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Project Management Strategies for Sustainable Development

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Abstract*—This paper delves into Project Management Strategies that may be deployed for Sustainable Development. The various facets of sustainability viz. economic, social and most importantly environmental sustainability are discussed in detail to establish the need for Project Management (PM) Strategies in the infrastructure development sector which has been identified as an important component of sustainable development. Sustainability today is being painted with a restrictive view limiting sustainability to merely buildings, industrial processes, etc. However looking at the larger picture and introducing sustainability to the infrastructure sector itself would translate into greening at a much wider platform. The paper presents an overview of life cycle stages of an infrastructure project, the interdependencies and complex relations of various domains that get affected during such a project. The paper attempts to create a framework of sustainability objectives for each stage of project life cycle and introduce PM strategies for each level. The same is illustrated with relevant case study which has been analyzed and assessed on sustainability parameters.*

1. INTRODUCTION

So far, efforts to deliver sustainability have largely been concentrated in the building sector. In fact there are regulatory and mandatory frameworks in place to guide sustainable construction practices in different nations. But what good is a sustainable building, if it has unsustainable means of sourcing power and water. A sustainable building would be rendered useless with conventional sewage disposal mechanisms and polluting transport infrastructure. Infrastructure sector is the lifeline of our cities, the very backbone of our existence and hence developing sustainability standards for such a project is of utmost importance. The need of the moment is to,

- define, plan and design more sustainable infrastructure systems;
- procure, construct, commission, operate and maintain them in more sustainable ways; and
- supply more sustainable design and engineering technologies, systems, products and materials used within them.

2. SUSTAINABLE DEVELOPMENT: AN OVERVIEW

The green building movement that has already gained momentum is just the tip of the iceberg called “sustainability”. The challenge for the future is not only an environmentally sound future but a socio-economic change that can replace our consumer society with a community which is sensitive to issues of sustainability. Issues like energy consumption, water use, pollution, embodied carbon, threats to biodiversity are all challenges facing not only the construction industry, but the entire society. New development has to enhance our quality of life, and support economically and socially as well as environmentally sustainable communities.

According to the World Commission on Environment and Development (WCED), sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." A definition of sustainable development from an ASCE/UNESCO working group on developing sustainability criteria for water resources systems is put forth as “… systems designed and managed to fully contribute to the objectives of society, now and in the future, while maintaining their ecological, environmental and [engineering] integrity”. [1]

Sustainable development is not just about the environment. It entails balancing the economic, social and environmental objectives of society- the three dimensions of sustainable development, integrating them wherever possible. This includes, in particular, taking into account the impact of present decisions on the options of future generations. Sustainability is a dynamic concept. Societies and their environments change, technologies and cultures change, objectives and aspirations change, and a sustainable society must allow and sustain such a change.

Another way of addressing sustainable development is based on Daly’s Triangle which advocates a framework suggesting development processes should stem from ultimate means and lead to ultimate ends and in doing so encompass all capitals-

natural capital, built capital, social capital and finally well-being of the community. [2]

The concept of 'Triple Bottom Line', emphasizing the role for the three *P*s- *People*, *Planet* and *Profit* [3] can also be applied to all enterprises or developments which can have specific measurable deliverables in economic, environmental and social terms if the outcome is to be regarded as sustainable.

Also the three domains that most of the definitions seem to have covered- social, economic and environmental; are inter-related. Man (the social realm) depends upon the natural environment for his most basic needs- air, water, earth, food etc. Also man is dependent upon the government that is responsible for providing basic infrastructure by means of production and distribution of wealth. Hence the economic dependency. Economy is however driven by human resources without which production cannot take place. Also the economy needs adequate natural resources to develop and maintain its built capital and infrastructure. Where all the three domains overlap, environmentally sound, economically viable and socially beneficial, hence holistic development takes place. However, even when two domains overlap, social equity, eco-efficiency and socially sustainable environments may be achieved. Therefore it can also be said that sustainability in one domain can be necessary for sustainability in another.

