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[Affordable Housing]

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Featuring

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Editor's Note

The provision of affordable housing at scale remains a challenge in most countries, particularly those in the developing world and in transition. Due to a lack of livable, affordable, and well located housing alternatives, approximately 500 million people in Asia live in slums and informal settlements. While in different countries and regions, the specificities of the affordable housing challenge vary, the universal truism is that it is becoming increasingly difficult for the vast majority of residents to obtain and retain adequate, resilient, and affordable housing.

The fourth issue of Technology magazine with the theme ***"Affordable Housing"*** provides an overview of research in the provision of affordable housing and presents several innovative initiatives, articles, and experiences that our community may find great value in. Our readers may appreciate how construction forms the cornerstone of development and expansion of human settlements. Other useful contributions include an analysis of Disaster Resilience Assessment for Self-help Housing Design which answers the questions why and how self-help housing is one of the major housing approaches implemented for solving slum problems in urban areas and an article focusing on the development of an amphibious house that can be used for flood relief housing solution. In the article Housing in the Context of Energy Transition in Asia, the author shares different techniques on how to ensure universal access to modern energy services, double the rate of improvement in energy efficiency, and the share of renewable energy in the global energy mix. A concept of eco-village is also presented to highlight the importance of living green to help save our planet from the consequences of climate change.

The magazine will also take you to a journey through Habitech's 25 years of developing technology for sustainable, resilient, and affordable construction, 20 years of ACECOMS provision of structural engineering software solutions, and 5 years of AIT Consulting's progress in developing integrated solutions and providing services in areas of technology, engineering, environment, management, and development among others.

We hope that this issue highlights a step forward in investigating the state of the global housing challenge and proposing innovative solutions, and the ideas shared in this issue will be of value to readers, initiate critical discussions towards designing policies to improve access to affordable housing opportunities and to bring solutions to scale.

My gratitude extends to all the authors for their valuable contributions to make this issue a source of useful information particularly to those involved in various aspects of the housing sector. I would like to extend my sincerest invitation to join our team in developing the next issue of Technology magazine by sending us your feedback, contributing your own articles, achievements, and opinions on matters relevant to the sustainable development.

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The Need for Affordable Housing

By Naveed Anwar

Housing is a basic necessity that provides shelter; security, safety, and means for storage of other essentials; and is the setting for the communal life of the neighbourhood. The provision for housing is identified as one of the basic rights by the Universal Declaration of Human Rights, article 25 as early as 1948.

The Need for Affordable Housing

Housing is a basic necessity that provides shelter, security, safety, and means for storage of other essentials; and is the setting for the communal life of the neighbourhood. Housing is an object of attachment to the important idea of home, a source of identity, and has a significant relationship to psychological well-being. The right to housing is explicitly supported by the international laws. The provision for housing is identified as one of the basic rights by the Universal Declaration of Human Rights, article 25 as early as 1948, at par with the need for food, clothing, and medical care. It states *"Everyone has the right to a standard of living adequate for the health and wellbeing of himself and of his family, including food, clothing, housing and medical care and necessary social services".*

This is clearly something that has been recognized long time ago, but even after more than 65 years of the declaration, we are still struggling to fulfil this basic human right and the crisis is getting worse. The Global McKinsey Institute Report, 2014 states that about 96 million urban households are financially overstretched while 235 million urban households are currently living in substandard housing. But this need will only get more demanding as population is growing exponentially. By 2025, 106 million additional low income households will face challenge of affordable housing. Demand for formal housing will be more in urban areas. This will be due to the fact that people will migrate from rural to urban, rapid growth of urban population and conversion of sub-urban land into urban. It is estimated that by 2020, 62% of the world population will be living in urban areas.

Though the gap between household and housing stock is narrowing, actual shortage is high due to a certain part of the current stock being dilapidated and people living in congested dwellings. Every major natural disaster further reduces the adequate housing available to the masses. The recent earthquake in Nepal destroyed nearly 500,000 houses leading to a crisis. Urbanisation has resulted in people increasingly living in slums and squatter settlements and has deteriorated the housing conditions of the economically weaker sections of the society. This is primarily due to the skyrocketing prices of land and real estate in urban areas that have forced the economically weaker sections of the society to occupy the marginal lands typified by poor housing stock, congestion, and obsolescence. Considering these factors, there currently exists a wide gap between the demand and supply of housing (both in terms of quantity and quality) in urban areas.

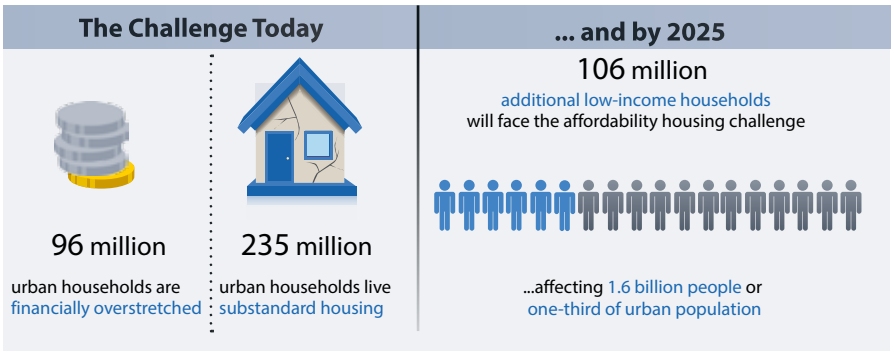

Figure 1: *The worsening challenge of housing*
(Source: Adapted from the Global McKinsey Institute Report, 2014)

According to population reference bureau (July 2011), even though the world population growth rate has slowed from 2.1 percent per year in the late 1960s to 1.2 percent today, the size of the world's population has continued to rise—from 5 billion in 1987 to 6 billion in 1999, and to 7 billion in 2011. Also it is entirely possible that the 8th billion will be added in 12 years as well and by 2050, more than 2 billion people will be added into the existing world population. Most of this population will be contributed by the world's poorest countries and will be in need of affordable low cost housing and infrastructure.

Commercial markets are mostly catering the needs of high income groups targeting high-end and upper-mid housing segment, since it fetches a premium over low income housing. This leads to a sustained supply for this segment, increasing market competitiveness for developers. On the other hand, the housing for the low income groups is suffering backlog especially for low end of the spectrum. Liveable options are often not affordable unless provided by subsidies.

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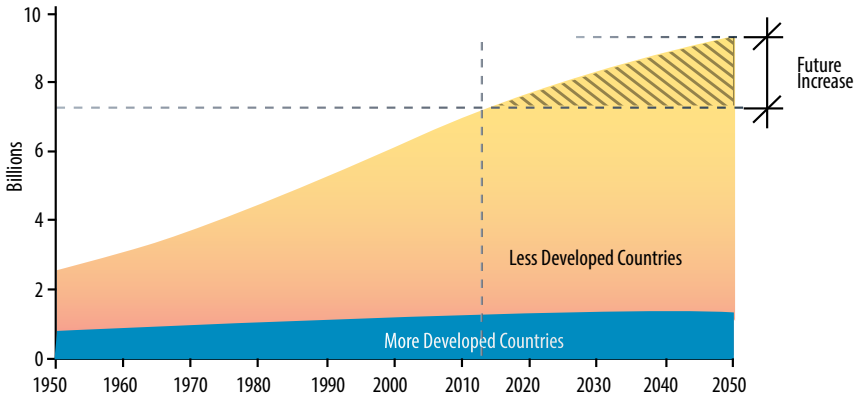

Figure 2: *Increasing population in less developed countries with less resources to provide housing*

(Source: www.prb.org, volume no.66 July, 2011.)

Based on the projected rate of urbanization around the world, it is estimated that the number of people affected by the affordable housing gap could rise to 1.7 billion in 2030 and 1.8 billion by 2035.

There is no clear-cut definition of the term 'affordable', as it is a relative concept and could have several implied meanings in different contexts. According to the McKinsey Report 2014, affordable housing can be defined through three parameters which countries need to tailor to their local contexts, as shown in Figure 3.

Affordability threshold can be defined as 30-40% of total income of the household (not an individual). Standard urban housing should have all the necessary amenities and located within less than an hour from workplaces. Households having 80% of median income of the particular country or region should be able to afford the housing. Whenever affordable housing is not accessible to low-income households, family resources needed for food, education, medical, and other provisions are diverted to housing costs (Anderson et al. 2003). The lack of affordable housing within a community can contribute to family residential instability and vulnerability, as families are forced to move frequently, live with other families in overcrowded conditions, or experience periods of homelessness.

The provision of housing depends on three aspects i.e., cost, price, and affordability. Cost is absolute and can be defined and measured. It can be controlled by architects, engineers, developer or manufacturers. On the other hand, price is what people are asked to pay or are willing to pay. Price mark ups to basic construction cost that may be directly or indirectly related to cost, controlled by demand and supply mechanism, location, taxes, and subsidies.

Price and costs of housing varies across regions and users. For consumers, it is price that matters, not the cost. Profit margin is seen as one of the critical factors by the providers and manufacturers, and therefore in urban areas, the lowest price solution may still not be affordable for many. In rural context, it is possible for nearly everyone to have housing because of availability of land, community self-help, local materials and indigenous technologies and minimal livability requirements.

Housing affordability gap can be defined as the gap between what people can pay for housing and price at which housing is available. Based on the projected rate of urbanization around the world, it is estimated that the number of people affected by the affordable housing gap could rise to 1.7 billion in 2030 and 1.8 billion by 2035.

Affordable price depends primarily on income level and cost of housing. Income side of affordable price is dependent on a particular country or region. The price is dependent on "size" of the minimum acceptable living unit, the services and facilities considered as minimum acceptable and the cost of construction. The affordability is further effected by available funding, loan, mortgage, land lease, and subsidy policies.

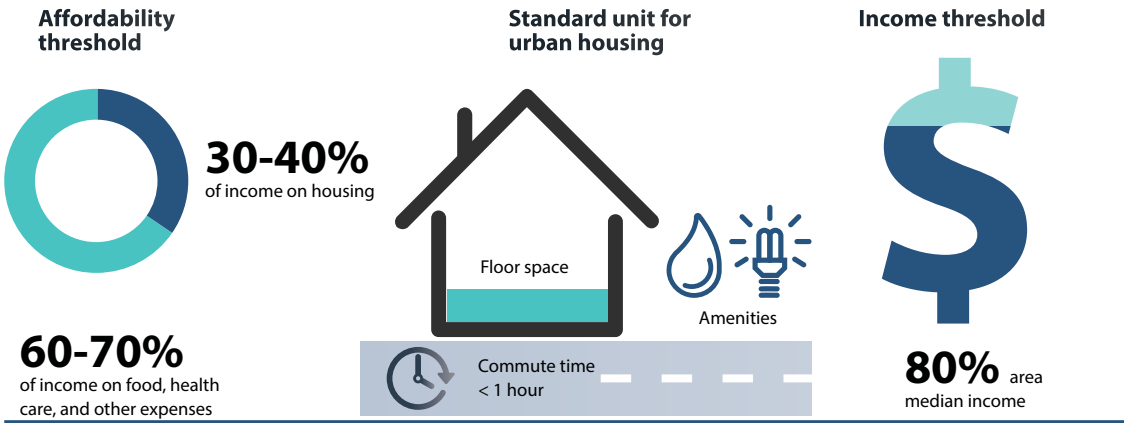

Figure 3: *The definition of affordable housing*

(Source: Adapted from the Global McKinsey Institute Report, 2014)

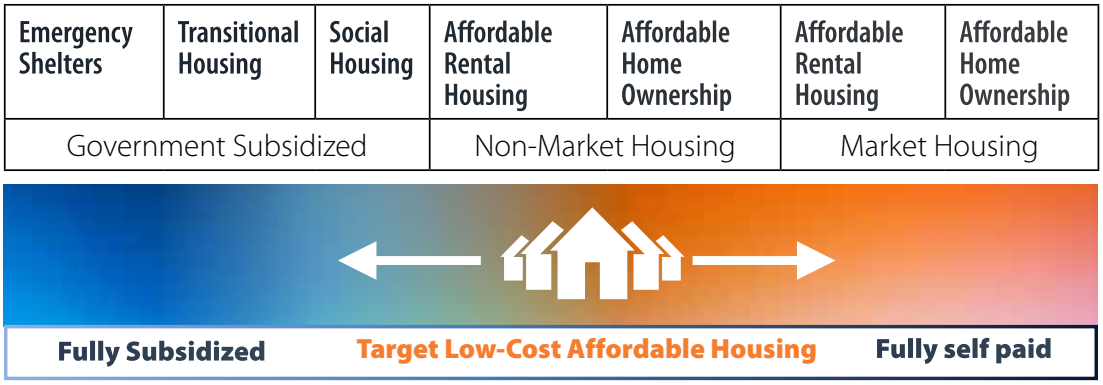

Figure 4: *The overall spectrum of housing*

Designing and Constructing Affordable Housing Solutions

Housing in general, and affordable housing in particular has many aspects to consider during development such as socio-economic, cultural, infrastructural, institutional, and environmental considerations. However, the key components of affordable housing solutions may include:

- Livable and affordable
- Safe, secure, and healthy
- Accessible and adaptable
- Resilient to disasters
- Socially and culturally appropriate
- Integrated with livelihood
- Resource efficient
- Environmentally aware and friendly

Designers and developers need to understand the specific needs of the target groups, the specifications such as family size, main livelihood, affordability, social and cultural interactions, particular expectations, and lifestyle. Similarly, consideration of housing schemes locations are also essential for developing appropriate solutions for construction and affordability that take into account various geographical factors by developers/planners. Rural areas have low land cost but are scattered and have little or almost no infrastructure. Sub-urban regions have medium land cost but are marred with high costs due to presence of residential estates, satellite towns and particularly developed infrastructure. Urban areas have very high land cost but they may have transit oriented development (TOD) and growth along commercial centres, with greater mobility.

Generally, studies must be undertaken for assessing affordability for low income groups. These studies typically include market analysis, formal surveys, technical need assessment (TNA), requirement analysis, and feasibility studies. Based on these studies, multiple options or models can be adopted for affordable housing solutions such as:

Option 1:	Build some housing at a certain price and offer in market; those who can afford, will get it, and others may be left out
Option 2:	Determine who needs housing, and provide it at the price they can afford
Option 3:	Provide predefined, subsidized housing to selected groups
Option 4:	Create a solution comprising all of the above

The primary stakeholders for providing affordable housing solutions include residents, service providers, financiers, developers, and managers. Government can act as the main facilitator for these stakeholders. Even if government is not directly involved in construction of affordable housing, it can influence type and amount of housing, where it is built, the pace of development, and the cost and type of infrastructure development to support it (Down, 2004). It may provide and unlock land leases and provide direct financial budget for the projects. Moreover, it can provide direct or indirect assistance to housing occupants and provide tax breaks, incentives and exclusions. It can also help in provision of relief in duties, charges and soft loans. Designers and developers can assist in developing appropriate designs for livable houses and innovative technologies that can help

Housing in general, and affordable housing in particular has many aspects to consider during development such as socio-economic, cultural, infrastructural, institutional, and environmental considerations.

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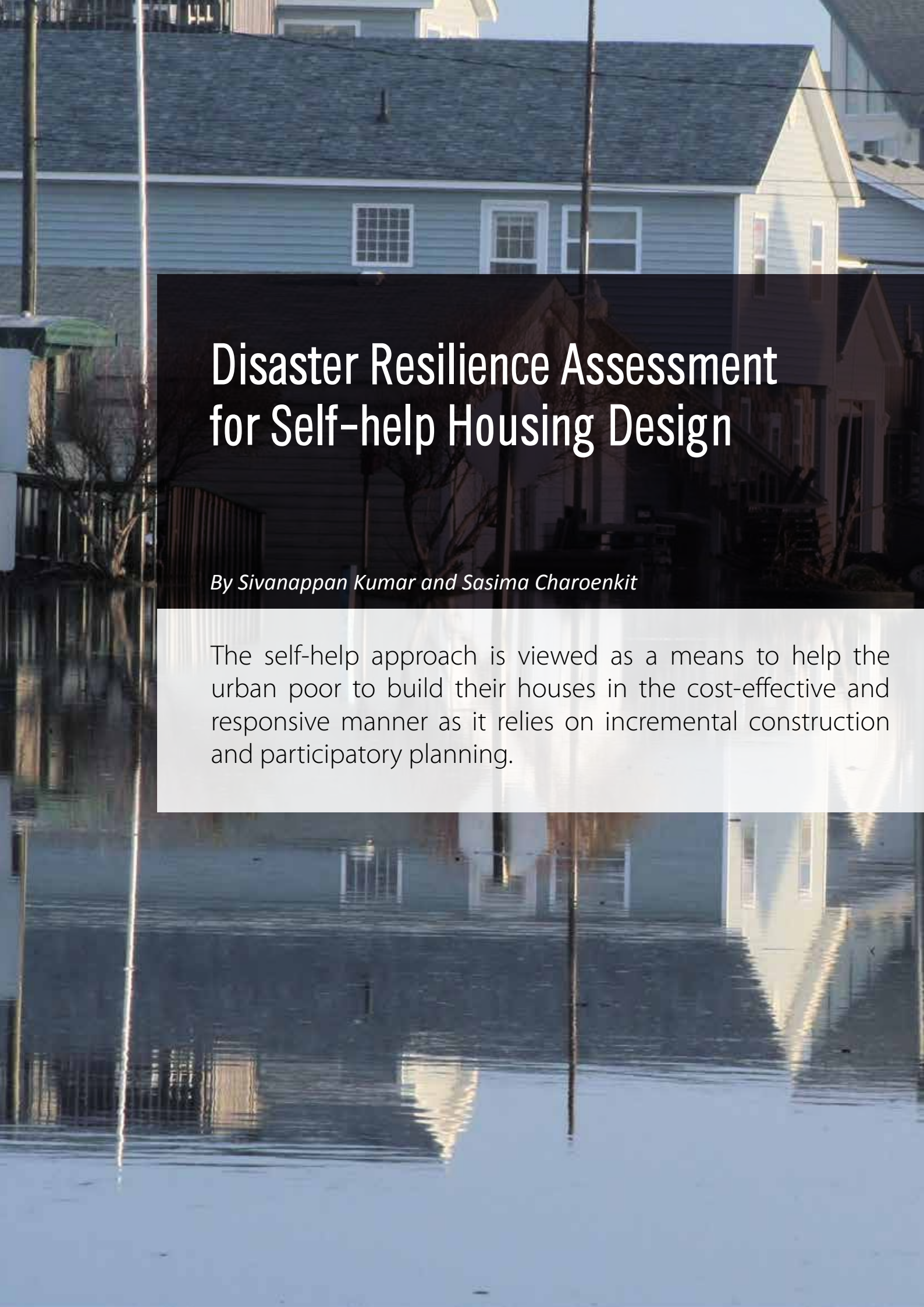
to reduce costs. These costs might include land cost (direct area and services area), infrastructure development, direct construction cost, planning, design, management services, mark-ups and profits.

Affordable housing should be seen as an opportunity by both private and public sector. It is often overlooked by for developers, investors, and financial institutions. It is assessed that the investment associated to close housing need gap would be $9 trillion to $11 trillion for construction alone.

There are several challenges to tackle. Governments have to give no priorities to low income groups as stated in housing policies. Housing departments are faced by limited budget and lack of financial resources for development. Despite having an extensive network of financial institutions, banks and apex housing cooperative societies, low-income groups lack access to home finance. At the same time, construction difficulties are being faced in rural areas. Developing and least developed countries are suffering from inadequate infrastructure and utility services. Climate change and natural disasters have further increased vulnerabilities and risks for existing and future affordable housing development. To cope with these issues, several structural and non-structural measures can be taken in form of policies, construction systems, technologies and delivery options, which can make the price of housing units more affordable. It is vital that these issues are addressed urgently so that a comprehensive framework can be established in ensuring the provision of affordable housing to a longer segment of the population.



Disaster Resilience Assessment for Self-help Housing Design

By Sivanappan Kumar and Sasima Charoenkit

The self-help approach is viewed as a means to help the urban poor to build their houses in the cost-effective and responsive manner as it relies on incremental construction and participatory planning.

