

Creating Sustainable Urban Systems: Need for Redesigning Indicators for Urban Infrastructure and Services

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Abstract- *The process of infrastructure project determination is often inadequate leading to outcomes that do not address the intended purpose and/or have unintended consequences. As the world and India commit towards charting a more sustainable development path, there is a need to take a 'relook' at the outcomes of a project from a 'sustainability' perspective. This paper presents a framework which elaborates on key sustainable development principles in the context of urban development. It further presents the results of an assessment of a select set of indicators against this framework to gauge their usefulness in measuring the sustainability of urban infrastructure and services. The results show that a majority of indicators are loaded towards measuring the efficiency and well-being of urban infrastructure and services, with little attention paid to equity and foresight.*

I. Introduction

The concept of sustainable development is a long-term agenda. It calls for the convergence of three aspects - economic development, social equity, and environmental protection (3Es) (1). A Sustainable City is defined as a city where achievements in social, economic, and physical development are long lasting (2).

Cities contribute about 80% of the world's GDP (3), while being large, concentrated sources of emissions and energy consumption¹. They are also emerging as the most vulnerable human settlements on account of the vagaries of nature. Keeping this in mind, a significant portion of the international dialogue on sustainable development has been increasingly focused on cities.

While cities have started embracing sustainability in articulating their vision and planning approaches, formidable challenges exist in translating these visions and plans into actions. As a start, cities need to first baseline themselves across sectors. These baselining efforts should also acknowledge inter-sectoral

linkages in order to enable cities to plan holistically for the future. Indicators create opportunities for dialogue on local conditions, offer quantification and objective identification of policy issues, monitoring and evaluation, and allow comparison of plans and programmes over different time periods and/or spatially (5). Further, indicators are important for establishing a mechanism for accountability necessary for good governance. However, in developing countries like India, planning for cities, its infrastructures and services are often driven by populist motivations that are less objective, biased and non-scientific. This has led to the implementation of projects which have contributed sub-optimally to improving the baseline conditions of city-level infrastructure and services, and urban systems (6) (7) (8). To summarise, a complete feedback loop in decision making processes, starting from problem identification, to selection of suitable projects, and monitoring and evaluation of the same to assess the outcomes against baseline conditions is not established in the planning practices of urban infrastructure and services (9). There is a need to shift from an output-oriented approach to a more outcome-oriented approach, and this requires adequate measures to evaluate outcomes (10).

Literature in urban domain indicates that designing and adopting indicators for sustainability especially in the urban context is limited. Well-designed indicators will enable a city to baseline itself against sustainability targets in a disaggregated manner. Adequate understanding of the indicators "will reflect their progress towards success, considering the specific conditions and socio-cultural environment of the city" (11). However, there are challenges towards understanding these indicators and these include:

- Lack of integration of the sustainability agenda in city development plans (consisting mostly of land-use and infrastructure investments plans)
- Inadequate selection of indicators that can effectively measure sustainability (12),

¹ Cities contribute 37-49% of global GHG emissions and urban infrastructure accounts for over 70% of global energy use (4).

especially in the context of municipal planning and services

- Lack of understanding and availability of relevant data
- Technical issues such as normalisation, weight and aggregation, and conceptual issues such as boundary delineation, heterogeneity, and scale in available urban sustainability indices (13)
- Capacity constraints with regards to technical knowledge, and financial and human resources at city level
- Lack of consensus and standardisation of methods, and documentation of good practices pertaining to sustainability indicators (12).

With this contextual overview, Section II of this paper proposes a sustainability framework for designing urban infrastructure and services indicators. Section III presents the results of an assessment of a set of urban infrastructure and services indicators in terms of their adequacy to address the main thematic areas of the proposed framework. Section IV concludes with a recap of the arguments and findings of the paper with a set of recommendations.