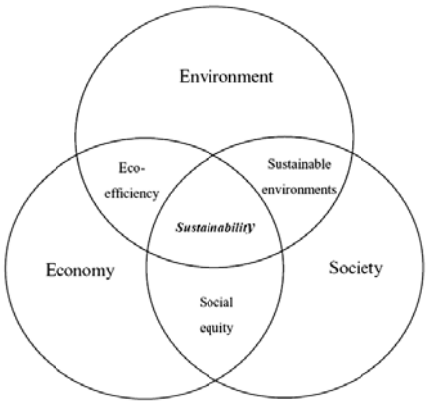

Fig. 1: Domain interdependency

3. INFRASTRUCTURE PROJECTS

Infrastructure systems are integral components of urban development and a deciding factor in delivering services to communities, in supporting economic growth, and in determining environmental impacts. Hence it is imperative that the three pillars of sustainability (social, economic and environmental) associated with this sector be investigated to bring about sustainable development. Infrastructure is not only costly and very resource intensive using energy, water, materials and land. It also locks cities into consumption patterns for decades. The choice of infrastructure is thus critical in determining the efficiency and effectiveness of service delivery, as well as the environmental impacts thereof on urban areas. Urban Infrastructure is often referred to as the built capital although it also covers social sectors like health and education. For purpose of this paper, only physical infrastructure has been dealt with; namely water, sanitation, waste management, sewerage, power and transportation. Traditionally physical infrastructure has been managed by the State because of its typical characteristics [4]:

- Financial: Large capital costs compared to operational and maintenance (O&M) costs. Large sums have to be committed upfront before project becomes operational. Long gestation periods. Slow revenue streams.
- Market-related: High costs of entry and exit reduces competitiveness and contestability of infrastructure services.
- Service-related: Non-tradable services; import and export not possible.
- Policy-related: Vulnerable to regulatory and policy changes. Sensitive tariff rates and revision.
- Social responsibility: Direct bearing on society
- Resource-intensive: Driven by natural resources

These peculiarities indicate the uniqueness of infrastructure projects and hence their provision needs to be differentiated from non-infrastructure projects. Also their characteristics differ between sectors and within each sector, between different phases of a project.

Stages of an Infrastructure Project Life-cycle

Infrastructure development encompasses a very broad range of interests, activities and stakeholders. Therefore, a good understanding of the project development cycle is necessary. A typical infrastructure project lifecycle will have the following stages:

3.1.1 Planning: This stage is the first and most important stage of any infrastructure project. It includes project preparation, feasibility studies and finance-related workings.

3.1.2 Design: This stage results in deliverables like detailed plans and technical specifications; detailed bill of quantities; detailed cost estimate and a general work schedule.

3.1.3 Procurement and Finance: It involves getting requisite funds from various sources identified earlier and its relevant tendering processes.

3.1.4 Project Implementation: Implementation is generally divided into three time periods: an investment period when the major investments are made; a development period when production capacity is gradually built up; and the period of full implementation.

3.1.5 Operation and maintenance: It is when the expected project benefits start to be generated.

The diagram above explains the various project stages. The last stage of evaluation for future projects are seldom followed in the industry and hence the cycle remains a linear one rather than a closed loop.

Infrastructure Project Finance

3.2.1 Traditional financing: Infrastructure has mostly been provided by the government with the government bearing the investment risk. Tax revenue and government borrowing has been the predominant source of finance. Developing countries also receive finance from bilateral and multilateral sources.

