Integrated Design Process and Green Mark: An alliance for design of sustainable buildings in developing countries

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IDP and Green Mark towards Sustainable buildings

In the present complex systems of construction industry which strives for achieving sustainability, integration of all building systems and agencies has become critical and essential. Integrated design process (IDP) is a method of realizing high performance buildings that contributes to sustainable communities. IDP is being extensively used in Canada and USA. Green building rating systems aiming for energy savings and sustainability have been developed such as BREEAM (UK), GREEN STAR (Australia), LEEDS (USA), Green Mark (Singapore) etc. Their aim is to enhance and measure the sustainability measures adopted by various projects in the respective countries. Green Mark of Singapore has been made as a statutory compliance which all projects have to achieve through scoring/certification.

The objective of this paper is to ascertain whether processes of IDP and GM collectively could help developing countries like India in achieving sustainable non-residential buildings.

IDP process and GM scoring/certification guidelines were surveyed among Architects of registered Architectural firms in New Delhi, India. 200 surveys were sent. 94 surveys questionnaire were received. The results demonstrated IDP as favoured concept with barriers to its acceptance. These barriers were: a) lack of strong contractual system; b) ignorance of client; c) lack of government push for integration; d) high cost for designing; e) architect reluctance in integrating design. Regarding the scoring criteria of GM, survey responses suggested that it resemblance to Indian green building council (IGBC). The scoring system was appreciated by 90% of the respondents. Some barriers to GM scoring were registered: a) lack of government push; b) reluctance by consultants; c) reluctance by clients to complex process of certification; d) extra cost involved.

A pilot application model of IDP+GM is developed in this paper as guideline for architectural firms in India to achieve better sustainable non-residential projects. It is concluded that integration by means of IDP and GM is supported by architects/ designers in India to achieve better sustainable buildings. However there is need for the proposed IDP+GM application model to be flexible to different project requirements.

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Keywords: Integrated Design Process, Green Mark, Sustainable buildings, barriers, application model.

1. Integrated design Process

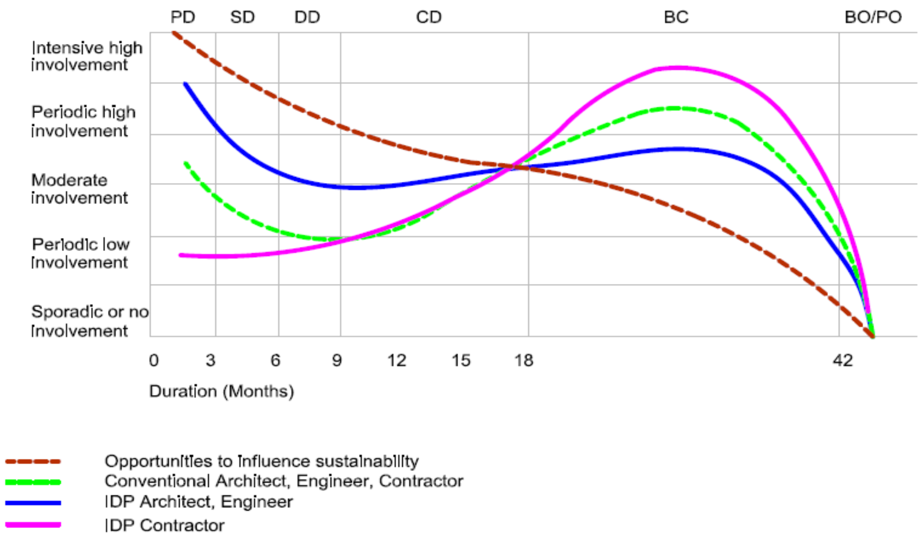
Building design as suggested by Boyd (1965) is like a puzzle. The puzzle is the unique set of problems and requirements set by the client and a host of other factors including site, legal constraints, function, budget and so on. Paul et al. (1999) mentions that optimizing components in isolation tends to pessimize the whole system and hence the bottom line. System becomes less efficient by not properly linking up the components. As components are not designed to work with one another, they will tend to work against one another. Modern buildings generally involve a lot of disciplines including structural, services, architecture, interiors and so on, therefore, the design puzzle requires cooperation and coordination among the various disciplines.

