollutants and GHG emissions. Many pollutants, specifically the various oxides of nitrogen (NOx) produced during combustion originate from fossil fuel combustion, as does carbon dioxide (CO_2), the primary greenhouse gas. Volatile organic compounds (VOCs) are ozone precursors, and will under certain circumstances, produce methane. Reducing VOCs improves air quality and helps protect the climate. The United Nations Environment Programme (UNEP) has launched an Integrated Assessment of Black Carbon and Tropospheric (ground level) Ozone to evaluate their roles in air pollution and climate Change

Climate Change and Air pollution are intimately linked through emissions from common sources, primarily those related to the use of fossil fuels; nevertheless in both science and policy these topics have often been treated separately. In continuing to address pollutant challenges, state and local officials have the opportunity to capture significant GHG emission reductions. The most effective path for achieving this goal is to ensure that, in obtaining emission reductions needed for pollutant attainment, the applied strategies are ones that also provide GHG reduction benefits, rather than measures that are ineffective or counterproductive from a GHG perspective. Electricity generation and road transport are two of the most significant sources of both air and climate pollutants. Other sources include shipping (NOx PM and CO_2), agriculture (NH_3), nitrous oxide (N_2O) and methane (CH_4)), and biomass burning (PM, NO_X and N_2O). Strategies that cut standard air pollution sometimes cut GHG emissions as well but often miss them or even worsen the GHG emissions; strategies that reduce GHG emissions almost always improve air quality as well.

AIR POLLUTION IN CITIES

Ambient air pollution (AAP) constitute the single greatest risk factor for adverse health outcomes in India. Sources of AAP include transport, industrial and heating emissions, biomass burning, and tobacco smoke. They produce pollutants such as sulphur dioxide (SO_2), nitrogen oxides (NOx), carbon monoxide (CO), ozone, and particulate matter (PM10 and PM2.5). A range of other toxic and carcinogenic by-products from biomass burning include formaldehyde, benzene, and poly-aromatic hydrocarbons. Sustained exposure to AAP leads to increased rates of respiratory disease, chronic obstructive pulmonary disorder, and lung cancer. Thus, air pollution acts as a catalyst for rising healthcare costs, placing an ever increasing stress on an already under-funded and ill-equipped health system. In addition, there are the economic losses resulting from the lower productivity of the afflicted labour force. Air pollution is among the leading causes of death in India. The Global Burden of Disease Report (WHO) has ranked outdoor air pollution as the fifth leading cause of death in India and indoor air pollution as the third leading cause. Outdoor air pollution was responsible for 6,20,000 deaths in 2010, increasing six-fold from 1,00,000 deaths in 2000

Air pollution has acquired critical dimensions and the air quality in most Indian cities that monitor outdoor air pollution fail to meet WHO guidelines for safe levels. The levels of PM2.5 and PM10 as well as concentration of dangerous carcinogenic substances such as Sulphur Dioxide (SO_2) and Nitrogen Dioxide (NO_2) have reached alarming proportions in most Indian cities, putting people at additional risk of respiratory diseases and other health problems. Furthermore, the issue of indoor air pollution has put women and children at high risk. 80 per cent of cities in India, which have comparatively much fewer vehicles, have exceeded the ambient air quality standards prescribed by the Government of India.

and this worsening air quality leading to a plethora of health problems. In Delhi, the Directorate of Economic and Statistics recorded an increase of death rate from 11.4% to 20.4% in certified death due to cardio vascular diseases and an increase from 3.8% to 4.6 % in certified death due to respiratory symptoms between the year 2006 to 2010, both of which have direct linkage to air pollution.

A World Bank report titled 'Diagnostic Assessment of Select Environmental Challenges in India" highlighted that the annual cost of air pollution, specifically pollution from particulate matter (burning of fossil fuels) amounts to 3% of the GDP of the country; outdoor air pollution accounting for 1.7% and indoor air pollution for 1.3%. The report also observed that a 30% reduction in particulate emissions by 2030 would save India $105 billion in health-related costs; a 10% reduction would save $24 billion. In light of the adverse impacts, coupled with the fact that the concentration of particulate matter and rising levels of GHG emissions still uninventorized maximum cities out of 180 Indian cities is almost six times higher than the standards set by the WHO, the issue of quality of air has become a major concern for the Government of India

EMISSION INVENTORIES

An emissions inventory (EI) is established using bottom-up and top-down as well as through a combination of both approaches, through consumption patterns for various sectors and using appropriate emission factors from the past and relevant literature. The emissions inventory is developed for all the criteria pollutants including PM10, PM2.5, NOx, SO_2, CO, VOCs and CO_2. and other GHG emissions The sectors included are – vehicle exhaust, road dust, domestic solid fuel combustion (in the low income and high income groups), food kiosks, generator usage in multiple venues (such as hospitals, hotels, markets, and apartment complexes), industrial emissions including those from brick kilns and rock quarries, construction activities in the city, and waste burning along the roadside and at the landfills. An EI is important step in the implementation of air quality management process, plans and climate change action plans because it helps in :

- Determination of significant sources of air pollutants.
- Establishing emission trends over time and periods.
- Targeting regulatory actions and adopting appropriate and adequate GHG mitigation measures because a complete inventory typically contains all regulated pollutants and GHG emissions
- Estimating air quality through computer dispersion modeling and estimation of the emissions from various pollution sources in a specific geographical area
- Gaining better insights into the relationship between improving efficiency and reducing emissions. So that organizations may redesign business operations and processes for the implementation of technological innovations, improved products and services, and ultimately saved money and sources
- Identifying emissions sources to develop a GHG profile and management strategies may help local governments prepare for and respond to the potential impact of new regulations

A review of GHG accounting required for the preparation of Emission Inventories for 40 cities of India reveals:

- The transport sector is the dominant source of emissions not only particulate matter but also GHG emissions, especially the diesel based trucks Dust emissions dominate the coarse fraction of PM (with particle diameter between 2.5 and 10 micron meter) and thus its dominance in the PM10 emissions inventory with percentages ranging from 20 to 45 %.
- Majority of cities proposed to be developed as Smart Cities are surrounded by brick kilns and their emissions contribute 6 to 15 percent of the emissions and similar fractions to the ambient pollution
- Among the silent contributors to PM and CO_2 emissions, the domestic cooking and heating emissions, especially the low income groups, outside the city district areas, where use of coal, biomass, and biofuels is at large; followed by the use of generator sets within the city limits in the sectors of hotels, hospitals, institutions, apartment complexes, and markets.
- The largest uncertainty lies in the emissions

inventory is the waste burning. This is due to lack of enough waste management programs, parts of the domestic waste is burnt and accounting for PM and other carcinogenic emissions.

CHALLENGES AND OPPORTUNITIES IN DEVELOPING HARMONIZED EMISSION INVENTORIES

- There is no comprehensive database available in India covering all types of sources in different sectors; therefore, many diverse sources covering various sectors have been utilized. Most of the activity data are derived from published reports/ documents of Government sources
- Emission inventorying is time consuming as well as the maintaining of the database. So far, the main focus lies in general on greenhouse-gas emissions; however, air pollutants are often covered as well. Nevertheless, no single source of information exists that might cover all necessary information for urban inventories.
- Uncertainties bring variable impacts, when EIs are applied for scientific and policy levels. Uncertainties are very important for scientific applications; an uncertainty analysis should always be part of any scientific study. The uncertainty analysis helps the scientist to explain their results. The policy level stakeholders are not interested in uncertainties because they are interested in knowing about whether, achievements of targets have been met or not. The uncertainty of an emission inventory may be in anyone of following elements :
    - The development and selection of indicators
    - The quantified valuation of indicators selected
    - Uptodation of emission factors
    - The representatively of the emission factor for sources as applicable for emission estimation models
    - The spatial and temporal attributing of emissions.
- Boundary issues: Top-down approaches quite frequently create the boundary problem. It is observed during work on CO2 inventorization while involving two different approaches.. For example , a port harbour may sell large quantities of oil and related products which is registered with port authorities, however information regarding utilization is often missing. Thus boundary problems arise during the dispersion modelling of emissions because of no information about the location of oil/products utilization. EIs developed through bottom-up usually do not face such type of boundary problem.
- Double counting of emissions: This is a common challenge observed and reported widely during the preparation of inventories. It is often due to applications of different methodologies while working for emission sources.
- Missing sources: Emission inventories are based on a certain amount of assumptions, best guesses and professional views and judgments..Sources that are often missed are: small scale activities aside big industrial complexes or installations such as cleaning tanks, storages, emissions from buildings, Illegal activities such as wire or cable burning in open air, burning of buildings, cars containers, Agricultural/ natural emissions, stops and starts of industrial installations, incidental releases (spills, valves, flares), start-up and shut-down emissions of several industrial installations.
- Majority of EIs lack Scenario Analysis which is required to be carried out for the evaluating the impact of preventive and control measures for both air pollutants and GHG emissions and by dispersion modeling .Therefore completeness of the inventory is often preferred over “fit for purpose”.
- Mixing emissions and shadow emissions in one inventory makes sense for local policy monitoring but the risk of double counting when regional emissions are aggregated is very real. Indirect emissions are highly significant at a local scale.
- Difficulties in obtaining and updating Correct Emission Factors: Rapid development on new (environmentally friendly) clean technologies based production methods and new (bio) fuels, make it difficult to update emission factors.
- Need for the harmonization of GHG and Air Pollutants exists due to data availability and accuracy can be a problem (historical records);

The data requires periodic evaluation and updating, meaning new time consuming work

CONCLUSION

- Ministry of Environment and Forest and Ministry of Urban Affairs should prepare action plans for the development of harmonized GHG and Air Pollution Emission Inventories for each city proposed to be developed as smart city for ensuring the effective implementation of climate change action plans and air pollution management in these proposed smart cities.
- Emission inventories should consistently updated and uncertainties associated need to be minimized through active collaboration among all stakeholders involved.
- Awareness and improved access for EIs need to be created in cities /adjoining areas so that stakeholders may through improved acess may realize that EIs are highly significant , even beyond boundaries of a city for addressing concerns of climate change action plans and air pollution management.

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ROLE OF GREEN BUILDINGS IN MAKING THE CITIES SMARTER –A CASE STUDY

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Abstract

The concepts of sustainable construction and green building are the recent responses to address environmental problems and reduce the overall impacts of the building sector on the natural environment. Smart cities can very well incorporate the green building concept for sustainable infrastructure development. In India, green buildings are on rising surge and for this, the introduction of green building certification systems that aim to assess environmental performance of new and retrofitted buildings and certify best practices are established. One of them is GRIHA-Green Rating for Integrated Habitat Assessment developed by TERI. The criterias of GRIHA-TERI are fulfilling the required aim of smart cities sub- themes like reliable utilities- water supply, sewerage, drainage, waste management; efficient energy management; environmental sustainability etc. Therefore, only requirement to make our cities smarter are by promoting the concept of green buildings in public and properly implementing the defined norms of recognised certifying agencies regarding green buildings.

The Haryana renewable energy development agency (HAREDA) building which has been developed on the basis of GRIHA-TERI methodology and provisionally rated 5-star is taken up as a part of case study. The case study represents that already existing criteria's for developing energy efficient buildings have been incorporating almost all the required norms of smart city.

INTRODUCTION

Making a city "smart" is emerging as a strategy to mitigate the problems generated by the urban population growth and rapid urbanization [1]. Smart city initiatives are forward-looking on the environmental front [2]. Core to the concept of a smart city is the use of technology to increase sustainability and to better manage natural resources [3]. More than half of the World's population now lives in urban areas [4-6]. This shift from a primarily rural to a primarily urban population is projected to continue for the next couple of decades (see http://www.unfpa.org). Such enormous and complex congregations of people inevitably tend to become messy and disordered places [7]. Cities are going to generate the new kinds of problems. Difficulty in waste management, scarcity of resources, air pollution, human health concerns, traffic congestions, and inadequate, deteriorating and aging infrastructures are among the more basic technical, physical, and material problems [8, 9, 10, and 11]. The urgency around these challenges is triggering many cities around the world to find smarter ways to manage them. These cities are increasingly described with the label smart city. One way to conceptualize a smart city is as an icon of a sustainable and liveable city. The intended aim of smart city has already been considered in the assessment methodology of GRIHA-TERI. The paper represents the co-relation between sub-themes defined for smart cities and criteria's of GRIHA methodology with the help of a case study.

TERI's green building rating system GRIHA has been developed as an instrumental tool to evaluate and rate the environmental performance of a building. There are 34 criterias (Table 1) to evaluate the performance of a building [12,13].

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Table I: Various Criteria of GRIHA-TERI

Criteria	Details
Criteria-1	Site Selection
Criteria-2	Preserve and protect landscape during construction/compensatory depository forestation
Criteria-3	Soil conservation (post construction)
Criteria-4	Design to include existing site features
Criteria-5	Reduce hard paving on site
Criteria-6	Enhance outdoor lighting system efficiency and use RE system for meeting outdoor lighting requirement
Criteria-7	Plan utilities efficiently and optimise on site circulation efficiency
Criteria-8	Provide ,at least, minimum level of sanitation/safety facilities for construction workers
Criteria-9	Reduce air pollution during construction
Criteria-10	Reduce landscape water requirement
Criteria-11	Reduce building water use
Criteria-12	Efficient water use during construction
Criteria-13	Optimise building design to reduce conventional energy demand
Criteria-14	Optimise energy performance of building within specified comfort
Criteria-15	Utilisation of fly ash in building structure
Criteria-16	Reduce volume, weight and time of construction by adopting efficient technology (e.g. precast systems, ready-mix concrete etc.)
Criteria-17	Use low energy material in interiors
Criteria-18	Renewable energy utilisation
Criteria-19	Renewable energy based hot water system
Criteria-20	Waste water treatment
Criteria-21	Water re-cycle and re-use(including rain water)
Criteria-22	Reduction in waste during construction
Criteria-23	Efficient waste segregation
Criteria-24	Storage and disposal of waste
Criteria-25	Resource recovery from waste
Criteria-26	Use of low VOC paints/ adhesives/ sealants
Criteria-27	Minimize ozone depleting substances
Criteria-28	Ensure water quality
Criteria-29	Acceptable indoor and outdoor noise levels
Criteria-30	Tobacco and smoke control
Criteria-31	Universal Accessibility
Criteria-32	Energy audit and validation
Criteria-33	Operations and Maintenance protocol for electrical and mechanical equipment
Criteria-34	Innovation(beyond 100)

THE CASE STUDY–HARYANA RENEWABLE DEVELOPMENT AGENCY BUILDING, PANCHKULA

The Renewable Energy Department, Haryana/ HAREDA has constructed its office building in a plot of area 0.96 acres at institutional Plot No.1, Sector-17, Panchkula (Haryana). This building is one of its kind in the country in having energy autonomy by incorporating the latest and futuristic energy efficient concepts. It has been the first building in the Government sector to be constructed in Compliance with the Energy Conservation Building Codes (ECBC). Moreover, this building has been provided 5 star GRIHA rating (Provisional) by Association for Development and Research of Sustainable Habitats (ADaRSH) which is first of its kind in North India and first Govt. building in India [14].

Some important features of HAREDA building are:

- This building has been constructed on the basis of solar passive design techniques having

Building Integrated Photovoltaic (BIPV) system of 42.50 KW capacity, solar chimney, evaporative cooling, cavity walls, use of fly ash based bricks, water recycling and energy efficient lighting etc. The incorporation of these features has resulted in achieving an internal temperature of about 280 C without air conditioning.

- The energy consumption in this building is estimated to be about 30 kWhr/m2/year as compared to consumption of about 200 kWhr/m2/year for other air conditioned buildings.
- No municipal water supply is required after the first monsoon with the 6.5 lacs litre underground tank that has been optimized for rainwater harvesting and consumption pattern of the building.
- Optimization of installed load has been about 55 kW only. This is one of its own kind of building with 25% reduced lighting energy need and Annual Energy Consumption at 3.48 units per sq, ft. against 18.5 units per sq. ft. of a conventional building.
- Also, evaporative cooling- fogging system (Mist Cooling) has been provided for cooling the non-AC areas of the building. The mist is created in the courtyard of the building with this mist cooling system and the pressure fans on the top of court yards makes squirrel effect in the area to cool the building. This cool air is sucked by solar chimneys. Due to this system the relative humidity ranges between 60%-75%.
- The very much emphasis with regard to plantation has been provided by planting herbal shrubs all across the building. Deciduous trees are planted on the West face of the building to allow winter heat gain while keeping the summer sun out. Evergreen bushes are planted on the North and East to cool the air as it enters the building.
- Evergreen high foliage planted in the berm along the main road to reduce the noise.

Fig. 1. HAREDA Building

Fig. 2. Interior Central Courtyard

RESULTS AND DISCUSSION

The co-relation between the sub-themes of smart city and GRIHA criterias has been established in the Table 2:

Table 2: Showing Co-relations

S. No.	Sub-themes related to smart city	GRIHA criterias
1.	Efficient Energy Management	Criterion 6 + Criterion 13 + Criterion 14 + Criterion 15 + Criterion 16 +Criterion 17+ Criterion 18 + Criterion 19
2.	Environmental Sustainability	Criterion 1 + Criterion 2 + Criterion 3 + Criterion 4 + Criterion 5 + Criterion 9 + Criterion 27 + Criterion 29
3.	Reliable Utilities- Water supply, Sewerage, Drainage and Waste management	Criterion 10 + Criterion 11 + Criterion 12 + Criterion 20 + Criterion 21 + Criterion 22 + Criterion 23 + Criterion 24 + Criterion 25 + Criterion 28

Therefore, in total of 26 criterias out of 34 are directly complying with the intended themes of smart city. Also, GRIHA evaluation report (2012) mentioned that Akshay Urja Bhawan/HAREDA was evaluated according to the benchmarks and guidelines of GRIHA Rating System. Final rating shall be awarded on compliance with the GRIHA criterion 32. The project has been awarded 90 points (87+3 bonus points) out of 96(92+4 bonus) applicable points by the evaluation committee of ADaRSH on providing necessary documentation and demonstrating compliance with mandatory criterion under GRIHA. Therefore, provisionally rated 5 star (97.83% (90/92 Points). These features will automatically made HAREDA building to be an ideal example for smart city.

CONCLUSION

The requirements required to make the cities smarter are mostly fulfilled by properly designing the infrastructures on basis of GRIHA-TERI methodology. Out of 34 criteria's in total, 26 satisfying the intent of sub-themes defined for smart city. Only step need to be taken by government for making cities smarter is efficiently implementing the norms of GRIHA. By making those criteria's compulsory achieved the desired goal. Apart from above mentioned sub themes in this paper, internet and communication technology (ICT) also need to provide special consideration. ICT can help in broad way to monitor the overall working of green buildings and also enable the public to easily access the knowledge regarding retrofitting options. The retrofitting of already existing structures by GRIHA methodology make them part of smart city. Therefore, we don't need to look for different alternatives but simply implement the defined norms of certifying agencies relating to green building to make cities smarter.

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SMART METERING FOR UTILITY SERVICES

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Abstract

Smart cities are based on use of information and communication technology for almost all the services and governance and thus smart meters are going to be used for measurement of consumption of electrical energy, water and gas in such cities so also may be in other cities in future. A smart meter records consumption of electric energy, water or gas in intervals such as of an hour or less and enables two-way communication between the meter and the central system. Smart meters can gather data for remote reporting and can provide information on actual time of use basis.

