Analytical Study on Sustainable Infrastructure and Transportation Development in Indian Smart Cities

Dr. Soma Sharma
Asst. Professor
Datta Meghe Institute of Management Studies, Nagpur, Maharashtra

Abstract
A sustainable city, is a city designed with consideration of environmental impact, inhabited by people dedicated to minimization of required inputs of energy, water and food, and waste output of heat, air pollution - CO_2, methane, and water pollution. Richard Register first coined the term "ecocity" in his 1987 book, *Ecocity Berkeley: Building Cities for a Healthy Future*. Other leading figures who envisioned the sustainable city are architect Paul F Downton, who later founded the company Ecopolis Pty Ltd, and authors Timothy Beatley and Steffen Lehmann, who have written extensively on the subject. The field of industrial ecology is sometimes used in planning these cities.

There remains no completely agreed upon definition for what a sustainable city should be or completely agreed upon paradigm for what components should be included. Generally, developmental experts agree that a sustainable city should meet the needs of the present without sacrificing the ability of future generations to meet their own needs. The ambiguity within this idea leads to a great deal of variation in terms of how cities carry out their attempts to become sustainable.

Keywords: Developmental, Indian Cities, Infrastructure, Sustainable, Transportation

Introduction:

Ideally, a sustainable city creates an enduring way of life across the four domains of ecology, economics, politics and culture. However, minimally a sustainable city should firstly be able to feed itself with a sustainable reliance on the surrounding countryside. Secondly, it should be able to power itself with renewable sources of energy. The crux of this is to create the smallest possible ecological footprint, and to produce the lowest quantity of pollution possible, to efficiently use land; compost used materials, recycle it or convert waste-to-energy, and thus the city's overall contribution to climate change will be minimal, if such practices are adhered to.

It is estimated that over 50% of the world's population now lives in cities and urban areas. These large communities provide both challenges and opportunities for environmentally-conscious developers, and there are distinct advantages to further defining and working towards the goals of sustainable cities. Humans are social creatures and thrive in urban spaces that foster social connections. Because of this, a shift to more dense, urban living would provide an outlet for social interaction and conditions under which humans can prosper.

Contrary to common belief, urban systems 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 for transportation and mass transit systems, and resources such as food. Finally, cities benefit the economy by locating human capital in one relatively small geographic area where ideas can be generated.

Architecture

Buildings provide the infrastructure for a functioning city and allow for many opportunities to demonstrate a commitment to sustainability. A commitment to sustainable architecture encompasses all phases of building including the planning, building, and restructuring.

Eco-industrial Park

The purpose of an eco-industrial park is to connect a number of firms and organizations to work together to decrease their environmental impact while simultaneously improving their economic performance. The community of businesses accomplishes this goal through collaboration in managing environmental and resource issues, such as energy, water, and materials. The components for building an eco-industrial park include natural systems, more efficient use of energy, and more efficient material and water flows Industrial parks should be built to fit into their natural settings in order to reduce environmental impacts, which can be accomplished through plant design, landscaping, and choice of materials. For instance, there is an industrial park in Michigan built by Phoenix Designs that is made almost entirely from recycled materials. The landscaping of the building will include native trees, grasses, and flowers, and the landscaping design will also act as climate shelter for the facility. In choosing the materials for building an eco-industrial park, designers must consider the life-cycle analysis of each medium that goes into the building to assess their true impact on the environment and to ensure that they are using it from one plant to another, steam connections from firms to provide heating for homes in the area, and using renewable energy such as wind and solar power. In terms of material flows, the companies in an eco-industrial park may have common waste treatment facilities, a means for transporting by-products from one plant to another, or anchoring the park around resource recovery companies that are recruited to the location or started from scratch. To create more efficient water flows in industrial parks, the processed water from one plant can be reused by another plant and the parks infrastructure can include a way to collect and reuse storm water runoff.

Urban farming

Urban farming is the process of growing and distributing food, as well as raising animals, in and around a city or in urban area. According to the RUAF Foundation, urban farming is different from rural agriculture because "it is integrated into the urban economic and ecological system: urban agriculture is embedded in - and interacting with- the urban ecosystem. Such linkages include the use of urban residents as labourers, use of typical urban resources (like organic waste as compost and urban wastewater for irrigation), direct links with urban consumers, direct impacts on urban ecology (positive and negative), being part of the urban food system, competing for land with other urban functions, being influenced by urban policies and plans, etc." There are many motivations behind urban agriculture, but in the context of creating a sustainable city, this method of food cultivation saves energy in food transportation and saves costs. In order for urban farming to be a successful method of sustainable food growth, cities must allot a common area for community gardens or farms, as well as a common area for a farmers market in which the foodstuffs grown within the city can be sold to the residents of the urban system.