As per Gail & Joel (2003),the design process needs to be based on a holistic approach, one that considers from the beginning issues like site development, building design, construction, operation and maintenance (the life-cycle costs of a building). This can be achieved through the use of an Integrated Design Process (IDP). William & Elliot (2000) state, that IDP supports multi-disciplinary teamwork and improves the integration of building, community, natural and economic system.

The IDP process is a method that brings together a multi-disciplinary design team of architects, engineers, specialist consultants and cost surveyors, stakeholders and building users in the initial design stages to collaborate on creating novel design solutions.

The Integrated Design Process (IDP) has been developed on the basis of experience gained from a small Canadian demonstration program for high-performance buildings called as C2000 program. This program was designed in 1993 as a small demonstration of very high levels of performance. Its technical requirements covered energy performance, environmental impacts, indoor environment quality, functionality and a range of other related parameters. The ambitious performance goals of the program led its managers to believe that the incremental costs for design and construction would be substantial, and provision was made for support of incremental costs in both the design and construction phase. However, after the first six projects were designed and completion of two of them , it was found that that incremental capital costs were less than expected, partly due to the fact that designers used less sophisticated and expensive technologies than anticipated. Despite this, the projects reached the required performance targets. The designers all agreed that application of the design process required by the C-2000 program was the main reason why high levels of performance could still be reached. The C-2000 process is now called the Integrated Design Process (IDP).

It is a collaborative process that focuses on the design, construction, operation and occupancy of a building over its complete life- cycle. The integrated Design Process (IDP) has been identified by many leading green designers as an essential tool for realizing sustainable buildings. Figure 1 below captures the differences in involvement of design teams in an IDP process and a conventional linear process of building design and construction.



Source: Author

Fig. 1: Image showing the involvement of design teams in IDP and linear process

In IDP the involvement of architect and design team is more extensive in PD (Pre-design), SD (Schematic design) and DD (Design development) stages in comparison to moderate involvement in these stages by a conventional / linear process design team. The reasons for this high involvement are the extensive discussions via workshops between the team members and stakeholders of project on all the aspects of the project.

As IDP favours the participation of contractor in early stages of project to unable constructive comments and for bridging the abyss between design and construction planning, therefore figure 1 indicates the involvement of IDP contractor in PD stage which gradually strengthens as it reaches the building construction (BC) stage. Figure 1 shows that in PD and SD stage, the sustainable characteristics of a project could be majorly influenced. This is owing to the reason that in PD and SD stage all major design and sustainability decisions are discussed and taken jointly by the stakeholders of the project. As PD and SD stage gives the design team an ample opportunity to work on various options of sustainability practices without the risk of any construction work happening therefore all these opportunities of sustainability prove to be cost-effective having ample possibilities of iterations.

The graph clearly indicates that, IDP team due to its high involvement in respect of a conventional design process, in PD stage followed by Schematic design and design development stage, could yield a better benchmarking of sustainability goals. This is owing to more interactions and communications between the team members. Consequently it would lead to an integrated design which will adhere and perform better in accordance to the predetermined sustainability targets and goals. In addition to the above benefits in IDP process the involvement of IDP team is less observed in building construction stage as compared to a typical conventional process. This majorly owes often due to changes, abortive works, detailing that is happening in this stage in a conventional process.

Integrated design process (IDP) standard description: As per (Reed et al. 2009) IDP following steps is the standard process description in IDP.

Step1: Research / Analysis: Individual expert team members initially develop a rough understanding of the issues associated with the project before meeting i.e. ecological systems, energy systems, water systems, materials & skill resources. This helps design process to begin with a common understanding of the base issues.

Step 2: Workshop: Team members come together with all stakeholders in the first workshop (charrette) to compare ideas, to set performance goals, and to begin forming a cohesive team that function as a consortium of co-designers. By being in relationship to each other, each team member allows the issues associated with the system for which he or she is responsible to come into relationship with all others, so that more integrated and optimized project results could be obtained.