Advantages of smart metering are energy efficiency, carbon di-oxide reduction, pricing transparency, customer protection and improvement of billing process. They do not save energy but their sole purpose is to change the behaviour of the consumer for savings. Then there is a question how the consumers are going to be benefitted from them. Smart meters need deployment of smart appliances which would affect the consumers. The appliances are to be compatible to smart meters, equipped with chips that will allow appliances to communicate with the smart meters. Smart metering system is likely to be connected to smart grids and may be in future to global smart grids of various countries. The companies may also switch over to peak pricing after installation of smart meters.

Advantages and issues of smart meters are discussed in the paper.

SMART METERS

A smart meter is defined as an electronic device that records consumption of electric energy, water or gas in fixed intervals such as of an hour or less and communicates that information back to the utility for monitoring and billing. The meters may be of gas type, thermal type or ultrasonic type. Smart meters are likely to be the part of all smart cities being developed in India as the government has already decided to develop one hundred cities.

The smart meters enable two-way communication between the meter and the central system. Smart meters can gather data for remote reporting and can provide information on actual time of use. Thus smart meter is a new type of electrical meter that not only measures energy usage but sends the information back to the utility by wireless signal such as radiofrequency or microwave radiation signal instead of having a utility meter reader come to the place and manually record it. Such an advanced metering infrastructure differs from traditional automatic meter reading in as it enables two-way communications with the meter. Smart meters may be of gas type, thermal type or ultrasonic type.

SMART METERS AND ENERGY SAVING CONCEPT

Smart meters do not save energy themselves but consumers do. The purpose of smart meters is to change the behaviour of the consumers. It is hoped that the consumers would save energy through awareness and the estimated bills. It is something like STD or ISD telephone bills. Sometimes back people

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used to go to STD/ISD booths and make calls for limited period as they had an eye on the bills while from their landlines or mobiles they used to call for a longer time and thus spending more. Similarly when they would have the energy bill say on daily or hourly basis, they are likely to save it through awareness of high consumption. Thus smart meters reflect the actual energy consumption and provide information on actual time of use basis, unlike home energy meters and can gather data for remote reporting and for collecting data on remote basis, smart grids are essential.

SMART GRID

Smart grid is the digital and Wi-fi enabled power meters that enable communication between the appliances in the home or office with the power provider. The Smart grid has three main parts as; new communication and digital sensors and automation capabilities for the distribution and transmission systems; new digital metering systems for all customers; and direct interfaces between the new metering systems and customers.

Smart meters may be in future a small part of the global plan to upgrade and interlink various grids to a smart national grid. First let us think for a national smart grid. All the smart grids would be connected to the national smart grid and then national smart grids can be interlinked to other countries and finally to global smart grid. For example say smart national grids are interlinked, an American or Canadian company will be able to provide energy to Indian grid and charge accordingly. Suppose American company has spare energy during night, it can provide energy to India as it would be day time in India. Similarly an Indian company can also do same, if has excess power. Thus smart meters are a very small component of overall global smart system though very important and likely to be implemented first. Interlinking national grids of various countries may require a global treaty in future.

SMART APPPLIANCES

Smart meters will be equipped with the chips that would allow the appliances to communicate between the appliances and the smart meters. The energy consumption of each appliance can be recorded and communicated by the smart meters. Suppose a consumer desires that he wants to run the air conditioner only between nine and twelve in the night, it would be possible and the consumer would also be able to communicate the decision and control the appliance. In case, one finds the bill too costly, he may decide to run the air conditioner between nine and eleven or ten to twelve. This way he will save the energy by switching it off though smart metering system.

But for the communication system, each appliance would require the chip and ordinary appliances would not be able to make the communication. Thus one needs to switch over to new appliances. If someone still insists to keep appliances without chips, electricity companies may charge for full period consumption whether they are run or not i.e. on the basis of maximum usage. This may be like penalizing the consumer who does not opt for new smart appliances, able to communicate to smart meters. Thus though smart appliances may not appear mandatory, may become mandatory in future to the consumers. In case the appliances are not compatible to the smart meters, they may become useless.

PEAK PRICING

There are various systems of pricing the energy consumption. A simple system may be uniform pricing but electric companies or the governments may not like to implement it. The governments and the companies would like to take mileage on the issue by having two, three or four tier billing system. For example first tier may be free electricity say the consumption is thirty units per month in which hardly say 0.05 % consumers may find place. Another tier may be say up to one hundred units, having lower rates and above that, higher rates. In lower rate bracket an analysis can be made so that a low percentage of consumers say one to five percent find place. Above this bracket another tier may be created say 200 to 300 units where say 60% consumers may fall in and fourth tier may be highest rates if one consumes higher or even any amount of energy during “peak hours” say for the period nine to twelve in the night for which “peak pricing” may be adopted. Peak pricing is adopted when consumers are used to smart meters. Since during peak hours if consumption goes up the electricity companies are to pay higher for withdrawal and also they are not able to

manage it, this management can be transferred to the consumers after installation of smart meters. Smart meters will therefore be necessary for recording the consumption during peak hours and for calculating the bills. Effect of such peak pricing would be that industries would not be able to pay such higher prices and would like to shut down their establishments or appliances during peak pricing hours and also poor would not be able to run their appliances during such period due to high pricing.

To attract consumers initially electricity companies may offer rebates on highest bracket and thereafter once the system gets stabilized may switch over to "peak pricing" system. Though companies may claim that by adopting "Peak Pricing" system, the consumption has gone down and saving has occurred to the consumers but actually this will not be energy saving due to any improvement in the system but due to high cost of energy and at the cost of reduction of comforts. The solution from many energy saving experts may come in the form of putting thermostats in the appliances for minimum withdrawal of electricity, in the name of smart thermostats.

PRIVACY AND SAFETY ISSUES

It is a matter of deliberation whether smart metering system has the issue of encroachment of privacy and safety. Modern era is no doubt of data collection and information technology. Smart metering system will have the data of all the appliances connected with smart meters and thus in a fraction of second, one can have the data of refrigerators, TVs, air conditioners or any other appliance consuming energy in the country and even exact increase of the appliances in a day. Electric companies would have the data of each consumer and also of the period when someone is using them, and even when he is taking breakfast, viewing TV or running the air conditioner. If someone has locked the house, the information can be drawn by the electric companies from the data of energy consumption. Thus few claim that the system will have a close eye on the consumers, and such smart metering system is the infringement in their privacy. According to a study by the Ponemon Institute, a research organization based in Traverse city, Mich, the more people know about smart meters, the more likely they are to worry about the impacts smart meters will have on their privacy. It is expected that large personal data of the consumers would be available with the electric companies. Thus they can reconstruct even most of consumers daily requirements and their lifestyles like what appliances they use and for what duration, when they wake up, when they go to sleep, when they go to office or for the business or on vacation, and may pass data or information to other companies or sister companies or to any third parties for marketing or even sell it. Suppose you and your wife are not using same room, electric company would be able to reconstruct the data from the use of two separate air conditioners installed in two different rooms. In brief in the smart metering system companies will have granular data while in normal metering system they had aggregate data. For example granular data may be in the form given in Fig. 1.

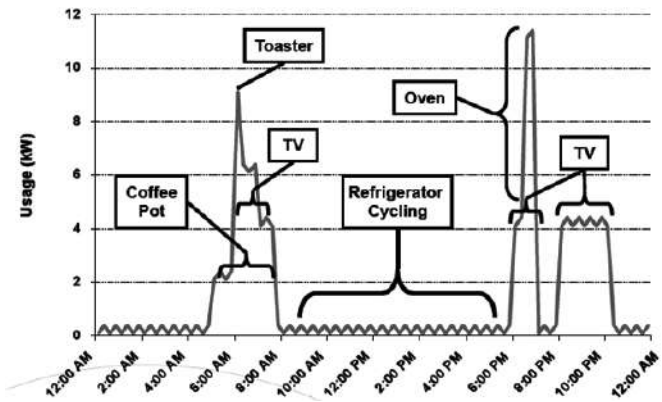

Fig. 1. Granular Data

As far as safety is concerned, the issue is again debatable. Smart metering system would require all the appliances running with electronic chips and also the smart meters which would radiate electro-magnetic waves in the house and around it. Some doctors describe such radiation as "dirty electricity" or "electric pollution". Dr Sam Milham, author of "Dirty Electricity" has made his study on the subject and it is claimed that dirty electricity can lead to dangerous diseases. If the data are stolen, it is feasible that unlawful elements may use the information for the theft or other type of misuse. Cloning may even raise your bill and by the time you would be aware of the hackers, a hefty bill will be in your drop box. Few environmentalists have already raised their voices against smart meters due to privacy, safety and health concerns in many parts of the world. In future Act may be enacted in the country which would fix the limits of radiation in case of smart metering

systems and appliances but it will take considerable time. Similarly Act may include privacy standards in future when consumers would have the awareness. Thus right to privacy in the houses and right to disclosure of personal information or right to own data may become the issues of the future. In such cases, companies may be asked to take consent of the consumers to share their personal data.

Then there is a security issue. All electronic equipments are susceptible of security threat easily. Smart meters would require electronic chips in the appliances and if some companies engaged in the spying just present free of cost such appliances to VIPs or to those to whom such companies want to keep on surveillance, it is relatively easy and even may be that they themselves purchase such equipment without their knowledge and install without doubting on them. These spying gadgets then may be available right in their offices, living rooms, bedrooms and even washrooms.

ADVANTAGES OF SMART METERING

The following are the advantages of smart metering;

- Pricing transparency
- Improvement of billing process
- CO_2 reduction
- Energy efficiency
- Customer protection
- Prevention of theft of electricity

The question is whether electric companies will install smart meters at their own. Probability is yes as this will lead the path of peak pricing and converting appliances compatible to their requirements. The cost of smart metering may be adjusted by the companies in their expenditure and thus ultimately will be loaded on the consumers. Though in smart cities, there is likelihood of providing smart grid system including smart meters from the beginning. Electric energy providing companies will change their grids to smart grids. Smart grids will have new communication and digital sensors and automation capabilities for the distribution and communication systems, new digital metering system for all customers and direct interfaces between the new metering systems and consumers through in home technologies. Companies thereafter can connect smart meters to their smart grids. In US, government started programme for smart grids in 2009-10. Companies may also charge based on higher rates for peak hours and lower for other duration. "Peak pricing" is implemented by the companies at some point after consumers are used to smart meters. Consumers will have to pay much higher prices for using the same energy during certain hours.

Another issue is whether the consumers would be asked about the option of installation of smart meters. There is no likelihood of the same as this may lead to controversy if the consumers are getting more and more aware of the smart meters and their compatibility. But once the consumers are aware, they may ask for not opting of such meters, then company may even agree to provide normal meters but with the condition that they would bill according to maximum load and maximum usage which would increase their bill substantially.

An important issue which would be deliberated is smart meters would save wastage of resources in taking meter readings, manual error, late bills, prevention of theft of electricity and thus smart meters being treated energy efficient or green. Companies may also initially provide some incentives for providing smart meters like rebates otherwise even without intimating them or casually intimating them through circulars or advertisements for change of their meters. Initially consumers are not going to pay any attention due to unawareness of the new system.

Finally there would be a question whether consumers have a right to refuse to get smart meters installed and the answer would be in general – no as the companies may disrupt their supply and it is unlikely that the companies would be ready to provide both the systems.

CONCLUSION

Smart meters may come in India sooner or later with or without knowledge of the consumers. There is a need of deliberations of the advantages and dark sides of the smart metering system before they are installed. Once the consumers are well aware and convinced about the necessity of smart meters, they should have option to select the meters with

the commitment that they would not be charged on "peak pricing" basis in future. Also privacy, safety and security of the consumers will require to be ensured by the companies and the government by enacting suitable laws/Acts.

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BUILDING SMART INFRASTRUCTURE BY COMBINING SHM AND ENERGY HARVESTING FOR A SMART CITY

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Abstract

Smart Cities have smart (intelligent) physical, social, institutional and economic infrastructure, thereby ensuring sustainable environment to its citizens. To achieve this, the urban infrastructure (buildings, bridges, etc.), need be monitored by sensors. The sensors should ideally be capable of energizing themselves through 'energy harvesting' rather than depending upon external power supply or batteries. This paper presents futuristic insights into innovative integrated solutions for combined Structural Health Monitoring (SHM) and energy harvesting of civil infrastructures using new emerging ideas in piezoelectricity. Such technologies will enable the creation of a new generation of 'smart civil infrastructures', which deploy possibly self-powered ubiquitous sensing to assess full-scale structural performance, and thereby supporting their own power management. The idea of extending the proof-of-concept, already demonstrated in lab environment by the author, to the smart cities, so as to monitor its vast infrastructure in an intelligent fashion, has been presented here.

The proposed work will focus on two concerns – energy harvesting and SHM, with special focus on fatigue damage, which has long received the attention of bridge engineers.

INTRODUCTION

In line with the Prime Minister's vision to set up 100 smart cities in India in next 15 years with an investment of $1.2 billion (Aggarwal, 2015), building/converting the existing civil infrastructure to 'smart infrastructure' becomes an agenda of prime significance. Smart Cities are those cities which have smart (intelligent) physical, social, institutional and economic infrastructure while ensuring centrality of citizens in a sustainable environment (Indiansmartcities, 2014). Whether India builds new cities, or extends and develops existing ones, it needs a new technology that is faster, more sustainable and cost-effective. In the next step of evolution, the urban infrastructure (buildings, bridges, etc.) will be monitored by sensors. The sensors should ideally be capable of energizing themselves through 'energy harvesting' rather than depending upon external power supply or batteries.

The main aim of this research is to develop innovative integrated solutions for Structural Performance Monitoring (SPM) and energy harvesting of civil infrastructures using new emerging ideas in piezoelectricity. Such technologies will enable creation of a new generation of 'smart civil infrastructures', which deploy possibly self-powered ubiquitous sensing to assess full-scale structural performance, and thereby support their own management. In order to prevent the deterioration levels reaching severe dimensions, it is desirable to monitor the condition of strategic structures right from the construction stage using structural health monitoring (SHM) techniques. The recent bridge collapse near Jawaharlal Nehru stadium in New Delhi, India (Fig. 1), during which 27 persons were injured, in addition to delaying project at critical hour, could have been averted if proper SHM techniques had been used during construction stage.

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Fig. 1 Bridge collapse near Jawaharlal Nehru Stadium in New Delhi

FUTURE VISION OF SMART INFRASTRUCTURE

Energy concerns are also a key feature of "Smart Cities". Energy efficient practices need to be adopted in transportation systems, lighting and all other services that require energy. Emerging advances in low cost electronics and energy harvesting technologies (Park et al. 2008 and Kaur and Bhalla, 2014a,b) could further simplify installation and maintenance of monitoring systems. Fully air conditioned commercial buildings, possessing a huge potential of wind energy harvesting from the arrangements of heating, ventilation and air conditioning (HVAC) will also be explored during this research.

Technology Readiness Level (TRLs) given by Roach and Neidigk (2011) can be adopted as a method for ranking technology/systems through the development stages. This classification system clearly defines benchmarks, direction and maturity of emerging technologies. The author has extensively worked in the area of integrated SHM and energy harvesting using thin piezo patches in both surface bonded and embedded configurations (Kaur, 2014), including the development of concrete vibration energy harvester (CVEH), a new energy harvesting device (Kaur and Bhalla, 2014c). Future studies may focus on instrumenting of actual structures and carrying out field measurements of actual harvestable power i.e. extending the work to TRL 7 (demonstration of complete system prototype in operating environment). Special focus needs to be diverted on fatigue damage, which has long received the attention of bridge engineers. Such integrated SHM and energy harvesting using piezo transducers for real-life bridges would substantially facilitate the development of smart infrastructure as a part of 'smart cities'. This will aid in refinement of the earlier technological developments transitioning from TRL 4 to TRL 7, when applied on real-life RC structures.

FUTURE RESEARCH DIRECTIONS FOR CIVIL ENGINEERS

The mechanical energy generated due to the vibrations of the bridges can be converted into electromechanical energy by the piezo transducers bonded to the structures, using the recent inventions by the author. This can be stored using the energy harvesting circuits for direct or future use. This stored energy can be utilized by the same piezo transducer to perform the SHM of the real-life bridge for its monitoring via electromechanical impedance (EMI) and/or global vibration techniques.

A coupled electro-mechanical model for power generation from the surface bonded or embedded piezo transducers, considering the losses associated with the PZT patch and the bond layer, has been derived and validated with experimental measurements by the author (Kaur and Bhalla, 2014a,b). It can be extended to measure the existing vibration data in typical flyover and bridges in India and estimate the energy generation capacity. The model can also be extended to embedded configuration employing concrete vibration sensor (CVS) and CVEH, duly considering the piezo-bond-structure interaction, which is much different in this configuration.

In fact, the real-life structures can also be numerically modeled to estimate the power generated by the surface bonded/ embedded piezo transducers and compare with actual experimental measurements on a real-life bridge.

HVAC is important in the design of medium to large industrial and office buildings such as skyscrapers and in marine environments, such as aquariums, where safe and healthy building conditions are regulated with respect to temperature and humidity, using fresh air from outdoors. The structural vibrations or indoor air flow resulting from HVAC can be used for harvesting energy using piezo transducers, which

can be utilized by various low power consuming electronics, as demonstrated by recently concluded research projects in Smart structures and Dynamic Lab (Mahesh, 2014; Sreenitya, 2014).

CONCLUSION

This paper has provided some visionary ideas to show the possible directions of SHM and energy harvesting research in the light of smart cities, which will have huge power requirements, especially for numerous sensing systems, which will be an essential part of the city infrastructure. Primary energy consumption in India has more than doubled between 1990 and 2012, reaching an estimated 32 quadrillion British thermal units (Btu). India's per capita energy consumption is one-third of the global average, according to the International Energy Agency (IEA), indicating potentially higher energy demand in the long term as the country continues its path of economic development. In the International Energy Outlook 2013, IEA projects India and China will account for about half of global energy demand growth through 2040, with India's energy demand growing at 2.8% per year (EIA, 2014). While the oil rich countries have adopted an energy intensive approach, others have adopted a more energy efficient growth path. In India, since we are still a developing economy and mostly inbuilt, we have the opportunity to choose the path we want to take. Clearly, we should adopt the low energy path, especially in view of environmental sustainability as well as in view of the fact that for becoming globally competitive, we need to be efficient in terms of energy utilization.

SHM has been listed among one of the ten technologies which could drive world's economy (Majcher, 2011). Also, the growing energy demands of the masses cannot be catered by the non-renewable resources. Hence, for success of smart cities, India needs a sustainable technological solution which can enable integrated health monitoring and energy harvesting of real-life RC/ steel bridges using piezo sensors. A unique health assessment index needs to be formulated so as to generate a complete picture of the present status of the bridge health. Due implementation of the ideas presented in this paper by research community followed by rapid commercialization by industry will surely pave way for dual use of the ordinary piezo patch in SHM as well as energy harvesting.

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ENERGY EFFICIENT CONCEPTS FOR SMART CITIES

USHA BATRA*

Abstract

Goals of a smart city are to achieve sustainable development, increase the quality of life of its citizens and improve the efficiency of the existing and new infrastructure. Planning Commission indicates that total domestic energy production will be 70 % of demand. Rest 30% will be met from imports. India is projected to be the world's most populous country by 2025 leading to further increase in the energy demand creating a wider gap between the demand and production. Therefore, conservation and efficient utilization of energy resources will play a vital role in narrowing the gap between demand and supply of energy. Improving energy efficiency is one of the most desirable options for bridging this gap. It is possible to reduce the demand to the extent of 40-50% apprx. through energy-efficient concepts.

But these concepts being new in India need to be tested at large scale for different design options of their performance under real use before implementation in Smart Cities to obtain desired results.