II. Proposed Urban Sustainability Framework (9)

There are a few prominent sustainability planning approaches that are used by cities and various agencies for planning purposes. These include frameworks, methodologies, and study reports having sustainability planning as their primary scope, or indirectly contributing to the sustainability agenda as a larger goal². Applications of these frameworks vary with context, availability of data, scope and objective of a particular exercise, etc. Thus there is neither a single universally accepted nor widely practiced framework for sustainability planning, nor for designing sustainability indicators. The 17 draft Sustainable Development Goals (SDGs) and their respective targets suggested by the United Nations (UN) emerge as a comprehensive point of reference in this regard (14).

² Such as Agenda 21; Aalborg Commitments; DPSIR (Driving forces, Pressures, State of the Environment, Impacts, Response); Cities for Climate Protection Campaign - International Council for Local Environmental Initiatives (ICLEI); Millennium Development Goals; Integrated urban development framework; Ecological Footprint; Global City Indicators Program (GCIP); Human Development Index; IPCC Assessment Reports etc.

SDGs reinforce the 3Es of sustainable development. It is important to recognise the futuristic nature of sustainable development as a concept which is articulated by the recently adopted SDGs and their timelines post-2015. This paper articulates four major principles that emerge from SDGs, namely a) well-being, b) equity, c) efficiency, and d) foresight. A review of the available literature on urban sustainability indicators reveals that the categorisation of indicators are mostly done based on sectoral divisions of sustainable development such as economic, social and environmental factors. However a thematic categorisation cross-cutting all these three pillars of sustainability has not been attempted. Thus this study proposes a framework for the assessment of indicators based on the four thematic principles mentioned above. This will comprehensively address the concept of sustainability which is needed for better urban systems. The following paragraphs describe each principle briefly along with set of broad questions which seek to further elaborate them.

a) Well-being

Well-being or welfare is a general term used to describe the condition of an individual or group, for example their social, economic, psychological, spiritual or medical state; high well-being means that, in some sense, the individual or group's experience is positive, while low well-being is associated with a negative state of being.

Table 1. Well-being description and questions

Well-being described by:
<ul style="list-style-type: none"> □ Overall sector performance □ Access and coverage □ Citizen perception
Questions seeking to answer well-being conditions:
<ul style="list-style-type: none"> - How the citizens are rating their city? - How is the average accessibility to infrastructure/ services / facilities situation? - How is the per capita availability situation? - What are the attainment levels (say literacy rates etc.)?

b) Equity

A society's well-being depends on ensuring that all its members feel that they have a stake in it and do not feel excluded from the mainstream. This requires all

groups, but particularly the most vulnerable, to have opportunities to improve or maintain their well-being. In this framework, equity indicates a disaggregated assessment of well-being conditions across all segments of a city.

Table 2. Equity description and questions

Equity described by: <ul style="list-style-type: none"> <input type="checkbox"/> Access and coverage of poor, marginalised and minority groups <input type="checkbox"/> Participation status
Questions seeking to answer equity conditions: <ul style="list-style-type: none"> - How are specific groups within the city doing with respect to well-being indicators? (minority/ slum population/ BPL/ different age groups/ differently abled) - What is the gap between well-being indicator performance, with equity indicator performance? - Do citizens participate in decision making?

c) Efficiency

The efficiency aspect of good governance means that processes and institutions produce results that meet the needs of society, within a reasonable timeframe, while making the best use of resources at their disposal. The concept of efficiency also covers the aspect of sustainable use of natural resources and protection of the environment. Efficiency mainly refers to the performance of a city with respect to resources, finances and human power to produce the desired outcomes (i.e., city goals).

Table 3. Efficiency description and questions

Efficiency described by: <ul style="list-style-type: none"> <input type="checkbox"/> Reliability <input type="checkbox"/> Quality <input type="checkbox"/> User friendliness <input type="checkbox"/> Resource optimisation
Questions seeking to answer efficiency conditions: <ul style="list-style-type: none"> - What is the city’s footprint? - What are the energy efficiency levels? - Overall resource efficiency levels? (recycle and reuse) - Overall financial viability? - How much employment is generated vis-a-vis per capita investment?

d) Foresight

Foresight provides a broad and long-term perspective on what is needed for sustainable human development and how to achieve the goals of such development. This can only result from an understanding of the historical, cultural and social contexts of a given society or community. Foresight tries to establish capacities for future growth to take place along a sustainable development trajectory. Foresight also signifies a commitment to address the long-term challenges and aspirations of a city.