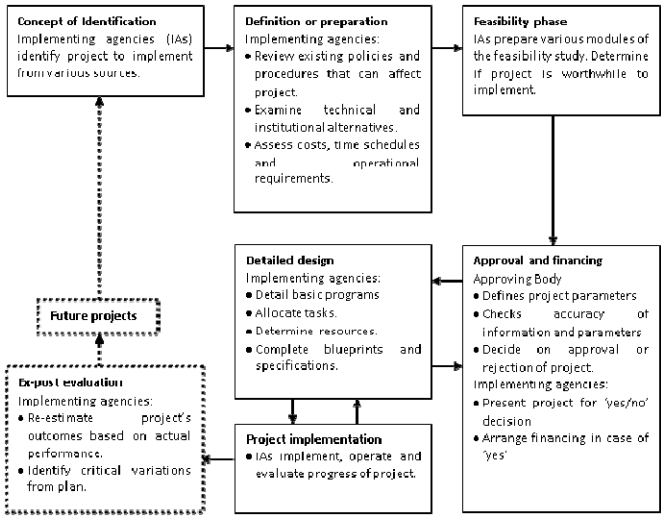

Fig. 2: Infrastructure project life-cycle

3.2.2 Private Participation: Governments have realised that their limited financial resources are not sufficient to cover the needed expansion of infrastructure services to meet the continually growing demand for water, waste, energy and other urban services. Even where governments do find the resources to subsidize public utilities, service is often poor and sectors of the population largely unserved. One of the most viable options is to involve the private sector in the state monopolies. This is done through associations with private sector on a project-to-project basis and generally termed as PSP-Private Sector Participation, PPP- Public Private Partnerships, PFI -Private Finance Initiatives etc. Under many of these structures, a private sector operator is contracted to design, build, finance, and operate a facility, borrowing capital from a lender, either through debt or bonds, and investing equity. The provider then receives payment from the government and/or the end users for the duration of the contract that covers the cost of operations, repays the loan, and provides a return on investment. The long-term nature of a PPP provides a source of dependable cash flow for project sponsors (contractors, operators, and other long-term private sector investors that invest in public infrastructure).

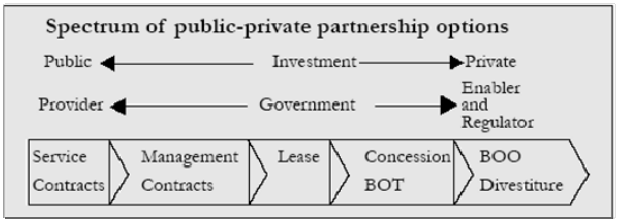

Fig. 3: Spectrum of public-private finance

The various contractual arrangements mentioned above can be compared on the basis of parameters like ownership, operations accountability, investment, commercial risk bearing and period of contracts as per a study illustrated in Table 1 [5].

Table 1: Various facets of contractual agreements

Option	Asset Ownership	O&M	Capital Investment	Commercial Risk	Duration
Management Contract	Public	Private	Public	Public	3-5 years
Lease	Public	Private	Public	Shared	8-15 years
Concession BOT	Public	Private	Private	Private	25-30 years
BOOT/BOO	Private/ public	Private	Private	Private	20-30 years

Key Stakeholders

In case of private participation, as the project moves from the development stages to financing and thereafter construction and finally operations, several project parties get involved with the project. A brief description of key stakeholders and their typical role is given below:

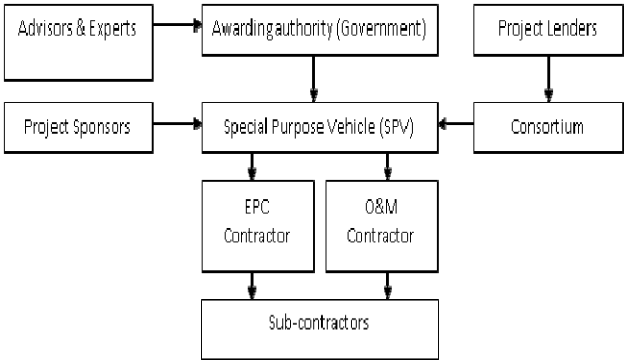

Fig. 04 Key stakeholders in an infrastructure project

3.3.1 Government: is the key project party, provides concession to the private body to set up the project and ensures proper legislative and regulatory framework.

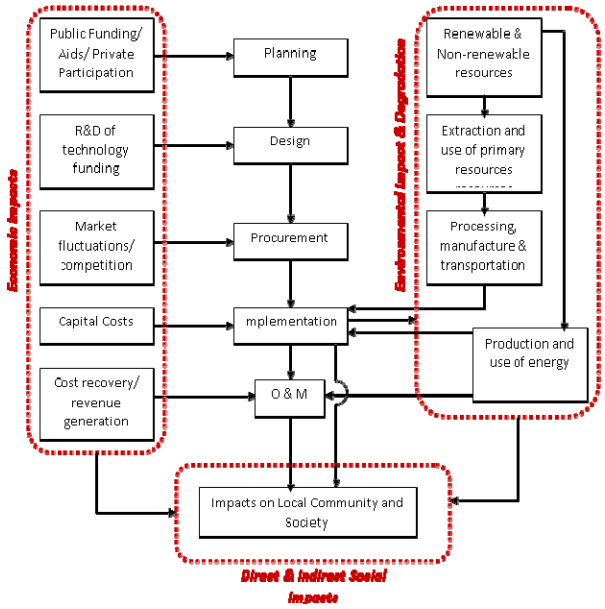

Fig. 5: Effects of Infrastructure on the Economy, Society & Environment

3.3.2 Project Sponsors: are responsible for converting a concept into a project and have a role in setting up the project vehicle by subscribing to a significant proportion of equity in it, depending upon the project's cost, sponsor's ability and lenders' requirements.