Disaster Resilience Assessment for Self-help Housing Design

The tool for assessing disaster resilience performance of housing will be useful for enabling ordinary people like self-help builders to determine the extent to which the design features of their housing meet the desirable requirements of disaster resilient development.

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The Need to Integrate Disaster Resilience in Self-help Housing Design

The number of the urban poor around the world is increasing due to the rapid growth of urbanization. By 2020, slum dwellers are expected to reach almost 900 million (UN-Habitat, 2012), and about 167 million housing units must be built or upgraded in the near future to accommodate the increasing number of urban poor population in developing countries (Anderson & Beck, 2012).

Self-help housing is one of the major housing approaches implemented to solve slum problems in urban areas (Bredenoord & van Lindert, 2010). The self-help approach is viewed as a means for helping the urban poor to build their houses in the cost-effective and responsive manner as it relies on incremental construction and participatory planning (Figure 1). However, self-help housing is often vulnerable to natural disasters, such as earthquake, floods, landslide due to several reasons including housing location in disaster-prone areas, poor housing quality, and the lack of basic infrastructure. When natural disasters occur in cities, it is the urban poor who are the most vulnerable group suffering from loss of life and property (Laukkonen, 2009). Due to the negative consequence of climate change, urban disaster risks are presumed to be higher. It is therefore necessary to mitigate the effects of adverse natural events through the development of disaster-resilient housing for the urban poor. Disaster resilience concept should be integrated into participatory planning process of self-help housing.

Sustainability assessment tools, such as LEED for Neighborhood Development and BREEAM-Community, have been developed in recent decade to assist design professional to create sustainable projects. These assessment tools consist of multiple indicators, which can be used as the design guideline for a wide range of urban projects, including housing, and they are aimed to achieve the desirable characteristics of sustainable development. Indicators of the existing tools can be classified into several aspects covering three dimensions of sustainability: social, economic, and environmental. For environmental aspect, a number of indicators are dedicated to measure four to five issues relating to natural resource use, water efficiency, energy efficiency, and indoor quality. In contrast, only a small number of disaster resilience indicators are found, reflecting little interest given to this issue despite an increasing frequency and intensity of disasters across the world (Charoenkit & Kumar, 2014). In addition, the existing tools were designed for design professional not ordinary people. It is therefore too complicated to use these assessment tools in participatory planning process of self-help housing.

The need for a simple and practical tool to assess disaster resilience performance of housing in the design phase is apparent. This tool will be useful for to enable ordinary people like self-help builders to determine the extent to which the design features of their housing meet the minimum or desirable requirements of disaster resilient development. Importantly, the tool should consider the use of no- or low-cost measures to encourage the application of disaster resilient measures in housing design.

Figure 1: *Participatory planning process in self-help housing design*
(Source: CODI, 2008)

A Low Carbon and Disaster-resilient Assessment Tool for Self-help Housing (LoDAT-SH)

To address this need, a Low Carbon and Disaster-resilient Assessment Tool for Self-help Housing (LoDAT-SH) was developed to assess self-help housing located in flood-prone areas of Bangkok, Thailand. LoDAT-SH is an indicator-based tool designed to assess four aspects which are low carbon development, disaster resilience, community participation, and financial consideration. Based on local context and stakeholders' opinions, the tool was designed to have 44 indicators for the assessment of the above mentioned four aspects. The majority of indicators were selected from those found in the existing assessment tools (e.g. LEED-ND, CASBEE-UD) and some were developed with the consideration of several sources including local standards, best practices, and relevant literature to ensure theoretical soundness, measurability, simplicity, comprehensibility, and relevance of all indicators. Nine indicators were devoted to disaster resilience[1]. To assess each indicator, users are asked to assign score ranging from 1-4 according to design features of their housing. These scores indicate different performance levels; 1) represents poor performance, 2) average performance that meet minimum requirements of certain aspects, 3) good performance, and 4) very good performance. The overall performance of housing can be obtained from the weighted aggregation method[2] .

Figure 2: *Comparison of a canal-community before and after the upgrading as a part of self-help housing development in Thailand with the aim to improve the quality of life of the poor and enhance their resilience to flooding.* **(Source: CODI, 2008)**

Table 1 on page 12 illustrates nine LoDAT-SH indicators used to measure flood resilience of community planning and house design in two sub-categories of water management and flood resilient design. Different weightage values were given to each sub-category and indicators, based on the survey of experts and self-help community leaders as shown in Table 2 (page 13). Water management contains four indicators related to the use of water efficient fixture, the presence of water reuse practice, and the presence of rainwater harvesting practice and the consideration stormwater management in community planning. For flood resilient design, five indicators are included which are consideration of flood-risk level for site selection, the inclusion of flood-resilient measure in house design, the availability of alternative sources of power and water supply, the consideration of safety in the design of evacuation route, and the presence of community garden.

[1] The references used to develop disaster resilience indicators were indicators found in flood resilient assessment index, international guidelines, and best practices of flood resilient house design in Thailand due to the absence of local standard for housing development and building design in flood zone.

[2] The Analytical Hierarchical Process (AHP) technique was employed as the consensus method for eliciting LoDAT-SH weighting.

Table 1: LoDAT-SH Indicators for Disaster Resilience

Disaster resilience	Description	Score			
DR1.1 Efficient water use	Number of water efficient fixtures used. Efficient use of water can reduce the volume of water in drainage system. This can increase the performance of drainage system during flooding events. Efficient water fixtures include as follows; *a. Low-flush toilet or squat toilet* *b. Low-flush taps and faucets* *c. Low-flush shower head* *d. Water efficient washing machine or a front load washing machine*	None	1	2	>2
DR1.2 Water reuse	Sources of water reused Reusing water not only improves the efficiency of water consumption but also reduces the volume of drainage water discharged to drainage system. Grey water from following sources can be reused; *a. Kitchen sink* *b. Cloth washer* *c. Shower/ bath sink*	-	None	1	>1
DR1.3 Rainwater harvesting	Size of tank for rainwater storage Rainwater harvest can reduce flood risk due to the reduced amount of rainwater discharged to drainage system.	<2000 liter	2000 liter	3000 liter	4000 liter
DR 1.4 Stormwater management	Number of measures considered Several techniques should be considered to slow down and reduce the amount of stormwater to a centralized drainage system by allowing stormwater to retain on the surface or infiltrate into the soil. Such techniques are as follows; *a. Use of hollow concrete block for paved areas* *b. Use of permeable concrete for roads or paved areas* *c. Use of open channel system to drain stormwater* *d. Use of detention pond to capture and retain stormwater*	None	1	2	>2
DR2.1 Avoidance of risky area	Flood depth that frequently happens in the area Intensity of floods can indicate the level of flood risk. According to DEFR, flood depth is classified into 3 levels: less than 0.3 m, 0.3-0.6 m, and above 0.6 m. The interval of 0.3 m is also used by NSO to classify flood depth in Bangkok and Central region of Thailand in 2011. It therefore considers a flood depth of less than 0.1 m as no risk, 0.1-0. 3 m as low risk, 0.3-0.6 m as moderate risk and above 0.6 m as high risk.	>0.6 m	0.3-0.6 m	Less than 0.3 m	No floods
DR2.2 Resilient building design	Number of measures taken to increase flood resilience *a. Elevated floor level above flood level* *b. Use of water proof materials for wall and floor components* *c. Raised electrical sockets and switches above flood level* *d. Separated electricity circuit and water supply system for each floor* *e. Use of prefabricated floor tiles or wall panels that can be easily replaced after floods* *f. Use of wall and floor materials that can be easily cleaned*	-	None	1	>1
DR2.3 Utility planning	Provision of backup system Backup systems are required when central power or water systems are not functional during disaster events	<2000 liter	2000 liter	3000 liter	4000 liter
DR2.4 Evacuation route	Characteristic of streets Durable streets with adequate width can mitigate flood impacts by facilitating residents to rescue and reduce infrastructure damage. Also, at least two exits are preferable to evacuate residents during emergency events.	Temporary road made of compact soil or aggregate	Concrete road	Concrete road with a width of at least 3 m	Concrete road with a width of at least 3 m and two exits
DR 2.5 Local food production	Availability of green space for food production Local food production can increase level of community sufficiency during disaster events	None	Individual edible garden	Individual and communal edible garden	Roof top garden or vertical garden

Disaster Resilience Performance of Self-help Housing in Thailand

LoDAT-SH was applied to assess two self-help housing in Bangkok: Klong Bang Bua (KBB) and Sangsan Nakorn Rangsit (SNR). Figure 3 illustrates housing characteristics of both communities that represent typical type of self-help housing in Thailand. Both communities are low-rise development, consisting about 200 housing units. KBB is the canal-side community upgraded from informal settlement, which is located in inner city. SNR is situated in low-lying areas which was once paddy fields.

Figure 3: *Exterior views of self-help housing: KBB (left) and SNR (right)*

Table 2 presents scores of both communities. The overall scores for the category of disaster resilience were less than 2 for KBB (1.7) and SNR (1.9), indicating resilience performance that is slightly below the minimum requirements. In the sub-category of water management, both KBB and SNR were awarded the highest score of 3 for water efficiency due to the usage of water efficient fixtures such as toilets with manually flushing or squat toilets. In contrast, KBB and SNR had low scores for the remaining indicators due to the absence of stormwater management practices. For the sub-category of flood resilient design, both communities had low scores for almost all indicators except for the DR2.1 indicator for KBB due to housing location in low-risk area (a flood depth of 0-0.3 m) and the DR 2.3 indicator for SNR due to its durable streets with sufficient width for evacuation in emergency events.

Table 2: Assessment Scores of two Communities

Category	Sub-category	Weight	Assessment Score	
			KBB	SNR
DR	DR1 Water management	0.45	1.6	1.6
	DR1.1 Water efficiency	0.30	3	3
	DR1.2 Water reuse	0.20	1	1
	DR1.3 Rainwater harvesting	0.25	1	1
	DR 1.4 Permeable outdoor surface	0.25	1	1
	DR2 Resilient planning	0.55	1.9	2.2
	DR2.1 Consideration of flood risky areas	0.20	3	2
	DR2.2 Resilient planning	0.30	2	2
	DR2.3 Utility planning	0.15	2	2
	DR2.4 Evacuation planning	0.15	1	3
	DR2.5 Food security	0.20	1	2
Total DR score			**1.8**	**1.9**

Potential Measures for Enhancing Disaster Resilience of Self-help Housing in Thailand

With regard to the performances of two self-help housing above, potential measures are suggested to increase resilience to flooding as summarized in Table 3. Potential measures are classified into two groups: embedded and optional. Embedded measures refer to those that should be incorporated into housing planning and design during the early design process as it is difficult to adopt such measures later. Optional measures refer to those that can be implemented during post-occupancy phase, allowing residents to incrementally improve their dwellings. Incremental approach is argued as the appropriate practice for low income households because the approach enables them to improve housing quality to meet their needs and expectations whenever their financial resource is available (Lizarralde, 2011). Most of embedded measures relate to several issues determined during the process of housing layout. These measures require low or no cost and provide long-term benefits. In contrast to optional measures, additional costs are often required. This implies the opportunity to enhance resilience to flooding of self-help housing through incremental approach. With incremental approach, the implementation of the optional measures depends on financial situation of each household. However, institutional assistance is required for some measures that are beyond the ability of local residents such as the installation of back-up systems.

Table 3: Potential Measures for Self-help Housing

Category and Sub-category	Measures
1.1 Water management	Use of water efficient faucets, shower heads, and washing machine (E) Installation of rainwater storage tanks (o) Use of permeable concrete or concrete blocks for streets and pavement (E)
1.2 Resilient planning	Elevated floor above the average flood level (E) Install back up system for electricity at the community center, prioritizing solar PV system (o) Install water storage tank and water filtration system at the community center (o) Provision of community garden where edible plants can be grown (E)

Note: E = embedded measure, o = optional measure

In conclusion, the application of LoDAT-SH to the selected community demonstrates the average and poor performance of the existing self-help housing in Thailand and the potential areas to improve disaster resilience of this settlement type for the urban poor. Low scores of some DR indicators obtained from the selected self-help housing deserves high attention from decision makers and self-help builders to enhance flood resilience in low income housing design. Importantly, the use of simple assessment tools like LoDAT-SH in the participatory planning process of self-help housing should be encouraged. With simple and practical indicators, this type of the assessment tools potentially assists self-help builders to make better informed decisions on their living environment.

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News in Brief

November 2015

42 Companies Participate in AIT Career Fair

Prof. Sivanappan Kumar, AIT Vice President for Academic Affairs welcomed the participants of the Career Fair

AIT-SU Research Exhibition was organized concurrently with the AIT Career Fair and showcased prototype, exhibit or poster of students' original research or project from the 3 schools of AIT

Ph.D. Candidate Adnan Nawaz presenting his research to Dr. Naveed Anwar, one of the judges in the Exhibition. Top three ranks belong to Nipuna Wickramanayake, Adnan Nawaz and Fawad Ahmed Najam, all representing SET

The Asian Institute of Technology (AIT) Career Fair held on 4 November 2015 at AIT Conference Center brought together a record number of 42 companies, 17 of which were first-time participants. Nine companies including Pylon, Maxim, Inteqc, DSGAP, MFEC, Agoda, Thunder Oilfield, Chuchawal-Royal Haskoning, MACkerel conducted campus interviews to recruit AIT students.

Prof. Sivanappan Kumar, AIT Vice President for Academic Affairs, welcomed the participants on behalf of AIT President Prof. Worsak Kanok-Nukulchai. He stated that the Career Fair was beneficial to both the companies and the students as this was an opportunity for recruitment, forging alliances, and networking. Prof Kumar also highlighted the Research Exhibition sponsored by AIT Student Union (AIT-SU) showcasing posters and prototypes related to students' researches or projects from the three schools in AIT, School of Management (SOM), School of Environment, Resources and Development (SERD), and School of Engineering and Technology (SET).

AIT Consulting was among the companies that joined the Career Fair to recruit future employees and showcase the organization's projects, activities, and expertise to the broader AIT Community. Over 100 job-seekers and students visited the AITC's booth.

October 2015

Sultan Qaboos University, Oman and AIT Joint Research Utilizing Waste Water and Sand in Habitech Building System

Mr. Gyanendra R. Sthapit presented the Habitech Building Technology to staff and students from Department of Architecture and Civil Engineering.

Sultan Qaboos University (SQU), Oman collaborated with Habitech Center and AIT Consulting, Asian Institute of Technology (AIT) on a research project to develop a way to provide an effective onsite solution utilizing water generated during oil extraction in the drilling sites of Petroleum Development Oman. The solution involves using the innovative Habitech Building Technology to produce interlocking bricks which then can be used to build structures, well liners, and many other applications. The Habitech technology is proven to be disaster resilient, green, and cost-effective as it can utilize local materials (desert sand and soil in Oman) and waste water from oil production.

As part of collaboration, Habitech team led by Mr. Gyanendra R. Sthapit, Director of Habitech Center visited SQU to set-up a brick press at the Structural Engineering laboratory of the university. The team demonstrated the production process of interlocking bricks and trained university staff and students to make interlocking bricks using local soil and desert sand. During the visit, Mr. Sthapit also presented in a seminar on Habitech Building Technology, which was attended by the university staff, faculties, and students of Department of Architecture and Civil Engineering.

AIT Participates in CTBUH 2015 Conference in New York

Dr. Naveed Anwar (right) presenting a token of appreciation to Ole Scheeren of Buro Ole Scheeren, Beijing

Recognized as the world's leading resource for professionals focused on the inception, design, construction, and operation of tall buildings and future cities, the Council on Tall Buildings and Urban Habitat (CTBUH) organizes annual conferences in different parts of the world to bring together high-level architects, engineers, developers, building owners for knowledge-sharing and networking activities.

AIT Consulting, Asian Institute of Technology submitted a poster in CTBUH Conference 2015 focusing on the outcome of an ANN-based approach to directly determine design parameters based on experience gained from previously designed buildings, using both code-based and performance-based approaches. One of the authors of the poster titled "***Preliminary Design of Tall Buildings Using Artificial Neural Networks***," Dr. Naveed Anwar, Executive Director, AIT Consulting attended the CTBUH Conference in New York from 26-30 October 2015. Dr. Naveed also chaired Session 1d: The MahaNakhon Tower, Bangkok. In this session, Ole Scheeren, Partner, Buro Ole Scheeren shared the design philosophy of the latest tallest building in Thailand, while interior designer Yuki Ikeguchi, Partner, Kengo Kuma and Associates and Ian Schrager, Founder, Ian Schrager Company, presented their approach for The Edition Hotel, a unique boutique hotel inside MahaNakhon tower.

Universities in Asia Collaborate for Seismic Strengthening of Buildings in Chiang Mai, Thailand

Four of the top universities in Asia have collaborated to work together on a project focusing on seismic strengthening of school buildings in Northern Thailand funded by the Temasek Foundation (TF) of Singapore. Nanyang Technological University (NTU), Singapore is the main coordinator of the project together with the Asian Institute of Technology (AIT) Thailand as the local coordinator and King Mongkut University of Technology Thonburi (KMUTT) and Chiang Mai University (CMU) are partner institutions.

The project aims to address the earthquake risks by promoting the use of strengthening methods and to transfer the technology to the professionals, engineers, and local builders in order to enhance their capacity. The project will address the earthquake risks by applying the strengthening methods to selected school buildings in order to mitigate the disruption to the education development of the young within a community.

On 1-4 October 2015 the "***Training and Capacity Building Programme on Seismic Strengthening for Master Trainers and Local Builders in Thailand***," focusing on promoting good construction practices and imparting earthquake strengthening techniques to faculty members, postgraduate students, government officials/ engineers, and sector professionals as 'master trainers' was held at the Mercure Hotel in Chiang Mai. Expert speakers included Assoc. Prof. Li Bing, Nanyang Technological University (NTU); Prof. Dr. Amorn Pimanmas, Sirindhorn International Institute of Technology (SIIT); Assoc. Prof. Dr. Sutat Leelataviwat, King Mongkut's University of Technology Thonburi (KMUTT); Assoc. Prof. Dr. Phaiboon Panyakapo Sripatum University (SPU); Asst. Prof. Dr. Chayanon Hansapinyo Chiang Mai University (CMU); Prof. Dr. Pennung Warnitchai Asian Institute of Technology (AIT); Dr. Pramin Norachan, Asian Institute of Technology (AIT); and Gerald YEO Director, Temasek Foundation.

IABSE Conference 2015 Focuses on Structural Engineering as Solution Provider to Global Challenges

The International Association for Bridge and Structural Engineering (IABSE) is a fellowship of structural engineers comprising of members in 100 countries around the world, with interest in all types of structures and materials. IABSE Conference 2015 with the theme *"Structural Engineering: Providing Solutions to Global Challenges"* was held from 23-25 September 2015 at Geneva, Switzerland. More than 100 experts from various organizations and institutions presented during the technical sessions. The Asian Institute of Technology (AIT) through Dr. Naveed Anwar, Executive Director, AIT Consulting delivered two presentations under the theme Global Engineering Challenges: *"Challenges of a Single-layer Reticulated Inverted Monk Bowl Dome" and "Case study: Challenges of an Iconic Pedestrian Bridge".*

ADB Prioritizes School Building Reconstruction in Nepal

One of the school buildings being retrofitted in Nepal

The Asian Development Bank (ADB), one of the development agencies helping Nepal address the immediate and medium term impacts of the damage, approved a $200 million loan to finance the Earthquake Emergency Assistance Project (EEAP). The project will support rebuilding of schools, roads, and district-level government buildings, and strengthening resilience to future disasters. In line with this, ADB has engaged a team of experts to provide technical assistance for the post disaster management, specifically aimed at school buildings. ADB Nepal Resident Mission (NRM) engaged Dr. Naveed Anwar, Executive Director, AIT Consulting, through the Asian Institute of Technology (AIT) to provide overall guidelines for developing the type design for various types of school buildings, facilities, and related physical infrastructure for post-earthquake reconstruction of schools in 14 most affected districts. As part of the project, site visits were conducted to get a real view as well as to get first-hand information on the extent of damage to the schools in various districts of Nepal. Based on initial findings, standardized design and details were developed along with guidelines so that consistency and up scaling could be achieved before applying this strategy to a very large number of schools in a short time. This effort is likely to contribute to the overall aim of the Nepal government and its development partners to significantly improve the disaster resilience of schools.