Table 4. Foresight description and questions

Foresight described by: <ul style="list-style-type: none"> <input type="checkbox"/> Long term <input type="checkbox"/> Robustness <input type="checkbox"/> Capacity
Questions seeking to answer foresight conditions: <ul style="list-style-type: none"> - Does the city have a future development plan including economic growth plan prepared in a participatory way? - Does it consider climate change, resilience building, and energy efficiency? - Does the city have a framework for knowledge and capacity building? - Does it have a resource management plan? - Is it capturing and storing data? Is it updated periodically? - Does it follow a specific decision-making process? Is data analysis done?

The four guiding principles are further elaborated in Tables 1, 2, 3 & 4, which will be used as a framework for understanding urban sustainability. The questions in these Tables have been applied to assess indicator-sets for their inclusion of the four principles, as presented in Section III.

III. Validation (Indicator Gap Analysis)

Under the framework mentioned above, an assessment of a number of indicator-sets was carried out. The methodology used included the following steps:

Step 1: Indicators for nine sectors namely water, sanitation, solid waste, transport, housing, environment, health, energy, and education were collected from 42 different sources. The resources collected comprise of indicators that exist in international as well as Indian contexts. Some sources provided indicators for an entire city covering almost

all sectors while some sources dealt with indicators for a specific sector. References to the sources can be accessed in the section titled ‘Indicator References’.

Step 2: The indicators extracted from each source were analysed against the questions posed under the four principles (as shown in Table 5). The indicators were categorised under these four principles based on the major query they intend to answer. Each indicator was categorised under one or more principles in cases where it is implicit that they can deepen the understanding of conditions under these principles. For example the indicator “Coverage of water supply connection” for the water sector mainly gives answers to percentage of population that have access to water supply connection in both slum and non-slum areas; thus it addresses the overall well-being and equity principles of the framework. Thus both, well-being and equity principles are added for this indicator in water sector.

Source Name	Guiding Principle
Ministry of transport , New Zealand	
Number of Cycling trip legs	WB
Road fleet by fuel type	data
Travel time	EF
Employment in transport sector	EF
Percentage of the population who can get to key locations door-to-door by public transport, walking and cycling	WB+EQ
Percentage of households with access to a motor vehicle	EQ
Availability of accessible information about public transport services	EQ+EF

EQ – Equity, WB – Well-being, EF – Efficiency, FS – Foresight

Table 5 Indicators categorised under guiding principles

Step 3: For the next step, the indicators under each principle and in each sector were mapped. An aggregated mapping of the indicators of all the sectors under the four principles was also conducted. The percentage of indicators available under each of the principles, both sector-wise and aggregated for all nine sectors were analysed. The remainder of this section provides a description of the indicators for the different sectors.

1. Water

The analysis of the water-sector indicators shows a larger emphasis on efficiency, with 73% and less stress on well-being, equity and foresight with only 8%, 8% and 11% respectively (Fig. 1). The percentage of indicators under efficiency is significantly higher than that present under the other three guiding principles.

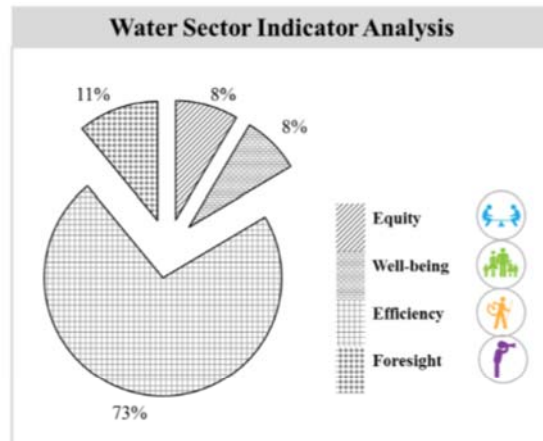


Figure 1. Water Sector Indicator Analysis

2. Transport

The transport-sector indicators’ analysis also shows that a large emphasis - 56% is placed on efficiency, and comparatively less stress on equity and well-being with 17% and 18%, respectively (Fig. 2). The aspect of foresight, such as assessing the impacts of transport sector on climate change by means of emissions, is generally lacking.

