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BES and GSC in AECI

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Abstract. Sustainable – Green Design is an approach to Plan, design, construct and innovatively salvage (considering lifecycle as an asset) the efficiencies of materials, resources, energy, water, external atmosphere, indoor environmental quality, emphasizing on minimizing environmental impacts on surrounding sites; creation of livable, productive, valuable assets, and sustainable sites; Reducing wastes. BES is achievable when implemented in 3 levels strategic, tactical, and operational. In a way implementation of process driven EMS supports sustainability efforts in identifying wastes, reducing costs, improving public relations, accommodating knowledge transfers, assisting risk management, providing visibility/avenues for continual improvement. Sustainability is sensitive to project planning, design, architecture, materials, technologies used, construction practices, project delivery, GSC/PMS taking both product & processes into account. Team productivity, performance and efficiency improve substantially if implemented on a common platform of understanding of concepts, logic and principles of sustainability in I&C environment. I&C approach of AECI stakeholders contribute to SD through Sustainable Planning, Design, Architecture & Construction. Surveys carried out by the author over 100 companies in India reveals that BES in AECI has large spread, is deeply entrenched requiring an approach and a framework as a fundamental criterion, within a contextual envelope for implementation. This paper is based more on field surveys conducted by the author and reference to numerous literatures in the field. The paper concludes by providing the basic framework/approach to implement BES along AECI GSC, and suggests that the AECI should continue to expand its R&D in Sustainable Design & Development by incorporating measurable sustainability measures & commitments to its Sustainable Business Process, and GSC for benefits to all (top, middle and bottom line) stakeholders.

Keywords: BES: Built Environment Sustainability, AECI: Architecture, Engineering & Construction Industry, EMS: Environmental Management System, LEED: Leadership in Energy & Environmental Design, PLC: Project Life Cycle, SD: Sustainable Development, WBS: Work Breakdown Structure, I&C: Integrated & Collaborative, PMS: Project Management System

1. Introduction

AECI is significant source of local employment, economic activity and energy use. It generates large scale landfill wastes, thus is ideal for implementing Sustainable Planning, Design, Green-Architecture & Construction Techniques as per regulations/specifications by evaluating/reducing Life Cycle Cost, wastes, & energy consumption. This is a requirement today due to overwhelming demand of stakeholders for sustainable assets to increase asset value by reducing the use of un-sustainable construction materials/processes; improve market for green construction products/services by adopting sustainability in their business strategy/services along Green Sustainable Construction for value creation by ensuring interaction between business practices & the environment. Many agencies emerged with their own guidelines, requirements, and criteria's by adapting precepts outlined in the U.S Green Building Council - LEED Rating System. AECI requires Green: Architecture, Design, GSC, & Construction applied in-spirit as implied needs

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than as regulations/statutory requirements with guidelines for basic requirements for project standardization, validity, visibility & Green Design Process. LEED rating system identifies 6 categories to guide/evaluate Green Design Process: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, Indoor Environmental Quality, and Innovation & Design Process. AECI faces sustainability challenges through incremental changes, requiring recognizing the complexity & Multi-Disciplinary aspects of problem.

2. Green – Sustainable Architecture In India

AECI-India is focused on green building construction practices with its fastest growing environmentally aware construction industries. Survey reveals major constraints/factors slowing down environmentally friendly property development and the pace of adaption of green practices as: 1) awareness 62% 2) education/knowledge transfer 41% 3) innovative technology 36% 4) government regulations 36% 5) Cost of Sustainability 67% 6) Code confusion. SD Genesis dates back to 2001 with green property footprint of 20,000 Sft. In Jan'2010 it was about 490 green buildings (330 million Sft) with market potential for green building material & technologies of over US$40 billion by 2012. Factors affecting positive growth of SD are: numerous tax benefits, lower loan interest rates, other financial incentives to developers of green buildings, assistance from green industry groups, regulations/codes. IGBC in 2001 was formed to drive market transformation in green building concepts/materials/ technologies. It comprises of wide cross-section of industry-stakeholders, corporate, government, nodal-agencies, architects, designers, institutions, builders, developers, product manufacturers, suppliers & facility managers. IGBC defines green building as amalgamation of many codes & standards. LEED India rating Program (for residential sector Energy Conservation Building Code, standards & guidelines, National Building Code) define use of less energy, water and natural resources; creating less wastes as healthier for the people living/working inside sustained building compared with a standard building. SD induces 30-40% energy saving from day-1; enhanced indoor air quality; higher productivity of occupants; 20-30% Potable water saving; enhanced day light/ventilation.