Asia-Pacific Housing Forum Discusses Building Impact through Ecosystems for Bottom of the Pyramid

The Asia-Pacific Housing Forum is a biennial conference which gathers under one roof all stakeholders engaged in seeking solutions to low-income housing issues. The fifth housing forum with the theme *"Building Impact through Ecosystems for Bottom of the Pyramid Affordable Housing and Sanitation"* was held in New Delhi, India at the Leela Residences Hotel on 3-4 September 2015. The conference covered a wide range of topics such as Building Shelter for All, Impact through Sanitation, Building Market Systems for Affordable Shelter & Sanitation, and Impact through Affordable Housing Finance. Mr. Gyanendra R. Sthapit, Director, Habitech Center, AIT Consulting (AITC/H), presented the key features of the Innovative Affordable Housing Technology developed at the Asian Institute of Technology (AIT). Mr. Parthiv Bharali, Marketing Strategist and Partner Development Manager, AIT Consulting also represented AIT in the exhibition area where Habitech had a booth showcasing the technology.

Society of Structural Engineers Sri Lanka Celebrates Silver Jubilee

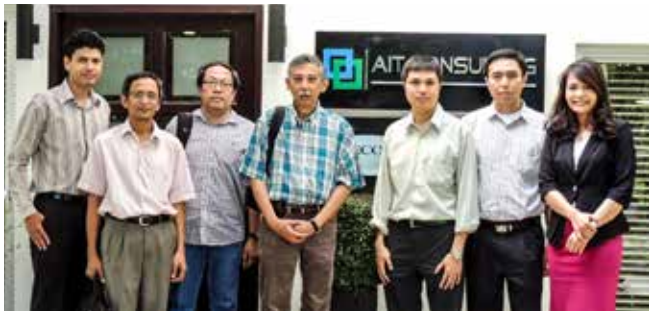
The Society of Structural Engineers, Sri Lanka (SSE-SL) celebrated its Silver Jubilee with a commemorative International Conference on Structural Engineering carrying the theme *"Towards Excellence in Structural Engineering"* from 24-26 August 2015 at the Cinnamon Grand Hotel, Colombo, Sri Lanka. The conference brought together engineers, academics, scientists, government officials, and other professionals across Asia and Europe. Dr. Naveed Anwar, Executive Director of AIT Consulting delivered a presentation on the topic *"Progression of Structural Design Approaches: Working Stress Design to Consequence-based Engineering".*

Nepal Holds Exhibition and Workshop on Sustainable Safer Buildings

The Ministry of Urban Development (MoUD) and Department of Urban Development and Building Construction (DUDBC) of Nepal in collaboration with UN Habitat, Asian Institute of Technology (AIT), and Institute of Engineering (IOE) organized a three-day exhibition and presentation carrying the theme *"Sustainable and Safer Building Technologies"* on 20-22 August 2015 at IOE Pulchowk campus, Kathmandu. The program focused on various building construction techniques for urban and rural context. AIT and Innotech Nepal Pvt. Ltd jointly presented Habitech Building System with a full scale model and presentations on its efficiency and durability. Dr. Naveed Anwar, Executive Director, AIT Consulting provided an illustrative presentation on technical aspects of the Habitech Building Technology (HBT) while Mr. Gyanendra R. Sthapit, Director, Habitech Center further explained the benefits of this innovative technology. During the exhibition, Mr. Sthapit and Innotech Nepal Director Mr. Iswar Joshi along with Innotech technical staff explained to the locals how to build their houses using HBT.

August 2015

De La Salle University (DLSU) Manila Fosters Collaboration with AIT



AIT Consulting team with DLSU Professors Prof. Andrea Winston C. Oreta, Dr. Renan Ma. T. Tanhueco, and Dr. Lessandro Estelito O. Garciano

The De La Salle University (DLSU), Manila Philippines has a long-term association with the Asian Institute of Technology (AIT) through AIT Consulting (AITC) and ACECOMS since 2000. Apart from being an Associate Center of ACECOMS in the Philippines, DLSU has also invited Dr. Naveed Anwar, Executive Director of AITC and ACECOMS as speaker in conferences they organized. In August 2015, Professor Andrea Winston C. Oreta, Dr. Renan Ma. T. Tanhueco, and Dr. Lessandro Estelito O. Garciano of Center for Engineering and Sustainable Development Research (CESDR), DLSU visited AIT to discuss the possibility of collaboration between CESDR and AITC. Both organizations have mutually-aligned areas, one of which is Disaster Risk Reduction. DLSU expressed interest to collaborate in this area as the Philippines is challenged by various types of disaster such as typhoons, volcanic eruptions, floods, and earthquakes. It was agreed that AITC and CESDR would categorize and share their work conducted in the priority areas as identified in UNISDR's Sendai Framework for Disaster Risk Reduction 2015-2030, the successor tool to the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters.

August 2015

AIT Launches Engineering Leadership Program to Make Engineers Great Leaders

Dr. Gregory Chiu, AIT Leadership Program Director

The Asian Institute of Technology (AIT) launches the Engineering Leadership Program (ELP), designed for professionals who wish to develop their leadership skills by providing practical real-world case-method of learning. ELP's mission is to prepare leaders who take on engineering challenges with in-depth knowledge, skill, and insight through practical learning that employs various methods including experiential learning, communicative skill training for leaders, case studies, and personal development of leadership traits. The Leadership Program would present the structure, roles, responsibilities, practice, and application of leadership traits, skills, and knowledge to the students. The Entrepreneurship and Innovation Program would introduce relevant business and innovation skills and their application to meet these needs of the technical and engineering economic sectors.

July 2015

AIT Aims to Help Rebuild Houses in Nepal Using Habitech Building System

In July, a team of experts from AIT visited the Department of Urban Development and Building Construction (DUDBC) office in Kathmandu, Nepal to present and discuss the strength, safety, and earthquake resiliency of AIT's Habitech Building System to several stakeholders. The technical presentations were delivered by Dr. Naveed Anwar, Executive Director, AIT Consulting and Mr. Gyanendra Sthapit, Director, Habitech Center, AIT. The talks focused on the Earthquake Resilience of the Habitech technology and why it was the best solution to use in an earthquake prone country like Nepal. The participants represented Ministry of Urban Development, National Planning Commission, Department of Urban Development and Building Construction and others.

July 2015

ASEAN Countries Discuss Affordable Housing Challenges and Solutions in Regional Forum Organized by AIT and NHA, Thailand

The National Housing Authority (NHA) Thailand in collaboration with the Asian Institute of Technology (AIT) through AIT Consulting brought together leaders and policymakers from ASEAN countries to discuss today's affordable housing challenges in a three-day event held from 1-3 July 2015 at Centara Grand Mirage Beach Resort Pattaya, Thailand. Representatives from Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, and Thailand participated in the forum and discussed in detail about the affordable housing challenges and policies and strategies being pursued in their respective countries. *More information and photos about this event can be found on pages 52-53.*

June 2015

Seminar on Effective Bridge Management Systems & Bridge Design & Construction

A three-day seminar from 24-26 June 2015 was organized by Smart Infrastructure Asset Management Australia (SIAMA) and the Asian Institute of Technology (AIT) on *"Effective Bridge Management Systems & Bridge Design & Construction".* The seminar presented several topics focusing on effective bridge management systems, bridge monitoring, bridge design and construction from renowned experts in the field of bridge engineering. The distinguished speakers included Prof. Pennung Warnitchai, Professor, School of Engineering and Technology, AIT; Dr. Jaeho Lee, CEO and CTO, SIAMA; Dr. Yang Li, Project Manager, SIAMA; Mr. Fujita, Project Enigneer, EJEC; Dr. Songkiat Matupayont, Technical Director, Civil and Structural Engineers Co. Ltd., Thailand; Dr. Kittipoom Rodsin, Assistant Professor, King Mongkut's University of Technology North Bangkok, Thailand; and Dr. Naveed Anwar Executive Director, AIT Consulting, AIT. The seminar attracted a total of 37 participants from 13 countries including Myanmar, Thailand, India, Nepal, Philippines, Japan, Cambodia, Pakistan, and Sri Lanka.

Conference on Hybrid Canal-Rail Connectivity: Linking Bangkok's Canals Networks to Mass Rapid Transit Lines

A conference on the development of water and rail transit networks *"Hybrid Canal-Rail Connectivity: Linking Bangkok's Canal Networks to Mass Rapid Transit Lines"* was organized by the Research Team of Faculty of Architecture and Planning, Thammasat University, Bangkok Metropolitan Administration (BMA) and the Rockefeller Foundation, Thailand on 26 June 2015. This conference focused on the current practices, research implications, future challenges and solutions to improve the canal-rail connectivity specifically in Bangkok. Dr. Naveed Anwar and Ms. Rakdao Pakdisi attended the conference on behalf of the Asian Institute of Technology (AIT).

Kenya Officials Attend Capacity and Capability Enhancement Training Program on Integrated Affordable Housing Solutions

Kenya sent a three-member delegate to attend a comprehensive training program on capacity and capability enhancement at the Asian Institute of Technology (AIT) from 21-26 June 2015 to learn integrated solutions to fulfill the housing needs of the various income groups in Kenya. The participants were trained on the manufacturing of interlocking bricks and building construction technology developed at Habitech Center in AIT. The training program is part of the package which also include supply of one set of Manual Brick Press machines to be shipped to Kenya and a step by step process for the design of a comprehensive housing scheme.

Technical Exchange Seminar between AIT and TEAM Group of Thailand

AIT President Prof. Worsak Kanok-Nukulchai and TEAM Group Chief Executive Officer Dr. Prasert Patramai

A Technical Exchange Program was organized by the Asian Institute of Technology (AIT) and TEAM Group on 3 June 2015 to strengthen mutual understanding, involvement, and collaboration for joint research and/or certain joint projects. Aware of the importance of mutual collaboration and student internships, TEAM Group signed MoU with AIT to continue working together. The TEAM Group also donated 3 million (THB) to the AIT Library Modernization Campaign. The half-day seminar brought together 22 senior TEAM Group officials, AIT faculty members, and students. Under the MoU, AIT undergraduate and postgraduate students would now have a chance to intern at the leading conglomerate of Thai-based consulting firms, during the summer months of June and July.

30 Afghan Students from Ministry of Energy and Water Arrive in AIT under ADB Program

Thirty engineers and associated professionals working in the Western Basins Region of Afghanistan arrived at the Asian Institute of Technology (AIT) under Capacity Building for Western Basins Water Resources Management Project, on a grant funded by Canadian Department of Foreign Affairs, Trade and Development (DFATD), and approved by the Asian Development Bank (ADB). Ministry of Energy and Water (MEW), Government of Afghanistan through Cowater International Inc. has engaged AIT to assist and support in the provision of Master Degree Programs in AIT. A dedicated unit in AIT Consulting headed by its Executive Director Dr. Naveed Anwar is currently managing the project, keeping in view the objective of strengthening and expanding the knowledge, experience, and professional competence of the participants.

May 2015

AIT Team Visits Nepal after Earthquake

AIT team visit to the International Center for Integrated Mountain Development (ICIMOD) – there are 9 AIT alumni working at ICIMOD including from Bangladesh and Pakistan, aside from Nepalese nationals

A three-member team from the Asian Institute of Technology (AIT) comprising of Mr. Gyanendra Sthapit, Director, Habitech Center; Dr. Sangam Shrestha, Associate Professor, Water Engineering and Management, School of Engineering and Technology (SET); and Mr. Karma Rana, Institute Secretary, visited Nepal from 5-11 May 2015. The team was sent by AIT President to conduct an on-the-spot survey to ascertain the ways in which AIT could assist. A high-level seminar on the topic ***"Low Cost Disaster Resilient Housing Technology"*** was jointly organized by the Social Democracy Studies Centre and the Asian Institute of Technology and Management (AITM), where AIT's Habitech technology was presented. The AIT team met with the International Center for Integrated Mountain Development (ICIMOD) and also the Rotary District of Nepal for a possible collaboration to build eco-friendly houses as part of Nepal's reconstruction plan.

May 2015

Charity Event for Nepal Aims to Build Houses Using AIT's Habitech Technology

A fundraising event ***"Heart Quake: Home and Heal"*** organized by Mekong Organization for Mankind (MOM) in collaboration with the Asian Institute of Technology (AIT) was held on 24 May 2015 at the EmQuartier shopping complex in Bangkok, to rebuild homes in Nepal using AIT's Habitech technology. The goal of this charity event was to raise funds to build at least 50 houses in disaster affected areas in Nepal. These houses are to be built by using the AIT's Habitech technology which is cost-effective, durable, sustainable, disaster-resilient, uses local resources and is simple to use and construct. AIT's Habitech technology was prominently featured and showcased in this event.

April 2015

6th Annual Affordable Housing Projects Tackles Challenges in Housing Supply and Demand

The 6th Annual Affordable Housing Projects conference was held on 15-17 April 2015 at Marina Mandarin, Singapore focusing on major challenges in the supply and demand of affordable housing, innovative approaches to fulfill housing demand and drive sustainable development as well as examine the relationship between governments and private sector to harness the abilities of all stakeholders to accelerate provision of affordable homes.

The three-day conference featured international expert presentations and case studies on the key topics. Dr. Naveed Anwar, Executive Director, AIT Consulting was invited to present a topic on ***"Increasing Resistance to Hazards Using Enhanced Structural Design and Disaster Resistant Materials,"*** and was also a panelist on the discussion on this topic.

April 2015

EJEC and AIT Strengthen Partnership with Technical Exchange Seminar

To strengthen mutual understanding and involvement about each of the organization's own technologies, researches, and projects and to build up the basis of collaboration for joint research and project, the Eight-Japan Engineering Consultants Inc. (EJEC) and the Asian Institute of Technology (AIT) held a Technical Exchange Seminar on 23 April 2015 at the AIT Conference Center. The seminar kicked off with three presentations including: AIT by Dr. Gabrielle Groves Punyaratabandhu, Head, External Relations and Communications Office; AIT Consulting by Dr. Naveed Anwar, Executive Director, AIT Consulting; and EJEC by Mr. Atsuyuki Nakaseko, Head, International Department, EJEC. Three parallel sessions were conducted afterwards focusing on: Disaster Mitigation; Tunnels; and Solid Waste Management and Energy.

April 2015

UNESCAP to Fosters Partnership with AIT

Mr. Adnan H. Aliani, Director, Strategy and Programme Management Division, UNESCAP visited the Asian Institute of Technology (AIT) on 3 April 2015 to discuss possible collaboration and opportunities. He also took the opportunity to meet with Dr. Naveed Anwar, Executive Director, AIT Consulting who introduced AITC's expertise and services through a detailed presentation of several global applications of AIT's technical adroitness. Dr. Naveed informed Mr. Aliani that AIT through AIT Consulting and Habitech Center in collaboration with its key partners was organizing an event related to affordable housing. Mr. Aliani advised AIT to consider organizing a competition in order to acquire relevant talents and resources, to which AIT agreed.

March 2015

IAPEX 2015 Lahore Convention Focuses on Technology in Architecture

The annual Architects Annual Convention and Building Material and Products Exhibition (IAPEX) was held from 4-6 March 2015 in Lahore, Pakistan. The event, with this year's theme *"archiTECHture – technology in architecture,"* brought together a full house of architects, engineers, allied professionals, builders, faculty, students, exhibitors, building industry, and related field partners to exchange ideas and benefit from each other's knowledge and expertise. Dr. Naveed Anwar, Executive Director, AIT Consulting delivered a presentation on *"Structural Technologies for Meeting Architectural Challenges".* The program featured a three-day elaborate exhibition of architectural, building materials and products, professional workshops, forum with accomplished local and international speakers and the students jamboree workshop and symposium attended by architecture students and faculty from all the accredited architecture schools of Pakistan.

Housing in the Context of Energy Transition in Asia

By Brahmanand Mohanty

Cities around the world are believed to consume 66% of the world's energy today and account for 70% of current GHG emissions, as a result of rapid urbanization, high economic growth, and rising middle class.

Housing in the Context of Energy Transition in Asia

Introduction

54% of the Asian population currently lives in urban areas; urbanization is expected to increase rapidly to reach 66% by 2050 (United Nations, 2014)

Cities around the world are believed to consume 66% of the world's energy today and account for 70% of current GHG emissions, as a result of rapid urbanization, high economic growth, and rising middle class.

Asia is the largest and most populous continent, comprising 60% of the world's population and accounting for 30% of the land area. Asia also has the highest population growth rate, almost quadrupling during the 20th century. The rapid population growth and fast economic development are already threatening its limited resources through quick expansion, destruction of natural habitats and urbanization.

Already 54% of the Asian population currently lives in urban areas; urbanization is expected to increase rapidly to reach 66% by 2050 (United Nations, 2014).[1] With such growth rate, UN-HABITAT (2011) estimates that 120,000 new residents would need to be accommodated every day in urban areas, leading to a daily demand for around 20,000 housing units.[2]

Housing is a major concern for middle- and low-income groups. Due to the lack of adequate housing, large-scale slums and informal settlements are common in Asian cities. In South Asia alone, there is a shortage of more than 38 million housing units (World Bank, 2010).[3] Taking the average family size into consideration, this would mean 212.5 million homeless people or 14% of the total population of South Asia.

Based on 2011 census data, the number of urban households in India is expected to double by 2032. According to the report of Mckinsey Global Institute (2010), India would have to build 700 – 900 million m^2 of residential and commercial spaces annually for the next 20 years in order to meet the ever-increasing demand for constructed built-up area.[4] Multi-storey buildings are being considered favourably due to land scarcity, high land cost, and the need to avoid urban sprawl.

In 2011, residential buildings accounted for 25% of India's total electricity consumption. According to the projections of the Planning Commission, the electricity consumption in residential buildings is expected to increase seven-fold between 2012 and 2032, making the residential sector the largest consumer of electricity in the country with a 36.5% share of the total electricity consumption in 203 2.[5]

In China, it is estimated that 40% of the urban inhabitants do not yet own a home. About 10 million units of houses need to be constructed annually until 2030 to make up for the shortage of 70 million units. According to the China Greentech Report 2012, buildings account for approximately 20% of the primary energy consumption and 30% of the electricity use; they cause roughly half of all urban carbon emissions.[6]

Apart from the consumption of high amount of operating energy over its lifetime, the contemporary construction practices of buildings are very energy intensive. According to UNEP and CSIRO (2010), the extraction of construction minerals in Asia and the Pacific grew at the rate of 7.1% per annum during 1970-2008, far exceeding the rest of the world.[7] Scarcity of natural resources and a growing concern for environment protection are in direct competition with the ever-growing demand for housing infrastructure, rising energy price shocks, inadequate and unreliable energy and water supply systems, and air and water pollution.

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[1] *United Nations, Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352).*
[2] *UN-HABITAT (2011). Affordable Land and Housing in Asia. Nairobi: UN-HABITAT*
[3] *Tatiana Nenova (2010). Expanding Housing Finance to the Underserved in South Asia: Market Review and Forward Agenda, World Bank*
[4] *Mckinsey Global Institute (010). India's Urban Awakening: Building Inclusive Cities, Sustaining Economic Growth. April*
[5] *Planning Commission. India Energy Security Scenario, 2047. New Delhi: Planning Commission, Government of India.*
[6] *China Greentech Initiative (2010). The China Greentech Report 2012, Greener, Smarter, More Productive.*
[7] *UNEP and CSIRO (2011). Resource Efficiency: Economics and Outlook for Asia and the Pacific.*

Apart from the issue of the lack of housing and the foreseen growth in energy demand for housing, one needs to consider the fact that there are still a very large number of Asian households that are yet to be electrified and do not have access to modern and clean cooking fuels.