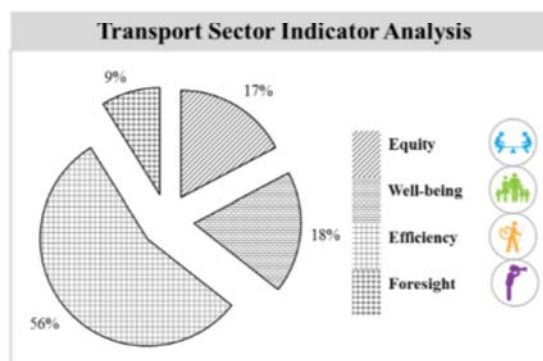


Figure 2. Transport Sector Indicator Analysis

3. Sanitation

The sanitation-sector indicators analysis shows a large emphasis on efficiency with 62%, and comparatively less focus on equity and well-being with 14% and 21% respectively. Indicators intended to measure inclusion of foresight are not adequately present, indicators such as climate resilient sanitation infrastructure.



Figure 3. Sanitation Sector Indicator Analysis

4. Solid Waste

The analysis of the solid waste sector indicators shows a large emphasis on efficiency with 77% and less focus on well-being and foresight with 12% and 9% respectively. The least number of indicators were under equity with a share of just 2%. This suggests a lack of indicators to measure the solid waste services provided to slum dwellers or underprivileged citizens.

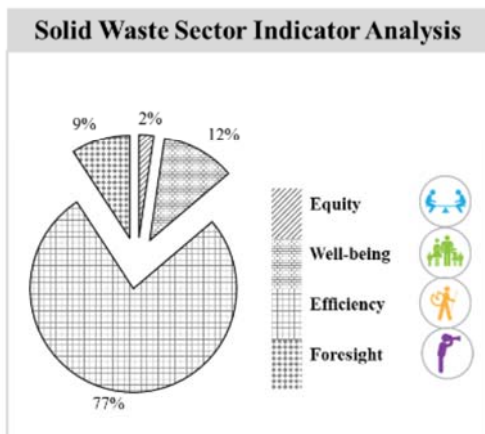


Figure 4. Solid Waste Sector Indicator Analysis

5. Energy

The energy-sector indicators analysis shows that more than half of the indicators pertain to efficiency (66%). The second-most important aspect was well-being with 24% indicators. Both foresight and equity have very less emphasis with 8% and 2% respectively. This suggests a lack of indicators to measure the energy services provided to the slum population of a city, as well as lack of indicators that will help in building capacity for the future growth.

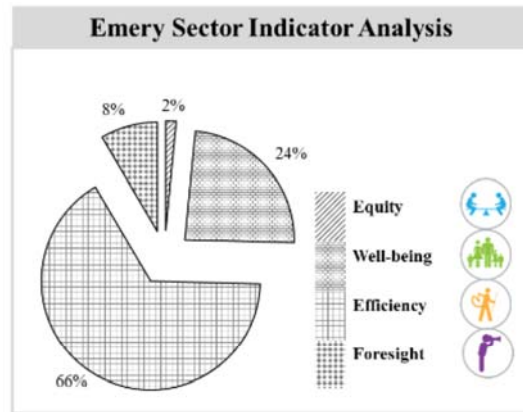


Figure 5. Energy Sector Indicator Analysis

6. Housing

The housing-sector indicators analysis shows less bias of indicators towards any particular guiding principle. Both equity and efficiency are significant with 43% and 34% indicators respectively. The next important aspect was overall well-being of the sector with 24% indicators. The sector provides least emphasis on foresight with only 3% indicators. The aspect of foresight is very crucial in meeting the future housing demand and making city densities more sustainable.