Urban infill

Many cities are currently in a shift from the suburban sprawl model of development to a return to urban dense living. This shift in geographic distribution of population leads to a denser core of city residents. These residents provide a growing demand in many sectors that is reflected in the architectural fabric of the city. This new demand can be supplied by new construction or historic rehabilitation. Sustainable cities will opt for historical rehabilitation wherever possible. Having people live in higher densities not only gives economies of scale but also allows for infrastructure to be more efficient.

Walkable urbanism

Walkable urbanism is a development strategy in opposition to suburban sprawl. It advocates housing for a diverse population, a full mix of uses, walkable streets, positive public space, integrated civic and commercial centers, transit orientation and accessible open space. It also advocates for density and accessibility of commercial and government activity.

New Urbanism

The most clearly defined form of walkable urbanism is known as the Charter of New Urbanism. It is an approach for successfully reducing environmental impacts by altering the built environment to create and preserve smart cities which support sustainable transport. Residents in compact urban neighborhoods drive fewer miles, and have significantly lower environmental impacts across a range of measures, compared with those living in sprawling suburbs. The concept of Circular flow land use management has also been introduced in Europe to promote sustainable land use patterns that strive for compact cities and a reduction of Greenfield land taken by urban sprawl.

In sustainable architecture the recent movement of New Classical Architecture promotes a sustainable approach towards construction, that appreciates and develops smart growth, walk ability, architectural tradition and classical design. This in contrast to modernist and globally uniform architecture, as well as opposing solitary housing estates and suburban sprawl. Both trends started in the 1980s.

Individual buildings (LEED)
Main article: Leadership in Energy and Environmental Design

LEED, or Leadership in Energy and Environmental Design, is an internationally recognized green building certification system. LEED recognizes whole building sustainable design by identifying key areas of excellence including: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Locations & Linkages, Awareness and Education, Innovation in Design, Regional Priority. In order for a building to become LEED certified sustainability needs to be prioritized in design, construction, and use. One example of sustainable design would be including a certified wood like bamboo. Bamboo is fast growing and has an incredible replacement rate after being harvested. By far the most credits are rewarded for optimizing energy performance. This promotes innovative thinking about alternative forms of energy and encourages increased efficiency.

Transportation

As major focus of the sustainable cities, sustainable transportation attempts to reduce a city's reliance and use of greenhouse emitting gases by utilizing eco friendly urban planning, low environmental impact vehicles, and residential proximity to create an urban center that has greater environmental responsibility and social equity.

Due to the significant impact that transportation services have on a city's energy consumption, the last decade has seen an increasing emphasis on sustainable transportation by developmental experts. Currently, transportation systems account for nearly a quarter of the world's energy consumption and carbon dioxide emission. In order to reduce the environmental impact caused by transportation in metropolitan areas, sustainable transportation has three widely agreed upon pillars that it utilizes to create more healthy and productive urban centers.

The Carbon Trust states that there are three main ways cities can innovate to make transport more sustainable without increasing journey times - better land use planning, modal shift to encourage people to choose more efficient forms of transport, and making existing transport modes more efficient.

Car free city

The concept of Car free cities or a city with large pedestrian areas is often part of the design of a sustainable city. A large part of the carbon footprint of a city is generated by cars so the car free concept is often considered an integral part of the design of a sustainable city.

Emphasis on proximity

Created by eco friendly urban planning, the concept of urban proximity is an essential element of current and future sustainable transportation systems. This requires that cities be built and added onto with appropriate population and landmark density so that destinations are reached with reduced time in transit. This reduced time in transit allows for reduced fuel expenditure and also opens the door to alternative means of transportation such as bike riding and walking.

Furthermore, close proximity of residents and major landmarks allows for the creation of efficient public transportation by eliminating long sprawled out routes and reducing commute time. This in turn decreases the social cost to residents who choose to live in these cities by allowing them more time with families and friends instead by eliminating a part of their commute time.

Diversity in modes of transportation

Sustainable transportation emphasizes the use of a diversity of fuel-efficient transportation vehicles in order to reduce greenhouse emissions and diversity fuel demand. Due to the increasingly expensive and volatile cost of energy, this strategy has become very important because it allows a way for city residents to be less susceptible to varying highs and lows in various energy prices.