Housing in the Context of Sustainable Energy for All

The United Nations Secretary General's initiative, "Sustainable Energy for All" or "SE4All" in short, is focused on achieving three inter-linked and complementary objectives by 2030: a) to ensure universal access to modern energy services; b) to double the rate of improvement in energy efficiency; and c) to double the share of renewable energy in the global energy mix. All stakeholders need to come together to address these issues over the next two decades in all economic sectors of activities, including the housing sector which is reported to account for as much as 40% of the world primary energy.

As far as ensuring universal access to modern energy services is concerned, the reference is principally made to electricity for lighting and human comfort and clean fuels for cooking. Over a billion people, 95% of them living in sub-Saharan Africa and developing Asia, lack access to electricity which has become synonymous to development. Activities of some people come to a halt after dark and some others depend on alternative lighting options such as kerosene or candle lamps that are costly and inefficient. Similarly, nearly 40% of the world population is deprived of clean cooking fuels. They rely on wood, coal, charcoal, and animal waste to cook their daily food, and as a result breathe in toxic smoke that causes lung disease and kills nearly two million people a year, mostly women and children. Solutions already exist to address these challenges, as exemplified in the different parts of the world in the form of improved cook stoves, small-scale lighting solutions, micro or mini grids operating with local energies such as solar, wind, micro-hydro or agricultural/agro-industrial waste (rice husk, bagasse, corn cobs, etc.). Governments, businesses, and civil societies are working together to ensure minimum energy access which is also a pre-requisite for achieving the Millennium Development Goals.

As far as energy efficiency is concerned, it makes a lot of sense in a resource-constrained world. In fact, the building sector provides a huge potential to reduce the energy consumption cost-effectively without compromising the comfort or services. Energy efficiency allows to achieve resource productivity, reduces cost for the building occupants, and supports economic growth. It also improves energy security for energy-importing countries and lessens emissions of greenhouse gases. Energy efficiency can be considered as the low-hanging fruit because it guarantees a fairly quick return on investments in comparison with the capital investment made for the building itself. Interestingly, energy efficiency very often serves to make the penetration of renewable energy more affordable. For example, while inefficient incandescent light bulbs are still in use in many households that are connected to the centralized power grid, a light bulb using the very highly efficient and several times more expensive Light Emitting Diode (LED) becomes the natural choice for a household without access to power grid in order to meet the energy needs from renewable energy.

Finally, energy from renewable sources such as the sun, wind, water, and biomass is inexhaustible. Though it constitutes only about 15% of the global energy mix, renewable energy is becoming increasingly cost-competitive and global investment in this domain is growing by leaps and bounds. In fact, the price of solar and

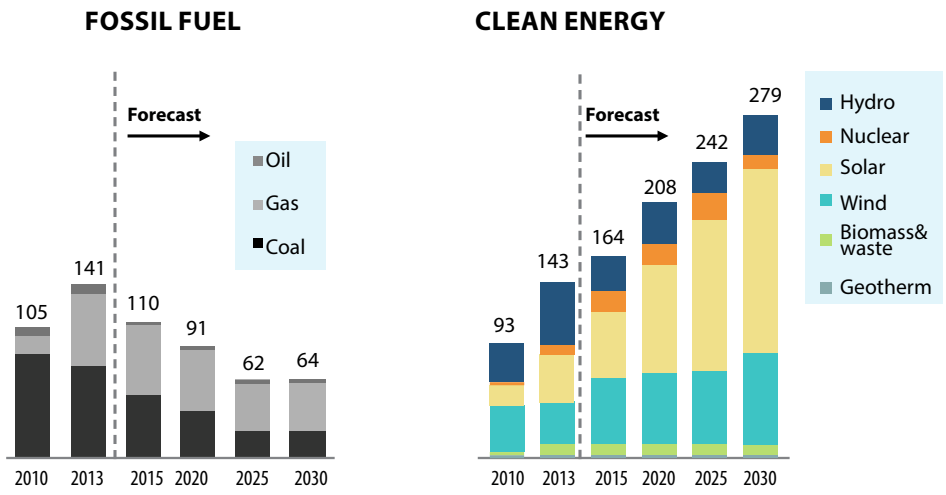

Figure 1: *Power generation capacity addition around the world* [8]

[8] *http://www.bloomberg.com/news/articles/2015-04-14/fossil-fuels-just-lost-the-race-against-renewables*

wind power continues to plummet and is now at par with or cheaper than grid electricity in many parts of the world. As reported by Bloomberg New Energy Finance, the world has added more capacity for renewable power in 2013 than coal, natural gas, and oil combined.

Ensuring Housing for All: Affordability and Sustainability

Adequate housing is a fundamental right for all humans to ensure their health and well being. And yet, according to the last global survey attempted by the United Nations in 2005, about a billion people lacked adequate housing. The key to ensure adequate housing is the implementation of this human right by appropriate government policy and programmes, including national housing strategies. McKinsey Global Institute has outlined four key strategies to reduce the cost of delivering affordable housing by 20 to 50 percent: a) unlock land at the right location (the most important lever), b) reduce construction costs through value engineering and industrial approaches, c) increase operations and maintenance efficiency, and d) reduce financing costs for buyers and developers.[9]

Two of the above four levers that can be linked to energy issue are the reduction of construction costs and improvement of operations and maintenance efficiency. Energy needed in a building can be broadly categorized into two forms: (1) embodied energy in the construction of raw materials and building components, grey energy associated with the transportation to the building site, and construction/induced energy required during the construction stage; and (2) operational energy which is consumed during the service lifetime of the building. As far as housing construction phase is concerned, proven technologies and approaches and regulatory support can enable large-scale and low-cost housing production. In most parts of the world, residential houses are still being constructed using traditional approaches. By adopting industrial construction methods, it is possible to carry out a major share of construction activities off-site through pre-fabrication of structural elements, reducing the cost and time needed for construction. Another alternative is the adoption of in-situ techniques using lightweight metal forms. An added benefit of these approaches is the substantial reduction of construction debris. Industrial housing techniques are often looked down because of the stigma associated with them in the past during the Soviet Union era but this can be easily tackled by addressing the quality and aesthetic issues that can help to provide distinct identity to each building.

The industrial housing technique requires high capital investment and may not always be feasible in several developing Asian countries where

Figure 2: *Apartments constructed with stabilized compressed earth blocks in Auroville, India*[10]

[9] *McKinsey Global Institute (2014). A blueprint for addressing the global affordable housing challenge, October*
[10] *Photo credit: Satprem Maini, Auroville Earth Institute, India*

the construction market is rather fragmented. Moreover, such techniques are highly dependent on materials produced using construction minerals extracted from the nature. Ways to reduce the embodied energy of the housing material include lowering the energy intensity and increasing its longevity. Traditional building materials tend to have lower embodied energy mainly because of local availability and non-industrialized production methods. Rammed Earth, Stabilized Soil Blocks (SSB) and Compressed Earth Blocks (CEB) are such technologies that exhibit low embodied energy.[11] Such technologies favour on-site extraction and use of raw material and guarantee multiple benefits including the reduction of carbon footprint, avoidance of transportation energy and costs, increasing the accessibility to low-income population and last but not least, creation of local employment and livelihoods.

Strategy to Achieve Low-energy Buildings

Buildings consume considerable amount of energy over their lives. Experiences around the world show that it is possible to drastically reduce the energy needed in buildings by first adopting the right building science at the time of construction and then choosing efficient equipment and appliances that are needed to achieve the expected comfort and/or productivity of the building occupants. For example, the star-rating program for office buildings developed by the Indian Bureau of Energy Efficiency (BEE) shows that an office building located in warm and humid climate with more than 50% air conditioned area may have the Energy Performance Index (EPI) varying to a large extent. Accordingly, a building that consumes less than 100 kWh/m^2 per year gets a 5-Star rating whereas a building that consumes more than 250 kWh/m^2 per year does not qualify for any star rating at all. This proves that it is indeed possible to divide the energy use in the building by 2 to more without sacrificing the comfort or rendered services. One can well imagine the benefit that a country like India can accrue if a fair number of the future buildings opted for 3-, 4- or 5-star certification.

Low-energy buildings can be guaranteed if one adopts a whole-building design that requires all stakeholders (owner, architect, engineers, etc.) to work together from the initial stages through the construction stages to the final commissioning. A typical building is considered to have an average economic life of 30 to 50 years. Thus, any design especially with respect to building orientation, solar protection, choice of walls and roofing materials, etc., gets locked into the building throughout its lifetime. Hence, it is important to include sustainable strategies at the conceptual design phase and invest at the very beginning since any modification during the construction process of the building will result in higher costs and sometimes may not be feasible after completion of building construction. A logical sequence of building design can ensure that the building consumes minimal amount of energy, as described below:[12]

1. **Sustainable Design** - While general guidelines can be established, the design approach shall be unique for different cases. The design has to take advantage of the natural elements in order to reduce the need for energy supply. This includes passive design and improvement of the building envelope.
2. **Energy Efficient Appliances** - After optimizing building design, energy efficient end use appliances should be selected to further reduce the demand.
3. **Process/System Integration** - During the design stage, especially for large commercial buildings, opportunities for system integration can be considered such as heat recovery and heat exchanger networks.
4. **Energy Efficient Systems** - This includes electrical and mechanical equipment such as boilers, chillers, etc. Depending on the scale and complexity of the system, building management systems can be used to control and further bring down the energy consumption of the building.

While the integrated approach provides a general overview for designing low energy buildings, complex simulation software that takes into account the climatology and complex building physics, is often required to conduct a detailed analysis in order to assess the effectiveness of the design solutions/technologies and predict the future building energy performance. This can be a major deterrent for the architects or building

One can well imagine the benefit that a country like India can accrue if a fair number of the future buildings opted for 3-, 4- or 5-star certification.

[11] *UN-Habitat. Going Green (2012). A Handbook of Sustainable Housing Practices in Developing Countries.*

[12] *Mohanty B. (2012). Buildings: Policy Recommendations for the Development of Eco-Efficient Infrastructure, Background Policy Paper for Low Carbon Green Growth Roadmap for Asia and Pacific, UN-ESCAP and KOICA, United Nations Publication, Bangkok.*

owners/developers as they do not always have the necessary expertise and have to depend on external consultants. Another important deterrent is the fact that while the simulation software is able to predict energy performance of the building, it cannot predict the extent to which the selected energy performance improvement options will impact the overall construction cost.

The International Finance Corporation (IFC) has developed an internet-based free-to-access building design tool called EDGE (Excellence in Design for Greater Efficiencies) that aims to achieve reduction of not only operating energy but also the embodied energy as well as the water use in the building in nearly 100 emerging market countries. Depending on a user's design inputs together with information on typical local practice and available building codes, EDGE develops a building's base case for energy and water use and the impact of embodied energy in materials. A spectrum of localized data supports the base case for the project, ranging from the local ambient temperature profile, rainfall patterns, solar radiation, the building's actual dimensions and the economic strata of the occupants.[13]

Rather than suggesting a perfect or prescribed scenario, EDGE provides users with a set of best-practice options to explore in order to identify an optimum design solution. The user has the full freedom to determine which set of technical measures is the best choice to attain the required efficiency levels. As an example, a simple test is carried out to assess the scope to reduce the energy consumption of a 120-m^2 upper-middle income house on two floors with 4 bedrooms by considering the following features in comparison with the base case:

- Use of external shading devices (Annual Average Shading Factor of 0.51)
- Insulation of roof (U value of 0.45)
- Variable refrigerant volume cooling system
- Energy saving light bulbs (indoor, common areas and outdoor areas)

By considering the above options, the house can save as much as 36.02% of energy compared to the base case, as shown in Figure 3 below. The Energy Performance Index (EPI) of the building has been reduced from 136 to 87 kWh/m^2 per year. Thanks to the adoption of roof insulation and external shading devices combined with the variable refrigerant volume cooling system, the maximum EPI reductions in the house are from the lower cooling energy, followed by efficient lighting.

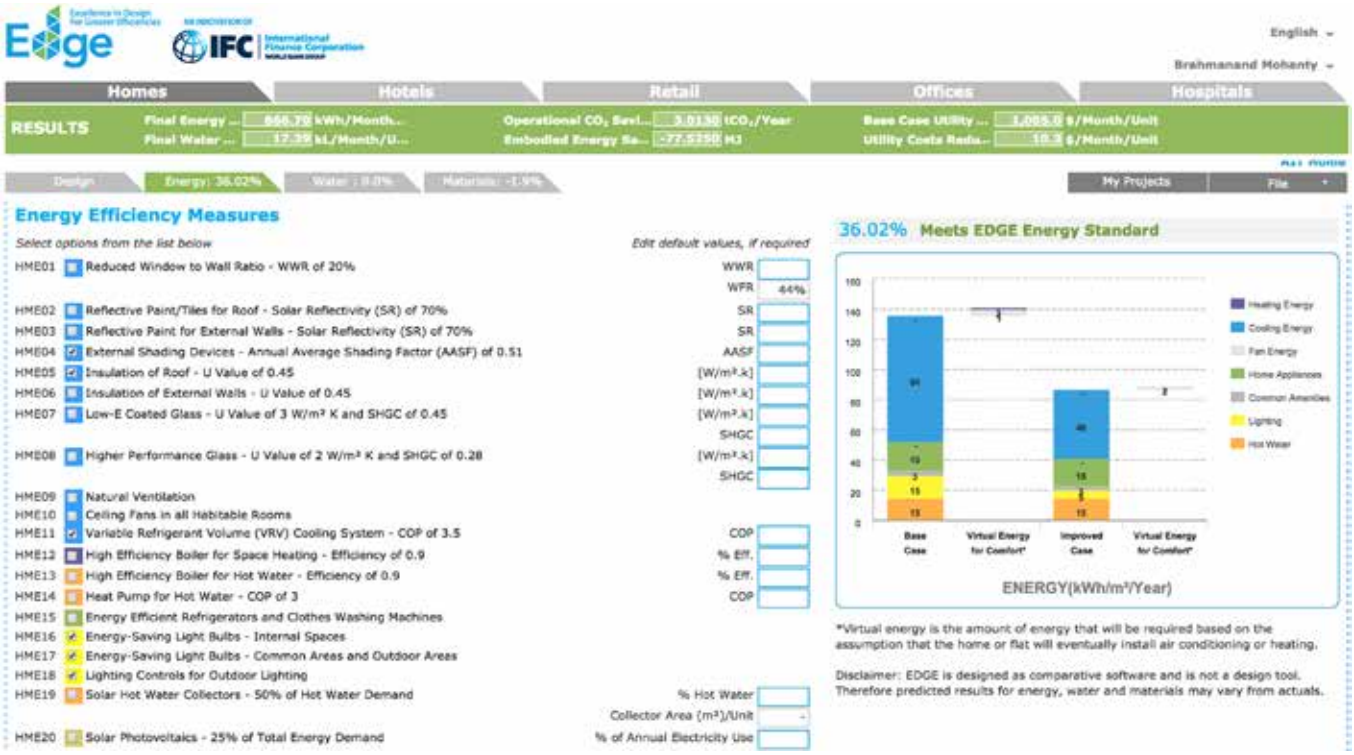

Figure 3: *Screenshot of EDGE tool for energy efficiency measures in an upper-middle income house*[14]

[13] *International Finance Corporation (IFC), Excellence in Design for Greater Efficiencies: User Guide for Homes, http://www.ifc.org/wps/wcm/connect/Topics_Ext_Content/IFC_ External_Corporate_ Site/EDGE/Learn+more/*

[14] *Result of the simulation with selected energy efficiency measures, http://edgebuildings.com/#/Tools/*

From Consumption to Prosumption: Net-zero Energy Housing

The world is increasingly concerned with the rapidly depleting fossil energy sources and their adverse impacts on global environment. All stakeholders are being called upon to take concerted actions in order to achieve a smooth energy transition from fossil to renewable energy sources. Buildings can play a specific role to accelerate the energy transition by transforming themselves from being an energy consumer to an energy prosumer.[15]

A low energy building mainly reduces the energy demand through efficiency gains while a net-zero energy building tries to match its reduced energy demand with renewable supply options. Hence, a low energy building is actually a pre-requisite to net-zero energy buildings. The supply options could be fulfilled by on-site or off-site generation from renewable energy. Houses and office buildings can be converted into places of production with relatively minor alterations. By installing rooftop solar photovoltaic installations, existing structures can minimize their dependence on fossil fuel resources, thereby reducing their carbon emissions.

This concept is illustrated in Figure 4 which shows the gradual progression of a small two-storey commercial building of 100 m^2 floor area and 50 m^2 roof area towards achieving net-zero energy status. Better designing of the building would allow the EPI to drop from 250 to 150 kWh/m^2 in a year. Thanks to the adoption of energy efficiency and conservation measures, the building's EPI can further reduce to 50 kWh/m^2 per year. The building then has the option to cover half of its roof with solar photovoltaic panels in order to become a net-zero building, or even go further to become net energy-positive building by covering the entire rooftop with solar PV panels and exporting 5,000 kWh of excess energy to the power grid annually.

A net-zero energy building can export the excess electricity generated during sunshine hours to the local power grid and import an equivalent amount of electricity for its own use from the grid during the periods of no sunshine. Apart from avoiding to pay any electricity bill, such a building will help the local grid to lower the losses associated with the transmission and distribution of electricity from the centralized power plants located far from the end-users. Such rooftop solar power generators can help to improve the reliability and power quality of the power grids in some Asian developing countries that lack the capacity to meet the users' demands. The countries with adequate power supply infrastructure can reduce their dependence on fossil fuel for power generation during the periods when the users are able to not only meet their energy needs from renewable sources but also export the excess to the power grid.

Case-study of Energy Transition: Net-positive Energy Home

This case study is about the author's home. The author's family lives in a coastal city of South India, which is known for its warm and humid climate throughout a good part of the year. During the designing of the house, care was taken to orient it properly, provide adequate solar protection, and benefit from natural daylight and ventilation. As a result, there is practically no need for artificial lighting during daytime and ceiling fans alone can create a fairly comfortable indoor environment. Air conditioning is needed in specific areas of the house only during extremely hot and humid periods, totalling about a couple of months in a year.

Efficient light emitting diodes assure the artificial lighting needs, consuming 5 to 10 times less electricity and lasting several-fold longer than the traditional incandescent or halogen lamps. Fans used in the rooms for air circulation and

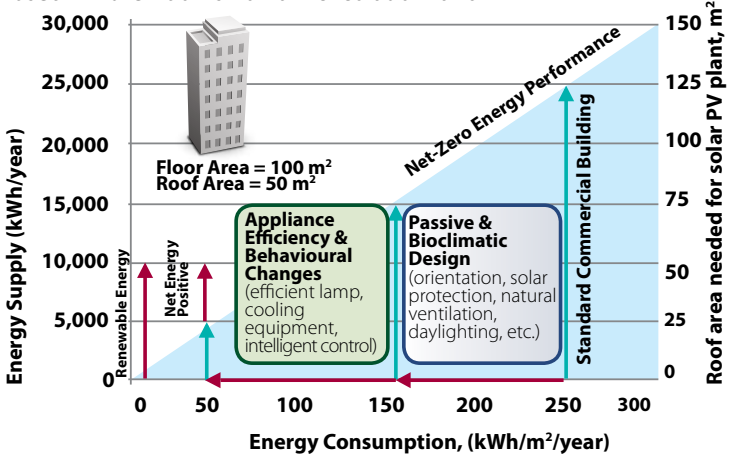

Figure 4: *Progressive move of a standard building towards the net energy-positive status*

[15] *Prosumption is a concept that emphasizes producing what one consumes. The prosumption index can be used as a yardstick to measure what is produced as a share of resources consumed.*

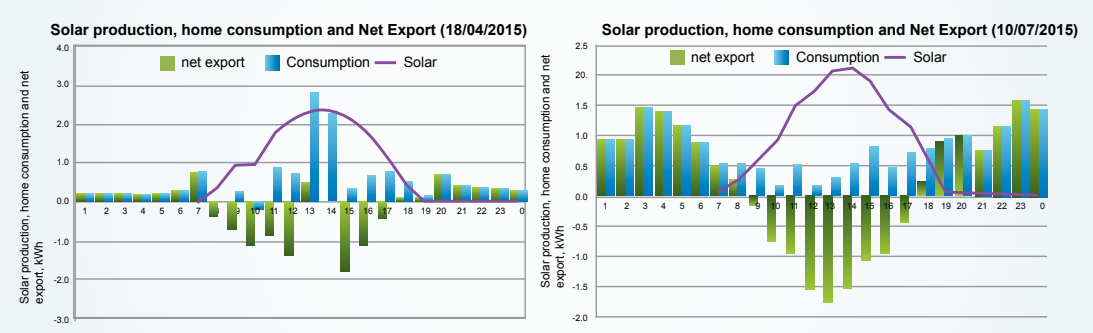

Figure 5: *(Left) Charging of car and scooters during mid-day; (right) Use of air conditioners at night*

ventilation are the most efficient ones, consuming about 50% less electricity than the standard products sold in the Indian market. Similarly, other household electrical appliances including inverter-based refrigerator, washing machine and air conditioner, water pump and TV are chosen such that that they consume far less electricity than the standard appliances sold in the market. It should be noted here that this has been possible thanks to the recent initiatives of the Indian government in introducing energy performance ratings for the high-energy consuming devices sold in the country. All these measures have helped to divide the energy demand of the house by at least two times.