Step 3: Research / Analysis: Team members go back to work on their respective issues for refining the analysis, testing alternatives, comparing notes, and generating ideas in smaller meetings.

Step 4: Workshop: The team reassembles for a deep discussion of overlapping benefits and opportunities. They work on utilization of the “waste” products from one system to benefit other systems. New opportunities are discovered, explored and tested across disciplines, and new questions are raised.

Step 5: Research / Analysis: Team members go apart again to design and analyze with more focus and potentially with greater benefits accruing. New ideas are uncovered.

Step 6: Workshop: The team reassembles once again to further refine the design and to optimize systems being used (building and mechanical systems) and to integrate systems connected with the project (sun, water, habitat, materials, etc.)

The above pattern continues until iterative solutions move as far as the team and client wishes. Simply stated, good integration is a continuously dynamic iterative process. It is a continuous circling process, one that encourages exploration in order to ensure discovery of the best opportunities, while permitting continuous adjustments as more understanding emerges. Three to five charrettes/workshops are the typical number of large meetings required to move integration forward, in conjunction with many additional sub-meetings. When and how team members interact is the responsibility of the project manager or integration facilitator.

2. Singapore Green Mark

In order for a country to progress, the development of land into buildings for commercial purposes comes along as part of the progressive step. As a result of the country’s progression, a built environment follows up shortly and uses a significant amount of scarce resources contributing enormously to the production of global emissions and waste

(Edwards, 2002). The health of people living around the world and the state of the natural environment are being affected negatively due to the construction activities taking place (Forsberg and Von Malmborg, 2004). In order to acknowledge the destructive effects these construction practices have on the natural environment, building performance is a rising concern amongst building occupants as well as the built environment professionals (Crawley and Aho, 1999; Ding, 2008; and Kohler, 1999). In order to address this concern of minimizing environmental impact of the buildings' design and operation, many researchers have devised methods for the measurement of the environmental performance of buildings with the creation of a sustainable built environment in mind (Crawley and Aho, 1999). Green buildings are favorable as they are designed to minimize and ultimately eliminate the overall negative impact of the built environment on the health levels of human as well as the natural environment. Various tools have been developed or adapted from existing green assessment tools (Cole, 2005; and Haapio, 2008). These green building rating tools can be referred to but not limited to green building rating systems (Yudelson, 2008) and building environmental assessment tools/methods/systems (Gomes, 2007; and Cole, 2005). The objective of these tools is to enhance the environmental awareness of building construction practices as well as provide basic direction for the building industry to head in the direction of environmental protection and achieve sustainability (Ding, 2008) since they provide a measurement of how successful a building has been when expected level of performance in various declared criteria has been met (Cole, 2005). There has been a steady increase in anxiety and concerted action taken by individuals (and also by groups from diverse communities), in addressing environmental troubles on global, national and local levels (Ho, et al., 1997). Awareness and emphasis on environmental issues everywhere in the global landscape has mounted, and "green" businesses are rapidly becoming "the world's fastest growing industry" (Cheam, 2007). Governments in many countries have recognized the advantages of green buildings and are passing laws to make green building measures compulsory. For instance, Leadership in Energy and Environmental Design (LEED) certification is a highly recognized standard administered by the U.S Green building councils. It promotes design and construction practices to increase profitability and reducing the negative impacts of buildings (Cryer at al., 2006).This worldwide development has also influenced the construction industry in Singapore.