Among the different modes of transportation, the use alternative energy cars and widespread instillation of refueling stations has gained increasing importance, while the creation of centralized bike and walking paths remains a staple of the sustainable transportation movement.

Access to transportation

In order to maintain the aspect of social responsibility inherent within the concept of sustainable cities, implementing sustainable transportation must include access to transportation by all levels of society. Due to the fact that car and fuel cost are often too expensive for lower income urban residents, completing this aspect often revolves around efficient and accessible public transportation.

In order to make public transportation more accessible, the cost of rides must be affordable and stations must be located no more than walking distance in each part of the city. As studies have shown, this accessibility creates a great increase in social and productive opportunity for city residents. By allowing lower income residents cheap and available transportation, it allows for individuals to seek employment opportunities all over the urban center rather than simply the area in which they live. This in turn reduces unemployment and a number of associated social problems such as crime, drug use, and violence.

Urban strategic planning

Although there is not an international policy regarding sustainable cities and there are not established international standards, there is an organization, the United Cities and Local Governments (UCLG) that is working to establish universal urban strategic guidelines. The UCLG a democratic and decentralized structure that operates in Africa, Asia, Eurasia, Europe, Latin America, North America, Middle East, West Asian and a Metropolitan section work to promote a more sustainable society. The 60 members of the

UCLG committee evaluate urban development strategies and debate theses experiences to make the best recommendations. Additionally, the UCLG accounts for differences in regional and national context.

Development

Recently, local and national governments and regional bodies such as the European Union have recognized the need for a holistic understanding of urban planning. This is instrumental to establishing an international policy that focuses on cities challenges and the role of the local authorities responses. Generally, in terms of urban planning, the responsibility of local governments are limited to land use and infrastructure provision excluding inclusive urban development strategies. The advantages of urban strategic planning include an increase in governance and cooperation that aides local governments in establishing performance based-management, clearly identifying the challenges facing local community and more effectively responding on a local level rather than national level, and finally it improves institutional responses and local decision making. Additionally, it increases dialogue between stakeholders and develops consensus-based solutions, establishing continuity between sustainability plans and change in local government; it places environmental issues as the priority for the sustainable development of the city and serves as a platform to develop concepts and new models of housing, energy and mobility.

Obstacles

The City Development Strategies (CDS) has evolved to address new challenges and to provide space for innovative polices that involves all stakeholders. The inequality in spatial development and socio-economic classes paired with recent concerns of poverty reduction and climate change are new factors in achieving global sustainable cities. According to the UCLG there are differences between regional and national conditions, framework and practice that are overcome in the international commitment to communication and negotiation with other governments, communities and the private sector to continual to develop through innovative and participatory approaches in strategic decisions, building consensus and monitoring performance management and raising investment.

Social factors of sustainable cities

According to the UN Habitat, around half of the world's population is concentrated in cities, which is set to rise to 60% within a couple decades.[20] The UCLG has specifically identified 13 global challenges to establishing sustainable cities: demographic change and migration, globalisation of the job market, poverty and unmet Millennium Development Goals, segregation, spatial patterns and urban growth, metropolisation and the rise of urban regions, more political power for local authorizes, new actors for developing a city and providing services, decline in public funding for development, the environment and climate change, new and accessible building technologies, preparing for uncertainty and limits of growth and global communications and partnerships.

5 Keys to Sustainable Development in Indian Cities,

Indian cities are urbanizing at an unprecedented scale and pace. Over the next few decades, India's urban population is expected to increase significantly, from 377 million in 2011 to 590 million by 2030.

The problem is that the country's existing urban transport infrastructure is already over-capacity. This fact--coupled with the alarmingly high rate of traffic fatalities, increasing air pollution and greenhouse gas emissions, congestion, and urban sprawl--has created a sense of urgency to improve the quality of life in our cities now for the benefit of future generations.

Against this backdrop, WRI's Center for Sustainable Transport in India (EMBARQ India), in collaboration with the Brihanmumbai Electrical Supply and Transport Undertaking (BEST), held its first annual CONNECTKaro conference last week. The theme was two-fold: first, to "CONNECT" sustainable urban transport to urban development, and second, "Karo," a Hindi word meaning to "do it"--to make it happen. Scaling sustainable transport and integrating it with land-use development is essential so that Indian cities remain dynamic engines of economic growth, whilst providing a high quality of life for residents.