3.3.3 Special Purpose Vehicle (SPV): is a distinct corporate entity incorporated with the objective of delivering the project during the financing phase, implementing it, and thereafter operating it. It selects and appoints all the project contractors, negotiates and executes the contracts, raises financing, supervises construction and commissioning, and operates the project either directly or through an O&M contractor.

3.3.4 Project Lenders: provide debt to finance the construction of the project. Typically a consortium of project lenders, led by a "Lead Bank", ascertains a bankable project cost and in consultation with the SPV and the project sponsors, disburses debt, and performs a monitoring role during the construction phase, and on commissioning monitors the performance and operation of the project till all debt is repaid. The lenders are secured by the project assets and in case of default, enjoy substantial rights.

3.3.5 EPC Contractor: is hired by the SPV and is responsible for design of project, procurement of engineering skills and equipment to construct the project, construction of facilities testing and commissioning, all on a turnkey basis as per pre-defined specifications and within a certain cost and timeframe. Also it provides guarantees to SPV. It may choose to sub-contract certain portions of work but this does not relieve it from its sole responsibility of delivering the constructed facility to the SPV.

3.3.6 O&M Contractor: is responsible for operating and maintaining the plant in line with industry best practices. Performance parameters that need to be achieved during operations are pre-defined in the O&M contract and the contractor provides managerial skills and operations experience.

4. THE PM CONTRIBUTION TO SUSTAINABLE INFRASTRUCTURE DEVELOPMENT

Project managers are increasingly implementing – on their own initiative and at the request of clients – project management practices and processes designed more precisely to deliver sustainable projects. The figure below illustrates a generic framework put forward to help define the infrastructure system and understand its interaction with environmental, economic, and social systems.

Table 2: Checklist for Social Sustainability

Social Objectives Checklist	
Community services	Will it increase (or decrease) the number of education, leisure, cultural, health and other services?
	Will it promote an improvement (or decline) in the quality of education, leisure, cultural, health and other services?
Active and engaged community	Will it encourage more (or fewer) people to participate (actively and or passively) in cultural, leisure and or recreational activities?
	Will it lead to a reduction (or escalation) of health impacts and improvements (or declines) in community health?
	Will it provide more (or fewer) stakeholders with the opportunity to participate in Municipality's decision making processes?
	Does it reflect the multicultural nature of community?
Culture heritage	Will it facilitate the protection (or loss) of buildings or areas of significant cultural or heritage value?
	Will it be compatible with the existing built form and streetscape?
Transport and accessibility	What additional capacity (i.e no of people services, kms) will there be for sustainable transport options such as walking, cycling and public transport?
	Will the proposal encourage increases (or declines) in pedestrian access, bicycle access and public transport connections between key services, public spaces and city assets?
	How will the proposal improve (or reduce) the mobility of people especially those with a disability, older people and low-income earners?
Safe public space	How will the proposal facilitate a reduction (or increase) in crime in the city's public spaces?
	How will the proposal improve physical safety?
	How will the proposal lead to an increase (or decrease) in the amenity of the public environment (eg toilets, seating, street furniture and signage)?
	What increase will there be in the amount and accessibility of public spaces?
	Is the proposal compatible with surrounding land use?

Any infrastructure project throughout its project life cycle impacts the three essential realms (society, economy and ecology) directly or indirectly. And the impacts can be either positive or negative. The aim of sustainable development should be to maximize the positive impacts and minimize the negatives.

Sustainable Development Objectives

A generic framework may be devised to be able to address some major aspects of infrastructure projects in order to make them sustainable. The following basic social, economic and environmental objectives are what infrastructure projects shall seek to achieve:

4.1.1 Social aspects: Following may be considered:

- Community services- improve quality/quantity or increase variety of services
- Active and engaged community- cater to all sectors of community, accessible to all sectors of community (eg. disabled access)
- Cultural & heritage values- protect cultural values, urban form consistency
- Transport and accessibility- enhance public amenities and transportation
- Public health and safety- enhance/ improve public health and safety

4.1.2 Economic aspects: Following may be considered:

- Key business sectors- promotes sector growth and investment
- Life cycle costs- eg ongoing maintenance costs minimised
- Cost recovery- revenue raising, payback on investment
- City assets - enhance/protect value of assets

Table 3: Checklist for Economic Sustainability

Economic Objectives Checklist	
Key business sectors	How many new businesses will be attracted to (or lost from) the city of as a result of this proposal?
	Will it increase the number of start-up businesses?
	What will be the increase in turnover revenue for businesses as a result of the proposal?
	What effect will it have on the city's finance, generate revenue?
	What number of more (or fewer) small to medium sized businesses will start up or relocate to the city?