AECI-India is well informed & culturally sensitive to the need of environment-friendly construction techniques, innovative ideas & practices are combined with modern resources, designs & materials. Solution for SD is localization of Green concepts/principles, promotion of green building materials & technologies, and sales programs alongside educational programs. BES depends on project phases, types and stakeholders. ***Stakeholders***: individuals, project owner, functional units, operations team, Architectural & Engineering design & construction team, vendors, suppliers, organizations directly & indirectly involved in project (client to end user), external parties-involved in commercial, residential, civil infrastructure, industrial, housing, & real estate development. ***Project Phases***: planning, designing, construction, procurement, commissioning, operations & maintenance; ***Project types***: new & re-construction; rehabilitation; retrofit.

BES is attained on implementing in 3 levels: **strategic, tactical and operational**, with sustainability as fundamental criterion for decision making at every stage of PLC/GSC. BES needs eco-friendlily landscaped human environment factors; utilization of renewable energy sources; effective environmental protection, preservation to enhance natural features and (appropriate) biodiversity; work that stalls environmental/social damages and controls Micro/Macro environmental pollution. Implementation of BES requires Positive publicity & media comments to encourage environmental & community improvement, and sustainability activities of wider environment & ecosystem by comparing to past. Architects require continuous professional development & knowledge to make Sustainable Design & Development possible for sustainable living by delivering built development to sustain life by improving, monitoring and reporting through Life Cycle Assessment, the complex product-based practice requires knowledge of all product development stages, Regulations, implied needs, statutory requirements, hedging against future legislation & regulation.

3. Strategic Level

AECI requires fundamental approach/frame, facilities/infrastructure systems at strategic level within a contextual envelope with BES as a fundamental criterion to achieve Sustainable Architecture & Design to enable decision making for actions to advance strategic SD approach and have edge over business competitiveness. This requires factors/immediate actions, meeting requirements, Specific facility Characteristics, Infrastructure Systems; End Product associated Processes, Consumed Resources promoting

Project Delivery & uses. Case dependent applicable actions are: 1) Internal: Incorporate sustainability precepts into strategic management decision making, Develop & maintain EMS, Seek/obtain ISO 14001 certification, Develop sustainability "best practices" living document to ensure efficient knowledge transfer, Prepare & identify baseline operating parameters for future environmental improvement measurements, Develop manager training programs emphasizing EMS, SD, Corporate Social Responsibility, and assess positive impact on the triple bottom line. 2) External: Develop growing portfolio of Sustainable Design & Construction expertise for sustainability leaders, obtain market-share in high-growth sector, incorporate sustainability practices both internally/externally into contract/subcontract requirements, Communicate sustainability efforts/benefits to triple bottom line, local stakeholders, elected officials, and investors.

4. Tactical Level

Tactical level includes sustainable planning, design, Procurement, construction commissioning, operations & maintenance. Sustainability is fundamental decision making criterion for stakeholders at every PLC-stage requiring common ground for understanding the concepts/logics/principles to achieve High Team Performance. BES implementation must ensure sensitivity to project planning/design, Architecture, materials, technologies, project delivery & PMS (both product & processes). Fundamental application knowledge of processes/practices/operating procedures applicable in each project phase/stage along PLC is essential to provide entry point for formal/explicit proportionally varying inputs manifested to establish overall BES.

4.1. Sustainable Planning

Initial Stages include Pre-Project planning (Architectural building schemes/Planning), funding approval, systemic analysis of the attributes, project definition development, schematic/conceptual designs; outline of project requirements, characteristics, & qualities with a formal/explicit setting of project performance goals for BES, site selection, corporate business aligned project objectives & scope for BES with physical/nonphysical contextual constraints, influence cost-effectiveness of overall project sustainability. Pre-construction planning process requires creating Green Design synergies among project stakeholders. Technological improvements in sustainability systems increase efficiencies of building systems, procurement, GSC operations, materials, resource recovery, and life-cycle asset values. For realization of system-wide benefits, sustainability must be regarded as a system not as component. AECI must Integrate & Collaborate sustainability as an asset evaluation-metric into all existing criteria, communicate the financial benefits of waste minimization, pollution prevention, and LEED certified assets. As part of I&C process, this paper enlists all factors that need to be taken care along PLC/GSC of AECI during the implementation of the BES.