INTRODUCTION

It is estimated that by 2020, housing shortage will reach about 30 million dwelling units, 200 million new water connections will be required, 250 million people will have to be given access to sewage, 160 GW of power generating capacity will have to be added and the number of vehicles on our urban roads will increase by 5 times.

According to recent studies, by 2030, 40% of India's population will be living in urban areas, 68 cities will have a population of more than 1 million and 70% of net new employment will be generated in cities. It is estimated that, on average, about 75% of the global economic production takes place in cities, and Indian urban areas will also follow the trend and account for nearly 70% of the country's GDP by 2030.

India is the fourth largest consumer of energy. A projection in the Twelfth Plan document of the Planning Commission indicates that total domestic energy production of 669.6 million tons of oil equivalent (MTOE) will be reached by 2016-17 and 844 MTOE by 2021-22. This will meet around 71 per cent and 69 per cent of expected energy consumption, with the balance to be met from imports, projected to be about 267.8 MTOE by 2016-17 and 375.6 MTOE by 2021-22.

India meets its electricity demands with 67 percent from thermal resources, i.e. coal and gas, 19 percent of that demand is met with hydropower, 12 percent from renewables, and 2 percent from nuclear power. While many analysts point to developing solar and nuclear capabilities as essential, India will need greater capacity and efficiency in all sectors to meet India's energy needs.

The Ministry of New and Renewable Energy has swung into action to evolve guidelines as per which all power producers in private and public sector would have to generate 10 per cent of solar power of their total installed capacities to lighten the smart cities.

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(economic times Mumbai dtd. 25.03.2015). As per economic times Mumbai dtd.26.03.2015, Public sector banks agree to lend Rs.1.71 crores to green energy sector in project financing over next 5 years. India is projected to be the world's most populous country by 2025. This may lead to increase in the energy demand creating a wider gap between the demand and production. The concept of smart city in itself will further increase the demand of energy due to the fact that almost all the services will be IT based and will be required to run 24x7. There is no possibility of increasing the production. Therefore, Conservation and efficient utilization of energy resources will play a vital role in narrowing the gap between demand and supply of energy. Improving energy efficiency is one of the most desirable options for bridging the gap in the short term.

According to an analysis conducted by NRDC and ASCI, if states across India adopts the ECBC and developers participate in strong programs for rating commercial buildings, an estimated 3,453 TWh of cumulative electricity could be saved by 2030.

Energy efficiency concepts for reducing consumption of smart cities are as under:-

- New buildings with net zero energy requirements and refurbishing of the existing buildings to bring them to the lowest possible energy consumption levels.
- Maximum use of Smart materials.
- Smart lighting (in particular solid state lighting for street and indoor), appliances (ICT, domestic appliances), and equipment (e.g. motor systems, water systems)
- Innovative and cost effective Heating and cooling techniques.
- Increasing share of renewable generation and storage.
- Smart grids, Smart metering and smart energy management systems.
- To foster local RES electricity production (especially PV and wind applications).
- Battery operated public and individual transport systems, including smart applications for ticketing, intelligent bus stops and traffic management and congestion avoidance.

DEFINING A SMART CITY

Though no clear definition, the premise of a smart city is that by having the right information at the right time, citizens, service providers and city government alike will be able to make better decisions that result in increased quality of life for urban residents and the overall sustainability of the city. It is, therefore, stipulated that information resulting from a smart city implementation has a two-fold impact: (1) it shifts the social behaviour of citizens towards a more efficient and sustainable utilization of city resources (bottom-up), and (2) it allows service providers (such as utilities and transit companies) and city government to provide more efficient and sustainable services (top-down). Goals of a smart city are to achieve a sustainable development, increase the quality of life of its citizens and improve the efficiency of the existing and new infrastructure.

The most important thing without which a smart city won't be able to perform is the change in mindset for responsible behavior, where every citizen feels sense of belongingness for each and every utility and service of his / her country. This change itself is a time consuming job. Moreover to bring this change, education to all is very necessary. Education is even necessary to make use of right information at the right time.

It also requires to take into account the problem of functioning of two cities (a smart city and a conventional city) within one city, with two different systems of working, two different norms of land use, two different sets of infrastructure and facilities. Projection of requirements for preparing development plan in itself is a challenging task as master plans prepared for future 30 years eat up everything in 20 years only.

NET ZERO ENERGY BUILDINGS

A net-zero energy (NZE) building is one that relies on renewable sources to produce as much energy as it uses, usually as measured over the course of a year. While the exact definitions of metrics for "net zero energy" vary, most agree that Net Zero Energy Buildings combine the two i.e. Exemplary building design to minimize energy requirements and renewable energy systems that fully meets these reduced energy needs. Indira Paryavaran Bhawan is

the first NZEB in India. This will not remain NZEB after 8 years as the energy production reduces by 1 % every year from SPV.

Inside a 'zero-energy' home

A San Francisco company is planning to build multifamily townhomes, lofts and apartments that create as much energy as they use. Here is a look at some of the net zero energy methods and materials.

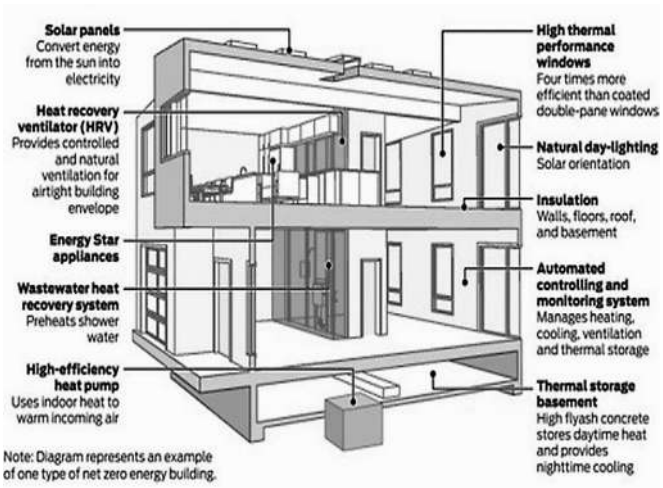

Fig. 1. Different Component of Net Zero Building

Source: Zeta Communities

Minimizing the energy use through efficient building design is a fundamental design criterion and the highest priority of all NZEB projects. It is the most cost-effective strategy with the highest return on investment, and minimizes the cost of the renewable energy. Energy efficiency measures include design strategies and features that reduce the demand-side loads such as high-performance envelopes, air barrier systems, daylighting, sun control and shading devices, careful selection of windows and glazing, passive solar heating, natural ventilation, and water conservation. Second step will include energy efficient lighting, electric lighting controls, high-performance HVAC, and geothermal heat pumps.

Once efficiency measures have been incorporated, the remaining energy needs can be met using renewable energy technologies. Common on-site electricity generation strategies include photovoltaics (PV), solar water heating, and wind turbines.

Grid Connection and Net Zero

Most Net Zero Energy Buildings are still connected to the electric grid, allowing for the excess energy produced from renewable energy sources to be exported back to the utility grid and used when renewable energy generation cannot meet the building's energy load due to weather conditions. Buildings that meet all their energy needs on their own and are not connected to an external source are described as off the grid.

Two milestones for NZEB have also been defined by the Department of Energy for residential and commercial buildings.

- Marketable Net Zero Energy Homes by the year 2020
- Commercial Net Zero Energy Buildings at low incremental cost by the year 2025.

These objectives align with the Energy Independence and Security Act of 2007, which calls for a 100% reduction in fossil-fuel energy use (relative to 2003 levels) for new federal buildings and major renovations by 2030.

SMART MATERIALS

Smart materials are specially designed materials that have one or more properties that can be significantly changed in a controlled fashion by external stimuli, such as stress, temperature, moisture, pH, electric or magnetic fields. Some of the materials are :-

Smart Concrete that will heal its own cracks

Concrete is a core building material. But even concrete starts to crumble when it comes face-to-face with water, wind, stress and pressure. A new type of smart concrete contains dormant bacteria spores and calcium lactate in self-contained pods. When these pods come into contact with water they create limestone, filling up the cracks and reinforcing the concrete. Self healing concrete is estimated to save up to 50% of concrete's lifetime cost by eliminating the need for repair.

Shapeshifting Metal

Shapeshifting metals can undergo great stress and temporarily change shape, but they are designed to 'remember' their original form and revert back to

it if altered in some way. Used in the construction of a bridge, for example, would help sustain the bridge against damage from a hurricane or earthquake. Practical use of this type of metal is largely still in the development phase.

Self Healing Coatings

Self healing coatings, sealants and adhesives are already in use, though new to the market. The coatings are made with polymers that innately react with one another when they rupture, creating a process of self healing. This discovery is only for water-based structures as on date. A self healing coating that could be applied to concrete is in the process of being tested by a group of scientists.

Façade That eats Smog

Sliding Façade

Sliding Façade

Fig. 2. Smart Building Skins

Sliding Façade: Pair ofAbu Dhabi Towers. Double skin- with inner layer as thin glass and outer layer in fibre glass. The outer layer opens and closes in response to the temperature of the façade. Therefore, at night one can see maximum of glass façade.

Façade that eats smog: The material contains Titanium dioxide, which effectively scrubs the air of toxins by releasing spongy free radicals that eliminate pollutants. Used in Hospital in Mexico. Provides clean air for patients inside.

A Low Tech, operable skin

In Melbourne, façade of small sandblasted glass circles-each fixed to a central rod. Based on the humidity and temp. inside the building, rods pivot automatically to facilitate air flow.

Smart Nano-Materials in Construction Industry

According to researchers, following is a list of areas, where the construction industry could benefit from the nano-technology.

- Replacement of steel cables by much stronger carbon nanotubes in suspension bridges and cable-stayed bridges
- Use of nano-silica, to produce dense cement composite materials
- Incorporation of resistive carbon nanofibers in concrete roads in snowy areas

- Incorporation of nano-titania, to produce photocatalytic concrete
- Use of nano-calcite particles in sealants to protect the structures from aggressive elements of the surrounding environment
- Use of nano-clays in concrete to enhance its plasticity and flowability.
- Urban air quality could be improved by if the civil structures are treated with nano TiO2

SMART LIGHTING, APPLIANCES AND EQUIPMENTS

According to several surveys, Street lighting equals 40 percent of the electricity bill of municipalities. Maintenance of streetlights is an operational issue due to large numbers and large geographical distribution. According to the data, lighting accounts for 19 percent of all electricity consumed. One-third of the world's roads are still lighted by technology dating back to the 1960s. The installation of new street lighting solutions can save up to US$13.1 billion in energy per year. A leading lighting company estimates that a complete switchover to LED technology world over can generate savings of about US$179 billion - an enormous sum equivalent to the elimination of 640 medium-sized power stations globally.

Further, use of energy efficient and star rated home appliances e.g. air-conditioners, TV, refrigerators, water purifiers, washing machines and equipments like motors, pumps etc. will add to reduction in energy consumption.

SMART GRIDS, SMART METERING AND SMART ENERGY MANAGEMENT SYSTEMS

A smart grid is an electricity network that uses digital and other advanced technologies to monitor and manage the transportation of electricity from all generation sources to meet the varying electricity demands of end-users. Smart grids co-ordinate the needs and capabilities of all generators, grid operators, end-users and electricity market. Furthermore, Smart Grids can provide superior data on the amount of energy available which can lead to better management and prioritization of local manufacturing investments. In areas where a higher percentage is necessary for public consumption, governments can target manufacturing and incentivizing the appropriate type of investment. It will also ensure that the energy grid is not overburdened.

Next generation smart grid may enable the Smart City to grow its power requirements to meet its growing energy needs. Key Characteristics of the Smart Grid are:

- Self-healing: The grid rapidly detects, analyzes, responds, and restores.
- Empowers and incorporates the consumer.
- Tolerant of attack: The grid mitigates and is resilient to physical/cyber-attacks.
- Provides power quality to users: The grid provides quality power consistent with consumer and industry needs.
- Accommodates a wide variety of supply and demand: The grid accommodates a variety of resources, including demand response, combined heat and power, wind, photovoltaic, and end-use efficiency.
- Fully enables and is supported by competitive electricity markets.
- Transform the Indian power sector into a secure, adaptive, sustainable and digitally enabled ecosystem that provides reliable and quality energy for all with active participation of stakeholders.

While enhancing supply to meet the demand is important, Smart Cities should also lay special emphasis on demand management, by creating incentives for savings and disincentives for excessive consumption.

Smart Meters

Smart meters enable two-way communication between the meter and the central system. Advantages of smart metering are said to be energy efficiency, carbon di-oxide reduction, pricing transparency, customer protection and improvement of billing process. Smart meters do not save energy but their sole purpose is to change the behavior of user or consumer to save energy through increased awareness of usage to estimate the bills. Smart meters need deployment of smart appliances. These may require replacement of appliances affecting pockets of customer.

The core of Smart Energy Management System is the energy conservation. By providing smart grid and smart metering, excessive costs on energy usage can be saved. Energy management also includes shutting down those power plants which are running inefficiently and it is not possible to bring their efficiency to normal levels due to various reasons.

ENERGY EFFICIENT TRANSPORTATION

On-road vehicles account for more than 80% of all transportation energy use. Reducing the number of miles vehicles travel, decreases petroleum use in transportation and reduces vehicle emissions. Fuel efficiency can be improved by using mass transit, car pooling, using active transit like biking and walking, teleworking of employees, exploring ways of modal shift from non renewable energy based transportation to conserve fuel and reduce vehicle miles traveled. e.g. DMRC earns carbon credits by 'Modal Shift Project' on account of Regenerative Breaking System.

Alternative low-carbon fuels should gradually substitute fossil fuels for transport propulsion in the long term. Some examples are :

- The first Solar-Powered Plane Lands in India in march 2015.
- Maini group's Reva was India's first electric vehicle in 2010.
- We have 2 ,3 and 4 wheelers battery operated vehicles but according to electric/ hybrid vehicle manufacturers, lack of suitable charging infrastructure, a general fear to try out an alternative mode of transport and speed limitations contributed to the low sales of electric vehicles.

The Ministry is promoting research, development and demonstration projects in the field of battery operated vehicles (BOVs) under the Alternative Fuel For Surface Transportation programme, with the objective of conserving oil and curbing environmental pollutions. Different institutions, like IISc. Bangalore, CECRI Karaikudi, NCL Pune, C-MET Pune, RRL Bhubaneswar; Jadavpur University, Kolkata have undertaken research and development projects.

CONCLUSION

Since all the above concepts are new in India, they need to be tested at large scale for different design options in different climatic zones. In particular the focus should be on the design integration of the different technologies to prove cost-effective solutions and monitoring of the performance under real use before implementation to obtain desired results. Preparation of development plan for a smart city itself requires a lot of Research and study of the past experiences to arrive at a workable solution. It also requires timely implementation of the scheme to avoid cost- overruns and simultaneously to avoid declaration of scheme becoming unsuccessful due to cost and time overruns. Success of a smart city also lies in behavior change of its citizens to a great extent. Due attention is required to be paid to bring about this change.

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INNOVATIVE TECHNOLOGIES FOR SMART CITIES

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Abstract

The paper aims to get the insights of the new and innovative construction technologies and methodologies being adopted in the real estate industry. It studies various smart features that are being incorporated in the existing/proposed smart cities. It incorporates features of green building, adopted by the projects aiming the green building certification. Further it entails information regarding basic infrastructure and their optimal utilization as per the existing demand. It emphasizes on Smart City features like green building characteristics, smart water supply system, power infrastructure, energy efficient air conditioning systems with radiant cooking, ground loop heat exchange, multi-level substations, twin elevators etc.

Paper also gives a case study of Dholera Special Investment Region in Gujrat.

INTRODUCTION

Building up a smart city not only involves smart planning but also smart integration of innovative technologies. The various technologies successful under green building certification have been studied and incorporated on the same canvas to throw some light on smart city planning. The various technologies and methods studied are discussed in depth. Some of them involve smart power, smart urban infrastructure, city command and control centre, Smart Street, geothermal exchange system etc.

CITY COMMAND AND CONTROL CENTRE

Command centre is constructed to keep a control on all the smart facilities at a city. It functions like a monitor, regulating and sustaining all the features.

Various aspects which the City Command and Control Centre checks are:

- Smart Urban Infrastructure which includes water systems, power, Information and Communication Technology (ICT) system, district cooling, domestic gas, waste management, fire fighting, utility tunnel, etc.
- Smart Buildings consisting of homes, hotels, schools, hospitals, offices, etc.
- Smart Transport which controls traffic management, parking, Area Traffic Control (ATC), road condition system and real time travel response.
- Smart Landscape with smart irrigation system
- Smart Streets with digital signage system and streetscape.
- Smart Desk incorporating city information and facilitation centre.
- Smart City Security and Surveillance.

SMART WATER INFRASTRUCTURE

Smart water infrastructure includes various aspects like potable water for every tap in the city, storage of surface run-off and rain water, utility monitoring, bulk metering, leakage detection, smart analytics and demand forecasting. As shown in Fig. 1, flow chart depicts smart water infrastructure being used in Gujarat International Finance-Tech City (GIFT), Gujarat for water distribution within the city.

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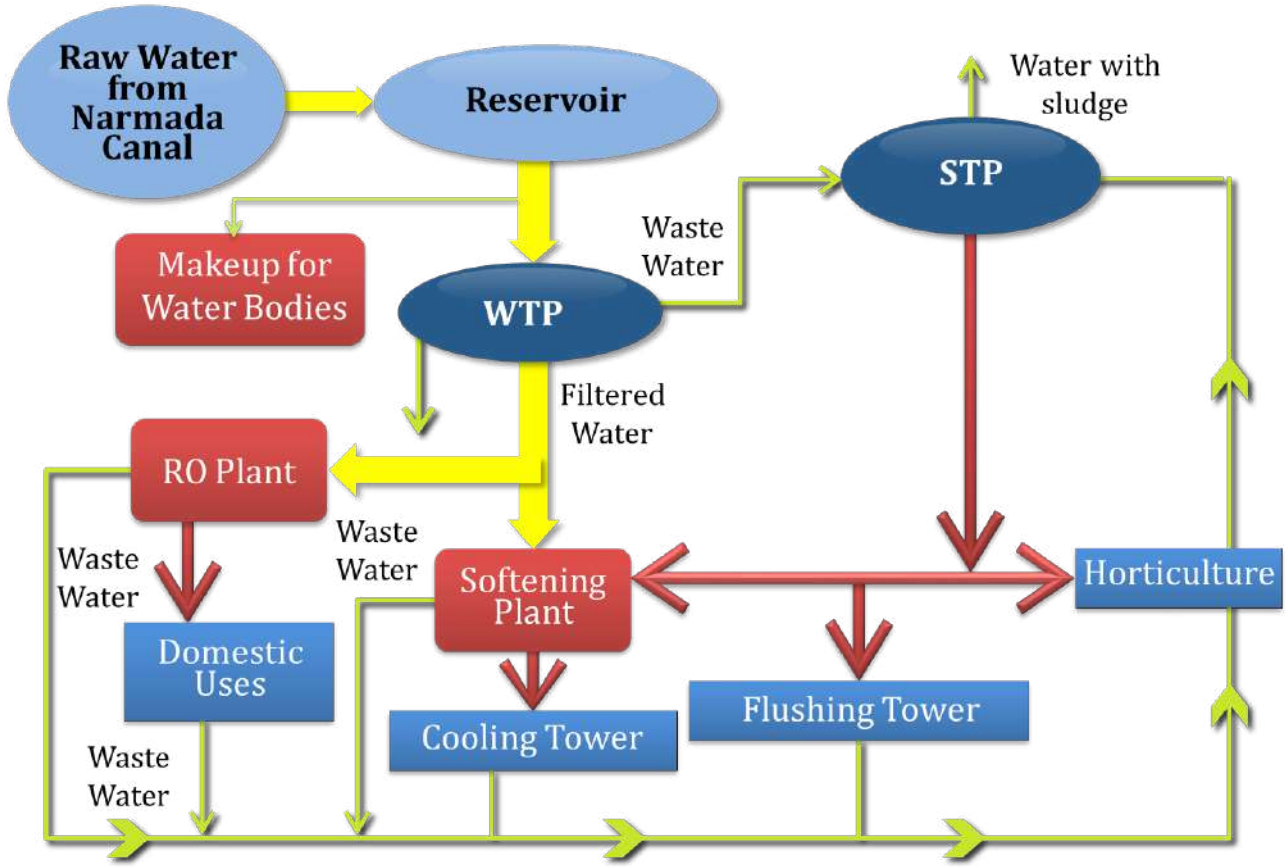

(Source: V. Kumar, GIFT City, 2014, www.slideshare.com)

Fig. 1. Water Treatment Cycle

POWER INFRASTRUCTURE

Modern power infrastructure incorporates underground cabling for power distribution within the city. Substations are built at regular distances and distribution is completely automated. The providence of indoor substations is also gaining recognition nowadays. Gas Insulated Switchgears substation for sub-transmission and distribution of electricity within the city is also a novel concept currently being used in GIFT city Gujarat. When there are space constraints Compact Sub Station in buildings and multi storied buildings.