- Infrastructure benefits- improves transport systems and telecommunications

4.1.3 Ecological aspects: Following may be considered:

- Energy- consumption, efficiency, energy sources (eg. renewable energy sources)
- Greenhouse emissions- fuel types, abatement, sequestration
- Water- consumption, efficiency, quality, recycling Resource use- minimisation, non-hazardous, sustainably sourced
- Waste generation- minimisation, recovery, reuse, recycling

Planning & Design Stage

The following checklists (Table 2, Table 3 and Table 4) may be used at the onset itself, during the planning stages while doing the feasibility reports. This will ensure that the next stage of design is able to address most of the issues as raised through these checklists.

Environmental Objectives Checklist	
Water consumption	By what percentage/amount will this proposal reduce (or increase) the total water consumption?
	How much wastewater will be generated annually by the proposal?
	How much waste or storm water will be recovered and reused per annum (percentage/litres)?
Flora and fauna	What effect will this proposal have on flora and fauna on private and public land and in the aquatic environment?
	What will be the net increases (or decrease) in the total number of native plant and animals found within the city?
	What will be the increase (or decrease) in the number of species in the city?
	What will be the impact on the health and habitat of native vegetation and animals?

As per MoEF, Notification on EIA (Environmental Impact Assessment) provides a checklist based on 9 parameters- land, water, vegetation, fauna, air, aesthetics, socio-economic aspects, building materials and energy conservation. EIA has now been made mandatory under the Environmental Protection Act, 1986 for 29 categories of developmental activities involving investments of Rs. 50 crores and above. [6] All of the above listed parameters have been incorporated under the three wide areas of social, economic and environmental sustainability as efforts need to be made in all the domains. At this stage, detailed plans and estimates should be drawn up based on the checklist.

Table 4: Checklist for Environmental Sustainability

Environmental Objectives Checklist	
Energy use and greenhouse emissions	By what percentage / amount will this proposal reduce (or increase) the total energy consumption?
	Has the built form been designed to maximise energy efficiency?
	By what percentage / amount (tonnes) will this proposal reduce (or increase) total greenhouse gas emissions ?
	What will be the increase (or decrease) of availability of renewable energy?
	How will the proposal encourage (or discourage) the substitution of high emission fuels with lower emission alternatives?
Resource use and waste generation	How, and by what amount, will the proposal encourage (or discourage) greater rates of waste recovery, reuse and/or recycling?
	What will be the reduction (or increase) in the quantity of non-renewable materials?
	Will the proposal encourage (or discourage) greater use of renewable, recyclable and recycled materials?
	By what percentage / amount will this proposal reduce (or increase) the total quantity of waste generated?
Pollution	Will the proposal result in an improvement (or decline) in local air quality?
	Will the proposal facilitate an improvement (or decline) in the levels of noise pollution?
	Will the proposal lead to depletion and pollution of soil on sites?
	Will the proposal facilitate an improvement (or decline) in the quality of storm water run-off?
	Will the proposal encourage (or discourage) the substitution of non-renewable materials and / or hazardous materials with resources that are less environmentally harmful?

Finance and Procurement Stage

Financing options like Public Private Partnerships are a sustainable means of financing infrastructure projects. The Planning Commission of India [7] mentions accelerated delivery, cost-effectiveness, clear customer focus, enhanced social service, efficiency and effectiveness in service delivery as benefits of PPPs. PPPs not only bring about social and economic sustainability but also can bring about environmental benefits as there is an increased opportunity to use of sustainable designs, materials, and construction methods and techniques.