4.2. Sustainable Architecture And Design

To attain sustainability prior to start of on-site construction operations through sustainable site development & design of: concepts/schematic & detailed design, integrated building systems, energy & water efficiency schemes, material use, indoor environmental quality, implementation of EMS, maintaining relationship with project specific client, Regulations, implied needs/statutory requirements, hedge against future legislation & regulation. These attributes end with development of contract documents, bidding, negotiation, award of the construction contract marking transition to start of on-site construction activities/operations. The challenges of Sustainable Design is to provide holistic planning for overall BES, ecological balance for improved life quality, multiple schemes for safety/reuse; improved performance of existing built assets, relate land-use planning/transport infrastructure, Enhance biodiversity, preserve/ conserve/restore archaeological heritage features, Capture Rain water & recycling grey water as non-potable water, design for increased water efficiency-building services, solve water problem/conserve water resources, accommodate other civil works, minimize transport, design for minimized whole-life energy consumption in (general, transport, construction); respect people indicators, quicker planning permissions, land use, Locate new developments in appropriate localities, design to minimize nuisance to neighbours during construction/operational phase; provide Eco-designs-product design with desired environmental considerations.

4.3. Sustainable GSC, Materials, And Equipment Procurement

Parallel activities between design & construction phases interfaces GSC providing technologies, systems,

products, materials, resources and equipment as per project specification (laid down jointly by architects, designers, engineers & other stakeholders) depending on project scope/size, keeping in view the statutory/implied/regulatory needs for project realization in physical form on-site. Considerable Factors at this stage are packaging, reduction, elimination, recycled material contents, waste minimization, and alternative manufacturing processes to minimize micro-environmental issues. Coordination between the return material rates/actual demand; %age volume of useable materials from sustainable sources. Reducing/modifying the amount of packaging/packaging-material; efficient/prudent use of natural resources (water/others); waste minimization; elimination of hazardous materials, facilitate material reduction/recovery, dismantling, recycling, collection, sorting & transportation of used materials for re-manufacturing, Internal Environmental Management, External GSC Management practices, Investment recovery, Eco-design-product/process-based are factors to be governed along GSC/PLC processes. The nature, performance levels, desired attributes of resources are fixed by project design/logistics, specified architectural/construction materials brought into work-site. GSC must govern 3-types of environmental relationships: 1) setting environmental requirements, 2) sharing information 3) collaboration for products/processes improvement. Greening the supply is: 1) process-based: incorporation of environmental practices into supplier's management, 2) Product-based: changes in the product supplied, 3) Advanced green supply is proactive measures into the customer-supplier relationships (such as environmental goals in supplier selection).

4.4. Sustainable Construction

Construction Stage bridges the gap between concept designs to on-site project realization (project completion). BES is achieved by proper planning & construction operations, that begin with project start-up and marks transition to operations phase like site disturbance, indoor environmental quality, construction recycling & resource reuse, and construction health & safety. Factors for consideration in this phase are: Design for lean construction; site waste management plan for minimization of: waste, effective use of resources, inventory; delays; site security; construction process; direct costs from construction phase, reportable accidents & incident rate; operational; embodied energy & consumption. Reverse Logistics plans, transportation, incineration, environmental criteria for supplier selection, environmental attributes/requirements in approved vender & suppliers list, type of waste generated, re-using methods, recycled/disposed, actions performed by customer/supplier (collection, composting/disposal of goods traded between stakeholders(involving detailed amount). SD & project delivery is achieved if GSC is normal way for building works (Architects & engineers take imitative, lead, involve & listen to others).

4.5. Sustainable Commissioning

At Construction Stage all building systems/equipments are installed and tested for desired/specified performance parameters. Poor/lack of commissioning escalates costs (Operation/management) substantially resulting from in-efficient energy/water uses, and bears direct negative impact on labour Productivity.