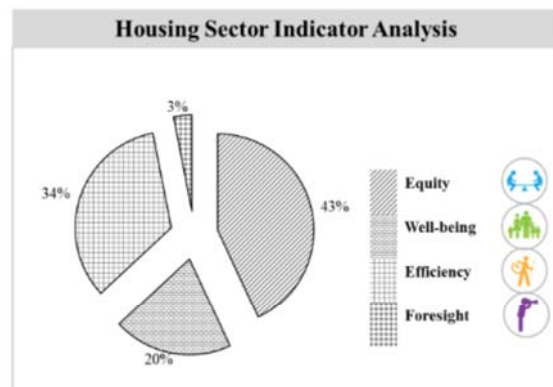


Figure 6. Housing Sector Indicator Analysis

7. Health

The health-sector indicators analysis shows fairly less bias towards any particular guiding principle. Both efficiency and well-being stand out to be significant with 46% and 30% indicators. Notably, the studied indicator-sets show less emphasis on equity, with only 5% indicators, while this aspect is vital in order to achieve universal well-being.

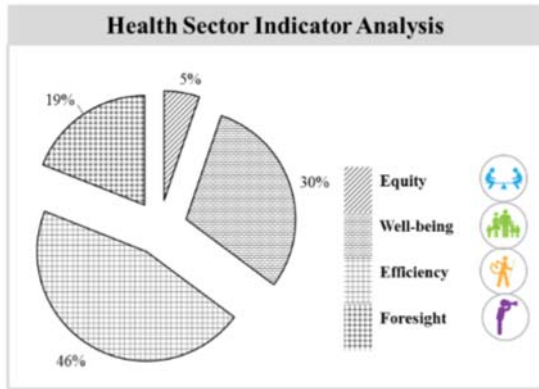


Figure 7. Health sector Indicator Analysis

8. Education

The education-sector indicators analysis shows no significant bias towards any particular guiding principle. Unlike the situation of the other sectors, the indicators in this sector give almost equal emphasis to efficiency, well-being and equity with 35%, 28% and 24% indicators respectively. Foresight is given a reduced emphasis with 13%.

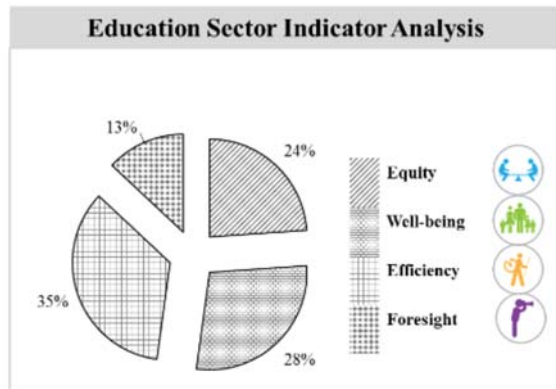


Figure 8. Education Sector Indicator Analysis

9. Environment

The environment-sector indicators analysis shows a significant bias towards well-being with 90% indicators and the sector pays very less emphasis on efficiency with only 10% indicators. The studied indicator-sets show complete exclusion of equity and

foresight. With climate change presently being a major challenge, it is crucial to study the aspect of foresight for future environmental management to diminish the impacts of climate change. Environmental management in slum areas is imperative as they are the most vulnerable, yet neglected.