During this period, tendering of contractors, procurement of material, labour and service suppliers represent an opportunity to embed sustainable actions during implementation stage. Following innovative mechanisms may be used to deliver sustainable development [8]:

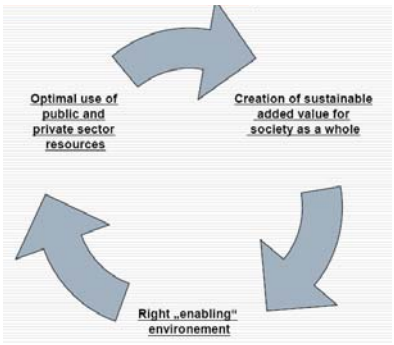

Fig. 06 PPP & Sustainability

Lane Rental makes provision for a rental fee assessment. The lane rental fee is established during design and placed in the contract to be assessed for each day or half-day of lane closure(s) in "excess" of the number of total lane rental days originally bid by the contractor. Once the lane rental exceeds the total number of lane rental days bid the predetermined lane rental fee will be multiplied by the excessive time and the result will be deducted from the monthly estimate's payment.

Warranty Clauses like Defects Liability Period shifts the risk of maintaining an acceptable level of project quality to the private contractor. This can internalize the risk of poor workmanship. Two types of warranties are currently used in the industry: (i) materials and workmanship and (ii) performance warranties. These warranty types differ by the degree to which the contractor is liable for product failure.

No Excuses Bonus is designed to provide the contractor with a substantial bonus to complete a project within a specified time frame regardless of any problems or unforeseen conditions (no time extensions allowed for the purpose of the bonus.)

Incentive/Disincentive is designed to reduce the overall contract time by giving the contractor an incentive for every day that the contract is completed early and a disincentive for failure to complete a project on time.

Liquidated Savings reward the contractor for each calendar day the contract is completed and accepted prior to the expiration of allowable contract time. Contract time is adjusted for time extensions under this concept. The amount of incentive or reward will be based on the direct saving to the Government agency related to construction engineering inspection and contract administration costs.

Bid Averaging Method (BAM) is designed to get contractors to bid a true and reasonable cost for a project. If 5 or more bids are received; the Department will exclude the low and high bids, average the rest and select the bid is closest to the average. If 3 or 4 bids are received, all will be averaged and the one closest to the average is selected. If fewer than 3 bids

are received, all bids are rejected and there is re-advertisement.

Tort Liability is applicable to a situation in which an injury or harm has occurred, due to a breach of a pre-existing duty or obligation, resulting in potential exposure for damages. Potential tort liability poses significant risk to private investors in road projects. Although there is a certain amount of financial risk, the mechanism still falls under sustainable ways of contracting for being socially and environmentally relevant.

Implementation and O&M Stage

This stage is by far the longest period in the project life cycle. Also this becomes a resource-intensive stage which will set up the delivery of sustainability for the asset's life. Moreover, there are significant costs incurred at this stage, providing a strong business case to be made for embedding sustainability into construction and operational performance. Proper commissioning can check if systems are designed, installed and calibrated to operate as intended. Energy performance can be monitored through metering. In case of infrastructure projects, wastage from raw materials used need to be effectively managed. Also redirecting recyclable recovered resources back to the manufacturing process or redirect reusable materials to appropriate sites would optimize material use.

Monitoring of Environmental Management Plan (EMP) shall be carried out in earnest by a Third party and any deviation shall be brought to the notice of the Appraisal Committee.

Constant up gradation of services and revenue generation can bring about socio-economic benefits. Customer satisfaction may be gauged by way of feedback mechanism. People's participation in operations and management of facility brings about a sense of ownership and hence reduce maintenance costs.

Sustainable Development and other PM strategies

1.1.1. Key processes involved in Human Resource Management like recruitment, deployment, development, retention and disemployment can incorporate sustainability by selecting the right kind of manpower, aligning them with their specific interest areas, training them in issues of sustainability, providing them with the requisite incentives and environment and ultimately get a feedback before discharging them so that useful information may be plugged into the process wherever required.

1.1.2. Communications management can go a great way in promoting the cause of sustainability. Governments need to communicate to their citizens the reasons behind projects, and focus efforts on creating lasting behavioral changes. This could result in community understanding and agreement on shared sustainability values and a sense of project ownership. This could change people's misperception that public goods and natural resources are "free."