The conference was a major success, attended by more than 220 people representing public transport authorities, government planning agencies, civil society organizations, private corporations, media, and academia. Additionally, more than 2,100 people watched the conference sessions via live webcast.

Through a dozen sessions spanning two days, conference participants discussed in detail how to scale and replicate a variety of sustainable urban transport and development solutions in Indian cities. Five key messages emerged from their deliberations:

1) Bus Rapid Transit Is Here to Stay

Years ahead are to witness a significant expansion of bus rapid transit (BRT) systems in Indian cities. Janmarg in Ahmedabad, India's first fully fledged BRT launched in 2009, will expand its network from 62 kilometers to 88 kilometers. New BRT systems are set to launch in Indore and Surat. In total, nearly 50 kilometers of additional BRT corridors are operational in Indian cities from the end of 2013.

Meanwhile, other cities--such as Hubli-Dharwad, Pimpri-Chinchwad, and Naya Raipur--are in advanced stages of BRT planning and construction. Mumbai and Bangalore are in the initial stages of planning their own BRT systems. Given these developments, the next few years are likely to be a "tipping point" for the expansion of BRT in Indian cities. With the right combination of political will, resource allocation, knowledge-sharing, and technical expertise, India could witness a true scaling of these advanced bus systems across its cities.

Key to realizing this success, as Abhijit Lokre from CEPT University pointed out, will be building BRT systems based on the idea of "local innovations for local conditions." Given the diverse conditions in Indian cities, it would be counterproductive to insist on a rigid blueprint for BRT. Instead, flexibility in implementation would allow each city to develop a system to match its own unique needs and constraints.

Moreover, the experiences of Ahmedabad, Delhi, and Pune have shown that successful BRT systems in India are those that are treated as programs, not projects. We must move beyond the tendency to treat BRT systems as mere construction projects and commit to regarding them as systems that require continual resource investment, performance monitoring, and quality improvement.

Finally, treating public consultation and outreach as a core activity rather than an afterthought would result in increased buy-in from local communities.

2) Transit-Oriented Development Is the "Next Big Thing"

While the scaling-up of BRT systems is an encouraging development, merely increasing the supply of mass transport will not be enough. The integration of land use and transportation is also essential. Transit-Oriented-Development (TOD) is increasingly viewed as the next big solution that will connect sustainable transport to sustainable urban development in India. Given that the spatial expansion of Indian cities is inevitable, mainstreaming concepts like TOD will be vital for ensuring this growth happens in a compact and sustainable manner, minimizing negative externalities like sprawl, air pollution, and increased infrastructure cost.

However, a lack of clarity remains on what, exactly, TOD entails and what good TOD looks like. In Indian cities, TOD has been largely used to mean transit-adjacent development, with the discussion revolving largely around increasing the intensity of real estate development near transit stations. There has been little regard for other elements of the urban fabric. Instead, we need to focus more on "multi-modal transport integration, urban design, and enhanced priority for pedestrians and cyclists", said Manjula Vinjamuri, Commissioner of the Directorate of Urban Land Transport, Government of Karnataka. This would ensure the creation of truly walkable and attractive neighborhoods.

There are lessons to be learnt here from India's BRT experience. The scaling of BRT resulted largely from the existence of a high-quality Indian example, like Janmarg, to build support for the concept. This proof-of-concept was followed by significant technical and financial support from the central government through the Jawaharlal Nehru National Urban Renewal Mission (JNNURM). Similarly, developing good demonstration projects (promising pilots are underway in Delhi and Hubli-Dharwad) and ensuring that these concepts are integrated into city master plans and funding allocations for urban renewal (the second round of JNNURM, for example), would go a long way toward mainstreaming TOD.

3) City Bus Systems Will Remain the Backbone of Urban Transport

City bus services are and will continue to be the primary mode of public transport for the majority of India's urban citizens. In major metropolises like Delhi and Bangalore, buses account for more than 40 percent of all motorized trips. For medium and smaller-sized cities, buses are and will remain the only cost-effective mode of public transport.

Improving the scale and quality of city buses, then, should be central to any city's strategy to promote public transport over private vehicle use. Significant efforts have been made toward this goal. In 2009, the Government of India, through the JNNURM, funded the procurement of 15,625 buses for 61 cities across India. At CONNECTKaro 2013, Dr. Sudhir Krishna, Secretary of the Indian Ministry of Urban Development, reiterated the Indian Finance Minister's commitment to fund the procurement of an additional 10,000 buses for public transport in Indian cities.