4.6. Sustainable Operations & Maintenance

Sustainable Operations (total operation, maintenance, management of facilities/infrastructure systems till decision making on end-of-service-life of the facilities/systems), involves effective planning & resource allocation over the operational life of the facilities/systems. This stage factors for BES are: indoor air quality; thermal comfort; light quality; energy, water, resource conservation; and waste management. Explicit due consideration to be given to the future of the facilities/infrastructure system at the end of useful life of the facilities during PLC, identify mechanisms for disassembly/reuse components, recovery/recycling of materials, and reclaiming the site. Stakeholder's awareness to the decisions, choices and actions undertaken at any stage of project phases impact the project at this final point of facilities/infrastructure life.

5. Operational Level

Operational level defines integrated approach to project definition & design within an AECI project by providing multiple entry points for formal & explicit input of BES in its varied manifestations.

5.1. Sustainable Integrated Project Design

Solutions from project Phases, processes, & project stakeholders (Architectural, Structural, Mechanical, Electrical, Civil, & others) contribute to overall BES. Project design Integration is required for: parallel development; increased levels of coordination & detailing (concept, schematic design, design development, contract documents); to adopt regulatory mechanisms for flow of design, data, knowledge & information along inter/intra project phases among the stakeholders. Integration requires processes for analysis, generation, evaluation, selection, specification; decision making; and conflict resolution. Performance check provision in each project phase before proceeding to next design phase is must. Project performance enhancement analysis is the output for each performance check Parameters that provides mechanism for formal, explicit, systemic input and expansion of the specialized data, knowledge base, experiences, information, and assimilation of lessons learned from the present and previous experiences.

5.2. Sustainable Integrated Project Definition

I&C approaches bridges cohesively the sustainability efforts throughout AECI projects multi-dimensionally. Project Definition Package is the foundation for implementation/operations in BES. It defines project specification from stakeholder's perspective, includes Project Definition Process consisting of 3 phases: formation, communication & integration. ***Formation:*** is aligned to stakeholder's implied, statutory & regulatory needs/requirements. It is anchored to the vision, mission, strategic plan, & business plan of the project, provides point of departure for the project. 2) ***Communication:*** links design, construction, procurement, and external party's perspectives. 3) ***Integration:*** aligns & integrate project perspectives.

5.3. Sustainable Integrated Project Definition Process

7 main Project Definition Steps define the processes/characterizes project based on industry sector, project type/scope; identification, definition, key players documentation; principal project goals/objectives; characteristics - physical/nonphysical project contexts; major/minor project risks. Principal internal/external influences with potential to affect project performance are: 1) Project definition parameters 2) project execution plan 3) project team definition 3) integrated design package 4) design solution defining project responsiveness 5) production process plan 5a) production process model 6) WBS 7) project commissioning plan 7a) project procurement plan 7b) 3D spacial data/information model 7c) time/cost financial model.

5.4. Sustainable Integrated Project Definition Parameters

Performance factors: 1) contextual 2) compatibility 3) responsive 4) functional 5) formal/physical, cost, time, quality 6) reliability, safety, risk, procure ability, constructability 7) commission ability performance 8) operability 9) maintainability 10) security 11) health performance 12) sustainability performance. These 12 parameters require Formal, explicit, systematic, and systemic identification & documentation.

5.5. Physical & Non-Physical Contexts

Links project with the general business environment (bearing project site characteristics), other projects, & all external parties. ***Physical Context***: analyses geographical location, accessibility, transportation options, surface/subsurface & environmental conditions, existing infrastructure, surrounding activities/assets. ***Non-Physical Context:*** analyses policy issues; legal/regulatory; applicable codes, standards, regulations; issues (economic, financial, political, social, cultural, industrial and technological), public relations; community.

5.6. Project Execution Plan

Defines project execution mechanism through project, design and construction team link; establishes overall strategy based on 1) Execution Quality, initial conformance, long-term performance, redesign & improvement. 2) Most appropriate delivery system, 3) Project contract type characterization based on unacceptable/prudent reversible project risks, Probability assessment; allocation & impact of project risks (assessment, avoidance, mitigation, & management), prevention of total/partial failures, 4) protection of people, property, environment from natural, human-caused events & disasters.