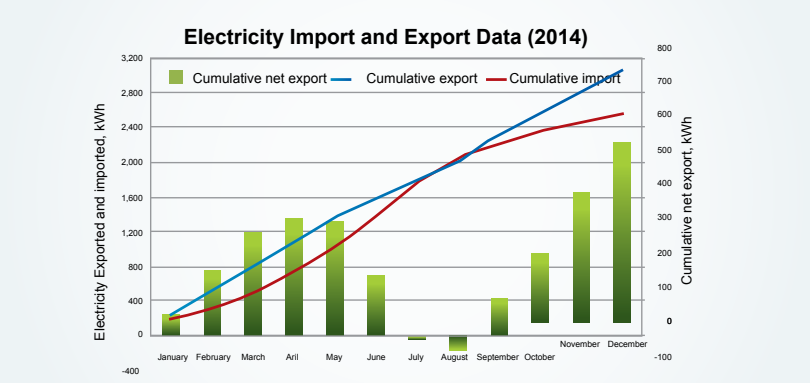

Figure 6: *Energy performance of the author's home for different months in the year 2014*

Once the demand for electricity was managed, a decision was taken to opt for a grid-connected 3-kWp solar photovoltaic system that produces on an average over 4,500 kWh of electricity per year. The family also charges an electric vehicle and two electric scooters whenever the solar power output is high during the day, thus eliminating any fossil fuel use for local transportation. Further, a decision was taken to use microwave oven for cooking with electricity to the extent possible, thus reducing the dependence on LPG (liquefied petroleum gas).

Exporting electricity to the grid is something that one could not imagine in India a few years back till the new Electricity Act made it possible for feeding in renewable energy into the grid. Since solar energy is available only during sunshine hours when the demand for energy in the house is quite low, the excess electricity produced by the solar system is fed into the grid. In return, whenever the solar electricity is not available or adequate, the house for its energy needs depends on the electricity grid. An added advantage of rooftop solar installations is their ability to protect the roof from the high solar radiation throughout the day, thus avoiding the need for insulating the roof and reducing the cooling load considerably.

Since the installation of the solar system on 1st October 2011, the home has maintained a net energy-positive status over the 4 years. Figure 6 shows the energy balance of the home for the year 2014, highlighting a healthy surplus of about 10% over its own electricity consumption despite the fact that the home faced a deficit of electricity during July and August due to less solar electricity generation and higher electricity consumption.

This is a small but significant step for the author's family to move towards sustainable energy goals, without any concern for energy insecurity or energy price hikes. If other households in urban Asia decide to follow suit by first lowering their electricity demands through adoption of energy-efficiency and conservation and then investing in rooftop solar power plants, the region would move in right direction in its quest for achieving sustainability through a smooth energy transition.

Delivering Integrated Solutions for Over 5 years

AIT Consulting, now AIT Solutions

Established in 2010 at the Asian Institute of Technology (AIT) as an outreach center, AIT Consulting (AITC) provides a link between AIT and the community by providing a wide range of consulting services in engineering, technology, environment, development, and management, built upon more than five decades of AIT's research and development, and network of alumni.

AIT CONSULTING
Technology . Engineering . Environment . Development . Management

Delivering Integrated Solutions for Over 5 years

As part of one of Asia's leading higher learning institution, AIT Consulting is in a unique position to deliver integrated solutions and to contribute towards sustainable development of the region

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It was incepted as a means to streamline the administration of consulting activities and to create united strength of schools and units to increase the outreach of AIT with an aim to enhance the application of science and technology in the development of Asia and the region.

AITC started its operations in June 2010, under the direction of Advisory Board headed by AIT President and Technical Council headed by Vice President for Research and Development, both comprising of AIT faculty and external experts, leading to AIT Consulting official inauguration at AIT on 20 January 2011.

In its five years of operations, with its qualified staff of professional engineers, researchers, and management team under the leadership of Dr. Naveed Anwar, Executive Director, AITC has been at the forefront of sustainable development of the region through development projects as well as its involvement in significant structural engineering projects around the globe.

As part of one of Asia's leading higher learning institution, AIT Consulting is in a unique position to deliver integrated solutions, to contribute towards sustainable development of the region and to serve as a direct link between research and its applications in the practical world.

Over the past 5 years, AITC has worked for more than 100 regional and international organizations from various public and private sectors and is committed to deliver projects that are of high quality, value creation, and having long-term impact on the society as a whole.

AITC worked on various projects encompassing the areas of technology, engineering, environment, management, and development. The next pages depict an overview of AITC's initiatives, activities, and accomplishments in the last five years.

"To contribute towards the technological development of the region through deeper and expanded engagement and delivery of AIT's research, knowledge, and expertise"

AIT Solutions
• Technology • Engineering • Environment • Management • Development

AIT Consulting has made significant progress in developing integrated solutions and providing services in areas of structural engineering, capacity building, software development, and project procurement related review among others. It is however felt that AIT Consulting mission could be better served by moving beyond ***"consulting"*** to actively build on the strengths, the vision and mission of AIT and its knowledge, skills, innovation, research, training, and development, and play an even more productive role.

Based on AIT Consulting's 5 years of result and experience, an enhanced mission statement is developed:

- Promote utilization of AIT's core knowledge base and innovation capabilities
- Facilitation of dissemination of technology and its applications
- Active engagement with government, private sector and civil society
- Close participation with faculty, student body, alumni, and AIT partners
- Contribute to the overall mission of AIT

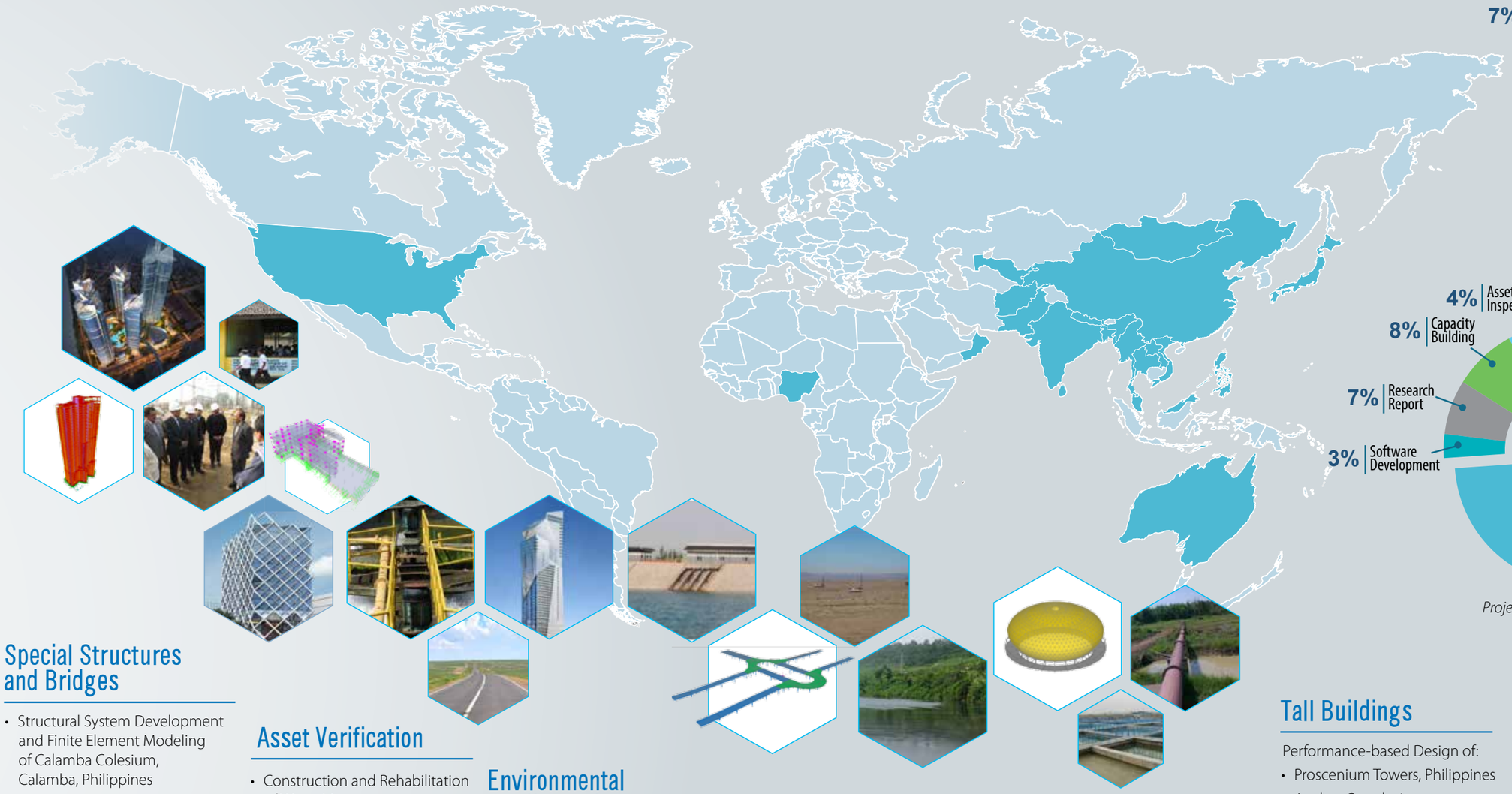
Taking into consideration the new vision and mission of AIT Consulting, it was decided that a new name, AIT Solutions, can best represent a broader mandate to contribute towards technological change and sustainable development by providing innovative and integrated solutions utilizing AIT's expertise and resources.

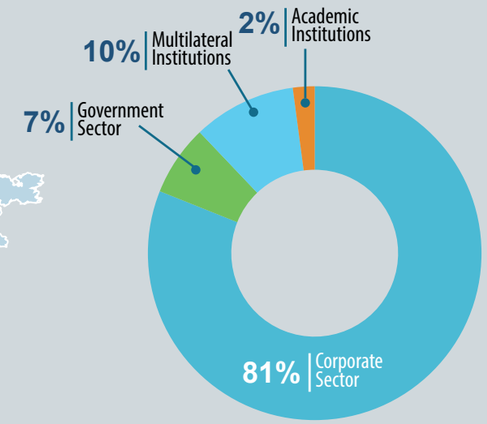
5 Years of Integrated Solutions & Services

200+ Projects

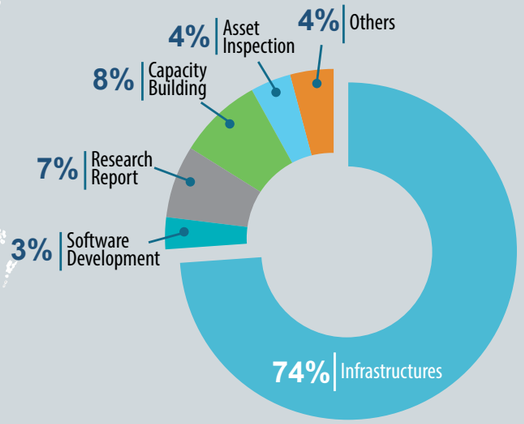
30+ Countries & Territories

100+ Regional & International Organizations





Project Portfolio by Sector



Project Portfolio by Work Scope

Special Structures and Bridges

- Structural System Development and Finite Element Modeling of Calamba Colesium, Calamba, Philippines
- Structural Design Review and Wind Tunnel Model Study of Buddha Saengdham Temple Dome, Saraburi, Thailand
- Structural Peer Review Buddha Metta Statue, Kanchanaburi, Thailand
- Structural System Development and Design of Manila Bay Resort Glass Dome, Manila, Philippines
- Structural System Development and Design of Iconic Bridge, Pasay, Philippines
- Structural Design Review of Lagos Badagry Bridge, Lagos, Nigeria
- Code Based Design of Serendra Bridge Way, Philippines

Asset Verification

- Construction and Rehabilitation of Water Management Systems, Lao PDR
- Power Transmission Enhancement, Pakistan
- Sustainable Agriculture, China
- Educational Facilities, Sri Lanka
- Road Development, Mongolia
- Road Improvement and Institutional Development, Philippines
- Civil Engineering and Highway Engineering, Timor-Leste
- Power Sector Expansion, Samoa
- Road Improvement, Tajikistan

Environmental Studies and Assessments

- Climate Compatible Urban Development, National Institute for Environmental Studies, Japan
- Engagement Methodology, CSIRO, Australia
- Promoting Renewable Energy, Clean Fuels, and Energy Efficiency, Greater Mekong Sub-region
- Nanotechnology Roadmap Development for Sewerage Sector, Malaysia

IT and Software Development

- Development of Software for Integrated Design of Roof Trusses
- Development of Software for Pole Design
- Development of Interactive, Computer-based Learning Tools
- Software Development for Structural and Earthquake Engineering Industry

Seismic Hazard Assesment and Disaster Management

- Probabilistic Seismic Hazard Map-Manila, Philippines
- Strategy and Plan for School Safety, Nepal
- Seismic Hazard Study and Zoning of Offshore Location, Malaysia
- Post Disaster Management of School Sector, Nepal
- Action Plan for Earthquake Disaster Prevention and Mitigation in Bangkok
- Incorporating Environmental Sustainability and Disaster Resilience in Myanmar Building Code
- Asia-Pacific Building Codes: Integrating Environmental Sustainability and Disaster Resilience in Building Codes

Tall Buildings

Performance-based Design of:

- Proscenium Towers, Philippines
- Anchor Grandsuites Masangkay, Philippines
- Acqua Private Residences, Philippines
- Century Spire Tower, Philippines
- Shangri-La The Fort, Philippines
- Shanta Glass House, Bangladesh
- Acropolis Building, Bangladesh
- Ireo Hotel and Office Tower, India
- Langsuan Block 3, Thailand
- Seed Mingle Residences, Thailand
- Pre CWG Building, Tower A, Thailand
- Hotel Nikko, Guam

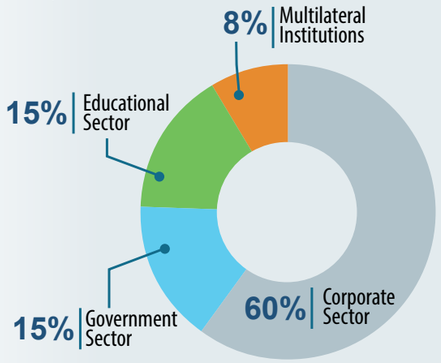
Capability Building Programs

- Training on Girder Bridges and Freeway Design, Road Development Authority, Sri Lanka
- BU Training, Balkh University, Afghanistan
- Basic Research and Quality Assurance Training, Ministry of Higher Education, Afghanistan
- AITC Training Program for Engineers, Ministry of Construction, Myanmar
- AITC Training Program For Engineers-II, Ministry of Ports and Highway, Sri Lanka
- Capability Enhancement for Affordable Housing Development, National Highway Authority, Thailand
- Seismic Strengthening Training for Master Trainers & Local Builders, Nanyang Technology University, Thailand
- Training on Irrigation Feasibility and Design, Project Coordination Unit, Afghanistan
- Building Capacity and Strengthening Community Participation for Water Resources Management and Wetland Ecosystem Restoration, Lower Songkhram River Basin

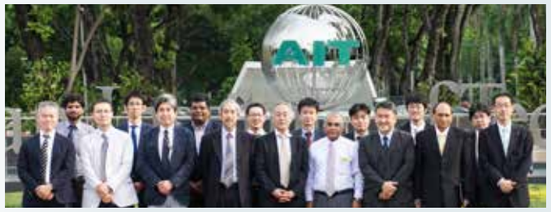
AIT Consulting is striving for best practices to be embedded in every layer of its operation from arranging a corporate visit to delivery of our projects. It participated in a range of knowledge sharing and networking activities throughout the span of five years:

Active engagement in CORPORATE VISITS

Keeping in view the importance of corporate visits and meetings as information acquisition and collaboration exploration activities, AITC arranged 70 on-campus and off-site meetings with various international organizations to initiate long-lasting relationships.



Several visits were organized for multilateral institutions such as Asian Development Bank, IFC World Bank group, and UNESCAP to explore possible collaboration areas.



Eight-Japan Engineering Consultants Inc. (EJEC) Delegates with AIT Faculty Prof. Chettiyappan Visvanathan, Prof. Pennung Warnitchai, and Dr. Naveed Anwar

EVENTS | To share AIT's research & technical excellence

During the span of five years, AITC organized exclusive events including workshops, seminars, and trainings to create and share knowledge, to leverage off AIT's research and technical excellence, and to enhance AIT's visibility across the region.

One of the main events organized was the ***"AIT Technology Event"*** in July 2013. This event brought together specialized experts and industry leaders to engage and explore mutually beneficial activities leading to advancements in relevant high technologies and cutting-edge management practices.

AITC also provided event management and promotional support to AIT for the ***"Regional Forum on Climate Change (RFCC)"*** held on 1-3 July 2015 at AIT, Thailand and to Computers and Structures, Inc. (CSI) USA for the "Theory and Practice of Performance-based Design: The Future of Earthquake Engineering" held in Thailand and the Philippines in August and November 2015, respectively.

Ashraf Habibullah, President, Computers and Structures, Inc. (CSi) answering question from participant in the PBD event in Bangkok

Incredible amount of learning & sharing through CONFERENCES

Considering networking and knowledge sharing as one of its main responsibilities and being part of higher learning academic and research institution, AITC encourages to participate and present in conferences.

ADB	Philippines	IABSE	Switzerland
ASEP	Philippines	iapex	Pakistan
ATC&SEI	USA	NHA National Housing Authority	Thailand
CTBUH	USA	PLSE	Australia
eacef	Indonesia	Society of Structural Engineers Sri Lanka	Sri Lanka

AIT President Prof. Worsak Kanok-Nukulchai (center) with AIT Faculty, Experts, and Keynote Speakers during the AIT Technology Event

TECHNOLOGY MAGAZINE | Asian outlook on engineering & technology

Latest issue: February 2015

AIT Consulting publishes Technology magazine, a forum for professionals and researchers to share and disseminate their contribution to the technological development of the Asian region. Building upon the foundation laid by its pre-cursor *"Civil Computing,"* a magazine published for over 15 years by ACECOMS, Technology magazine covers a broader mandate and features articles from various experts and expertise.

AITC maintains a dedicated website as a platform to share knowledge and features AIT's expertise and experience in the areas of engineering, technology, environment, development, and management.

Capacity building for sustainable development through SPECIAL PROJECTS

AIT Consulting initiated capacity building programs with the higher education ministries from different countries. Following are the recent capacity building projects:

- **Strengthening Higher Education Program:** AIT-BU Partnership Project, Balkh University, Afghanistan
- **AIT-MOHE Partnership Project:** Ministry of Higher Education, Afghanistan
- **AFG Western Basins Water Resources Management Project**: ADB and Co Water Inc., Canada

AIT ALUMNI | Support, guidance, & networking

AIT Alumni is one of the supporting pillars of AITC in terms of providing linkages to expand its network as well as contributing guidance and expertise. AITC sponsored the 43rd AITAA GBM and Grand Filipino Alumni reunion and GA from AITAA Philippines Chapter and remained involved actively in other alumni activities. Regular communication through emails and publications has been in place to stay in touch with Alumni and increase their involvement in our activities.