But much remains to be done. Buses "are still seen as a down market mode of transport," said SK Lohia, Joint Secretary of Urban Transport at the Ministry of Urban Development. Modernizing city bus services will be crucial to changing this mindset.

Redesigning bus networks and routes to make services more efficient and user-friendly, as well as using technology to improve passenger information systems will be essential. While there are encouraging modernization efforts already underway in cities like Bangalore and Mysore, efforts must be made to share their results to facilitate the scaling-up of such initiatives to bus-based public transport networks across India. "Improving the quality of buses to make them more attractive and comfortable for users will also be required", said Jamshyd Godrej, WRI India Chaiman, a goal that necessitates greater engagement with manufacturers.

4) Pedestrians and Cyclists Must Be at the Core of Urban and Transport Planning

Every year, more than 130,000 people in India die as a result of traffic accidents — one-tenth of the global total. If current trends continue, traffic crashes will become the fifth-leading cause of death among all age groups by 2030, surpassing major diseases such as tuberculosis and AIDS. The most vulnerable road users are pedestrians and cyclists.

One of the reasons for this danger is the disproportionate allocation of road space. Mriganka Saxena from the Delhi Development Authority made the point that although Indian cities have a high share of walking and bicycle use, 80 percent of road space is allocated for only 15 percent of users (those driving private vehicles).

Participants discussed several strategies for improving pedestrian safety, including:

- **Leveraging the large investments in mass transit systems to improve pedestrian environments around transit stations**. For example, areas around the Mumbai Metro and Monorail line stations are being designed to increase pedestrian access and safety. Scaling up this work to the mass transit systems currently under construction in many Indian cities will go a long way toward ensuring safe access to these transport networks.
- **Industrial associations and business districts can take the lead in improving pedestrian environments, without waiting for larger, city-wide initiatives**. For example, businesses can create green spaces or pedestrian-friendly environments. One such project is the Maharashtra Industrial Development Corporation's (MIDC) initiative in Mumbai.
- **Civil society can take the lead in bridging the design capacity gaps that public agencies sometimes face**. For example, the Tender SURE project in Bangalore sourced U.S. $160,000 through civil society groups for the development of road design templates. The project then leveraged this funding into a U.S. $56 million commitment by the Karnataka State Government to provide adequate space and safety features for pedestrians while constructing 30 km of major roads in the city.

Ultimately, central and state governments will need to rethink their priorities while designing roads, placing pedestrians' and cyclists' safety and comfort at the core of their road development process.

5) Engagement with the Private Sector Is Critical

A final key message from the conference focused on the tremendous opportunity to shift private sector investments toward sustainable outcomes. A recent study indicated that Indian cities will need almost U.S. $871 billion in infrastructure investments over the next 20 years. Of this amount, nearly U.S. $500 billion is needed for transport infrastructure alone. Given fiscal constraints in the public sector, a majority of this money is expected to originate from private investors.

In addition, real estate development will continue to be one of the largest sectors in urban investment. The manner in which such private developers plan their projects — building them around cars or building them to be supportive of non-motorized travel and public transport — will have significant impact on the future sustainability of Indian cities. Businesses will also increasingly invest in providing goods and services for urban consumers, some of which will focus on transportation.

Therefore, there is a significant opportunity to channel the actions of private sector players into sustainable transport and urban development initiatives— whether through real estate developers embracing sustainable transport principles in their projects; entrepreneurs creating companies that deliver sustainable transport services; or financiers providing the capital that allows these outcomes to materialize.

Private sector investors are also "increasingly keen to invest in the transportation infrastructure space", said Dr. Armin Bruck, CEO of Siemens India. However, such investments have historically been dominated by the state, and therefore significant knowledge gaps in terms of opportunities, viable business models, and regulatory requirements exist.

National and central government policies that support the development of sustainable transport solutions could help increase private sector investments. Madhav Pai, director of EMBARQ India, proposed developing a Sustainable Transport Market Development Alliance between private companies, government regulators, and civil society groups, which received broad support from participants. Such initiatives will create an ecosystem that channels private sector investments toward sustainable transport and urban development outcomes.

Indian Cities: Wide Gulf between Rich and Poor

"Indian cities are far from realizing their potential," says Dr. Shirish Sankhe, Director of the McKinsey & Company corporate consulting firm's Mumbai location. "That's a troubling situation, but the problems can be solved with the right policies." In an extensive study titled "India's Urban Awakening," Sankhe and his colleagues investigated how much dormant growth potential there is in India's cities, and how it can be brought to life — a topic that was also a focal point at the Future Dialogue symposium in late September 2011 in New Delhi, an event organized by Siemens and the Max Planck Society.