Power Control Centres are being constructed recently with following features:

- Power supply monitoring
- Power loss minimization
- Grievance redresser system
- Power usage and efficiency management
- Emergency power supply monitoring

RADIANT COOLING

Radiant cooling as shown in Fig. 2 refers to an innovative approach to comfortable and high efficiency cooling, in which, Cross-linked Polyethylene (PEX) pipes are fitted in walls, roofs, floors, and circulate cool water. This system evenly absorbs energy from a room. No drafts and hotspots are required. Practically, Radiant Cooling has to be used in supplement with the conventional cooling system. For areas with normal footfall, 2/3rd of the total cooling load can be catered with Radiant Cooling and 1/3rd with the conventional system. Whereas, for areas with high footfall, such as a mall on a weekend, system can be designed on 50-50 basis because of high latent heat loads.

Fig. 2. Radiant Cooling

(Source: V. Kumar, GIFT City, 2014, www.slideshare.com)

GROUND LOOP HEAT EXCHANGE

In this system, as shown in Fig. 3bores are dug deep inside the earth and loops are created with PEX pipes. The water is precooled before passing it through the chillers. Also, integration with piles is possible with parallel and series connections options available.

This technology has been implemented at Indira Paryavaran Bhavan, JorBagh, Delhi. The system has successfully replaced the cooling towers with this and are getting a temperature drop of 5 deg. C. (38 deg. C to 33 deg. C) with a reduction of 160TR load on cooling tower and also a reduction in consumption of water.

Fig. 3. Underground Heat Exchange Loops

(Source: V. Kumar, GIFT City, 2014, www.slideshare.com)

GROUND AIR HEAT EXCHANGE

The basic concept of a Ground Air Heat Exchange (Fig.4) system is that the temperature remains almost constant 4 m below earth's surface throughout the year.PEX pipes are laid at a depth of 3.5 to 5 m below ground in straight, U or spiral configuration and air is precooled. A temperature drop of 5 deg. C can be achieved before passing the air to Air Handling Units or Fresh Air Units. It has been installed at TERI Retreat, Gurgaon and Bangalore International Centre.

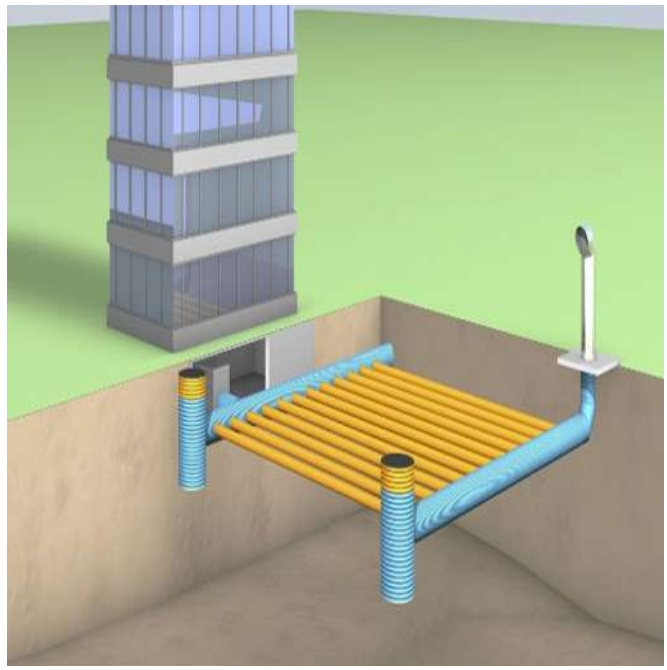

Fig. 4. Ground Air Heat Exchange System

(Source: V. Kumar, GIFT City, www.slideshare.com)

UTILITY TUNNEL

All Services (Power, Water, Sewage, Solid Waste, DCS, Fire Fighting, ICT etc.) will pass through a single underground tunnel in the entire city. The tunnel will be provided with separate dry and wet sections which are alsowide enough to allow a maintenance vehicle to pass through. Also there is a provision of suitable lighting and ventilation arrangement. Keeping in mind the length and width of the utility tunnel, access to it will be granted at multiple locations. This concept is being implemented at GIFT City in Gujarat (Fig.5).

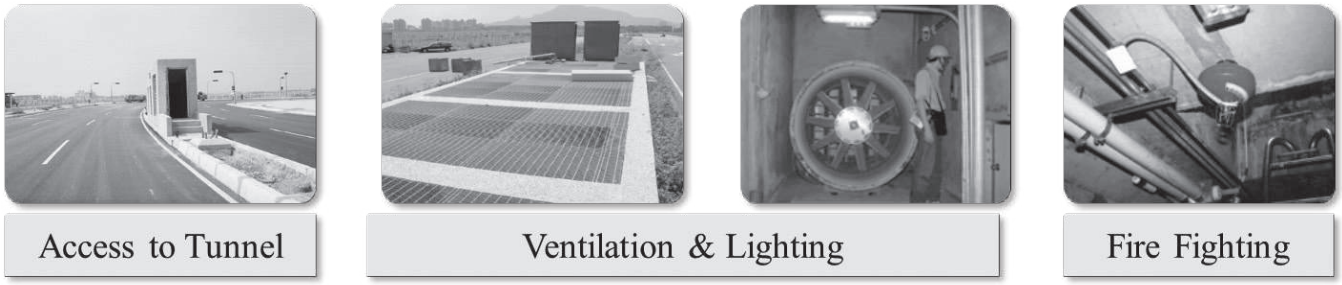

Fig. 5. Access to Tunnel, Ventilation & Lightning and Fire Fighting

(Source: V. Kumar, GIFT City, 2014, www.slideshare.com)

SOLID WASTE MANAGEMENT

Smart features of an efficient solid waste management system has following features:

- Maximum resource recovery.
- Least effect on environment, human hindrance, volume requirement, threat of health problems.
- Nil waste visibility
- Energy proficient
- Monitoring e-waste and bio-medical waste, and lethal-waste management
- Monitoring central waste handling facility
- Monitoring residual waste handling and rejects
- Safety supervision and contingency response

The waste is thrown into a disposal chute in buildings and in public trash cans. Then waste is drawn through underground conduits at a speed of 90 km/hr. When waste travels to waste collection and segregation centers at multiple locations in the city, automatic segregation of waste is done. Plasma gasification of waste is also done which is an exothermic process and leads to generation of energy.

This is a relatively newer and efficient method of waste disposal and management. Fig. 6 describes an efficient solid waste management system.

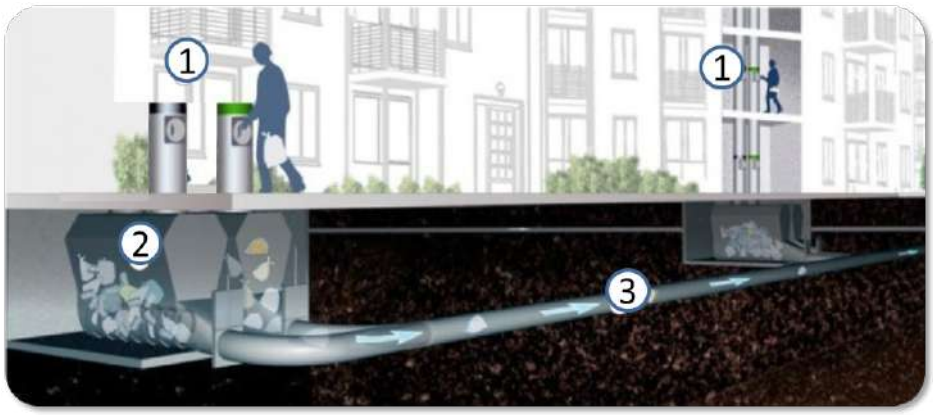

Fig. 6. Efficient Waste Collection System

1) Waste in the public dustbins (2) Waste in building dustbins (3) Waste sucked through conduits

(Source: V. Kumar, GIFT City, 2014, www.slideshare.com)

COLLAPSIBLE BRIDGES FOR FIRE SAFETY

Collapsible Bridges (Fig.7) are trigger controlled bridges connecting two buildings through a wooden/steel collapsible bridge/plank. They are used in case of fire emergency for evacuation purpose. They can be controlled manually at the building or at Central Command and Control Centre.

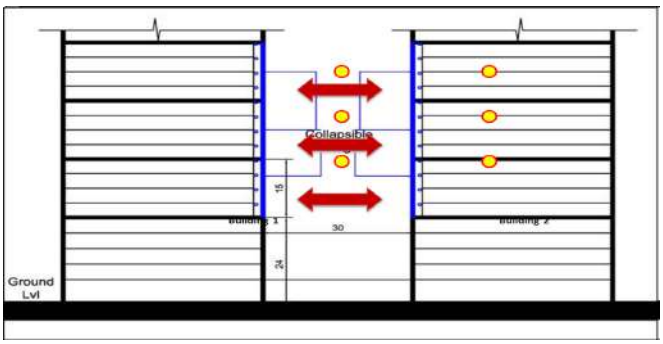

Fig. 7. Collapsible Bridges for Safety

(Source: V. Kumar, GIFT City, 2014, www.slideshare.com)

DRY WALLS

Dry Walls are made up of light weight material which reduces structural load. They are relatively faster to construct as compared to conventional brick walls (Table1). Also, they deliver high performance in terms of longevity and strength. For construction of dry walls, it is easier to transport raw material and construction equipment to higher heights and top floors. Dry walls are found to be good fire resistant for 1 to 4 hours. Also, they provide brilliant acoustic sound insulation (50db – 70db).

Table 1: Difference between Dry Wall and Brick Wall

Characteristics	Dry Wall	Brick Wall
Speed of installation	40-50 m^2 /day	10 m^2 /day
Water saving	Yes	No
Weight	Lightest – 19 kg/m^2 (non load bearing)	230 kg/m^2 (load bearing)
Fire Rating	Can be designed to provide stability, integrity and insulation	Weak in terms of insulation
Usage in Wet Areas	Yes	Yes
Wall Surface	Smooth and crack free surfaces	Difficult to get very smooth surfaces even with skilled labour
Sound insulation	Upto 65 db possible with insulation	35 – 40 db
Heat insulation	Four times less heat convection K=0.16W/m K	High heat convection, K=0.81 W/m K
Quality of Material	Standard quality, supply from single source	Difficult to control, various sources of supply
Quality of Wall	Standard installation, easy to control	Depending on labour skills
Services	Easy through cavity	Chasing in wall is required

(Source: V. Kumar, GIFT City, 2014, www.slideshare.com)

The dry walls are used for the following purposes:

- Internal room to room walls
- Room to corridor walls
- Bathroom and shaft walls

Wall thickness can vary from 75mm and can go up to a reasonable thickness depending upon the demand of the structure. The wall thickness is achieved by using boards of thickness 9.5mm, 12.5mm and 15mm in combination of channels of various widths. The wall thickness and type of wall to be used is mainly governed by

- Maximum height
- Acoustics
- Fire rating
- Total weight

The dry wall costs approximately Rs.150 - 250 per sq. ft.

MULTI-LEVEL SUBSTATIONS

When a particular construction project consists of multiple high-rise towers (more than 50 floors), then the concept of multi-level substations can also be used. Considering the height of the buildings, substation are installed in modular arrangement at multiple floors instead of placing it at ground or basement level. This methods leads to the decrease of length of the bus bars, voltage and transmission losses. This technique is rarely used in India, however in some urban pockets, the concept is getting recognition.

HIGH SPEED ELEVATORS

High speed elevators are used in case of high rise commercial and residential buildings which witness daily commuters traffic in heavy volume. Elevators with speed more than or equal to 8 m/s are considered high speed elevators. Elevator capacity varies from 1350 kg, 1600 kg for civilian purpose to 3500 kg for service elevators. Overhead Gearless Traction technology is used in the high speed elevators.

The elevators also have a regenerative braking system which feeds energy back to the grid while braking. The elevators are also integrated with monitoring solution to provide real-time view of elevator status and ensure high availability.

An E-Link Elevator and Escalator Monitoring and Command System can also be built for further

maintenance. Some of the major functions performed are:

- Real time traffic monitoring.
- In-car and lobby messaging.
- Access control.
- Monitoring equipment operation.
- Analyzing the traffic.
- Traffic history playback.
- System analyses and reporting.

TWIN ELEVATORS

Twin elevators (Fig 8) refer to a concept of lift system in which two cars travel in the same shaft over same guide rails independently. ThyssenKrupp is the only manufacturer of such lifts in the world. An intelligent destination selection control system ensures that the elevator group coordinates perfectly. They are energy efficient gearless machines and are also equipped with regenerative drives. They contain a quadruple-redundancy safety system. The maximum load carried by them is about 3.5 tons per car with a maximum speed of 8 m/s. The advantage of system is saving of space due to omission of shaft and increased handling capacity as shown in Fig. 9.

Fig. 8. Twin Elevators
(Source: www.thyssenkrupp-aufzuege.at/en/new-installation/elevators/elevator-innovations/)

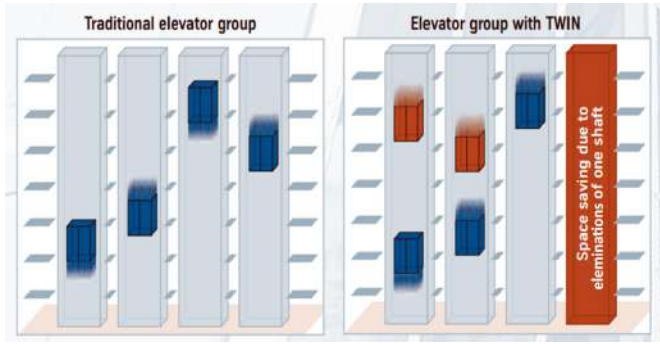

Fig. 9. Difference between Traditional and Twin Elevator
(Source: V. Kumar, GIFT City, www.slideshare.com)

HIGH OUTPUT BATCHING PLANT

A high output batching plant has an actual productivity of 70 to 80 cum per hour. The plant is also capable of producing M200 concrete prepared by Dr. Song (Samsung C&T) which is used for helipad. With this, concrete pumping at such great heights was achieved using special engines by CATER PILLAR.

CASE STUDY ON DELHI – MUMBAI INDUSTRIAL CORRIDOR (DMIC) and DHOLERA SPECIAL INVESTMENT REGION (DSIR)

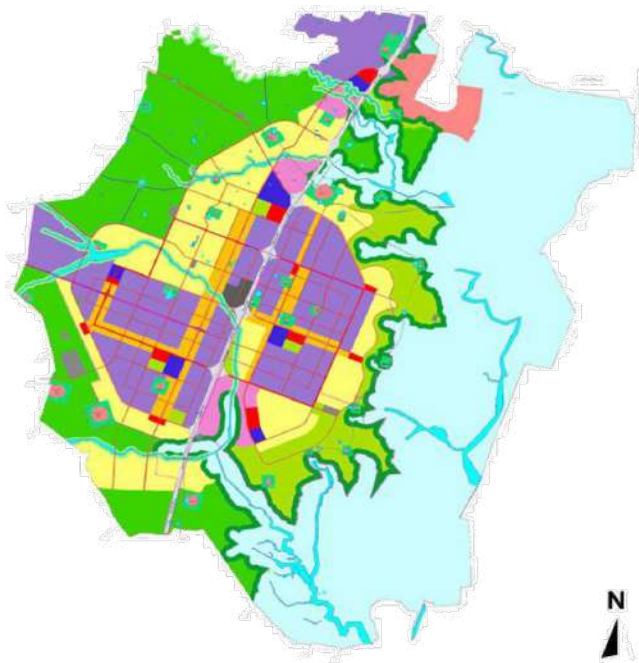

Fig. 10. Master Plan
(Source: www.giftgujrat.in)

Total DSIR Area – 920 sq. km
Developable Area – 567 sq. km

DMIC (Fig.11) is a joint initiative between Indian and Japanese Govt. to create a linear zone of Industrial Development Nodes along a Dedicated Freight Corridor (DFC) railway. DFC- Delhi to Mumbai is 1483 kms. DFC Influence Area is 150 kms on both sides of DFC, Covering 6 states with proposed 24 nodes. DFC Length in Gujarat is 565 kms (38 %) with 6 proposed nodes.

Fig. 11. Delhi-Mumbai Industrial Corridor

(Source: www.giftgujrat.in)

Dholera (Fig.12) is strategically located between main industrial centers of Ahmedabad, Vadodara, Surat, Rajkot and Bhavnagar. It is located about 100 km south of Ahmedabad and 130 km from Gandhinagar. It also encompasses 22 villages of Ahmedabad District. Dholera is linked to all major ports of Gujarat by State Highways.

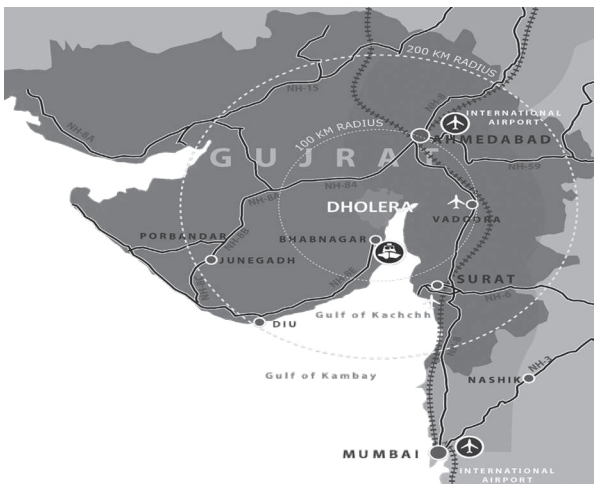

Fig. 12. Dholera Special Investment Region

(Source: www.giftgujrat.in)

DSIR will attract industries of pharmacy, automobile, electronics, biotechnology, heavy engineering, emerging technologies, auto ancillary, general manufacturing, agro and food processing, metals and metallurgy, tourism, IT, education etc., and is proposed to be a major industrial, commercial and residential hub.

Land use pattern of the area is given in Fig. 13.