In Singapore the government is looking to have high-performance, sustainable buildings through the use of statuary norms like GM scheme. Therefore good GM score translates for better/high performance and more sustainable buildings. To achieve this it integration has been repeatedly emphasized among all the disciplines of construction. The Green Mark Scheme (GMS) was launched in January 2005 to evaluate existing and new residential and non-residential buildings in Singapore for its environmental impact and performance. Singapore BCA's GM Scheme is endorsed and supported by the National Environment Agency. It assesses the environmental impact and performance of new and existing buildings. It aims to promote sustainable design, construction and operations practices to develop energy-efficient and water-saving buildings with extensive greenery and healthier indoor environments (BCA, 2011).The Version 4 criteria came into effect on 1 December 2010. The objectives of the GMS consist of the promotion of environmental sustainability, awareness amongst developers and promotion of green & efficient innovations; recognize the efforts by building owners in the creation of environmentally-sustainable buildings and to identify good practices in the development and design of green buildings. The Green Mark has received affirmation from the United Nations expressing interest in a tie-up with the BCA in research and training programs to promote environmental friendly buildings. The chief of sustainable consumption and production at the UN's Environment program, Dr Arab Hoballah, regards Singapore as an "Asian regional bridge" for promoting green building methods (Green Mark building scheme gets UN attention, The Straits Times, 12 September 2011). The Green Mark building scheme has come a long way since its launch in 2005 with only 17 buildings certified. The fourth version for new buildings was launched end of year 2010 and the number of Green Mark certified building across Singapore now stands at 1120. This 50 fold increase was over a period of 6 years. It took fine tuning and promotion through introduction of government incentive schemes, and education of the public to make green a change to support in the long-run.

LEED finalized version for New Construction and Major Renovations (LEEDNC) Rating System was launched in 2009 in United States of America. It is different from GM primarily on LEED’s prerequisite/credit alignment and harmonization, predictable development cycle, transparent environmental or human impact credit rating and regionalization (Sentman et al., 2009).The LEED-NC point’s allocation is based on applicant projects’ potential environmental impacts and human benefits of each credit with respect to a set of impact categories. The impacts are identified as the environmental or human effect of the design, construction and operation and maintenance of the building, such as greenhouse gas emissions, fossil fuel use, toxins and carcinogens, air and water pollutants as well as indoor environmental conditions (USGBC, 2009).For eligibility, applicant projects must comply with the Minimum Program Requirements (MPR). They include compliance with environmental laws, minimum occupancy rates, and commitment to sharing whole-building energy and water usage data.

British Research Establishment Environmental Assessment Methodology (BREEAM) was established in 1990. It is updated regularly in line with United Kingdom’s (UK) building regulations. Its stern assessment criteria and transparent evaluation methods have influenced development of other rating systems like LEED and GG. Having certified more than 100,000 buildings, including 3,000 outside the UK, it is claimed to be the most widely used rating system worldwide. BREEAM addresses environmental issues, construction methods, materials and products used to recognize good environmental performance. Green Globes (GG) was originally adapted from BREEAM by a private Canadian company to rate newly constructing developments, major renovations and existing buildings. Today, it is used for rating both commercial and multifamily projects in Canada and USA. It was adopted into the USA when the Green Building Initiative acquired the license to promote it in 2004. Since then, recognized as a standards developer by the American National Standards Institute (ANSI), the Green Building Initiative established GG as an official ANSI standard. A building’s sustainability assessment, education and feedback are provided throughout the design-build-commission project life-cycle. Based on its sustainability enhancement suggestions, assessed projects are expected to consume fewer fossil fuels, reduce greenhouse emissions, conserve water, reduce pollution, and minimize impact on the land surrounding the building and offer better working environments for occupants (The Green

Building Initiative, 2011). To earn a formal certification, an applicant project must submit an order for a GBI authorized and GG-trained third-party assessor to evaluate the building.

2.1 Comparison of assessment parameters of GM with LEEDNC, GG and BREEAM.

This research discusses on the BCA GM Certification Standard for New Buildings (Non-Residential, Version 4.0). Following table 2.1 gives a comparative credit/scoring statement of GM, LEEDNC, GG and BREEAM as per their respective parameters of assessment.

Table 2.1: Comparison of assessment parameters of LEED, GM, GG and BREEAM.