The challenge is huge. According to the Population Reference Bureau, India was home to 1,277 million people in 2013, accounting for 17.9% of the world's total population. Between 1950 and 1990 the country's population increased from 371 to 873 million, with another approximately 350 million people added in the 20 years since then. And the UN predicts the population will grow by another 300 million people by 2030, which would make a total of 1.5 billion. There would then be roughly 270 million more Indians in their employable years than there are today.

Most of them will seek work in cities. Although only one third of Indians now live in urban areas, more than two thirds of the economic output is generated there. So many people are leaving the countryside that city residents may account for over 40 percent of the population by 2030, claims the McKinsey report. Sixty-eight cities will then have over one million inhabitants and six megacities will each be home to more than ten million people. The McKinsey study "Urban World" from the year 2013 contrasts this urbanization with the increasing demand for consumer goods as a result of population growth. On the basis of this study, McKinsey comes to the conclusion that cities which fail to adjust their infrastructures to this growing population and its needs in advance will suffer major competitive and economic setbacks later on.

Link between Urbanization and Prosperity?

Essentially, this bodes well for India's development, because cities are "job machines." Infrastructure projects, home construction, education, entertainment and services power the economy. Dynamic cities could quadruple India's gross domestic product by 2030, to $5,060 per capita — and good planning could help boost the GDP by another one third by then, according to McKinsey.

But that won't happen unless many things change. To date, India's cities have mushroomed rather than grown. Neuwirth, the author, has lived in Mumbai's Sanjay Gandhi Nagar squatter neighborhood. Many of the people there, like Laxmi Chinnoo, live outdoors or in settlements they build on unused land, often without access to electricity, water lines or sewage systems — usually on the borderline to legality. "Though many squatters work as drivers and maids and child-care workers, they are seen as anti-social elements," says Neuwirth. "Whether a person is working as a scavenger or in a factory, whether they've started their own roadside business or are cleaning houses, they deserve to be treated with respect and dignity."

Needed: New Traffic Concepts Based on Public Transportation

Holistic Approach. In the biggest cities, where the urban landscape includes terrible slums, even affluent families are affected by poor air quality, noise and congestion. "India needs holistic solutions for its cities," says Sankhe. A key element here is the construction of modern infrastructures. "In the next two decades India's cities will need to invest $1.2 trillion." This means the average per capita investment in cities will have to be increased from the current level of $17 to $134.

Take congestion, for example. To ensure free-flowing traffic, experts suggest that no more than 112 vehicles should occupy a one-kilometer lane. But if you compare the current growth of the automobile market in India with the expansion of the road network, 20 years from now there could be 610 vehicles on each kilometer of road — which would essentially mean complete gridlock.

But the effects of traffic congestion aren't limited to slow travel and poor quality of life, they also contribute to reduced economic output, high fuel consumption and healthcare-related costs associated with serious air pollution. "Alongside new roads, India also needs an entirely new traffic concept whose central element is public transportation," says Sankhe. In addition to over 19,000 kilometers of new roads each year, cities will also need up to 400 kilometers of new subway lines — that's 20 times more than has been built in the last decade.

Infrastructures for Everyone

In the years to come India will need between 700 and 900 million square meters of new housing space annually. That's an area equivalent to two cities the size of Mumbai. Water consumption per capita will increase by 45 liters a day. And energy demand could double in the coming decade. "Without the latest technology, India's cities will not be able to meet these challenges," says Sankhe. "Infrastructure solutions like those offered by Siemens can make a crucial contribution." indeed, Siemens is active in many fields in India. For example, the company delivers commuter trains for Mumbai, New Delhi, Kolkata and Chennai. It is helping to boost the energy efficiency of new buildings, including Mumbai's Tata Tower, and it has installed treatment systems at the Panjrapur waterworks in Mumbai.

Infrastructure isn't the whole story, however. Sankhe explains that Indian cities also need more effective administration and political reforms, such as the direct election of mayors. And government needs to invest in low-cost housing.

"Governments need to work in partnership with shantytowns and squatter communities to plan for the future," says Neuwirth. Cities can offer reasonable quality of life only when they provide it for all inhabitants. And that includes not only India's new elites, but also hard-working people like Laxmi Chinnoo, who will hopefully one day have a proper roof over her head — instead of a bridge.

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