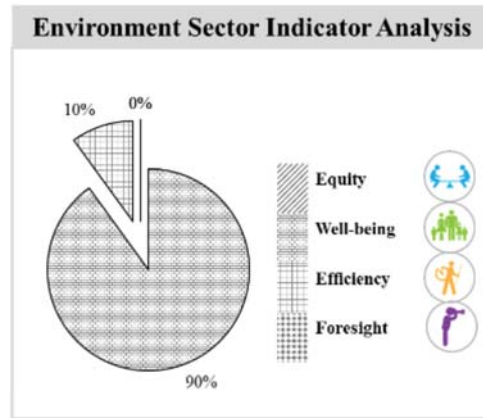


Figure 9. Environment Sector Indicator Analysis

Aggregated result:

The assessment of the indicator-sets available across the nine sectors indicates that in general, there is less emphasis placed on equity and foresight. Efficiency emerges as a major theme in the development of hard infrastructure such as water (73%), sanitation (61%), solid waste (77%), transport (55%) and energy (66%). The remaining indicator-sets are seen to be measured through well-being indicators except in the housing sector, in which the equity aspect is important. Foresight, which includes emerging threats like climate change, emerges as the most deficient theme across all sectors (with the exception of the education sector) (Figure 3). City development plans need to address the existing situation in a city against a set of indicators across a wide range of sectors within the sustainability framework. Based on this, the cities' future goals should be set, while being cognisant of potential opportunities and constraints and relative priorities. This process will enable a holistic method for the determination of infrastructure projects and also identification of potential areas for dovetailing different projects to have a larger impact on addressing the needs of a city and its citizens.

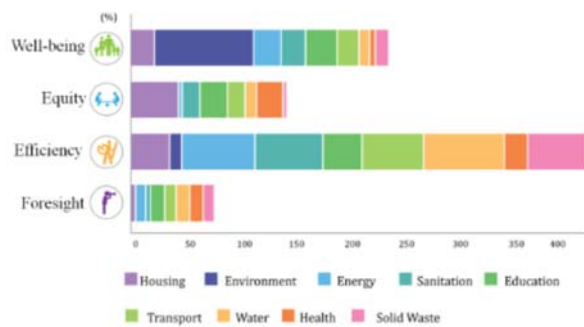


Figure 10. Summary of sector indicator analysis

The above sector-wise analysis of indicator sets, highlight the priority principles, and their lacunae. This study has considered sources that could be collected within the stipulated study period, thus the list may not be exhaustive. Many more indicators from various sources (other than those already mentioned) can be added to this analysis, thus making it a continuous process.

IV. Conclusions

As indicated in the analysis, equity and foresight indicators are not adequately addressed, and need more understanding and emphasis. Sustainability of a city is dependent on its environmentally conscious development, that is accessible (physical, social and economic) by all socio-economic sections of the city. Thus, when conceiving and designing a project, cognisance of this aspect is of vital importance. The projects should also be evaluated based on its contribution to the equity principle (along with the other three principles). The Terms of Reference for project proposals need to incorporate indicators that adequately address this aspect of equity. There could be projects that do not address equity adequately. These projects can be dovetailed with other aspects/proposals that can address the equity perspective. This will enable the integrated project to be equitable.

Sustainability is a long-term agenda of any city, and thus inclusion of uncertainty in its planning stage is important. It is important for cities, to have processes, protocols, and plans that address uncertainties like extreme weather, natural and man-made disasters, etc. Thus, baselining through the right indicators to understand this is very important. This will enable us to plan both proactively and reactively.

This paper highlights the fact projects and interventions in a city should be products of a process

that evaluates the intended and unintended outcomes before implementation. A well-designed set of sustainability indicators is a vital part of this process that helps cities baseline existing conditions as well as monitor and evaluate the outcomes of infrastructure projects and services.

There is need for mainstreaming sustainability indicators into municipal planning practices. It is noted that substantial work is being done on urban sustainability indicators. However, there is very minimal exchange of knowledge between formal urban planning practices and global literature and inventions in the areas of sustainability planning, especially in developing countries. Cities in developing countries continue to plan themselves based on traditional indicators focusing on municipal service delivery sectors, and thus miss critical intersectoral linkages and sustainability goals. Thus as we plan and create new urban systems, regular exchange of knowledge between academia, research, and institutions working on sustainability and city managers and policy makers is very important. This collaborative effort is vital in contributing to an outcome-oriented paradigm for creating sustainable cities.

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