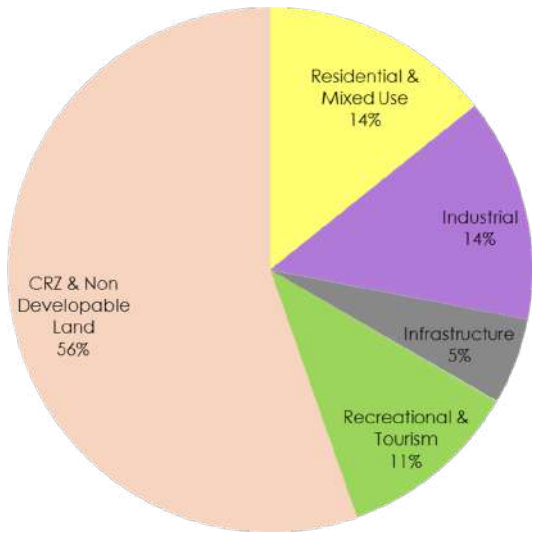

Fig.13. Land Use Pattern of Dholera

(Source:www.giftgujrat.in)

Town Planning Scheme (TPS)

The development authority brings together a group of landowners and a TPS for the area is prepared, laying out the roads and plots for social and public amenities. The remaining land is reconstituted into final plots for the original owners. Compensation is given to owners for land used for infrastructure and a betterment charge is levied on the owners based on the cost of the infrastructure.

6 Draft Town Planning Schemes have been prepared for the area of 422.42 sq.km. (45.89%) out of 920 sq.km

Approach Towards Sustainability

The approach towards sustainability involves integration of:

- Energy management with non-conventional energy generation.
- Information and communication technology

including information, interaction, transaction, transformation, health and education Services

- Water management consisting of water balancing through recycled and reusing of water.
- Land resources and landscape development by reserving CRZ area providing green spaces.
- Transportation giving seamless mobility, walk way, cycle tracks and public transport provisions.
- Waste management through waste collection, segregation, recycle, reuse, disposal by land filling.

CONCLUSION

This paper aims to highlight the various technologies proposed by the contemporary green building think tank. Shifting to smart city is not only the way forward but also the need of the hour. Thesecities sustainably use the stock resources and also curtail the cost as compared to most of the existing cities. It also engages progressively with its citizens. The key reasons to counter through smart cities are climatic changes, older segment of society, need for convenience and comfort, the ever growing inclination towards online retail markets and the thrust on the public finance. Thus, with proper planning and integration of the existing sustainable concepts and advancements one can achieve higher efficiency in terms of usage of energy.

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SIGNIFICANCE OF INTELLIGENT TRANSPORT SYSTEM FOR SMART CITIES

Dr. Indrasen Singh*

Abstract

Intelligent transport systems (ITS) which are ideally suited for Smart Cities are advanced applications which, without embodying intelligences as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated and smarter use of transport networks. ITS may refer to all modes of transport. ITS as systems in which information and communication technologies are applied in the field of road transport, including infrastructure, vehicles and users, and in traffic management and mobility management, as well as for interfaces with other modes.

This paper explains the means by which guidance is maintained and in-vehicle navigation system are integrated into the vehicle control system. This system integration feature allows the vehicle to operate in a mixture of both automatic and manually controlled vehicles. This include the relationship between the on-board control system and other non- automated automobiles, the efficiency and usefulness of the new navigation concept and the system approach to interactive linking of the in-vehicle control system with three transportation models: (i) other automated vehicles (ii) other non-automated vehicles and (iii) the public street and/ or expressway control system. Further discussed, in system descriptive terms, is the actual in-vehicle control system, in-pavement transponders, a flux gate compass, an automatic vehicle location reader, and lateral/ longitudinal radar proximity devices. The paper also illustrates the, logic of the on-board control system including the development of the various signal conditioning devices and local slave computer systems required to drive the main management/ navigational computer system.

INTRODUCTION

The advanced vehicle command and control system (AVCCS) is being developed to solve capacity problems on major urban arterial in a smart city using automation and current technology. The objective of AVCCS is to automate vehicle operations, minimizing the human element. AVCCS enables the integration of road side traffic control devices with on-board vehicle computer systems. The vehicle chassis and frame are based on current technology and require no alteration for the system to be fully functional. Changes are needed to integrate the command and control system, to interface with the steering and braking systems, and to develop a guidance system with communications capability.

The degree of system control is based on the roadway's functional classification; ultimately, however, the driver decides how much or how little automation to initiate. The major areas to be automated are navigation, speed, collision avoidance, and vehicle communication, the ultimate goal is fully automatic control. Automation ranges from the most limited (a navigation system identifying the shortest path to the driver's destination) to the most complex (fully automated control). The system reverts from fully automated to manual control with little human involvement. Information is shared with other automated vehicles through the cellular communications system. The primary components of the AVCCS are a distance measurement and direction sensing system, a radar proximity detection system, and a cellular communications system. AVCCS could

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be the basis of a novel solution to the congestion problem continually encountered in urban areas (Bray 1987; Ross 1986).

Transport professionals have come to realize that the urban Arterial in most of our major cities are in dire need of additional capacity. For example Delhi, Mumbai, Kolkata, Chennai etc. Historically, capacity has been added and the congestion problem solved by building new Arterial. Unfortunately, adding Arterial is not a viable solution in many urban areas for a number of reasons; lack of suitable land, escalating construction costs, environmental considerations, loss of housing stocks with resulting displacement of urban populations, and adverse public reaction. Because of these and other constraints, a different means of increasing capacity must be found. Many alternatives have already been explored including freeway management systems and high – occupancy vehicle lanes. All have the same objective to move the flow of traffic through the transportation system efficiently. Unfortunately, the impact of these alternatives is slight. To solve the congestion problems experienced in major urban areas capacity must be improved by at least 100%, not by merely 15% or 20%. This kind of dramatic improvement can only be accomplished by rethinking how the urban transportation system works. By increasing average operating speeds, dramatically closing vehicle headways and removing as much human involvement as possible from the system, a remedy to the problem can be achieved by using current and emerging technology. These concepts are the basis for development of the advanced vehicle command and control system.

ADVANCED VEHICLE COMMAND AND CONTROL SYSTEM

The advanced vehicle command and control system (AVCCS) is designed to operate in both automated and non automated vehicles. The vehicle chassis and frame are based on current technology and require no alteration for the system to be fully functional. Changes are needed, however, to integrate the command and control system, to interface with the steering and braking systems, and to develop a guidance system with communications capability.

In the AVCCS- equipped automobile, the vehicle is started when the driver's seat belt is fastened and the key is turned in the ignition system. The vehicle is under manual control as it leaves the parking spot or garage and proceeds toward the arterial street system. Once on the arterial the collision avoidance system and the speed control system may be engaged. When the vehicle enters a freeway or expressway or limited – access facility, activation of the automatic vehicle control system merges the vehicle into the high speed automated lane.

As seen in Fig. 1, the degree of system control is based on the roadway's functional classification (the interactive system provides for communication between transponders embedded in the roadway surface and the vehicle's on-board computer). Ultimately, however, the driver decides how much or how little automation to initiate. Some subsystems are acting at all times; others may be activated as the need arises (Fig.2).

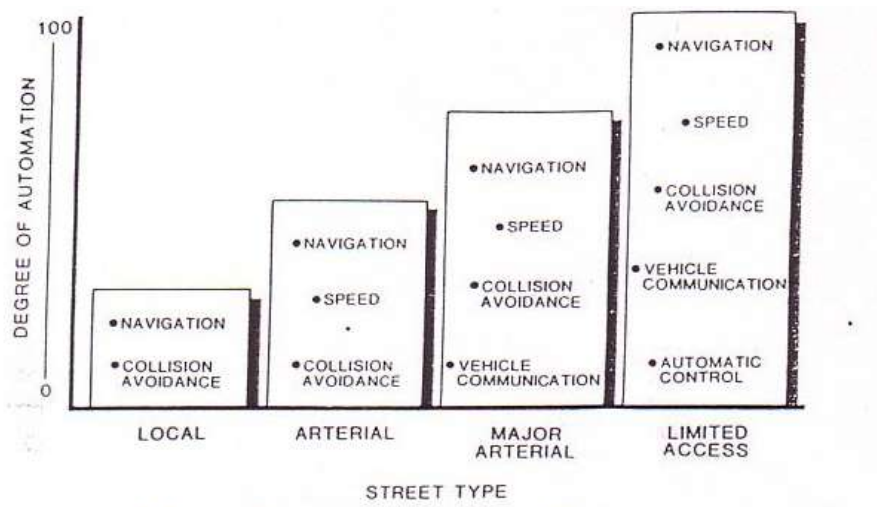


Fig. 1. Control Level v/s Street Type

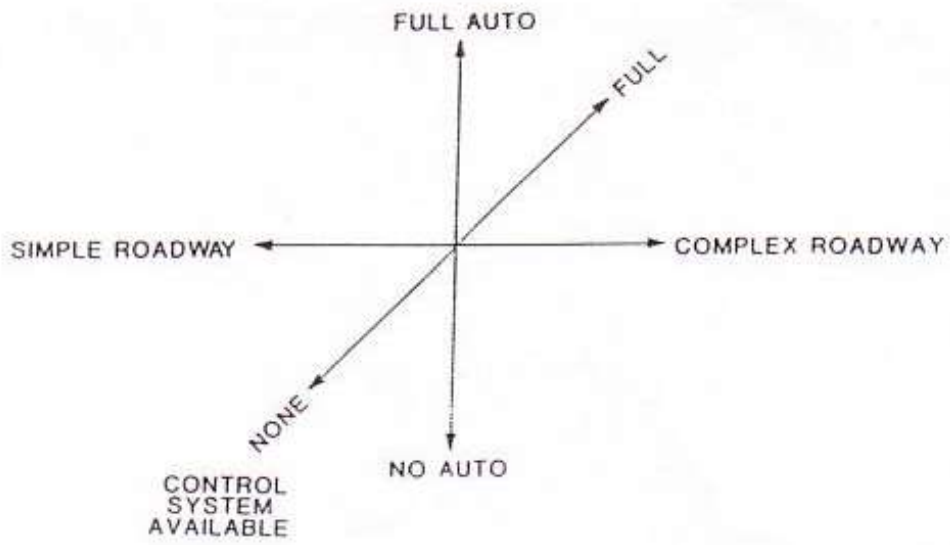


Fig. 2. Driver Desires

Upon starting the car, the driver inputs destination information into the navigation system. After the system completes automated start-up procedures and necessary safety checks (e.g., oil pressure, water temperature, fuel level, and seat belt), the driver proceeds to enter the local road system. The first transponder encountered on the roadway initializes the navigation computer, which then determines the shortest path to the desired destination. At pre-selected major intersections or as requested, the computer prompts the driver to make required route changes and turning movements. Along the way, the computer interacts with road side detector devices. These readers interrogate the vehicle's computer for origin/ destination and routing information, then provide the driver with up-to-date traffic information and estimated arrival times.

When the vehicle enters a major arterial, speed, control and auto stop proximity devices are activated. These devices compromise an automatic backup system to warm and protect driver from the careless actions of other drivers. The system also issues a warning in the event the driver is inattentive to driving details. The speed controller provides relief for the driver and allows the auto to operate at a smooth and uniform rate of speed, thus maximizing throughput on the Arterial system in both platoon and string traffic condition.

When the vehicle enters a limited access route, the highest level of command available may be actuated i.e. fully automatic control. The control system is engaged at the on ramp. This begins a series of complete system checkouts, which are scheduled to occur every 15 second while the vehicle remains in the full control mode. An indicator light in conjunction with an audible signal informs the driver that fully automatic control has been activated and that all systems are operating properly. Merging is accomplished smoothly, without the braking or rapid acceleration characteristic of a manual merge.

Vehicles on length trips are merged into the high speed premium services lane, where speeds average in excess of 160 km/hour. Automated vehicles are automatically merged into the high speed lane simply and efficiently.

The command and control system (CCS) is equipped with a cellular radio that provides the driver with updates on current driving conditions, at the same time informing the navigation system of the precise location of other vehicles in proximity. The on-board navigation vehicle management systems then calculates the next passing or merge point and initiates vehicle dynamics to accomplish the merge prior to the actual merge, the CCS transmits the intended action to other vehicles in the areas.

In the event the system experiences a failure while under automatic control (e.g., the electrical system is damaged when the vehicle runs over a large piece of metal in the roadway), the failure is immediately detected. Activating backup battery power, the system notifies the driver, restores the vehicle to manual control, and relays pertinent information to proximal vehicles by cellular radio. The system design accommodates failure to any major element of the control system.

COMPONENTS OF AVCCS

Measured Wheel

The measured wheel is the keystone of the vehicle's distance measurement equipment. The system comprises a magnetic sensor with a permanent magnet mounted on the inside of the wheel (Fig. 3). A magnetic impulse registers the number of times the wheel rotates. As the automatic vehicle – location sensor system receives information from roadway readers regarding the precise location of the vehicle, the magnetic sensor counts the number of revolutions the wheel makes to the next automatic vehicle location point and records the precise distance.

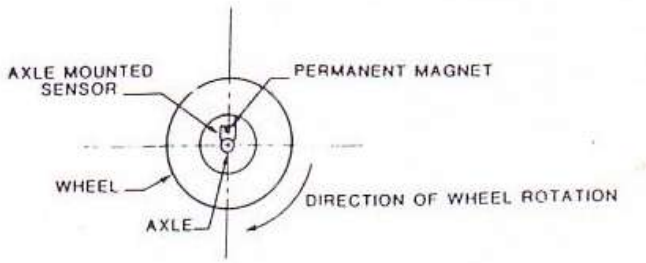


Fig. 3. Measured Wheel

$$\text{Precise Distance Factor} = \frac{d1 - d2}{\text{Number of Wheel Revolutions}}$$

Where d1 = first location marker

and d2 = second location marker

A correction factor is entered into the measured wheel algorithm, and between automatic vehicle location points embedded in the roadway, the measured wheel becomes the distance predictor.

Estimated $d\Delta$=(number of wheel revoltions) X (precise distance factor)

The measured wheel predicts the distance to the next automatic vehicle location point (French 1986a, 1986b).

FLUX – GATE COMPASS

To provide directional information to the vehicle, a direction – sensing instrument is required. The flux-gate compass not only provides the vehicle's basic direction of travel, but also provides the basis for internal system navigation and map matching. The flux – gate compass system assumes the configuration presented in Fig. 4.

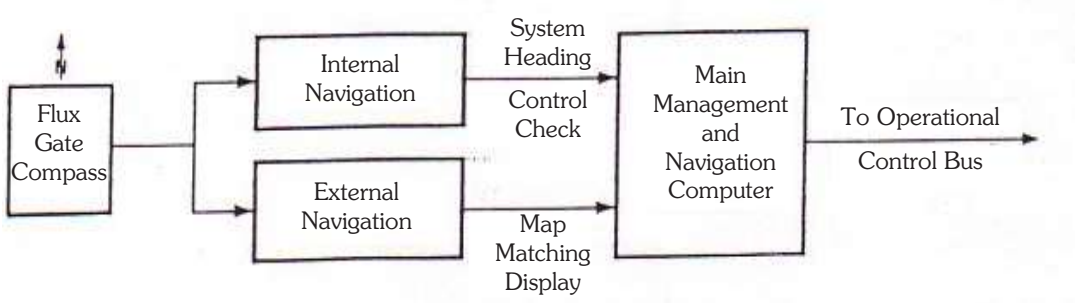


Fig. 4. Flux Gate Compass Navigation Interface

After the flux – gate compass provides the necessary heading information, both the internal and external navigation systems respond to changes in vehicle direction. The internal component of the system checks absolute vehicle heading and direction. If a sudden or unexpected heading change were to occur, the system would swiftly descend the vehicle to manual mode. The external component of the system provides visual location and travel planning information to the driver in real-time format. The main management and navigation computer reviews the information processed by the internal and external navigation systems.

AUTOMATIC VEHICLE LOCATION SENSOR SYSTEM

The heart of the AVCCS is the pavement–embedded passive transponder system (Fig. 5) and vehicle – mounted transponder reader. The embedded pavement transponder provides the vehicle with its precise location, heading and distance to the next pavement transponders will be embedded approximately every 30 metre. Where Arterial geometry changes are prominent (e.g., sharp horizontal curves or rapidly rising vertical curves), the distance between location transponders will be reduced.

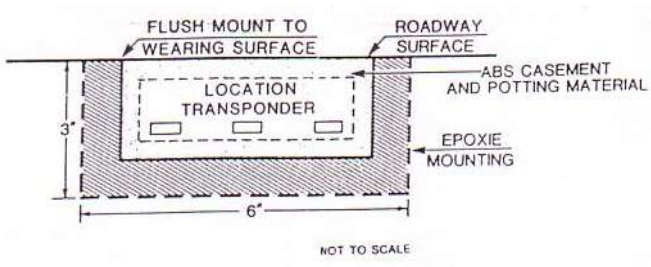


Fig. 5. Passive Transponder

The location devices will be placed in the pavement by a truck mounted core drill that will drill holes in the pavement approximately 15 cm in diameter by 7.5 cm deep. The location transponders will then be placed in a bed of quick setting epoxy, allowing the transponders to become permanently attached to the pavement surface; their precise location will be internally programmed.

The in-pavement location transponder can be simply and robustly designed using elements of known technology. Because of the need for continuous system performance and the probability of high density traffic through the system, the application of battery power does not appear viable. A more feasible design choice is a passive location transponder that is described as power – up upon the application of 15-20 W of radio frequency power transmitted from the vehicle reader. In power – up mode, the in-pavement transponder will transmit the 15 digit code that appears in Fig. 6.

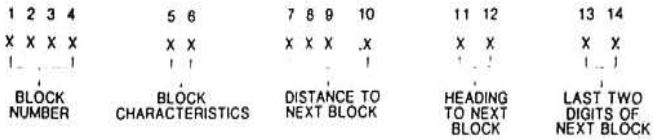
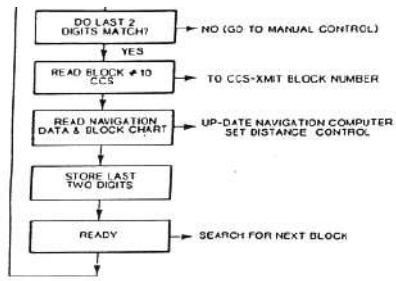


Fig. 6. In-Pavement Transponder Code Layout

The block number is a four – digit alphanumeric code that describes the location block in terms of block placement within the route segment and lane number. The next two digits in the code describe the block characteristics. Among the characteristics that may be described are direction of travel, maximum vehicle speed, minimum headway, and any other special information the on-board computer might require, such as the number of metre to an off ramp or merge point. Distance in metre to the next block is transmitted in digits 7-10. In the next three digits of the code, the heading to the next block is transmitted in degrees. Finally, the in-pavement transponder block transmits the last two digits in the code of the next block. The operational and computational sequences for reading a block code are presented in Fig. 7.



The vehicle mounted location transponder reader is a critical element of the system. The reader is a transponder that is capable of sensing the presence of a pavement location transponder,

powering it fully, and reading the pavement location transponder code with a high degree of accuracy. Figure 8 presents the operational sequence for the vehicle – mounted reader. The automatic vehicle – location sensor system is capable of future expansion to accommodate the transmission of regional information, such as roadway and weather conditions and emergency messages from roadside computers.