Comparison of scores/credits for: GM , LEEDNC , BREEAM and GG			
1	GM {Non-residential Version 4 New Buildings}	190 credits	Source: BCA, (2010).BCA GM Certification Standard for New Buildings.
2	LEEDNC 2009: New Construction and Major Renovations.	110 credits	Source: (USGBC, 2009). LEED 2009 For New Construction and Major Renovations Rating System.
3	BREEAM (2008) New buildings	115 credits	Source: BRE Global Limited. (2010). BREEAM Offices Scheme Document 5055 issue 4.0
4	Green Globes New Construction 2011(The Green Building initiative).	885 credits	Source: The Green Building Initiative. (2011). Retrieved from http://www.thegbi.org/green-globes/ratings-and certifications.asp

Assessment criteria of GM for New Buildings (Non-Residential, Version 4.0)

This research will focus on the BCA GM Certification Standard for New Buildings (Non-Residential, Version 4.0). It consists of two main sections, (i) Energy-related requirements where points are allocated to energy-efficient designs, practices and features and (ii) Other green requirements where points are allocated to water-efficient features, environmentally friendly design practices and innovative green features.

The first section consists of only Energy efficiency. The second consists of four categories – Water efficiency, Environmental protection, IEQ and Other green features. Applicant projects are assessed, evaluated and rated based on these five categories: 1) Energy efficiency (116 points available);2) Water efficiency (17 points available);3) Environmental protection (42 points available);4) Indoor environmental quality (8 points available); and 5) Other green features (7 points available).

2.2 GM Rating, Eligibility and Certification

The points-system is divided into two sections. 116 points are available for Energy-related requirements; 74 points are available for other green requirements. Thus, a total of 190 points are available. The building design's overall score is an accumulation of scores assigned based on the degree of compliance with the requirements (BCA, 2010). The applicant project is then certified in accordance to the rating system as shown below.

Table 2.2: GM for New Buildings (Non-Residential) V4 rating system (Source: (BCA, 2010))

Rating level	Range of points/scores
GM Certified	50-74
GM Gold	75-84
GM Gold^{Plus}	85 – 89
GM Platinum	90 and above

3. Research Method

In developing countries like India who have realised the importance of sustainability since last decade, an attempt is being made to design and construct sustainable buildings. Similar to other countries India has its green agency IGBC (Indian green building council, http://www.igbc.in/site/igbc/index.jsp). The vision statement of IGBC is to enable a sustainable built environment for all and facilitate India to be one of the global leaders in sustainable built environment by 2025. However since its inception in 2001, IGBC has been successful in certifying only 1795 buildings all across India. This stresses a significant gap in motivation towards building green sustainable buildings. In India architects, head the design team in a project. They are the main agency influencing the design towards sustainable parameters. In this paper a research is done to investigate the usefulness of IDP and GM benchmarks towards sustainability in context of a developing country India.

Based on the literature review, a questionnaire was designed for survey with the objective of ascertaining the relevance of IDP process and GM certification. Part I of the questionnaire requested respondents' background information for the purpose of identifying whether the respondents are suitable targets. In Part II of the questionnaire, each respondent was given a brief introduction of IDP process. Thereafter the respondents were presented with several questions regarding the use of IDP in their current design process. Respondents were also asked about the barriers to IDP in Indian context. In Part III of the questionnaire, each respondent was given a brief introduction of Singapore GM certification. Thereafter the respondents were presented with several questions regarding the possibility of GM like mandatory certification in design and building permit process in Indian scenario. Respondents were also asked about the barriers to GM process in India. Most of the questions of part II and III were qualitatively expressed on the Likert scale of 1 (poor) to 5 (excellent). Eventually, open-ended questions were provided for respondents to list other comments for improvement, if any.

A pilot study was first carried out to test the relevance and comprehensiveness of the questionnaire before it was sent to the respondents in the industry. The pilot survey involved eight participants: 2 professionals using IDP in US and Australia, 2 certified project managers/architects having projects with Singapore GM certification in Singapore and 4

Architects with above 20 years experience in India .They possess the requisite knowledge and skills that would enable them to operate the buildings in a sustainable way and to undertake sustainable improvement measures to reduce the building's environmental impact over its functional life cycle. Based on the pilot survey, the questionnaire was finalized, and the formal survey was carried out in India.