AIT distinguished alumni during AIT Alive at 55 by AITAA Philippines Chapter

Synergizing & unlocking opportunities together with ACECOMS & HABITECH CENTER

The Asian Center for Engineering Computations and Software (ACECOMS) established in 1995 at AIT, joined AITC in 2011 to synergize on projects covering software development for engineering applications and capacity building programs.

This collaboration has provided growth opportunities for ACECOMS in development, support, and promotion of structural engineering softwares as well as support to AITC in capacity building programs. ACECOMS is also celebrating its 20th anniversary this year.

The Habitech Center at AIT is a research and development unit, constituted in 1989, now celebrating its 25th anniversary, aimed to conduct research and develop solutions to provide sustainable, cost-effective, and appropriate infrastructure technologies and techniques to the community. Habitech Center has played an instrumental role in the region in developing and promoting affordable housing.

In 2014, Habitech center joined AITC to jointly explore and develop customized solutions for affordable housing sector and other areas of mutual interest. This association between Habitech and AITC has not only opened up new opportunities for both centers but has also nurtured the AIT's mission of sustainable regional development.

AITC and Habitech Center developed 5 concept notes and 3 proposals related to the use of Habitech technology and innovative, green technology solutions in affordable housing sector and many potential projects are in pipeline for upcoming years.

OUR TEAM | Our strength

With resourced and expert team, AITC is able to deliver high quality solutions across all sectors and is committed to enabling and encouraging its employees to achieve their full potential. AITC also welcomes graduates from AIT to become part of the team.

In 2011, the first annual AIT Consulting staff planning retreat took place on 14-15 January in Nakhonnayok, Thailand. The main purpose of the retreat was to communicate the direction of AIT Consulting to the staff, intern, and external resource people as well as to provide an opportunity for the team to contribute ideas regarding the organization and the business plan.

AITC also supports AIT students by providing opportunities for internships and exposure to work on practical projects with financial support.

Appropriate and Cost-effective Technology – An Enabling Framework for Large Scale Applications

By Vasudevan Suresh

Construction forms the cornerstone of development and expansion of human settlements – playing a key role in kick-starting the economic growth through its substantial contribution towards income and employment generation.

Appropriate and Cost-effective Technology – An Enabling Framework for Large Scale Applications

Construction forms the cornerstone of development and expansion of human settlements – playing a key role in kick-starting the economic growth through its substantial contribution towards income and employment generation.

Construction activity accounts for more than 50 percent of the development plan outlays in India. It has been observed that in the recent decades, the cost of building construction has been increasing at a pace with 50 percent higher than inflation's growth rate. This is more so on account of the spiraling prices of the conventional building materials such as cement, steel, burnt brick, timber, etc. often at short notice, which are not often captured in computing the index of inflation.

Higher cost levels are registered for using better finishes and amenities. Construction costs of this order is beyond the affordable capacity of the Economically Weaker Section (EWS) and Low Income Group (LIG) and a large cross section of the middle income group, whose income levels have not increased commensurately. This was rendering the housing activity beyond the bounds of affordability of EWS and LIG in the seventies and the eighties, even the middle class had become vulnerable to the unaffordable costs of construction in the nineties. It has become ever more relevant in the macro context due to the large volume of housing and construction activity by the state, central, and local governments for Panchayat Ghar or village council building, school buildings, health centers, community asset buildings, etc. to be done in both rural and urban areas as against the limited resource pool of conventional building materials and finance available. Hence, there is a need for the adoption of strong, durable, functional, aesthetic, environmentally friendly, ecologically appropriate, energy efficient and yet cost-effective materials, and appropriate technologies in construction.

The institutes and organizations involved in building material research and development include the laboratories of Council of Scientific and Industrial Research (CSIR), including Central

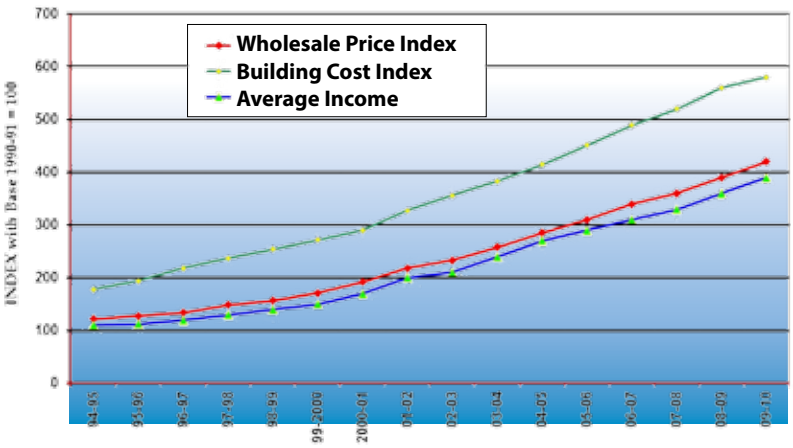


Figure 1: *Construction Cost vs. Average Income and Inflation*

Building Research Institute (CBRI), Structural Engineering Research Centre (SERC), and Regional Research Laboratories (RRL) have brought out a number of cost-effective and appropriate building materials and construction technologies in the course of extensive research and testing. This is in addition to the efforts by other institutions and laboratories such as ASTRA (Bangalore), Development Alternatives (New Delhi), INSWAREB (Visakhapatnam), CSV (Wardha), NCB (Ballabhgarh), IPIRI (Bangalore), Forest Research Institute (Dehradun), IJIRA (Kolkata), COSTFORD (Thrissur), COSTED (Chennai), CSR (Auroville), and other state-level institutes concentrating in specialized materials and technologies of interest. These premier Research & Development (R&D) bodies in the country and creative professionals like Laurie Baker have come up with many innovative options which can contribute to reduction in cost and at the same time offer solutions having aesthetic and which are acceptable for the varying geo-climatic regions and socio-economic profiles of India.

The rapid increase in population and the consequent increased requirement of food production make it mandatory to have increased cultivable areas. The irony is that the conventional construction activities constitute one of the major sectors contributing towards depletion of the fertile land owing to the stripping of the top fertile soil cover for brick making. Further, the damage caused to the environment has attained disastrous

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Figure 2: *Population Density Map of India.* **(Source: Wikipedia)**

proportions on account of the large scale mining and quarrying activities, unscrupulous extraction of precious sand and silt from the river beds, the inordinate dependence on fossil fuels and firewood for burning the bricks and indiscriminate lumbering and use of the precious timber resources. This is even more significant in view of the already decreasing forestry in India. Further, the production processes for conventional building materials are also energy intensive consuming around 200 tons of coal per million of clay bricks, hence contributing to global warming due to the emission of green house gases at the rate of 270 tons per million bricks.

The large-scale vulnerability of the land area and frequent recurrence of natural disasters in our country have raised question of safety of the habitat in face of earthquakes, landslides, cyclones, floods, fire, tsunami, and sea erosion. The design of shelter appropriate for varying bio-climatic environments, geo-lithological conditions and topographic profiles poses a daunting challenge in the provision of housing and community asset buildings. This is particularly significant in a country where nearly 30 percent of the land area is under black cotton soil, whereas the urban sprawl is often concentrated on newly reclaimed land calling for appropriate structural inventions and foundation designs.

The appropriate utilization of agricultural and industrial wastes in the manufacture of building materials with a 'waste to wealth' or 'refuse to resource' or 'thrash to cash' approach needs to be emphasized to take advantage of dual benefits. This could include the waste materials such as fly-ash, gypsum, blast furnace slag, redmud, etc. which could effectively be used in the manufacture of cost-effective alternative building materials as shown in Table 1.

Table 1: Utilization of Industrial Wastes

	Item	Source	Application in Building Material
	**Fly-ash**	Thermal power stations	Portland pozzolana cement, bricks, lime pozzolana mixture, lightweight aggregate, cellular concrete
	**Phospho-gypsum**	Hydro-fluoric/ phosphoric acid, Amm. Phosphate Fertiliser Plants	Gypsum plaster, fibrous gypsum boards and blocks, cement clinker, as a solid retarder and for making super sulfate cement
	**Red mud**	Aluminium ex-traction plant	Building bricks and tiles, light-weight structural blocks, roofing sheets and as additive to concrete
	**Blast furnace slag**	Steel plants	Portland blast furnace slag cement, super sulfate cement, as an aggregate in con-crete, as substitute for sand, light weight concrete
	**Limestone waste**	Limestone quarry	Masonry cement and activated lime poz-zolana mixture
	**Lime sludge**	Sugar, fertilizer, calcium carbide paper, acetylene	Portland cement, masonry cement, sand lime bricks, building lime pozzolana mixture

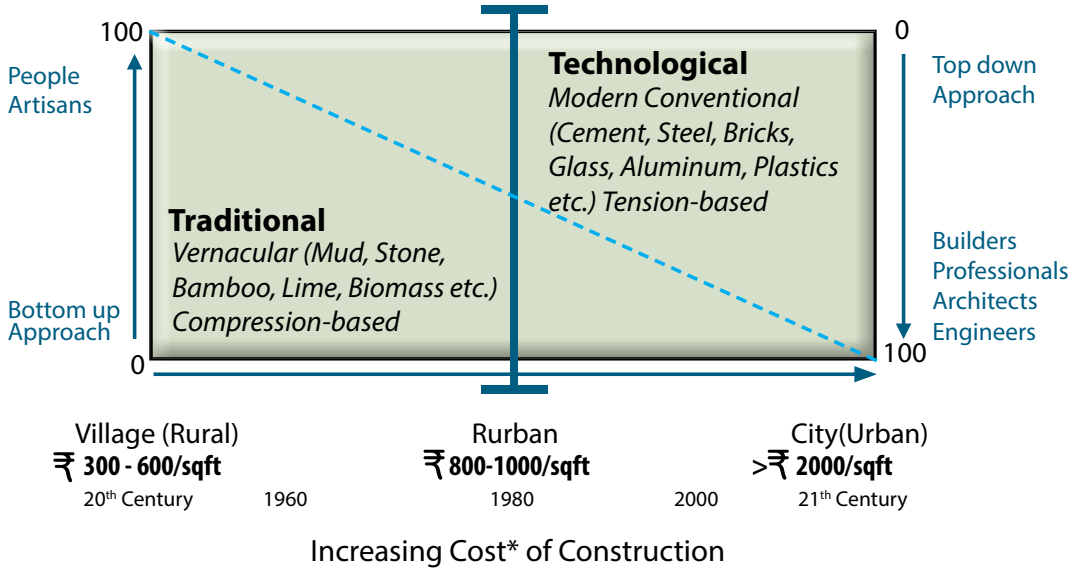

Figure 3: *Intermediate and Cost Effective Technology - Cost Matrix*

The National Housing and Habitat policy lays special emphasis on promoting these environment-friendly alternative materials in order to reduce environmental damage and bridge the gap between demand and supply of traditional materials.

Today, with the globalization of trade, the speed of penetration of technological advancements has immensely increased. In India, the most sophisticated technologies for construction in terms of systems and equipment, tools and machinery and management, and monitoring systems are available. These include the NO-DIG or trenchless technologies, water jet technologies, use of fly-ash, other concrete admixtures and additives, ready mixed concrete, slip form and tunnel form construction, etc., bringing forth state-of-the-art building construction technologies in India.

Today, with the globalization of trade, the speed of penetration of technological advancements has immensely increased.

Although the increased participation of the private sector in large development projects such as roads, bridges, industries, etc. has brought in mechanized and rapid construction practices, these are limited to the large scale top of the line projects for the affluent. The majority of construction activity in the country, however, is based on age-old techniques and norms of construction which have long out-lived their versatility. There is a need for necessary refinement and application of innovative and appropriate inputs to the traditional construction practices. This calls for a people-oriented bottom-up approach striking the right and sustainable balance between the intermediate, vernacular, and innovative technologies towards optimizing the construction costs.

It is imperative to utilize the large number of cost-effective options for foundation, walling, roofing, and timber substitutes. An illustrative list of cost-effective technologies with the amount of savings in cost envisaged as against the conventional options, is highlighted in Table 2.

Table 2: Estimated Cost Saving on using Innovative Building Materials

	Cost-Effective Technologies	In place of Conventional options	% of Saving
I.	**FOUNDATIONS**		
1.	Pile foundation (under reamed)	Traditional stone/bricks	15
2.	Brick arch foundations	Footings	25
II.	**WALLING (SUPER STRUCTURE)**		
1.	230 mm thick wall in lower floors	330 mm brick walls	5
2.	180 mm thick wall in bricks	230 mm brick walls	13
3.	115 mm thick recessed walls	230 mm brick walls	20
4.	150/200 mm Stone block masonry	Random rubble masonry Ashlar masonry	30 20
5.	Stabilized mud blocks	Burnt brick walls	20
6.	FaL-G b lock masonry	Clay brick walls	20
7.	Fly ash brick walls	Clay brick walls	25
8.	Rat trap bond walls	English/Flemish bond	25
9.	Hollow blocks walls	Solid masonry	20
III.	**ROOFING**		
1.	85 mm thick sloping RCC	110 mm RCC	30
2.	Tiles over RCC rafters	Tiles over timber rafters	25
3.	Brick panel with joists	RCC	20-25
4.	Cuddapah slabs over RCC rafters	CS over timber rafters	20
5.	L-panel sloping roofing	RCC	10
6	RCC planks over RCC joists	RCC	10
7.	Ferrocement shell roofing	RCC	40
8.	Filler slab roofing	RCC	22
9.	Waffle roofing	RCC	15
10.	RCC channel units	RCC	12
11.	Jack arch brick roofing	RCC	15
12.	Funicular shell roofing	RCC	18
13.	Brick funicular shell roofing	RCC	30
14.	Precast blocks over inverted T-beams	RCC	25
15.	Micro-concrete roofing tiles	Clay tile roofing AC sheet roofing	20 15
IV.	**MISCELLANEOUS ITEMS**		
1.	RCC door frames	Timber Frames	30
2.	Frameless doors (only inserts)	Frames and shutters	50
3.	Ferrocement door shutters	Timber shutters (second class timber)	30
4.	RCC window frames	Timber frames	30
5.	RCC jallies	Timber windows/ventilators	50
6.	Precast thin lintels	RCC lintels	25
7.	Precast sunshades	Cast sunshades	30
8.	Ferrocment sun shades-cum-lintel	RCC lintel-cum-sunshades	50
9.	Brick on edge lintels	RCC lintels	50
10.	Corbelling for lintels	RCC lintels	40
11.	Brick arch for lintels	RCC lintels	30
12.	Precast RCC shelves units	Timber/concrete	20-35
13.	Precast Ferrocement shelves	Timber/concrete	35-45
14.	Ferrocement manhole covers	Casion/concrete	50-40
15.	Ferrocement water tank	Rigid PVC	60

Sustainable Technology: Awareness, Application, and Propagation

It is noted that most of these technologies have not found much of acceptance for application in the construction industry due to various historical reasons. This is due to the lack of proper awareness, appreciation, and gaps in application efforts. One of the critical reasons put forward is that the construction work force is not tuned for application of most of these cost-effective technologies options. In most cases, the lack of awareness on the use of appropriate and affordable building materials is a major factor hampering development and in particular, affecting the shelter conditions of people, especially the poor. On one hand, large scale production of building materials is inefficient, with higher end costs to the consumer and added costs of transportation; and on the other hand the production and use of appropriate building materials have not received adequate attention and is often discouraged by outdated attitudes and mindsets, mental blockades and unrealistic building codes and regulations. Opportunities for the small-scale production of building materials are thus lost undermining both openings for employment and access to advancements made in construction technology.

A conscious effort to wedge the gap in "Taking technologies to the doorsteps" for appropriate grass-root level technology transfer mechanism was taken through the establishment of a National Network of Building Centres in 1988.

The major objectives of the building centres are to ensure:

- Technology transfer from `lab' to `land'
- Skill upgradation and training to the artisans (masons, carpenters, bar benders, plumbers, electricians, etc.) on innovative and cost effective technology options
- Production of various cost effective components using local resources and sales out letting the same
- Construction of housing and building using the trained work force and the produced components as a cost effective building system
- Giving necessary housing guidance, information and counseling to the people on the proven innovative, cost effective and appropriate building materials and technology options

The building centres have also been able to demonstrate cost reduction of 15 to 40 percent compared to conventional methods of construction. This has been demonstrated in construction of houses for all income categories as well as other social and community assets, amenities and facilities like Village Offices, Primary Health Centers, Community Centers and School Buildings etc. The building centers have made a significant impact to execute construction works and also provided help to impart help imparting training for over 250,000 construction artisans. This initiative has to be strengthened in the context of providing 50 million houses in urban and rural areas by 2022 and for spreading sanitation for all by 2019.

THE WAY FORWARD

Propagation through Building Technology Exposition, Building Technology Parks and Housing Guidance Centres

There is a need for extending the fruits of research and development in building technologies to suit the needs of individual and group home builders, professionals and others through the housing guidance centers and expositions in all state capitals. It should be open throughout the year for the general public to visit and familiarize with the building technologies. Such permanent expositions could be put up by state housing agencies/professional associations in all state capitals and over a period of time in all important cities.

Upgrading Educational Curriculum of Architectural and Engineering Courses

It is absolutely essential that the technical curriculum at the graduate level should be upgraded to include all the cost-effective building materials and appropriate technologies and

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It is necessary that these technologies are given appropriate projection using the power of media through television, radio, and other audio visual ...

innovations in designs, materials, and application in the syllabus. In addition, it is also desirable to give at least six months to one year practical exposure on actual field situations as part of the educational curriculum, before degree is conferred.

Standardization Validity through the Codes and Standards

Since most of the handbooks, manuals as well as codes and standards do not have coverage on the innovative building materials and technologies, speedy and time targeted actions need to be taken to include these technologies in important regulatory documents. It is also linked with the BIS standardization efforts for introduction of innovative technologies/materials/techniques of construction in design and construction codes and standards. The National Building Code of India 2015 version will be able to bridge the gap for providing space for all alternate, emerging and innovative technologies.

Figure 4: *The Release of the Latest Version of National Building Code of India*

Incorporation in Schedule of Rates and Standard Specifications

It is essential that the standard specifications and schedule of rates of the building agencies be revised to incorporate provisions and rates for the use of alternative building materials and technologies in construction.

Building Regulation Media

Since the operational part of building construction is regulated by the local bodies and development authorities through building bye-laws/ development control rules/planning standards etc., it is essential that the existing building regulatory media does have enabling mechanisms to push through innovative advances in building technologies for green field initiatives. This is where appropriate validation systems and agreement system of initial validation of technology can be used based on professional yard sticks and transitional and provisional standards, which over a period of time can be elevated to full-fledged Indian standards modified in context of experience in use of these innovative options. This techno-legal regime is an absolute must if we have to create an enabling environment for advances in building construction technologies.

The techno-legal regime becomes more necessary in the context of substantial damage to the buildings by various natural hazards like cyclone, earthquake, flooding, landslides, etc. Therefore, the need to put up construction with appropriate cyclone resistant, flood protected, earthquake resistant technologies etc., has become absolutely essential and the building regulatory media could easily insist on the same not only for the new construction, but also for existing housing stock which would be affected in case a natural calamity strikes.

This can be through an 'engineered' approach by having specific design for bigger structures and through 'non-engineered' approach where appropriate simplified disaster resistant technologies are identified by having relevant construction system and also by graphical inputs encompassing 'do's and don'ts' for various elements of construction be it for foundation, walling, roofing, joinery, and so on.

R&D Fund

With a view to popularize various building materials and also to build confidence among professionals, an R&D fund or risk fund needs to be created in the construction industry. This could be by setting apart 1 to 1.5 percent of the construction cost so that in case of any damages as a result of introduction of any new technologies, the corpus of funds available in the R&D fund could take care of the same. It is necessary as too often many practicing professionals are hesitant to use the cost-effective technologies from point of view of apprehensions of later consequences due to field application of construction systems, which could affect future career prospects. A portion of this R&D fund could be utilized for

training and capacity building of professionals on various cost-effective and appropriate building materials and technologies.