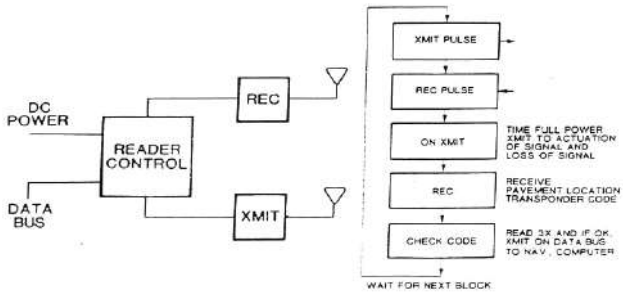


Fig. 8. Vehicle-Mounted Reader Operational Sequence

RADAR PROXIMITY DETECTION SYSTEM

The radar proximity detection system is a low power system with an out power level of 2-3 W and a range of power of approximately 300- 450 m (Fig. 9). The proximity detectors cover all four sides of the vehicle. The detector on the front of the vehicle is a steerable antenna that tracks the rotation of the steering wheel.

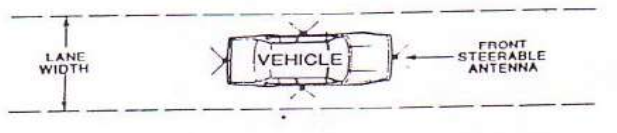


Fig. 9. Radar Proximity Detection System

The wide-angle lateral sensors on the sides of the vehicle define distances with a high degree of precision. The information is then processed and relative speeds and distances of other vehicles are computed by the navigation and operations computer. The longitudinal sensor system provides front and rear protection; the beams of these sensor are narrower than the lateral sensor beams. Information from lateral and longitudinal sensors is directed to the navigation computer's logic bit map. (Grimes and Jones 1974; Johnson 1979).

LOGIC BIT MAP

The logic bit map is a two – dimensional model of the vehicle's actual physical surroundings. The model is dynamic; it projects vehicle trajectories and anticipates possible conflicts. A pictorial representation of the bit map is presented in Fig. 10. In Fig. 10, Car A is about to overtake Car B, both of which are on an eastbound trajectory in lane 2. Changes in velocity are calculated, and the best alternative is logically determined from a list of pre-selected decision criteria. On this basis, the vehicle is directed either to pass to the right or left or to decelerate.

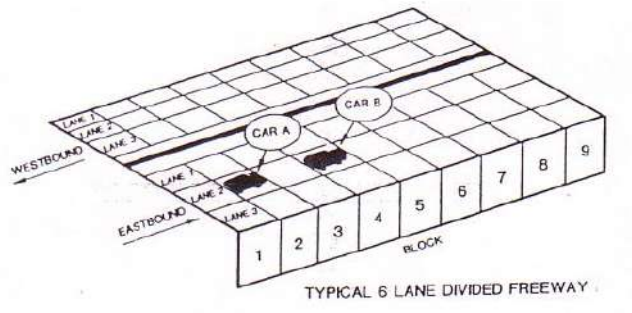


Fig.10. Logic Bit Map-Typical Six-Lane Divided Freeway

COMMAND AND CONTROL COMMUNICATIONS SYSTEM

The command and control communications system (CCS) serves to integrate all of the AVCCS subsystems. The navigation computer's logic bit map is limited in size by the range of CCS cellular communications (Fig. 11). Because of the ability to link cells together, however, the presence of several vehicles under automatic control limitlessly expands the system range (Fig. 12). The queue formed by striving together vehicles under fully automatic control can thus extend indefinitely. Automated vehicles moving in other directions and in other lanes in the same direction are also mapped. As with an ordinary telephone, the communications system is duplex. It transmits and receives at the same time.

The transmitter operates on two separate frequencies with imperceptible delay. Information includes the vehicle's current velocity and direction, the last location block passed, and the current status of the vehicle's control system (auto on/off or emergency). The receiver also operates on multiple frequencies and scans for information transmitted by other cars in the traffic stream. The frequency for both the receiver and the transmitter is set by the block that the vehicle last encountered.

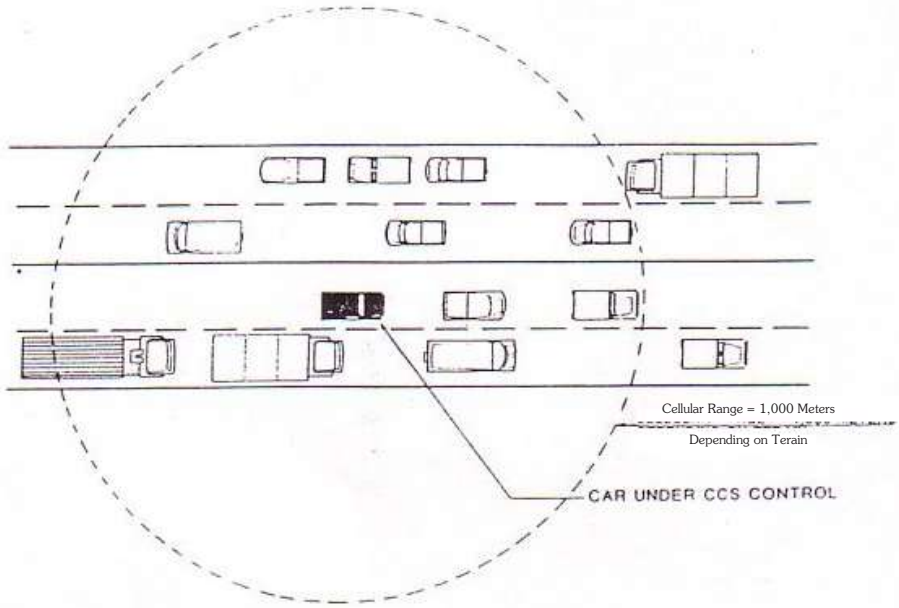


Fig.11. Command and Control Communications System

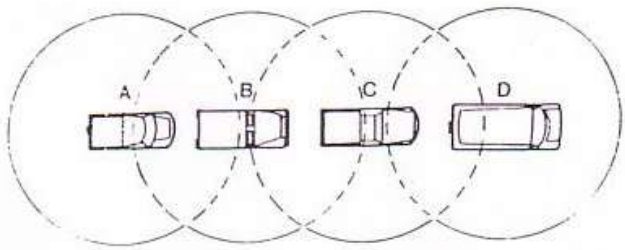


Fig.12. Cellular Communications System

The CCS communication system ties the cells together to form traffic strings. These strings of cells operate as a single unit both in automated and mixed mode environments. Other uses of the CCS include the handling of the following vehicle communication tasks (Ott 1977):

- Public telephone access.
- Uploading navigation information into the management computer.
- Uploading road – hazard warnings, such as construction ahead or accident ahead.
- Downloading the following information.
- Driver's license and vehicle registration.
- Intended destination.
- Vehicle operating parameters.
- Vehicle priority (e.g., emergency vehicles – police or fire)

CONCLUSION

Although the detailed operation of these systems, the integration of automated and non – automated vehicles in traffic, and potential systems applications have yet to be fully explored, the advance vehicle command and control system (AVCCS) has enormous potential for changing transportation system operations and solving the ever – increasing problem of urban congestion.

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MOBILITY MANAGEMENT FOR SMART CITY: JAPAN EXPERIENCE

Dr. Pawan Kumar*

Abstract

Mobility management is not only improvement in vehicle movements but overall augmentation in lower emission, control of vehicle demand, ecological and economical uses of vehicles, etc. through public participation. In fact, conversion of brownfield city to smart city needs proper encouragement of modal shift from personalized vehicles to sustainable public transport.

The paper describes a case study based on 'Demand Control for Vehicle Transportation in Japan' related to various issues of mobility management. The various measures such as revitalization of public transport (LRT), K. Park (Kanazawa City) System, environmental road pricing, eco-drive, road-to-vehicle communication, etc. are useful in urban India. Further, car sharing is a cheaper alternative to owning a car in Japan highlights social and ecological concerns of the smart city. Therefore, mobility management strategies should respect environmental laws, vehicle laws, environment and people friendly infrastructure provisions, safety standards for automobiles, etc. for smart and efficient mobility of vehicles and city residents.

INTRODUCTION

Smart city is a sustainable city and therefore environmentally sustainable transport is very crucial for smart and efficient mobility. For making brownfield city as smart city, mobility management is an approach which integrates the various aspects of demand reduction of vehicular transport by adopting various long and short term measures through public participation. The strategy of the same is also to reduce number of trips generated and promotion of public transport for sustainable development and effective movement of both passengers and goods. In fact, conversion of brownfield city to smart city needs proper encouragement of modal shift from personalized vehicles to public mode of transport. Further, mobility management has significant role in reduction of vehicular emission and level of pollution, improvement in quality of life of the city residents and moreover to make a city more healthy and walkable.

MOBILITY MANAGEMENT AS INNOVATIVE CONCEPT

Mobility management is also known as "Active Travel Management" where it adopts various measures for daily travel options (as per demand and supply) along with operation of transport services and optimal usages of existing infrastructure. The measures include two important components:

- Physical and digital infrastructure for maintaining smooth and efficient mobility and
- Integrated policy formulation with other sectors and effective implementation for sustainable travel options.

However, mobility management is the function of land use, economic base of the city, development of road network, existing environmental and transport policy, governance factor, etc. It needs proper and scientific studies and assessment of impacts of various measures before finalizing the management strategies for efficient and seamless mobility. In fact, it is an innovative concept based on scientific studies to improve mobility in town and city for providing smart mobility.

According to the Ministry of Environment, Govt. of Japan, mobility management is a

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communication-oriented transport policy to create a favorable transport environment for both society and individuals by promoting voluntary shift in mobility (attitude and behavior) such as facilitating the proper use of public transport and bicycles in order to avoid excessive use of vehicles. Eco-commuting is an integral part of mobility management and an effort to promote shift in the means of transportation from private vehicles to public transport and bicycles. It is imperative by appointing a person in each company to be in- charge of considering the ideal means of transportation to commute, providing timetables and route maps for busses and trains, and reviewing commuting allowances, etc. According to the Ministry of Land, Infrastructure, Transport and Tourism, Govt. of Japan, 840 corporations nationwide implemented Eco-Commuting projects. As a result, carbon dioxide emission was reduced by 11%. (Fig.1)

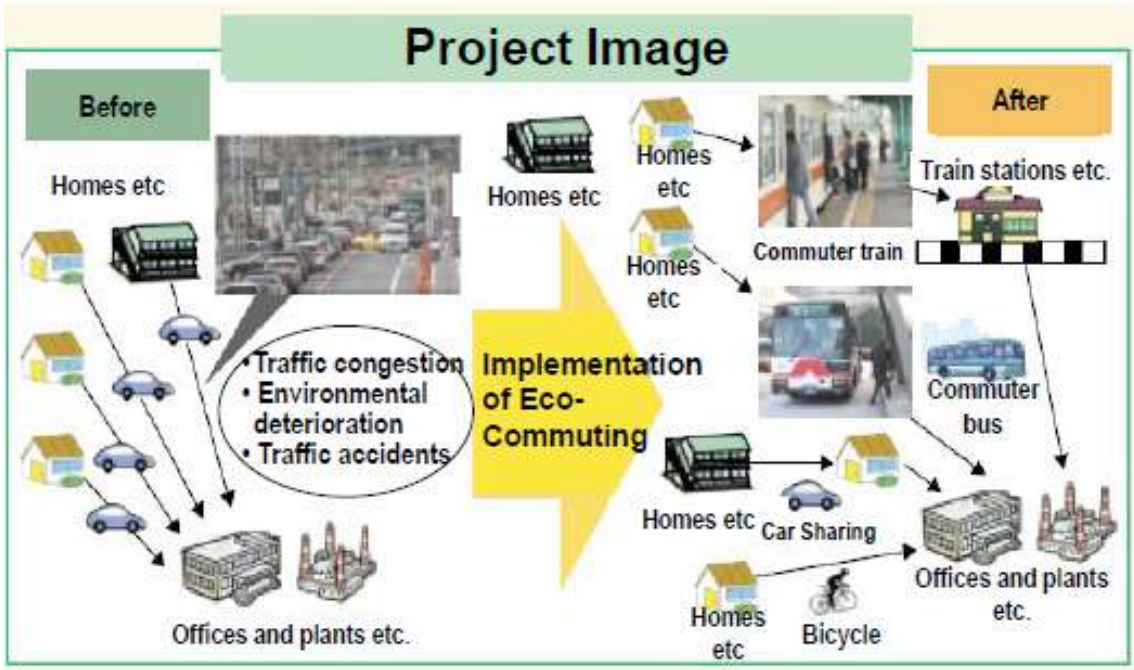

Fig. 1. Eco-Commuting: A Form of Mobility Management

(Source: System Project, Environmental Policy Division, Toyama City, Ministry of Land, Infrastructure, Transport and Tourism,Govt. of Japan, March 2010).

In broader perspective, mobility management also includes augmentation of existing supply, identification of alternatives, demand reduction of motorized vehicles, incentive for green travel habits, cost pricing on use of motorized vehicles, etc. However, implementations of such provisions vary from cities to cities on priority basis but certainly these can improve mobility more effectively towards smart city.

JAPAN EXPERIENCE

A case study based on "Demand Control for Vehicle Transportation" in Japan has been discussed to highlight various issues of mobility management. Further, promotion of low emission vehicles, encouragement to use public transport, ecological use of vehicles, etc. are some of the measures of mobility management which can not only manage the mobility smoothly and effectively but maintain reduction in emission, decrease in traffic density, improvement of travelling speed, etc. which can provide an image of the existing city as walkable city, vehicle-efficient city, healthy city, etc. and moreover a smart city.

The demand reduction of motorized vehicles is one of the strategies of mobility management. Japan uses the "control of demand for vehicle transport" for the same as well as one of the measures for environmentally sustainable transport. The various measures taken by Japan under control of demand

for vehicle transport for mobility management are discussed as follows:

- **Revitalize Public Transport**

The Govt. of Japan took initiative to improve un-used tram tracks and promote tram as efficient and environmentally friendly electric transit system. The one of the main initiatives to revitalize the public transport is to create light rail transit (LRT) network in Toyama city (Fig.2). The Govt. constructs the tracks but the private sector runs the business. The station is unified design for super low floor coaches with barrier free environment. The connection between LRT and buses is facilitated to improve overall convenience of public transport to reduce personal vehicular transport. At present, Toyama LRT system is well blended with the road based transport and cityscape and providing an amalgamation form of urban identity and urban mobility (Fig. 3).

Fig. 2. LRT in Cityscape, Toyama, Japan

Fig. 3 LRT as a Part of Roadscape and Interior View

- **K. Park (Kanazawa City) as Park and Ride**

The Park and Ride facility is one of the measures to reduce personalized vehicles to move on the road. In Kanazawa city, a Park and Ride system known as "K.Park" is implemented in which commuters drop off from private cars in parking lot of sub-urban commercial facilities etc. and switch over to buses to commute city centre. During holidays, temporary parking lots are provided near interchanges of highways and shuttle buses are provided in order to alleviate traffic jams. Fig. 4 illustrates various steps involved in K. Park system and emphasize economic advantages (saving= 15,000 Yen- 11,600 Yen= 3,400Yen plus Gift Coupon of 5,000 Yen) for commuting by K.Park with compare to private car.

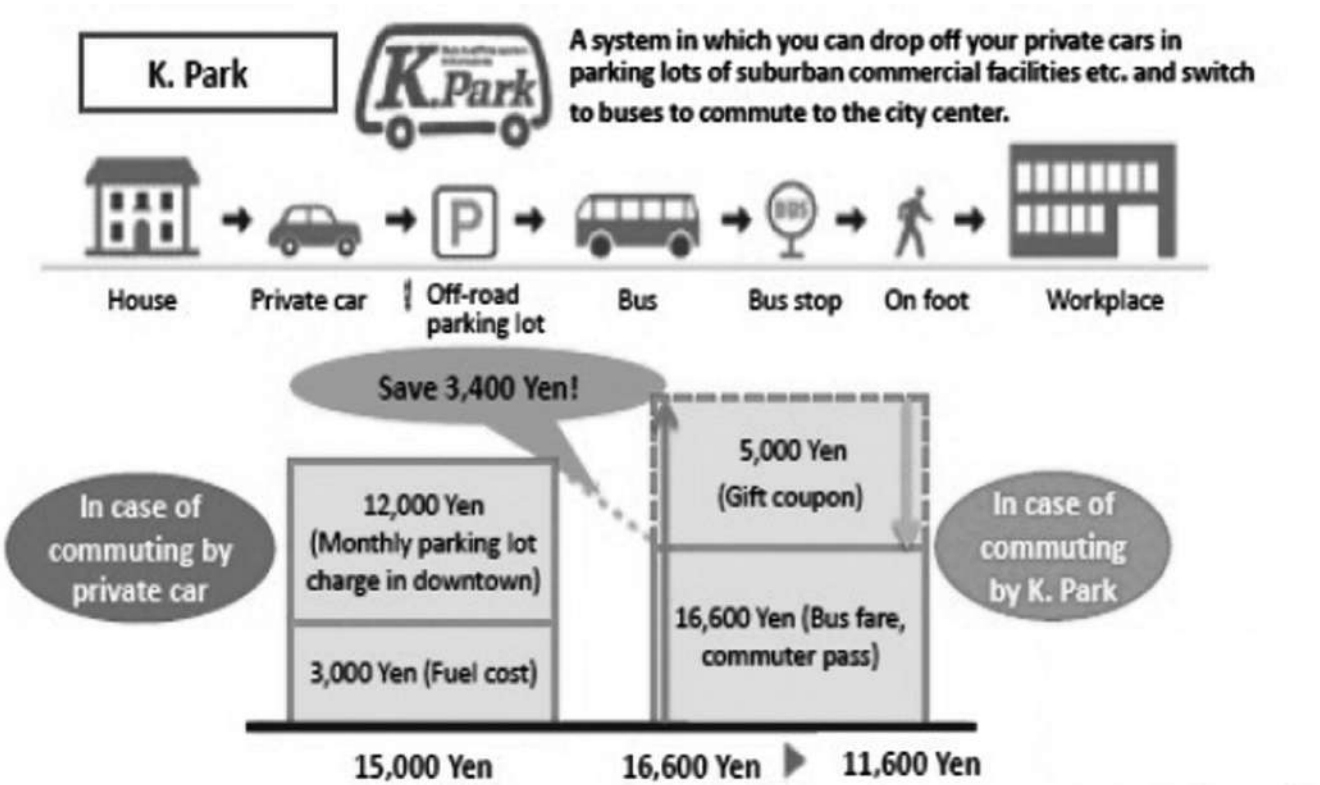

Fig.4. Movement Steps and Economical Advantages of K. Park System, Kanazawa, Japan

Reference: Web site of Ministry of Land, Infrastructure, Transport and Tourism

- **Ecological Uses of Vehicles**

The car sharing is a cheaper alternative to owning a car in Japan due to multiple taxes and cost of renting parking space. The car sharing is growing in busy and densely populated cities that have convenient public transport system. It is estimated that each household drove average 4,048km annually but only 2,563km after turning to car sharing (Source: The Japan Times dated Oct 6, 2014).According to Foundation for Promoting Personal Mobility and Ecological Transportation (popularly known as Eco-Mo Foundation; Tokyo based group promoting car sharing), 40.6% households own at least one car but the ratio fell from 13.2% after they started using car sharing. As a result, average carbon dioxide emissions per household decreased from 0.76 ton to 0.43 tons annually. Thus, car sharing is an environmentally feasible measure. However, there is a need for great collaboration between car sharing providers and railway companies.

- **Economical Use of Vehicles**

The Eco-friendly driving (Eco-Drive) is promoted with the collaboration of various ministries. They have formulated "Ten Eco-Driving Tips". The month of November is designated as "Eco-Drive Promotion Month". Fig. 5 illustrates 10 tips, reduction in accidents and saving of fuel due to eco-driving.