Target population of the questionnaire survey were Architects, who had minimum 10 years experience in the construction industry in India (New Delhi) and have been involved in non-residential projects. As it was difficult to determine the exact population, therefore the list of registered architectural firms was taken from council of architecture in India. Contacts were then established with the principal architects of the architectural firms. As an incentive to encourage participation, it was conveyed in the survey questionnaire that the findings can be shared with the respondents. A total of 200 questionnaires were distributed. Responses from the survey were analyzed by using the Statistical Package for Social Sciences (SPSS) software.

4. Data Analysis

Response Rate

Out of the 200 questionnaires that were sent out, 97 were received. Three responses were eliminated because of a high degree of incompleteness. Consequently, this study was based on 94 valid replies from the respondents who had more than 10 years experience as an Architect in non-residential projects. This agrees with the suggestion of many researchers that a minimum sample size of 30 is considered representative for any group (Sproull 1995; Ott and Longnecker 2001). The effective response rate was approximately 47%, higher than the average response rate of 25% for questionnaire surveys in India's construction industry (Tan 1995).

Profiles of Respondents

Table 4.1 summarizes the designations of the respondents in the survey. It indicated that the largest group of the respondents belongs to senior management personnel, i.e. directors, senior architects.

Table 4.1: Designation of survey respondents

Designation	Frequency	Percentage of total	Cumulative percentage
Director (Architect)	20	21.2 %	21.2%
Sr. Architect	30	31.9 %	53.1%
Architects	44	46.9 %	100%
Total	94	100 %	

53.1% of respondents were senior management (Directors and Sr. Architects). 46.9% responses received from architects having 10 to 11 years of experience.

Table 4.2: Experience of survey respondents

Years of experience in construction industry	Frequency	Percentage of total	Cumulative percentage
20-25	20	21.2 %	21.2%
15-20	34	36.2 %	57.4%
10-15	40	42.6 %	100%
Total	94	100 %	

The respondents' working experiences in the construction industry in India ranged from 10–25 years. 42.6 % of the respondents had 10–15 years of experience, which is the major group. None of the respondents has less than 10 years of working experience.

In the questionnaire, respondents were given a brief about the IDP (Integrated Design Process). IDP and GM were explained together in terms of designing sustainable buildings.

- 90 % respondents agreed that non-integration of various disciplines in construction industry is the reason of issues/problems that are still surfacing in designing sustainable buildings.

- 80 % agreed that design system followed in India is essentially linear, however in areas depending upon the project there is integration seen at different levels which is not very consistent.

- 80 % were eager to understand the whole IDP process and wanted its inclusion after customization to India statutory requirements.

- 80% agreed IDP being a flexible process can suit different project requirements in varying suitable ways. One of respondent after having some more discussions on IDP role/help in some issues of her current project looked very positive to even go for a pilot use of IDP in a newly starting project.

- 80% agreed that GM regulations are a good way of helping/ motivating the designers to make sustainable buildings.

- 10% were neutral to the introduction of IDP. They wished to use after somebody else tries it first.

During the questionnaire barriers to IDP and GM were asked by the respondents. Table 4.3 below depicts the barriers to implementation of IDP and GM in India.

Table 4.3: Barriers to IDP and GM implementation

S.No.	Barriers to IDP implementation in India	Barriers to GM implementation in India
Barrier 1	Lack of strong contractual system	Lack of government push for sustainability
Barrier 2	Ignorance of client	Reluctance By Consultants
Barrier 3	Lack of government push for integration	Reluctance By Clients To Complex Process Of Certification
Barrier 4	High cost for designing owing to iterative process, thus needing additional time of consultants.	Extra Cost Involved in implementing green technologies.
Barrier 5	Architect reluctance in integrating design process owing to pre-defined system setup.	