Propagation through Audio-visual and other Mass Media

It is necessary that these technologies are given appropriate projection using the power of media through television, radio, and other audio visual means on the lines of 'Krishi Darshan' an Indian television program which had helped in taking the message of scientific agricultural inputs to the public in the 'green revolution' movement. A similar effort is required in the building technology transfer effort, through 'Avas Darshan' or 'Nirman Darshan' or 'Bhavan Darshan' with frequent primetime slots over the powerful mass media. This would help give appropriate information on right type of materials and proven technologies, with information on the various applications and visuals of the demonstration buildings shown side by side.

Building Material Estates and Markets

With a view to encourage entrepreneurs to come forward to manufacture various cost-effective building materials and technologies, state governments may setup building material estates and also appropriate building material component sales outlet centres through the building material markets.

Financing Institutions to Recognize Alternative Technologies for Loans

It is quite unfortunate that a large number of Housing Finance Institutions (HFIs) and Development Funding Institutions, do not encourage introduction of various cost-effective building materials and technologies for housing and construction projects. Some HFI's provide a rebate of 0.25% in their housing loan for any segment of housing and building construction for use of innovative options in construction. It is necessary that a technology folio is made available to the HFIs, so that during the sanction of individual loans, the same does not get held up due to the introduction of these technologies. This will contribute to the techno-financing regime for making thorough advancement in the application of appropriate building technology.

Legislative Interventions

Equally important has been the initiative taken by the Government of India to bring out legislation to register and regulate the activities of the builders, developers and promoters. This will help to identify and segregate the fly-by-night promoters/operators and will help associate only the well established and qualified developers in the field. The proposed Engineers Bill on the pattern of the Architects Act is likely to give right signal for the association of professionals and their responsibility for planning, designing, and construction of the buildings, with adequate quality and safety.

Human Resource Development

There are over 5 million construction workers in the country classified under unskilled, semi-skilled, and skilled levels comprised of masons, carpenters, bar benders, plumbers, electricians, glass fabricators, tile fixers, laborers, etc. Nevertheless, the construction industry, has not been able to effectively project itself at par with conventional manufacturing industries on account of adequate attention to human resource development through training and capacity building. A strong need has often been felt for the upgradation of professional, managerial, technical and financial skills of the construction workers and agencies operating in the construction field. Construction skills have been seen to transfer from one generation to another on an inheritance basis, more so for basic skills of masonry and carpentry. This trend has undergone changes over the years and construction skills are now acquired by the workers as part of the on-the-job training. Normally a learning curve of 5 to 10 years is needed for the transformation of skills, but the

Unlike the formal education system for higher order manpower development, namely architects, engineers and specialists the segment of construction workers has been left more or less uncovered.

Figure 5: *HRD Training for Skill Upgradation Initiatives*

It is essential to insist on the services of trained and certified construction workers by the construction industry over a period of time to ensure not only the quality of work but to improve efficiency and productivity in the work output.

productivity and quality of work suffer in the initial period. Unlike the formal education system for higher order manpower development, namely architects, engineers and specialists coming through various educational avenues like polytechnics, engineering colleges, architectural schools, technology universities, the segment of construction workers has been left more or less uncovered. The minimum educational qualifications needed for securing entry into the Industrial Training Institutes (ITI) and the longer duration of training has made the ITIs increasingly inadequate to the needs of the construction industry.

The role of National Skill Development Council to give a new impetus to construction skill training and certification will bring good results.

Further, in addition to the efforts by the building centres, and many other agencies, there have been some good initiatives in imparting training to construction workers by Nirman Mazdoor Panchayats, Tamil Nadu Manila Kattida Thozhilalar Sangam, and some NGOs. They are also specialized in imparting training to urban and rural poor on construction related trades, primarily carpentry, welding, plumbing, and electrical work. A related matter is linked to issuance of certificates, which can be recognized by the Directorate of Labour and Training of the respective state governments for various trades. This would give the much needed recognition to the skill levels of construction workers and the institutes imparting training, besides ensuring the quality of work through a pool of skilled and trained construction workers.

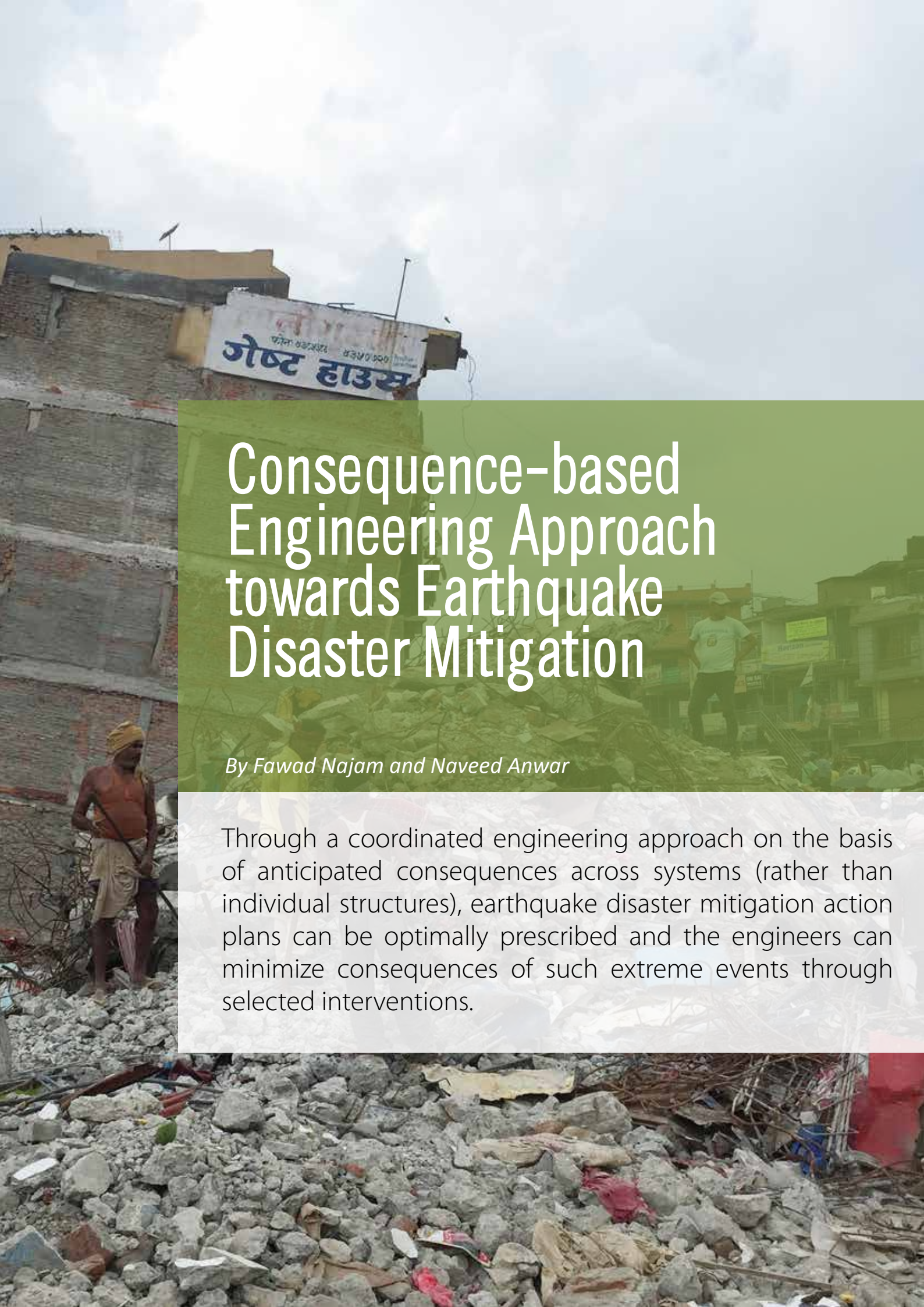
The faster pace of innovations and technology transformation in the construction industry demands constant updating of skills by practicing and employing professionals. A strong need has often been felt for the upgradation of professional, managerial, technical and financial skills of the professionals, employed or practicing in the construction field. While the literature and the media play a yeoman role in awareness creation, it is essential for firms and professional associations in collaboration with educational institutions to conduct regular Continuing Professional Development Programmes (CPDP), in order to ensure that the professionals keep abreast of the latest developments and state-of-the-art technology applications in the construction sector to ensure speed, quality, and safety in the process of delivery.

Business Process Re-engineering in Construction

The influx of appropriate technology is bound to put the construction sector on path-breaking effort towards facing challenges of the new millennium through Business Process Re-engineering. The professionals of architectural engineering need to be well versed with the application of alternative materials and appropriate technology in order to steer the construction sector in the right direction. There is a need to create a new breed of Habitat engineers and project managers with awareness, aptitude, sensitivity, and responsiveness to the quality, safety and durability in addition to the application of appropriate and cost-effective materials and technologies in construction and building services. It is also felt that specialized training in financial engineering should be imparted at the institutional level, in addition to teaching the core subjects of architecture, engineering, building services, planning, and management.

Figure 6: *One of the Trainings for Construction Workers in India*

It is essential to insist on the services of trained and certified construction workers by the construction industry over a period of time for ensuring not only the quality of work but improving efficiency and productivity in the work output. There is also a need for practical training to the budding professionals and increased industry-academia interactions in the construction sector. All these efforts would help meet the emerging challenges, and enable India and neighboring countries in scaling the pinnacles of excellence in construction and addressing effectively the massive housing challenges.



Consequence-based Engineering Approach towards Earthquake Disaster Mitigation

By Fawad Najam and Naveed Anwar

Through a coordinated engineering approach on the basis of anticipated consequences across systems (rather than individual structures), earthquake disaster mitigation action plans can be optimally prescribed and the engineers can minimize consequences of such extreme events through selected interventions.

Consequence-based Engineering Approach towards Earthquake Disaster Mitigation

The aim of an efficient disaster management system is to reduce (or avoid) the potential losses from hazards, to assure prompt and appropriate assistance to victims of disaster, and to achieve rapid and effective recovery.

According to UNISDR (2009), *"A disaster is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources".* As represented by the expression below, disasters are often described as a result of exposure of vulnerable people (having insufficient capacity to cope with the potential negative consequences) to a hazard.

$$Disaster = \frac{Vulnerability + Hazard + Exposure}{Capacity}$$

In recent years, due to social and economic reasons, a large number of people are continuously migrating towards urban areas resulting in an increased magnitude of risk associated with structural collapse/failures in densely populated cities. The needs and structural complexities of buildings are extensively increasing creating new challenges in disaster risk management (Zain 2014).

The aim of an efficient disaster management system is to reduce (or avoid) the potential losses from hazards, to assure prompt and appropriate assistance to victims of disaster, and to achieve rapid and effective recovery. The Disaster Management Cycle (Figure 1) illustrates the process considering which, the governments and civil society make plan, react during a disaster, and take measures to recover after a disaster has occurred. Each phase of this cycle has its own requirements (in terms of tools, strategies and resources) as well as challenges. Appropriate actions at all stages can lead to more preparedness, better warnings and reduced vulnerability during the next iteration of this cycle.

In April 2015, the central part of Nepal was struck by a strong earthquake of magnitude 7.8 on Richter scale. The epicenter was located at Barkpak village of Gorkha district which is 77 km NW of the capital, Kathmandu. The quake resulted in more than 9,000 deaths and around 23,000 people injured in Nepal, India, China, and Bangladesh, apart from huge economic loss. Thousands of houses were destroyed across many districts of Nepal, with entire villages flattened, especially those near the epicenter. Several of the churches and temples (including several pagodas on Kathmandu Durbar Square, a UNESCO World Heritage Site) in the Kathmandu valley, were also damaged.

Figure 1: *The Disaster Management Cycle*

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Figure 2: *Damages due to Nepal Earthquake in April 2015*

After every such tragic incident, beside cooperation in recovery and reconstruction process, serious attempts are made by international agencies and NGOs to devise efficient strategies for disaster risk reduction. Recent trends in national disaster management policies of developed countries are also showing an increased emphasis on mitigation. However we still require a holistic and integrated approach, especially for disasters with little or no warning (e.g. seismic activity).

Efforts are being made across the globe for devising measures to reduce losses from low-probability, high-risk seismic events. An important point to note is that regardless of the low probability of an event, its occurrence would cause losses which cannot be compared with those experienced at earlier times. As a result of such realizations among experts and professionals, two emerging paradigms are driving much of the research in this field (a) Performance-based Earthquake Engineering (PBEE), used by the Pacific Earthquake Engineering Research (PEER) group, and the (b) Consequence-based Engineering (CBE) framework, being developed and applied by the Mid-America Earthquake Center. The broader aim of these frameworks is to assist decision and policy makers in managing earthquake hazards.

The basic idea of PBEE approach is that performance levels and objectives of an engineered facility can be quantified and its performance can be predicted analytically. Moreover, the cost of improved performance can be evaluated to allow rational trade-offs based on life-cycle considerations rather than construction costs alone. In performance-based design, clients, engineers and all stakeholders work together to achieve the best possible balance between construction costs and ultimate performance. This approach requires the structural designers to go beyond building code's cook-book prescriptions and make them able to predict structure's response in case of future extreme events. This also requires sophisticated structural modeling and simulation using state-of-the-art computer software, and sometimes laboratory testing also. Although most of the recent developments on performance-based engineering are focused on earthquakes, the approach can be used for other disasters for the assessment, management and mitigation of risks associated with corresponding hazards. An overview of this approach is shown in Figure 3.

Recent trends in natural disaster planning policies of developed countries are showing an increased emphasis on mitigation.

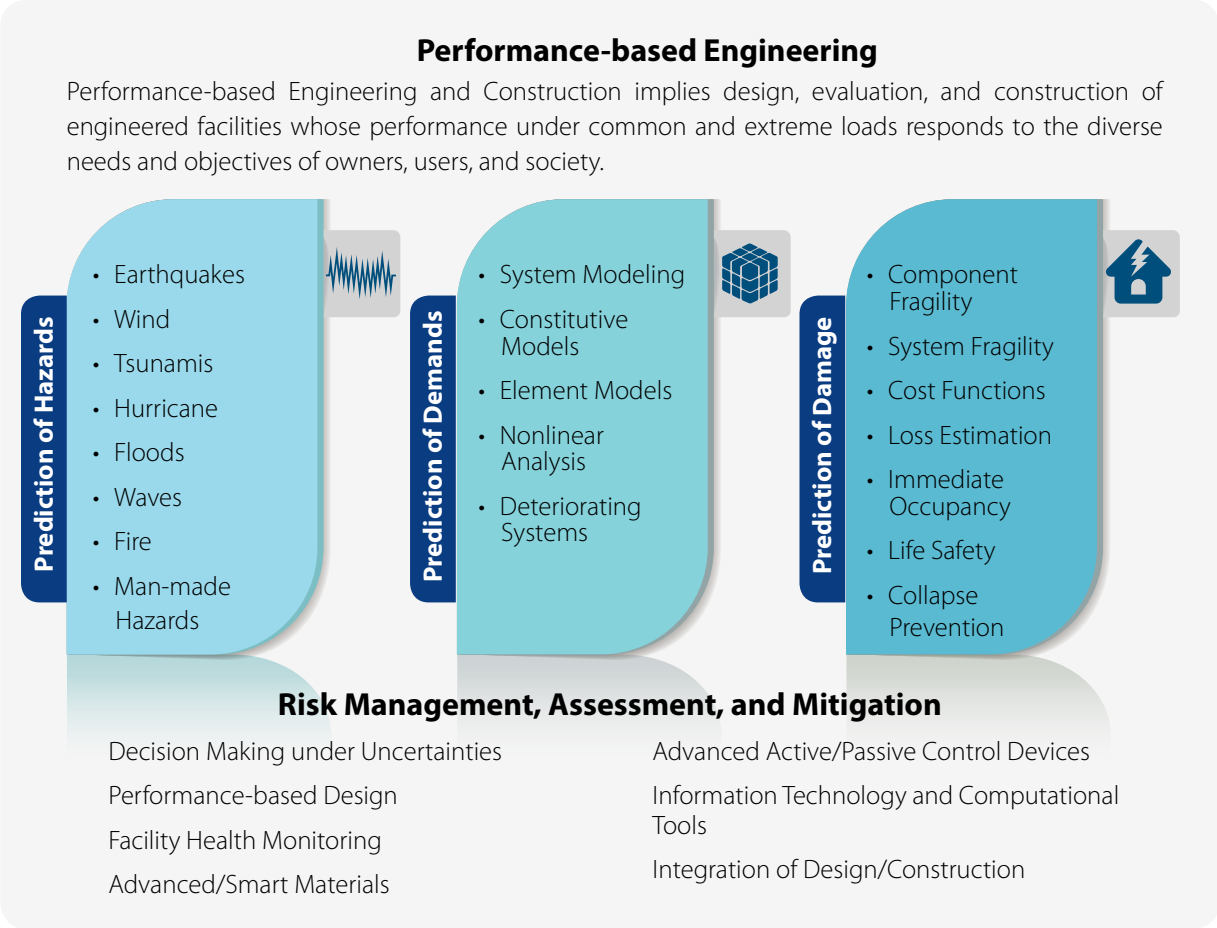

Figure 3: *Performance-based Engineering (Adapted from Stanford 2013)*

Consequence-based engineering attempts to broaden the decision focus from purely technical to an integrated socio-technical systems perspective, and to take into account the potential consequences of earthquakes for society as a whole.

Figure 4 presents an overview of second approach Consequence-based Engineering (CBE) towards disasters, as originally proposed by Abrams (2002). While performance-based engineering focuses on the desired performance of engineered facilities assessed through life-cycle analysis, the concept of "acceptable consequences" in Consequence-based engineering attempts to broaden the decision focus from purely technical to an integrated socio-technical systems perspective, and to take into account the potential consequences of earthquakes for society as a whole. It is a sequence of processes and decisions that identify what consequences are possible from a probable hazard, and the impact of specific mitigation interactions on reducing these consequences across a system of interest. It also quantifies the risk to societal systems and subsystems by working with policymakers, decision-makers, and stakeholders to ultimately develop risk reduction strategies and implement mitigation actions.

In CBE, after defining the system of interest, anticipated hazards and likely consequences, a decision tree can be used to determine if the estimated consequences are acceptable or should be redefined (Abrams 2002). It is further checked if modeling parameters need to be refined or further system interventions need to be considered. If anticipated consequences exceed the tolerable ones, and no further redefinition of acceptability is feasible, then parameters defining the hazard and built environment can be refined and/or system interventions can be prescribed to minimize anticipated losses. Using this methodology iteratively, consequences can be estimated for a number of different system intervention strategies with various input parameters describing the hazard or the built environment. Hence, with such a coordinated approach to engineering on the basis of anticipated consequences across systems (rather than individual structures), mitigation action plans are prescribed in an optimal way and the engineers can minimize consequences of such extreme events through selected interventions.