- **Corridor Space**

The corridor management is an integral part of mobility management which advocates allocating space for both motorized and non-motorized transport (NMT). In Japan, space for NMT particularly for pedestrians and bicyclists is respected and provided in all areas. This civic sense makes road space more vital and humane. The bike sharing and its location on main road encourages young people to use the same for short trips (Fig.6).

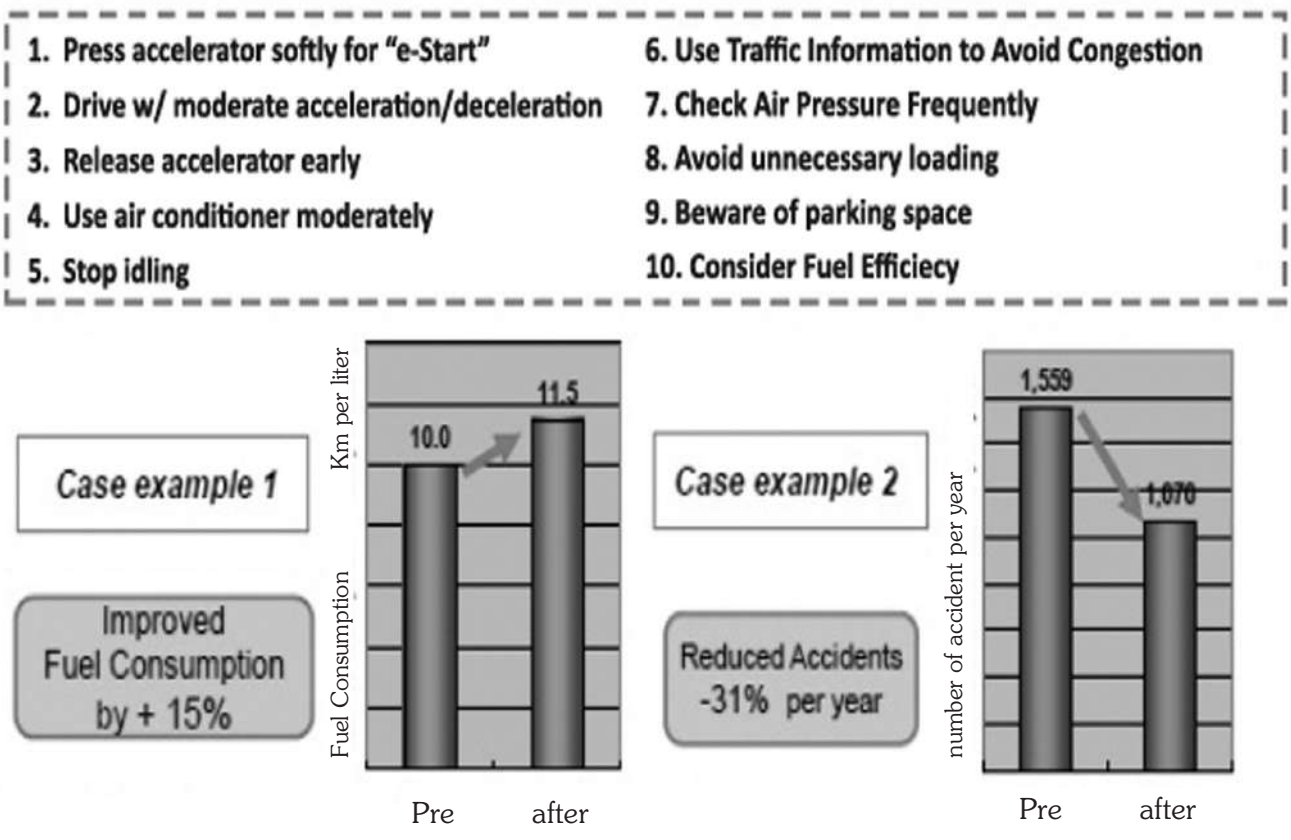

Fig.5. Tips and Advantages of Eco-Drive in Japan

Source: Eco-Driving Contest Japan

Fig.6. Location of Bike Sharing on the Main Road, Toyama, Japan

- **Environmental Road Pricing**

Japan's Environmental Road Pricing (JERP) is totally different from Singapore's Electronic Road Pricing (SERP). Environmental Road Pricing is a measure to abate air pollution in residential areas and therefore by inducing targeted vehicles (i.e. regular cargos, buses, trailer vehicles and microbuses) with 30% reduced fare to coastal areas which are less susceptible to environmental impacts (Honda, T. 2014). JERP on Hanshin expressway is effective on route no 5 (Bayshore Line) with discounted toll, in order to improve air quality along route no.3(Kobe line)viaduct above the national route 43 (Source: Hanshin Expressway Company Ltd.)

- **Road-to-Vehicle Communication**

The car navigation systems, voice and image communication system (VICS), electronic toll collection (ETC), etc. are two way communication system used in Japan. It helps in dynamic route search, traffic information, safe driving support information, etc on both on-demand and cashless payment.

DISCUSSION

- Revitalization of public transport in existing city is an innovative idea. Such initiative is low cost, economical and more effective than imposing a new and capital intensive system. The selection of mass transit which includes services of shared vehicles to provide mobility to the mass depends on economic and environmental health of the city. The conventional buses, BRT, tram, LRT, etc. are economical as compared to MRT. The adaptation of electric transit system also protect environment and promote mobility. Such concept is good for smart mobility in a city having primarily road based transport system.
- The "K.Park System" in Kanazawa city is an interesting idea to encourage people to shift from private car to bus through rewarding /gift. Such initiative holds good to create awareness and modal shift to public transport. The reduction of personalized vehicles on roads always improves the efficacy of public transport system for safe and secure mobility.

- Promotion of car sharing as economic and ecological use of vehicles, is also one of the strategies of mobility management. Further, it is an integral component of environmental sustainable transport. Therefore, it important to develop this system at city level through public private partnership and recognize the same as one of the strategies to reduce personalized vehicle on the roads for better and efficient mobility.
- The eco-friendly driving (Eco-Drive) is collective efforts for saving fuel, increase engine efficiency, reduce emissions, prevent accidents, etc. In fact, it is both practice and process to save environment and society by optimal and efficient use of vehicles. Such awareness fulfils the social responsibility of the transport sector for making city more secure and smart.
- Space allocation for NMT shows high civic sense of the society. Further, use of environmental pricing such as green tax, environmental tax, etc. holds double benefits: firstly, understand importance of environment and pay for the same if damage; secondly, individual concern and contribution in environment protection. Such initiative makes city more green, healthy and livable.

CONCLUSION

Smart mobility is one of the components of the smart city and therefore transport services should be provided in smart ways. Mobility management along the transit corridor is not only improvement in vehicle movements but overall augmentation in lower emission, control of vehicle demand, ecological and economical uses of vehicle, etc. The choice between public and private transport is an individual decision but there are many factors which encourage greater use of public transport such as: frequent services, comparatively lower fares, improved reliability, cleaner vehicles, better facilities at stops and stations, seamless transfer at interchanges, etc. Such initiatives are very effective to provide smart mobility in brownfield smart city. The smart movements of vulnerable road users such as pedestrians, bicyclists, cycle rickshaws, e-rickshaws, etc. need special attentions in both operation and management. Therefore, mobility management strategies should respect environmental laws, vehicle laws, environment and people friendly infrastructure provisions, safety standards for automobiles, etc. for smart and efficient mobility of vehicles and city residents.

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INNOVATIVE IDEAS FOR SMART CITIES

K P Singh*, Sandeep Kumar Sharma** and Manoj Gupta***

Abstract

There is no template for a smart city. A smart city is one that is more livable for its citizens. It has to be tailor-made for very city as each city has its unique problems and challenges. Each city has to have its own vision of what it wants to be for its people. India has shown that it has the required political vision but it must now begin listing its problems and priorities.

Delhi being country's capital, an important centre of economic activity has a large diversity in the typology in residential areas. It is very important to develop Delhi to be a smart city. Though, the Delhi Development Authority has undertaken the planned development in Delhi and developed authorized residential areas, yet there are resettlement colonies, regularized-unauthorized colonies, unauthorized colonies as well as slums and jhuggi jhompri clusters in various parts of Delhi. Moreover, the extent of non-residential activity seen as being necessary or desirable by the residents themselves varies from area to area based on the socio-economic status of residents as well as past pattern of development in that area. In the earlier planning by DDA, the supply of residential units vis-à-vis non-residential/commercial establishments was not balanced as per requirements of the residents which led to the mix use of residential areas.

The city of Delhi has two severe problems. The first one is parking problem for vehicles and the second one is solid Waste Problem. This paper attempts to give some innovative solutions of same.

INTRODUCTION

Prime Minister Narendra Modi's promise to build smart cities in India has attracted wide attention of experts. The vast potential and unique challenges posed by the Indian dream of creating 100 smart cities, has excited not only experts here but also small and large agencies that offer various technology to build them. The all-round consensus amongst them however is that India has a lot of work to get done before it can actually embark on its ambitious project. There is no template for a smart city. A smart city is one that is more livable for its citizens. It has to be tailor-made for every city as each city has its unique problems and challenges. Each city has to have its own vision of what it wants to be for its people. India has shown that it has the required political vision but it must now begin listing its problems and priorities.

The broad concept of a smart city, besides being more livable, is that it should be sustainable and efficient at all levels like energy use, public transport especially parking, communication and health and education facilities. Procuring technology to build a smart city is not an end in itself. It is only a means to achieve the goals a city has set for itself. It is therefore essential for a city to have its own vision and then look for technology companies that will adapt to its needs. Another essential for India before it embarks on smart city projects is to educate its people about the very concept and culture of smart cities and their required participation.

PARKING PROBLEM AND ITS REDRESSAL

The Economic Survey of Delhi 2012-13 depicts that the number of vehicles in Delhi is increasing at a high rate. The number of total vehicles increased from 31.64 lakh in 1999-2000 to 74.53 lakh in 2011-12 i.e. an increase of 135.59% within a span of two years. Moreover, total number of cars during

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the same period increased from 8.73 lakh to 23.47 lakh with an increase of 168.74%. Presently, the average annual rate of growth of cars is 7.90%. The increasing number of personalized vehicles together with unorganized road side parking has led to a peculiar situation in Delhi which in turn has become a major contributing factor to environment hazard. The vehicular pollutants have damaging effects on both human health and ecology.

PARKING DEMAND IN DELHI

Owing to the lack of integration among various modes of transport together with demographic profile of Delhi, large numbers of people prefer to use personalized vehicles such as cars, scooters, motorcycles and SUVs for their daily commuting to work places. Moreover, the mix use of residential areas has been a major contributing factor for enhanced parking demand in these areas. In the earlier planning of Delhi, the growth of motorized vehicles could not be foreseen and thus lacked proper planning of parking supply.

The section 12.13.2 of MPD – 2021 stipulates, "All existing areas of concentration of business / commercial activity, where absence of adequate parking and congestion is visible, should be identified and listed, and based on studies of vehicle volumes specific projects for multi level parking, using the latest available technologies should be formulated and implemented in a time bound manner". Further, the section 12.13.4 of MPD – 2021 stipulates that "Based on the site feasibility, parking facilities can be created under the open spaces without disturbing the green areas on the surface and surrounding environment. The approvals from the concerned agencies are mandatory before taking up such works".

With regard to parking in Mix Land Use Roads, the MPD 2021 stipulates as under:

- Parking @ 2.0 ECS per 100 sqm built up area shall be provided within the premises. Where this is not available, cost of development of parking, shall be payable by the plot allottee/ owner to the local body concerned. This condition shall apply even if residential premises are used only for professional activity.
- Common parking areas would be earmarked on notified on mixed use streets taking into account the additional load on traffic and parking consequent upon notification of the street under Mixed Use Policy. If no parking space is available, land/ plot on the said street may be made available by Traders association, wherever possible, or acquired for construction of parking facilities, preferably, multi level parking. Development of such parking facilities shall be done by either the traders Association or by local bodies and may include public-private partnership as model for implementation.

Accordingly, the erstwhile Municipal Corporation of Delhi identified the parking demand on 'Mix Land Use Roads' and 'Commercial Roads' in accordance with the provisions of MPD 2021 spread over all zones of MCD.

ENVIRONMENTAL CONCERNS

Vehicular pollution is considered to be a major source of air pollution in Delhi. The human health effects of air pollution vary in the degree of severity, covering a range of minor effects to serious illness, as well as premature death in certain cases. These pollutants are believed to directly affect the respiratory and cardiovascular systems. In particular, high levels of Sulphur doixide and Suspended Particulate Matter are associated with increased mortality, morbidity and impaired pulmonary function. Scarcity of parking spaces on many MLU and Commercial roads and other areas lead to traffic congestion on roads and this in turn is responsible for deteriorating air quality.

The following are the constraints in development of parking projects

- Non- Availability of Land
- Financial Constraint
- Resistance by Local RWA/Traders Association

AUTOMATED MULTILEVEL PARKING PROJECT AT KAMLA NAGAR - A CASE STUDY

Due to paucity of funds, the automated multilevel parking project at Kamla Nagar was taken up on 'Public Private Partnership' mode in accordance with clause 12.13.7 of MPD 2021 (Fig.1). Being the first project of Municipal Corporation, this was taken as pilot project. The brief of the project is described below:

Fig. 1. Schematic View

The Project was taken up by erstwhile MCD with M/s SMS infrastructure Ltd. – Proviron Technologies (Switzerland) consortium on Public Private Partnership basis. All the approvals from the concerned department were to be obtained by the developer of the project and in this respect following approvals/clearances were obtained by the concessionaire:

- Approval of DDA Technical Committee
- Approval from Fire Department
- NOC from Traffic Department
- Environment Clearance from DPCC
- Shifting of services by NDPL and Delhi Jal Board

Salient Features of the Project

- Area of Plot : 3195 sqm
- Built up Area : 25561.56 sqm
- Dia. of Plot : 64 mt
- Fully Automatic Parking Facility
- Maneuvering Floor- 2 Entry Ramps and 2 Exit Ramps
- Underground 7 floors
- Parking/Retrieval time : 180 sec (Max.)
- No. of ECS provided : 828
- Commercial Complex: Ground plus two floors above the ground

Considering typical shape and location of the given piece of land it was difficult to accommodate 828 car spaces. Many options were tried and discussed for parking scheme, entry and exit locations and retrieval time. M/s Delhi integrated Multi Modal Transit System Ltd. were appointed as consultant to conduct relevant traffic surveys, carryout video surveys, Test proposals of traffic management identify suitable solutions and simulation etc.

Highlights of Parking Complex

- System is designed to life of 50 Years with minor overhauling after every 15 years
- System designed To Operate - 24x7x365 Days
- System is designed with 6 lifts.
- System designed to work in extreme temperature conditions
- Two separate entrances and two exits
- Control center uses 24x7 CCTV and audio link to monitor parking activities.
- Equipped with latest fire safety arrangements with fire detection, alarming and suppression system.
- Provision of automatic smoke extraction, fresh air ventilation

- 100% power back up.
- Mechanical ventilation

Construction Phase (Top to Bottom Construction Technology)

After obtaining various clearances/approvals, the work was commenced at site in March 2010. The duration for completion of the project is 24 months. The work has been taken up at site in full swing right from the beginning. For monitoring purposes, the project was divided into three phases.

- The first phase
  - Construction of 72 no. outer diaphragm wall.
  - Construction of 60 no. inner diaphragm wall.
  - Construction of 173 no. piles.
- The Second Phase
  - Excavation of soil
  - Construction of top slab- entry Level
  - Construction of slabs for parking
  - Construction of bottom raft
  - Construction of commercial complex structure work
- The Third Phase
  - Installation of parking equipments
  - Fire fighting system
  - HVAC system
  - Electrical installation

Owing to peculiar situation of site, being in congested area surrounded by residential and commercial area, following technical challenges were imminent:

- Water table was very high i.e. 6m below ground level.
- Traditional method of down to top / excavate and build was not possible.
- The residential area was hardly 14 m away from our excavation area and there were chances of collapsing.
- No precedence / norms were available for similar project to take the decision.
- No space was available at site for storage, workshop, labors and RMC Plant.
- Being in National capital, heavy vehicles were not allowed during day time.
- Disposal of muck/soil at given municipal landfill site during rainy season was a tough task.
- Keeping residents and shop owners in goodwill during construction period when their business was affecting.
- Keeping traffic circulation throughout the year specially during festival season.

Challenges during Operation:

- People are not habitual of using paid parking in Kamla Nagar area.
- Skeptical to use automated parking.
- Though 'No Parking Zone' declared on surrounding roads yet implementation is a tough task.

Now, the installation of parking system is complete and parking has been made operational w.e.f. May 2014.

SOLID WASTE MANAGEMENT PROBLEM

The unprecedented growth in population, change in life style and consumption pattern have put tremendous pressure on the civic services, including solid waste management i.e. generation of municipal waste in the city. The different settlements in part of the city namely planned colonies, urbanized village, unauthorized- regularized colonies, resettlement colonies, JJ clusters, human settlements industrial estates etc. create the environmental degradation. The average per capita municipal solid waste generation is around 450 gm per day. The North DMC areas of the city generates around 3000-3300 MT of garbage per day. Under the provisions of DMC Act, the house hold is to dispose the municipal solid waste at the receptacles/dustbins/dalaos. The management of solid waste consists of sweeping, collection, storage, transportation and disposal of garbage. In addition to this, Safai Karamchries sweep the road and footpath, collect the waste and deposit the same in municipal receptacles/dalaos/dustbins. The garbage generated

by the colony/neighboring area is transported to the SLF sites by loading it mechanically. Municipal solid waste is transported to two SLF sites namely SLF, Bhalaswa and Engineered SLF, Narela-Bawana in North DMC, where it is compacted/dressed/leveled by bulldozers and converted into Compost and Refuse Derived Fuel (RDF) material. The following works/ projects for MSW are being undertaken.

- Door to Door Collection of MSW in Rohini and Civil Line Zone
- Collection and Transportation of MSW in Karol Bagh, SP and City Zones of North DMC
- Deployment of tippers: In various Zones of NDMC, tippers has been deployed for collection of silt unclaimed garbage etc. for maintaining sanitation in the area.
- Integrated Waste Processing Facilities at Narela-Bawana SLF: M/s Delhi MSW Solutions Ltd. has developed an integrated waste processing facilities at Narela-Bawana SLF for processing about 1700 MT per day waste from Rohini Zone and Civil Line Zone. Facility is spread in an area of 100 acres and consists of following components:
  - Compost plant
  - RDF segregation plant
  - Engineered landfill

  After processing the waste, the rejects must be less than 25% of the total waste.

Action Plan

On account of limited land resources in the NCT of Delhi and tremendous pressure on the existing SLF sites, MCD is having no alternative except to opt for waste technologies instead of cheaper land filling options. In order to minimize the projected quantity of municipal solid waste by 2021, various technological options are to be arrived at.

Sweeping: The sweeping on existing roads and streets are being carried out. The North DMC had planned to provide mechanical sweeping system through mechanical sweepers on the roads having right of way of 60' and above, but it somehow did not work.

Segregation: The most effective and logical point of segregation is at the source. The North DMC has organized awareness campaign among different group of people as part of introduction of segregation at house hold level into bio-degradable and non-biodegradable. This initial segregation will enhance the probability of reduction of waste by biological process and will have positive effect on quality of product i.e. green manure.

Thereafter, before reaching to community bins the recyclables materials like metals, papers, plastic etc. out of the remaining non-biodegradable most of the material is likely to be utilized in waste to energy plants via RDF for otherwise along with dairy waste and thus the process of segregation will be instrumental in reducing the waste quantity going for land filling.