5.7. Project Team Definition

Defines common well-defined goals/objectives for the project; implements: partnering development-team building process, project alignment/misalignment elimination process; partnering/team maintenance

process; strong quality leadership (on-going basis) defining the project team members/stakeholders. Establish a set of acceptable tolerances & team norms within which the team operates & co-relates;

5.8. Sustainable Integrated Design Package

Provides design solution by linking project & the design team from a product definition point of view

5.9. Sustainable Design Solutions

Defines project responsiveness to every element of project definition package like: ascertaining methods of user's physical health & well being; background; design requirements affected by the end-user's living & building conditions; lifestyle; project services methodologies supporting users; list of actionable occurring activities/processes, intra/inter-relationships; solutions for site-layout issues; performance of solutions over time; identification of adoptable technologies, systems, products, materials, equipment and their performance over time; issue based solutions for easy procurement, construction, commissioning & start-up; ease of operations, maintenance & security. ***Sustainable Design Solution*** is the function of indoor air quality; potable water quality; emissions from materials (e.g., paints, carpets, adhesives); lighting, noise pollution, work environment & comfort; methods to eliminates/reduces/mitigate impacts; resource consumption/waste generation; eco-system & environmental impacts to air, water, soil, and biota; Current & future human impact on all project stakeholders. ***Production process plan*** defines fabrication, project logistics requirement, provides project links with SC vendors & suppliers, overall strategies for supply & delivery of all required technologies, systems, products, materials, equipment, site installation, testing, turnover, workflow production unit control through Production process model defining the production process parameters followed at worksite during project construction.

5.10. WBS

Contains hierarchical levels representing increasingly detailed description of project elements for work breakdown (Specifically/generally) for easy project tracking (both process/product perspectives): 1) ***General Project WBS*** (project, contractual, organizational & resource) depends on project requirement. 2) ***Specific project WBS*** is of 2-types A) Specific Product-Oriented WBS (functional, building systems/processes, building components & elements); B) Specific Process-Oriented WBS (models of cost, time & cost control).

5.11. Other Plans And Models

1) Project Procurement Plan defines procuring methods of project resources. 2) ***3D Model*** defines 3D spatial data-information & solutions. 3) ***Sustainable Integrated Project Commissioning Plan*** defines method of commissioning building systems & equipment in the project. 4) ***Time & Cost-Financial Model*** defines specific parameters to ensure project cost & time performances like: cycle-time of the PLC phases, financing packages, Total Installed Costs, Operations & Maintenance costs, Life Cycle Costs

5.12. Sustainable - Social, Environment, Investment And Administration

Respect people, local environment, minimize nuisance to neighbours/grievances of ethical nature. ***Social:*** demonstrate corporate citizenship, social responsibility; involve/respond to local communities; Project plan for social progress meeting stakeholders needs; enhance individuals/societal development schemes to maximize positive impact on quality of life (social), minimize adverse social impacts/local opposition. Provide basic practical appropriate monitored education at gross root level of AECI. ***Investment:*** Trends in mainstream investment maintain high/stable economic growth, stability & employment by human resource investment, enforce engineers to be SD-sales force, enhancing social responsible & Corporate Community investments (social capital). ***Administrative:*** Small, positive step forward is relevant/worthy. Persuade clients/government/friends to avoid pollution incidents & environmental degradation leading to fines/court costs/damage to reputation. Generate positive publicity for project stakeholders, demonstrations by developers on their consciousness to administrative & staff sustainability through %age of employees receiving appraisals, absenteeism rate, Pension schemes, Staff turnover, Sickness absence, poverty reduction; Reward & recognition, financial, training/provision of information.

6. Conclusion

Implementation of BES occurs in 3 levels (strategic, tactical and operational). Tactical level: sustainable planning/design, Procurement, construction, commissioning/operations/maintenance. Operation level: integrated approach to project definition & design provides multiple entries for formal/explicit inputs of BES in varied manifestations. BES is achieved by adopting mechanisms to regulate flow of design/data, knowledge & information between inter/intra project phases among stakeholders in the processes for analysis, generation, evaluation, selection, specification; decision making; and conflict resolution. Sustainable I&C project design approach bridges multiple factors cohesively for overall BES. Project Definition Package is foundation of operational implementation of BES and defines project particulars from stakeholder's perspective. This includes Project Definition Process in 3 phases in 7 steps characterizing project: formation, communication & integration. Physical & Nonphysical project Contexts provide project link with characteristics of project site, other project, all external parties, and with the general business environment. Project Execution Plan provides linkages between project, design & construction team to establish overall strategies, execution qualities, delivery system, contract type, protection of resources & environment. At every stage GSC & PLC processes are mandatory besides the EMS practices.

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