Some of the barriers were common to both IDP and GM like lack of government push in pursuing integration and making green designing as statutory compliance. Another common barrier noticed was high cost element both in integrating the various design consultants and implementing green technologies. Some respondents suggested the need of an elaborate subsidy system / reward system to motivate the clients and designers towards sustainable design through IDP.

Based on the responses of survey a typical IDP+GM application model is suggested as follows as a possible process to help designers /clients go for sustainable buildings design as per criteria of IGBC (Indian green building council)

Table 4.4: Application model of IDP+GM for India:

Rationale: This application model is suggested to Architects to help them in systematically approaching / working for sustainable design. It is also meant for streamlining the whole design process. The model is built to holistically view the design process from Pre-design stage to construction documentation stage, thus giving the architect/designer to achieve better control/coordination of the proceedings all the way through with all the other team members /consultant teams.

	Pre-Design Stage	**Schematic design stage**	**Design development**	**Construction documentation**
Process	a)Coordinate the team for IDP; b)Establish a foundation; c) Plan key meetings and workshops for the	a)Enhance team cohesiveness and team values b) Ensure the functional program requirements and its implications are	a)Engage new specialists b)Assess feasibility and viability of green building strategies and technologies (IGBC guidelines);	a)Construction documents to be coordinated ; b)Integrate the IGBC green technologies c) Regular meetings are required to incorporate

	project start–up.	understood. c)Host workshops to brainstorm ideas, develop concepts, evaluate strategies	c) Smaller and focussed meetings are arranged for specific issues.	the suggestions in construction documents.
Outputs	a)Establishment of vision statement , goals and target matrix b)Pre-design report c)Preliminary budget including cost of IDP activities d) Establishment of communication pathways for the whole IDP process.	a) Refinement of goals and target b) Preliminary energy analysis; c) Preliminary financial estimate; d) Schematic design report; and e) Establishment of roles and responsibilities matrix.	a)Design Development report b)Detailed financial report c)Outline specification with embedded performance criteria; d)Updated roles and responsibilities matrix	a)Projects specifications with embedded IGBC criteria b)Tender documents with clear explanation of innovative aspects , contractor responsibilities for IGBC documentation, c)Commissioning plan

Table 4.4 above describes the proposed processes and expected outputs for an IDP+GM application model customized to criteria of IGBC. The outputs clearly identify the deliverables of each stage of design i.e. from pre-design to construction documentation stage. This application model was presented to 5 experienced architects of Indian construction industry (having 20+ years experience). Their comments and suggestions were incorporated in this application model based on an in-depth interview with each respondent separately. Further this model was presented to a mock up team created of 1 architect, 1 structural engineer, 1 HVAC engineer, 1 electrical engineer and 1 sanitary specialist. They were given a hypothetical design problem of a junior school. The design workshops were carried for 7 days and responses from each participant were noted (please refer table 4.5)

Table 4.5: Results of mock up exercise of application model of IDP+GM:

Professional	Response after working in the proposed application model
Architect	Design developed is much better coordinated and sustainable
Structural Engineer	Structural issues are resolved much easily before start of construction
HVAC engineer	HVAC coordination is better and streamlined and can save more energy.
Electrical Engineer	There is no-wastage of electrical fittings and wiring. The system is self-sustainable
Sanitary engineer	The routing of waste lines / water lines etc is much simpler. The process helped in removing unnecessary piping.

5. Conclusion

The principles of IDP and GM could help the construction industry in India to design better and effective sustainable buildings. The primary contribution of this study is to identify and analyze the importance of IDP and GM in Indian context. The study has found out the barriers to the implementation of IDP and GM in India. As a solution to the barriers, an application model has been developed which has been appreciated by a mock up team of professionals. Following the results identified in this study, project design organizations are able to successfully deliver sustainable projects in a more efficient and effective way. The application model needs further longitudinal research to test its effectiveness. Additionally, most project activities are multidisciplinary, with the involvement of several other external stakeholders, such as clients, suppliers, and subcontractors. Therefore, the relationships among Architectural/design firms and other external agencies should also be explored to improve the sustainable performance of building projects.

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