Disposal: The disposal of Municipal Solid Waste is done at two SLF sites, namely SLF site, Bhalswa, Narela-Bawana and Waste to Energy Plant Okhla.

MCD is also eyeing the technologies such as Plasma Gasification, Pyrolysis, incineration etc which can reduce the quantum of residual waste to be land filled as well as promoting local level composting with a purpose to restrict the growth of waste going to land fill sites. On success, the life of land fill sites will be enhanced considerably.

Status Report of the Sanitary Land Fill site, Bhalswa and Integrated Waste processing/ disposal facilities at Narela-Bawana, North DMC.

Sanitary Land Fill site, Bhalswa: It is situated near Mukarba Chowk and has an area of approximately 40 Acres. This site was started during the year 1994 whereas the Municipal Solid Waste (Management and Handling) Rules, 2000 came into force during the year 2000. Basically, the Sanitary Land Fill, Bhalswa is a dumping site and it not a secured Sanitary Land Fill site. At present, about 2000 MT of MSW per day is being received at this site from City. This Sanitary Landfill site through got exhausted long time back and the height of fill at present is about 40 mtr above the general ground level, but due to non availability of any other alternative site, the present site is being continued, by raising the level of filling above the general ground level.

Integrated Waste Processing/Disposal Facilities at Narela-Bawana: Integrated Waste Processing/Disposal Facilities is set up at Narela-Bawana on 100 acres of land by the M/s Delhi Municipal Solid Waste Services Limited during the year 2011 and it is in operation. The capacity of this plant is to handle 2500 MT of fresh waste per day. The plant capacity is being gradually increased according to the waste generation time to time. This waste is being converted into Compost and Refuse Derived Fuel (RDF) material. However, in future it is planned to generate electricity from the RDF so generated from the garbage.

Construction and Demolition (C&D) Waste/ Debris/Malba Plant at Burari: Construction and Demolition (C&D) Waste plant has been installed at Burari on 5 Acres of land near Jahangir Puri by M/s ILFS at their own cost during the year 2009-10. The capacity of this plant is 2000 MT of C&D Waste/ Malba/Debris per day for processing/recycling.

PROPOSED SOLUTIONS:

NDMC proposes to undertake the following projects:

Purchase of Machinery: NDMC is in process of Purchase of two bulldozers, six suction machines and 2 loaders apart from wheel barrow, rickshaws and sanitation store material for day to day use to maintain the sanitation.

New Land for SLF: NDMC has been actively pursuing with DDA for allotment of land at 08 locations for SLF to the Corporation. If the new land for SLF is made available from DDA, C&D waste plant, Plastic waste management plant, waste processing plants and Waste to Energy Plants will be installed, in addition to the waste already going to Waste to Energy Plant Okhla and Narela – Bawana.

At present, the existing dumping site at Bhaslwa has exceeded its capacity. Therefore, a concept was taken into consideration for landfill reclamation and construction of Integrated Municipal Solid Waste processing Complex at Site available for fresh MSW in near future so that a goal near to zero landfill site may be achieved because in a city like Delhi, where land is a scarce and a highly priced commodity, finding a new site for development of another landfill is not an easy task. Moreover, the expenditure required for closure, post closure maintenance of exhausted site and development of a new site would be very high.

It is proposed to carry out exclusive public awareness programmes for segregation of garbage by the public at the door level and further to have provision in the RRTs to carry the organic and in-organic garbage, separately.

MCD is making efforts to find out the adequate land to establish new SLF sites where gas could be collected and utilized for domestic as well as commercial use.

MCD also intends to organize the rag-pickers in shape of formal sector, i.e. from unorganized to organized with the help of the NGOs interested in this matter. This would help the rag-pickers to earn better to live with dignity.

The MCD is making efforts to make mechanical sweeping successful by examining the causes of failure in the past and to remove such hurdles, so that the efficiency of sweeping the roads through Mechanical Sweepers could be improved and better sanitation would be given to the Delhi ties.

These solutions are not the last, but least; and we will always welcome the suggestions from the general public as well as NGOs and expert agencies for better Solid Waste Management in Delhi to make Delhi a Smart City thus creating safe and healthy environment.

MOVING FROM VEHICLE CENTRIC TO PEDESTRIAN CENTRIC APPROACH IN SMART CITIES -A CASE STUDY

DR. UMESH SHARMA* AND AJAIN ANAND**

Abstract

Roads have played a major role in the development of transportation infrastructure. Hassle free movement of motorised traffic has always been preferred. The proportion of non-motorised traffic in fatal road accidents is massive in Indian cities and unfortunately non-motorised traffic in our road designs has always been ignored. To make an Indian city smart due considerations have to be given to all categories of road users.

The prerequisite for the evolution of a smart city is the minimisation of pedestrian accidents. This can be done by streamlining the pedestrian traffic and by predicting the pedestrian behaviour. The idea is to reduce the conflict points between pedestrians and moving vehicle. The concept of pedestrian light activated signals (pelican) serves this purpose while taking care of the parameters like cost, space and ease of use. The concept is best suited to persons with disability who are hesitant to use under and over surface crossings. In this paper evaluation of the pedestrian pelican signal installed in Chandigarh which is internationally acclaimed city has been done and the shortcomings of the installed system has been conceptualised in order to make it applicable in making the cities smart and safe for non-motorised traffic.

INTRODUCTION

With the population explosion in India there has been stress on the resources of our nation. The only solution to reduce this stress is optimum and efficient use of our resources. For a highway engineer to use his resources optimally he has to use his road design efficiently to accommodate ever swelling traffic. But in country like India where the vehicle penetration is increasing day by day, the solution lies in out of the box thinking. Today the Indian cities are over-crowded, not well planned and lack basic safety for its road users. Presently, there is demand to create smart cities because many cities of India are now saturated and does not have enough resources to fulfil the demand of its population. For a highway engineer what makes the city smart? It is the road design which carries the maximum traffic with acceptable level of service and taking care of the future demand along with the safety of all its road users. Level of Service can be maintained by designing the roads according to the present and future traffic predictions. The Indian cities lack in providing basic safety to all the road users inside the city. While designing the roads preference has always been given to the movement of motorised traffic at the cost of non-motorised traffic in Indian cities.[1] The table 1 shows the percentage of deaths of the pedestrians to the total lives lost per year in the road accidents in Chandigarh.

Table 1. Percentage of Pedestrian Deaths in Road Accidents in Chandigarh

Year	Pedestrian Deaths	Total Deaths	Deaths % of Pedestrian Deaths
2009	55	171	32.16
2010	48	138	34.78
2011	47	136	34.56
2012	44	136	32.35
2013	40	117	34.19

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The data in the table 1 gives the information about the deaths but it does not give information about the fatal injuries, injuries and accidents which might be caused due to the vehicle pedestrian conflict. It means the involvement of pedestrians in road accidents would be much more than suggested by table 1. Chandigarh is one of the well planned cities of India and it is also in the list of cities which will be converted into smart city. It might be the first city to be converted into smart cities. This kind of data in city like Chandigarh points us to the serious mistake of ignoring non-motorised traffic in our previous city designs and thus we cannot commit same mistake once again when the Indian cities are being converted to the smart cities.

LITERATURE REVIEW

[2]According to Kumar and Satheesh (2014) pedestrian is the most vulnerable road user among all categories of the road users. Incidentally, he is helpless victim of Road Traffic Accidents. Statistics also reveal that quite often, it is economically deprived, elderly citizens who fall prey to accidents. Infrastructural facilities that patronize the pedestrian, available at important locations along the road environment, would encourage the pedestrian to use the same with confidence, reliability and safety. But, it is equally important that such facilities should promote and encourage the usage by end users. They suggested that some case studies do depict situations which many a times, work against the design safe passage and mobility of pedestrian. Their study aims at mapping the conditions at site and comparing it with standards. Their analysis aids at remedial measures that may ensure safety of the pedestrian. [3]According to Chandra, Rao and Dhamaniya pedestrian crossing a road at mid-block section reduce the traffic stream speed and thus the capacity of the road. These crossings may be designated places where pedestrian markings are made or at the undesignated places where no such markings are present. They suggested a mathematical relation for reduction in road capacity with volume of pedestrian cross-flow. [4]According to Japs B. Pelican, puffin and toucan crossings are three types of autonomous signal-controlled pedestrian crossings, which are used throughout the UK. The City of Edinburgh Council has been proactive in executing an action plan to reduce the vehicle green time at all its independent signal-controlled pedestrian crossings, to ensure a minimal delay to the pedestrians using them. They carried out mathematical analysis to assess the average pedestrian delays and the total delay to pedestrians at specific examples of pedestrian crossings of all three types and signal-controlled junctions. It was found that pelican, puffin, and toucan crossings can be set to reduce pedestrian delays considerably compared with the delays at exclusive signalled junction crossings, during peak periods. [5]Jiangang Shi, YanyanChen, FutianRen and JianRong have reported that in China, many pedestrians lack knowledge of traffic rules and are not fully aware of safety problems. A high-risk area for pedestrians, the unsignalized midblock crosswalk is a conflict zone between pedestrians and through vehicles. They have studied the behaviours and traffic characteristics of pedestrians walking through the unsignalized midblock crosswalk without being disturbed by other pedestrians are analyzed. Pedestrian behaviours are analyzed with the use of comparisons between various categories and through statistics analysis. [6]According to Crabtree pelican crossings are well established in the UK allowing pedestrians to cross roads safely without excessive disruption to traffic. In recent years however, there has been an increasing feeling that Pelicans could be improved. To address this, the puffin crossing has been developed. The author during each of the four one-day surveys has measured and compared the delays to both pedestrians and vehicular traffic along with the study of pedestrian behaviour.

OBJECTIVES OF THE STUDY

The study was carried to understand the pedestrian response to the concept of pelican signal installed at Madhya Marg in Chandigarh. The objectives that were kept in mind for carrying out this study has been as follows:-

- To study the type and number of pedestrian using or not using the facility of pelican signal.
- To analyse the response of pedestrians regarding the concept of pelican signals.
- To suggest the way to improve the efficiency of pelican signals.

STUDY AREA

Pelican signals have been installed in Chandigarh at various locations. The signal chosen

for this study is installed on Madhya Marg i.e. a V2 road of Chandigarh. The road is three-lane two-way divided highway along with service road provided on both sides. The signal has been installed at a section about 160 m from the rotary of sectors 11-10-16-15. The section as shown in fig. 1 where signal is provided is between Government Home Science College Sector 10 and Government Multi Speciality Hospital Sector 16. The area was chosen due to the high percentage of vulnerable users in pedestrian traffic because of the Government Multi Speciality Hospital at one side of the signal.

Fig.1. Location of Pelican Signal and Study Area

COLLECTION OF DATA

The hourly pedestrian volume in the study area is taken for 11 hours between 8 A.M. to 7 P.M. The data is presented in the graphical form in fig.2.

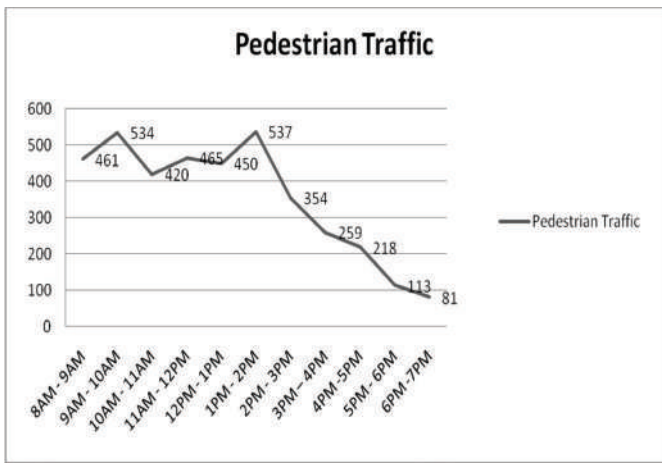

Fig.2. Hourly Pedestrian Volume at Study Area

The study was carried out in such a way that type of pedestrians were divided into two categories i.e. non-vulnerable users and vulnerable users which is further divided into school/small children and persons with disability/old age/ mothers carrying small child in their hands. The composition is shown in the pie chart presented in fig.3

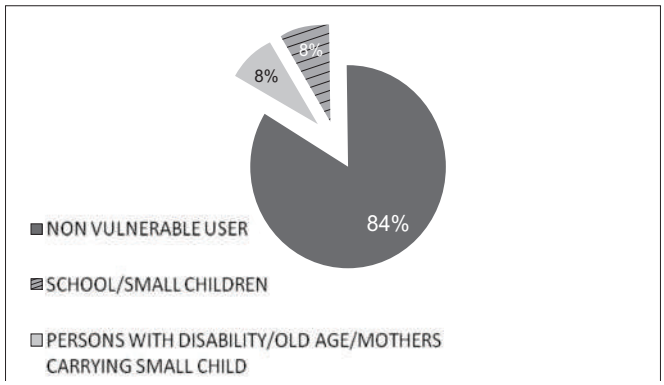

Fig.3. Pie-Chart Showing Composition of Pedestrians

The pedestrian's classification was further divided into two categories for checking the awareness among the people about this concept and how the signal is being used by the people.

ANALYSIS OF DATA

A total of 3,892 pedestrians crossed this stretch of road during these 11 hours of study. The peak of pedestrian traffic is around 1 P.M. -2 P.M. and 9 A.M.-10 A.M. i.e. 537 and 534 pedestrians respectively and the pedestrian traffic decreased towards the evening hours.After analysing the data the results were quite extraordinary as very large percentage of pedestrians is using this concept. The high use of this concept can be attributed to the daily users of this road section who are students of Govt. Home Science College, Sector-10 and employees or staff members of Govt. Multi-Speciality Hospital, Sector-16. This percentage of pedestrian is quite aware of this signal now and the other pedestrians who are not aware of this concept also move during the time allotted to cross the road when the aware people press the button of pelican signal to cross the road. So slowly and steadily the pedestrians using this signal has been increasing. The vehicle users also adhere to the signal timings due to the strict implementation of traffic rules by Chandigarh Traffic Police. Chandigarh administration has also posted

two policemen each having 6 hours shift to guide the people and to use the signal for vulnerable users.The vulnerable users constitute about 16% of pedestrian traffic so this percentage is quite high as it increases the probability of accidents if the section is not provided with pedestrian facility like pelican signal. This does not mean we can ignore the non-vulnerable road users because each and every life is important. The table 2 shows us the pedestrian type using and not-using the signal.

Table 2. Pedestrian Volume Using and Not-using Pelican Signal

TIME	PEDESTRIAN TYPE					
	Non Vulnerable User		Vulnerable User			
			School/Small Children		Persons with Disability/Old Age/Mothers with Small Child	
	USING	NOT-USING	USING	NOT-USING	USING	NOT-USING
8AM -9AM	381	27	17	3	33	0
9AM -10AM	353	88	32	0	54	7
10AM- 11AM	225	114	20	10	30	21
11AM - 12PM	213	168	23	5	39	17
12PM - 1PM	246	93	67	19	23	2
1PM - 2PM	317	123	32	15	40	10
2PM - 3PM	226	64	37	5	22	0
3PM – 4PM	176	59	7	0	17	0
4PM -5PM	157	43	12	0	5	1
5PM - 6PM	83	30	0	0	0	0
6PM -7PM	45	34	2	0	0	0
TOTAL	2377	809	247	57	263	58
%USING	74.61		81.25		81.93	

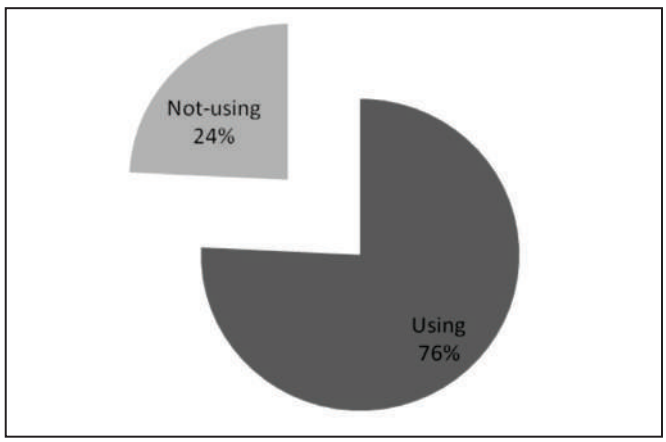

Fig.4. Percentage of People using Pelican Signal

The above table and pie chart in fig. 4 shows that quite large percentage of people are using this concept of pedestrian safety but this high percentage of usage is mainly attributed to strict implementation of traffic rules by Chandigarh administration, daily users like College students and staff of the hospital and most importantly the duties of police officers which is especialy to ensure the applicability of this concept.

IMPROVISATION OF EFFICIENCY OF PELICAN SIGNALS

In order to ensure the maximum use of the pedestrian pelican signal the following efforts are required to be made at the installation site of the pelican signal:-

- **Installation of Railing to Streamline Pedestrian Traffic:** The data presented above is only at the section where pedestrian signal is installed but the pedestrian crossing the road between the study area is quite high so in order to streamline the pedestrian traffic railings has to be installed on both side of the road. Till now the railings are not provided beyond 3.7m on both side of the given button on each side of the road. Fig. 5 is the photo of the railings installed at the study location.

Fig.5. Railing Provided at the Location

- **Non-porous Median of the Road:** The median of the road should be such that it forces people to use the crossing so that there is certainty in the pedestrian behaviour. Due to porous medians the pedestrians tend to cross the road from those points and thus creating the state of unpredictability in the mind of vehicle drivers and thus also defeat the whole purpose of providing these signals. Fig.6 shows how the pedestrians are using porous median to cross the road at study area.

Fig.6. People Crossing the Road from Openings in the Median

- **Location of Other Road Facilities:** The facility like bus-stops, rickshaw stops etc. should be made at appropriate locations. Fig. 7 shows how buses due to the presence of the bus-stop near the signals create difficulty for the pedestrians to cross the road. In the present location of study bus- stop is 15 m away from the pelican signal at the college side and 30 m away at the hospital side and thus when two or buses stop there the timings of the signals are not visible due to obstructions created by the stopped buses and there is also the problem of auto rickshaws which stop in front of the signal to load and unload the passengers. Thus these kinds of facilities must be provided at appropriate distance from the signal.

Fig.7. Buses Obstructing the Visibility of Pedestrians

The serious efforts like making the signals more user friendly, by creating awareness among people and strict implementation of rules can help in increasing the efficiency of this concept.

CONCLUSION

The concept is still relatively new to India as compared to other developed countries. The concepts like these are extremely handy to build our smart cities pedestrian friendly. The idea is still in its conception stage in Indian conditions and its future depends upon its implementation. The concept is quite useful in achieving balanced, sustainable and green development for a smart city. The city cannot be entitled as smart which ignores its basic road users i.e. pedestrians. The strict implementation of traffic rules and compliance by vehicle users in

Chandigarh has shown great signs for the success of this concept in Indian conditions. It is working quite efficiently but can be made more efficient by making minor modifications. The concept goes well in creating a balanced environment for vehicles as well as pedestrians. Presently vehicles have an edge over pedestrians in our road designs.

More studies have to be taken in order to calculate either the overall delays that have been increased to vehicles or to conclude that the delays have actually been minimised by streamlining the pedestrian traffic. But one thing is for sure that these kinds of facilities promote the safe pedestrian movement and ultimately it results in decreasing the congestion on internal roads of the city. The concept motivates the people to walk thus creating a greener and pollution free environment inside the city which are the corner stones of the smart city planning.

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