Social	Economic	Environmental
Finance and Procurement Stage: As suggested earlier projects may financed through PPPs. Innovative contracting mechanisms may be used to bring about sustainability at this stage.		
Ensure procurement of local labour /contractors/ goods if possible to generate employment opportunities.	Contracts awarded on the basis of value-for-money, not lowest price. Incorporate life-cycle cost criteria.	Incorporate criteria (local materials, resource management, waste management, energy-efficient appliances, equipments etc) in contracts.
Implementation Stage		
Ensure well-being, health and safety of project staff and protect interests of the affected communities.	Deliver project within budget and time. Ensure steady cashflow throughout implementation.	Minimise environmental impacts through implementation of Environmental Management Plan (EMP) on site. Ensure quality management.
Operations and Maintenance Stage		
Seek local participation. Provide added benefits to community. Customer relationship management	Marketing strategies to ensure better revenue generation. Incorporate innovative cost recovery models.	Conduct energy audits. Monitor environmental performance of facility. Ensure quality management.

Table 5: Project Management Framework for Sustainability

Social	Economic	Environmental
Planning Stage: With the help of checklists suggested, impacts on all the three domains should be investigated to make better feasibility reports.		
Communication shall be made with people regarding the situation and need for a project. Human resources shall be identified.	Financial, economic and market feasibility studies shall be conducted. Identify funding sources.	EIAs can Identify direct and indirect impacts on environment. R&D to look for alternative sources of energy and sustainable technology.

Design Stage		
Alternative design solutions should be discussed with local residents and their feedback taken. Incorporate Universal access.	With the concept of "Do more with less", make use of value engineering in design stage.	Simulations may be run to find out approximate energy consumption and optimize use. Make use of renewable energy, green products etc. Plan construction to avoid wastage.

1.1.3 Quality has been defined in varied ways in various contexts. Some defined quality as 'value', others as 'conformance to specifications or requirements'. Taguchi defines quality as 'the losses a product imparts to the society from the time the product is shipped'. In his seminal statement- "less than perfect quality creates a loss to society"; lies the core idea of quality and sustainability– as any process that contains losses is by definition unsustainable, be it a machine such as a clock, a construction project or an eco-system. Quality and sustainability are the two sides of the same coin. Hence quality management in the infrastructure sector can definitely lead to sustainable development.

Roadmap to Sustainable Infrastructure Development

We need to make certain that sustainability is addressed during conception and design, implemented during construction and managed and monitored during occupation and operation. The following is a roadmap to sustainable infrastructure development:

5. SUSTAINABLE INFRASTRUCTURE DEVELOPMENT CASE STUDIES

Various case studies were taken up for different sectors as follows:

Table 6: Case Studies in various Sectors

Sector	Project
Transport	Mumbai-Pune Expressway
Water Supply & Sanitation	Tirupur Water Supply and Sanitation Project
Solid Waste Mangement	Sewerage System & Sanitation In Alandur
Power	New Delhi Power Limited (NDPL)

A detailed study was carried out, detailing all salient features of the projects which were thereafter assessed for sustainability in the three domains using the checklists and totaling their positive and negative impacts which were then mapped on a 'Sustainability Meter'. Following were the results:

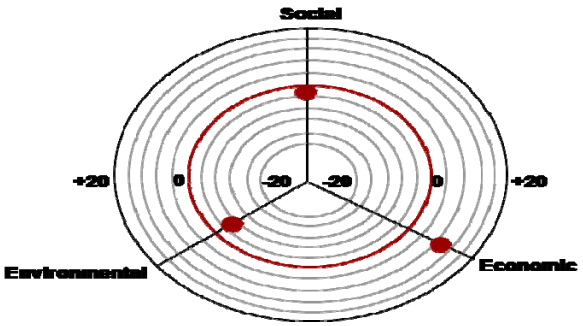

Fig. 07 Sustainability Meter, Mumbai Pune Expressway

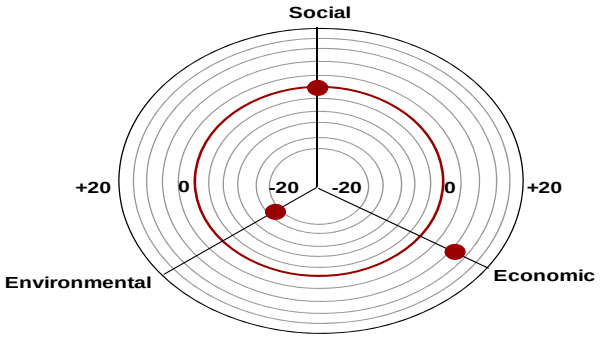

Fig. 08 Sustainability Meter; Tirupur

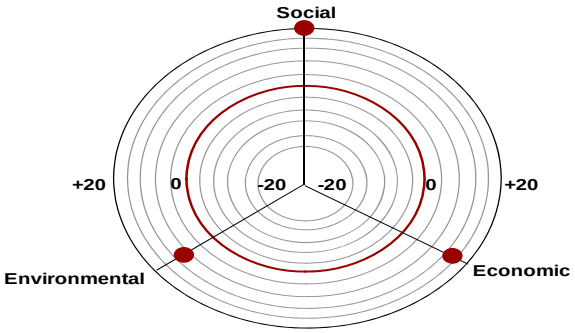

Fig. 09 Sustainability Meter; Alandur

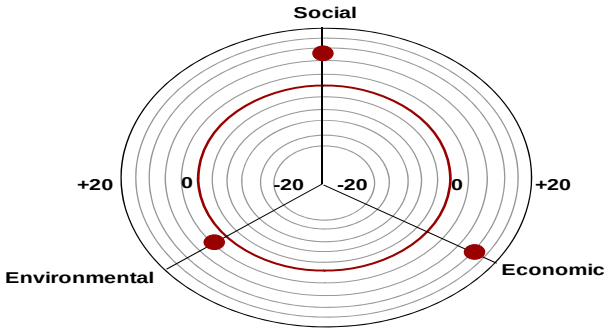

Fig. 10: Sustainability Meter; NDPL Case Study

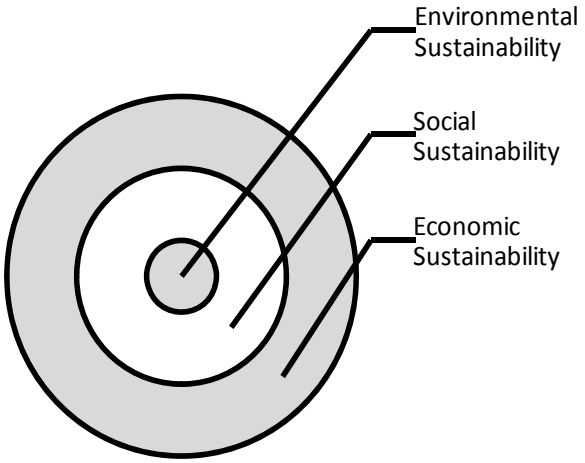

Fig. 11 Contrasting Theory for Sustainable Development

6. CONCLUSIONS

The common thread tying all the above projects was the type of financing involved in these projects. All of them were actually PPP initiatives and all were found to be economically sustainable. Hence, PPP gets validated as a means of achieving economic sustainability.

In the first three cases, EIAs were carried out but as is the case EMPs never get implemented. Projects get clearances initially but close monitoring during implementation phase, following the EMP with rigour, never takes place. In fact, in case of Tirupur Water Supply and Sanitation project [9], the Noyyal river was declared a dead river even before the project was launched. After the project got underway, its deterioration has been further increasing by the day. Pollution caused due to industrial waste continues to plague Tirupur, even as state of the art technology is being installed to extract and transport water from distant sources. New development should have first addressed the problem of existing textile industry and then decided the way forward. The project was found to be totally unsustainable on account of the environmental impact it had.

In terms of social sustainability, they all strived to achieve some sort of positive social impact as they finally did deliver to the people but some sections of the society still get marginalized and never get heard especially communities affected by such large projects. Mostly it was due to the lack of transparency and poor communications management that projects could not fare well in the social realm, except for the Alandur and NDPL project where there was direct interaction and participation of the community.

The representation of the three intersecting domains for sustainable development might not be correct after all. It has also been found from the various case-studies that projects can never address all the three dimensions equally. The three circles can never be of equal dimensions. One out of the three is always dominating or one is always left unattended. It becomes subjective then to adjudge projects on sustainability by deciding optimum levels of approach in all three directions. It might be interesting to have a fresh perspective on this theory. If the three intersecting circles are changed to concentric ones, it can still be able to represent sustainable development.

An economically sustainable project may not always be environmentally or socially sustainable as has already been seen in the case-study projects. On the other hand, an environmentally sustainable project can bring about both social and economic benefits. Hence, one shall begin with the environmental sustainability objectives. Only if there is environment, can our societies sustain and it is only because of the societies and for the societies that economy can flourish and has relevance.

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