The ultimate goal of both paradigms is to ensure safer, economic, and efficient infrastructure. These also represent the future of earthquake risk management and mitigation and have taken structural engineering practice to an advance level of creating optimized, reliable, and cost-effective structures. However the attempts and

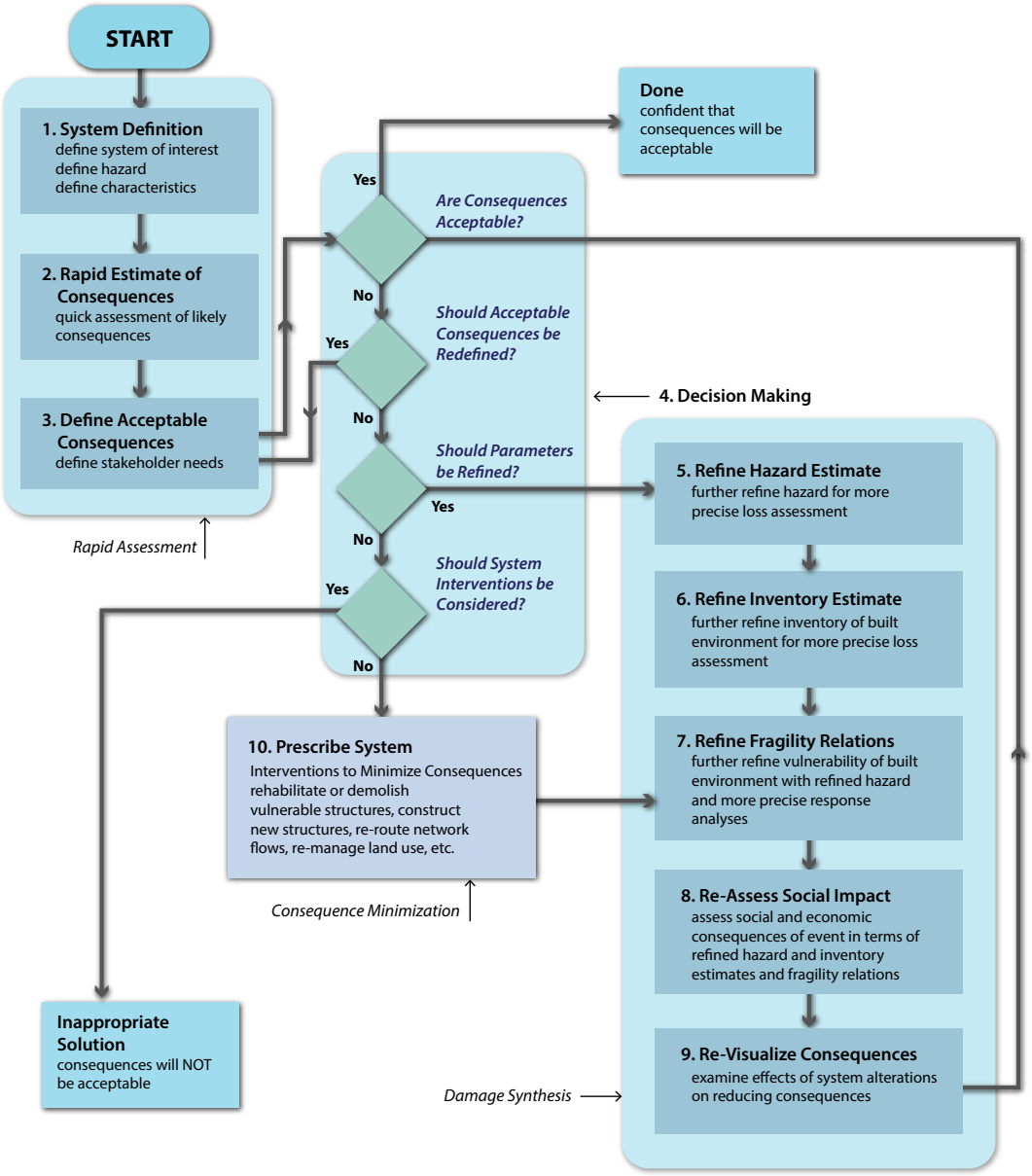

Figure 4: *Consequence-based Engineering (Adapted from Abrams, 2002)*

desire to develop smart-enough and integrated disaster risk management systems to cope with problems associated with increasingly vulnerable communities, still have a long way to go. It requires an integration between various disciplines, stakeholders, different levels of government, and between global, regional, national, local and individual efforts. This integration is the ultimate key to minimize future economic loss, causalities and structural damage in disasters like Nepal earthquake.

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Regional Forum:
Capability Enhancement for Affordable Housing Solution Development

A three-day event ***"Regional Forum on Capability Enhancement for Affordable Housing Solution Development"*** was organized by the National Housing Authority (NHA), Thailand in collaboration with the Asian Institute of Technology (AIT) through AIT Consulting on 1-3 July 2015 to discuss and tackle issues related to affordable housing in the ASEAN region.

Welcome dinner hosted by NHA

Representatives from ASEAN countries came together to discuss the housing issues and challenges in their respective countries followed by suggestions to move forward to resolve them.

Mr. Krishda Raksakul, Governor, National Housing Authority (NHA) Thailand, welcomes participants during the welcome dinner hosted by NHA

Ms. Ubonwan Suebyubol, Deputy Governor, NHA Thailand delivers the keynote speech

Ms. Suchada Sirorangsee, Director, Housing Development Studies Department, NHA, Thailand delivers welcome address

Dr. Naveed Anwar, Executive Director, AIT Consulting presents an *"Overview of Affordable Housing Concepts, Needs, and Solutions"*

Prof. Kioe Sheng Yap, Housing and Urban Development Consultant gives lecture on *"Housing for the Poor"*

Mr. Subrata Dutta Gupta, Principal Financial Officer, IFC, World Bank delivers a presentation on *"Housing Finance Models"*

Site visit to Baan Eua Arthorn Chonburi, one of the housing projects of NHA

Representatives from Brunei: Mr. Hj Md Zain bin Hj Mohammad and Mr. Md Rozaiman bin Hj Abd Rahman

Participants from Cambodia: H.E. Prak Angkeara and Dr. Mom Mony

Representatives from Indonesia: Mr. Ronald H. Navratiansyah and Mr. Rizqy Aswawansyah

Participants from Lao PDR: Ms. Visaphone Inthilath and Dr. Saysavanh Phongsavanh

Representatives from Malaysia: Ms. Prema Nair Suppariam and Mr. Muhamad Fikri Karmajaman

Participants from Myanmar: Mr. Min Aung Aye and Ms. Thazin Myint

Representatives from the Philippines: Engr. Maria Otelia F. Eclavea and Ms. Ar. Luzviminda C. Laguador

Participants from Singapore: Mr. Ignatius Lourdesamy and Mr. Yeo Jianxing Samuel

Representative from Thailand: Mr. Krit Goenchanat, Deputy Director for Department of Urban Renewal and Urban Development, NHA

Developing Technology for Sustainable, Resilient, Affordable Construction for Over 25 Years

Habitech CENTER BUILDING SYSTEM

Architects and engineers have made extensive progress in designing and constructing luxurious and expensive houses, apartments, and condominiums that provide modern and aesthetic facilities and amenities to make the life of inhabitants as safe and as comfortable as possible. However, due to the increasing gap between an average person's income and housing affordability, the main challenge of the 21st century is to design and construct an affordable, sustainable, environment-friendly, and disaster-resilient housing.

Established in 1989 as a research and development center at the Asian Institute of Technology (AIT), Thailand, Habitech Center has been developing innovative, safe, green, cost-effective, and appropriate building technologies and techniques for the community under the leadership of Mr. Gyanendra R. Sthapit for over 25 years.

Habitech Center has been instrumental in enabling sustainable and affordable housing and social infrastructure buildings for communities in Thailand and the Asian region which in turn has enabled AIT accomplish its mission of contributing significantly in the development of the region.

1989

- **Establishment of Habitech Center under Human Settlements Development Division supported by CIDA fund**

1990-1994

- Design and construction of first demonstration Core House at Habitech Center
- Technology transfer and technical support for the construction of 150 houses for Khao Kho Social Housing Project
- Awarded the prestigious "***Matsushita Memorial Prize"*** by the Japan Housing Association

1995

- Habitech Building Technology (HBT) was recognized by UN Human Settlements Program.
- Selected as the focal point for the ILO DECO Project for the dissemination of Micro Concrete Roofing Tiles (MCR) which was later added as part of HBT for roofing
- Reconstruction of Habitech office building with new generation of concrete interlocking bricks

UN-HABITAT

1996-2002

- Design and Construction of several residential, office, and school buildings with local partner.
- Design and Construction of AIT International School with interlocking brick technology, AIT, Thailand

2006

- HBT transfer to Afghanistan and Indonesia

Afghanistan *Indonesia*

2007-2008

- Design and construction of 56 houses and 1 community center for Post-tsunami Rehabilitation Project
- Awarded ***"Best Community Housing Project Award"*** for Post-tsunami Rehabilitation Project
- Technology transfer to Bhutan and Iran

Bhutan

Iran

The innovative building technology, the Habitech Building Systems, is an alternative way to build disaster-resilient housing and social infrastructure buildings using fabricated modular and interlocking components. This system was first applied to construct school buildings, health clinics, hospitals, and other low-rise buildings in countries such as Bhutan, Lao PDR, Myanmar, Nepal, and Thailand.

The prefabricated modular and interlocking components consist of:

- *Concrete bricks for walls and Concrete joists for floors*
- *Concrete pans for casting floors and Adjustable concrete beams*
- *Concrete staircases (treads and stringers) and Concrete rings for sanitary units (double vaults aqua privies)*
- *Concrete roofing tiles*

Habitech Center provides a 'complete solution' as some of the major building systems or building material such as bricks and joints used in the structures are produced using machines which were developed by the center including the manual and hydraulic press and manual for joist, windows, doors, micro concrete pan, and roofs. While producing the building systems, it ensures that it uses low-cost local materials, and utilizes environmentally friendly and energy efficient and low-cost processes and procedures. This not only helps the Habitech to control the quality of its products and services but also helps to make its end product or service clean, green, and cost-effective.

Besides providing building solutions, the center also conducts capacity building and training programs and provides technical support for structures. One of the major aspects of the center is research and development. In fact, because of its quality research and development, the center today has been able to develop its innovative solutions.

In 2014, Habitech Center joined AIT Consulting (AITC), now called AIT Solutions to collaborate on projects focused on providing green, affordable, and disaster resilient housing solutions and organizing capacity building programs. The first collaboration between Habitech Center and AITC was organizing a two-days workshop at AIT in November 2014 on 'Technology Solutions for Low-cost Housing'. The workshop was a capacity building program designed to demonstrate technological solutions to help achieve cost-effectiveness, sustainability, disaster resiliency, and long term durability for a variety of housing developments and civic infrastructures.

Habitech and AITC signed a Memorandum of Understanding (MoU) with Prashak Techno Enterprises, India for joint participation in generating, creating, and developing intellectual property and protection of Habitech Technology in commercial projects, in addition to promoting the technology for securing potential projects in India and other countries.

After the earthquakes that struck Nepal in April and May in 2015, Habitech participated in several seminars and trainings organized by the government of Nepal to find suitable solutions and building construction techniques that would be used to rebuild and construct infrastructures in Nepal.

In the coming years, Habitech Center in collaboration with AIT Solutions aims to continue providing green, affordable, and disaster resilient housing solutions and organizing capacity building programs to enhance knowledge in these areas.

2009-2010

- Establishment of Habitech Myanmar Center
- Technology transfer and technical support to the UNICEF Myanmar for the construction of 45 child-friendly primary schools
- Design and construction of Knowledge City Police Substation building, AIT
- Development of multi-purpose soil-cement interlocking brick

Myanmar

2011

- Establishment of Habitech Nepal Center
- HBT transfer to Nepal and Nigeria

Nepal *Nigeria*

2014

- **Habitech Center joined AIT Consulting**

2015

- Collaboration with Sultan Qaboos University, Oman on joint research utilizing waste water and desert sand for Habitech Building System

Oman

Selected Projects

Post-Tsunami Rehabilitation Project
Thailand

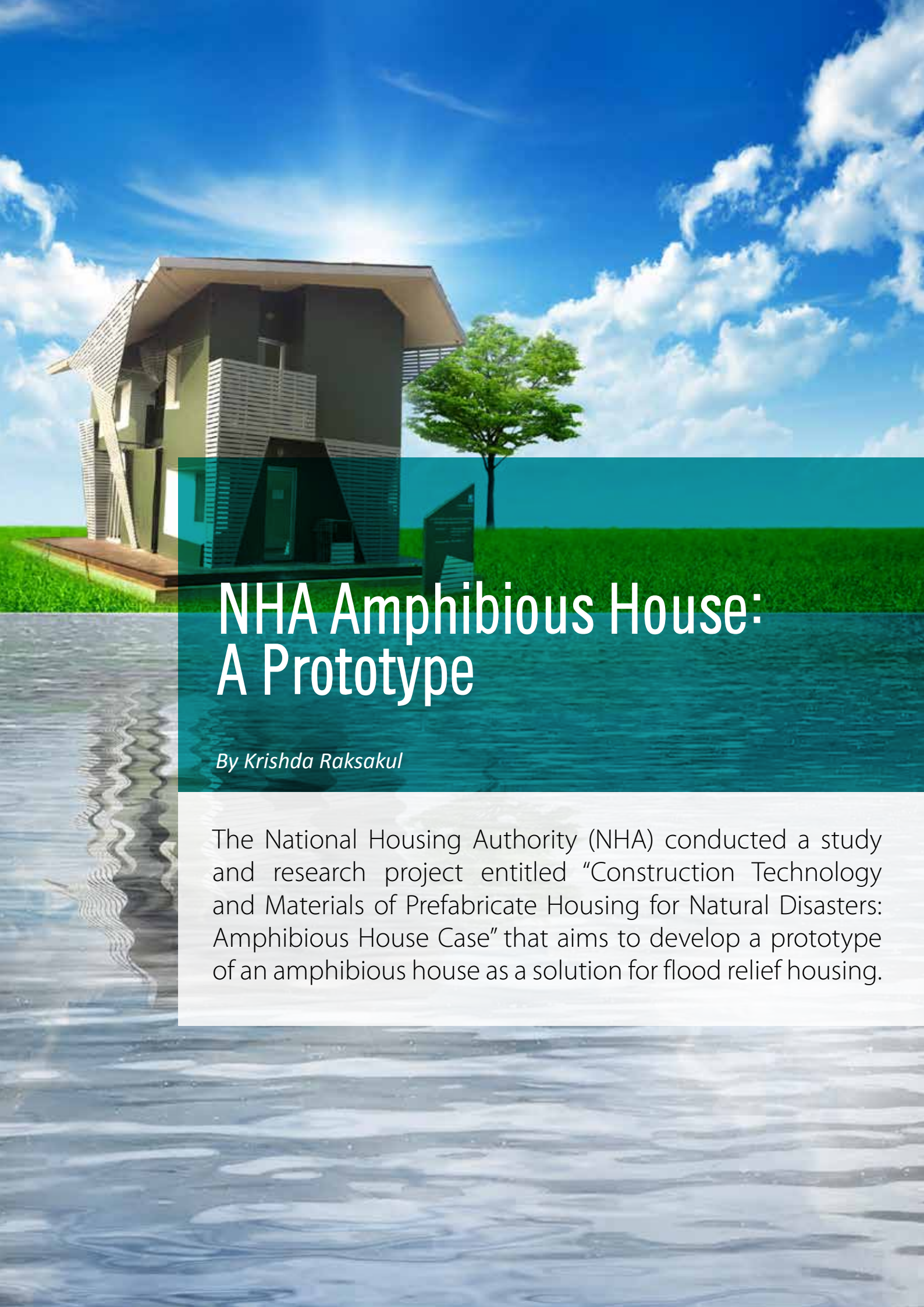
AIT International School
Thailand

Primary School Building
Lao PDR, Nepal

Residential Building
Bhutan

Child-Friendly Primary Schools
Myanmar

Chumphon Cabana, Resort
Thailand



NHA Amphibious House: A Prototype

By Krishda Raksakul

The National Housing Authority (NHA) conducted a study and research project entitled "Construction Technology and Materials of Prefabricate Housing for Natural Disasters: Amphibious House Case" that aims to develop a prototype of an amphibious house as a solution for flood relief housing.

NHA Amphibious House: A Prototype

The National Housing Authority (NHA) of Thailand is a core government agency for the development of public housing in the country. We have learned a lot from both our success and mistakes. As of July 2015, the NHA has developed more than 709,205 housing units. There are approximately 3 million people who benefit from NHA's housing projects countrywide.

Global warming is already having significant and costly effects on our communities, our health, and our climate. Average global sea level has increased eight inches since 1880. Global warming is now accelerating the rate of sea level rise, increasing flooding risks to low-lying communities. The effects of global warming can be seen in the world around us today. Natural disasters have become more frequent, more severe without warning. Flood has become the most common natural disaster that happens on a yearly basis and also getting more devastated.

Thailand, especially Bangkok, was hit by a huge flood by the end of 2011. Flooding persisted in some areas until mid-January 2012, and 13.6 million people were affected. Sixty-five of Thailand's 77 provinces were declared flood disaster zones, and over 20,000 square kilometres of farmland was damaged. The disaster has been described as "the worst flooding yet in terms of the amount of water and people affected." The World Bank estimated 1,425 billion baht (US$45.7 billion) in economic damages and losses due to flooding, as of 1 December 2011.

NHA, as a core government agency on housing, conducted a study and research project entitled

Amphibious House is designed and developed as a new typology of housing in Thailand that can fit within the current lifestyle of Thai people but at the same time is adaptable to the reoccurring flood problem.

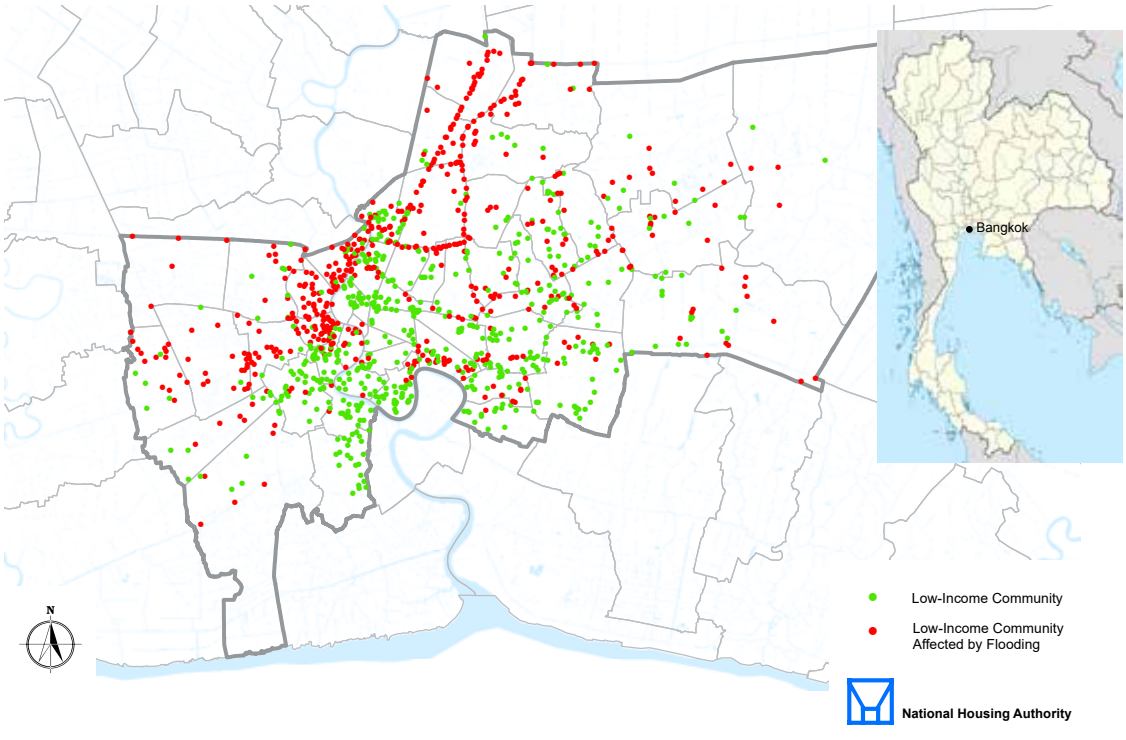


Figure 1: *Low-income communities in Bangkok affected by the 2011 floods*

(Source: Low-Income community survey (2007-2011) by National Housing Authority)

Author:

Krishda Raksakul
Governor, National Housing Authority
Thailand

Figure 2: *NHA Amphibious House Prototype*

NHA will make further steps of study and research to make construction cost cheaper to make it affordable to wider population.

"Construction Technology and Materials of Prefabricate Housing for Natural Disasters: Amphibious House Case" in the year 2012. This research project was assigned to a private company, Site-Specific Co.Ltd.

The objective of the project was to study and develop a prototype of an amphibious house as a solution for flood relief housing.

'Amphibious House' is designed and developed as a new typology of housing in Thailand that can fit within the current lifestyle of Thai people but at the same time is adaptable to the reoccurring flood problem. In the normal situation, the amphibious house sits on the ground. But in the case of flooding, the house can rise with the floodwater. The pit foundation system with floating pontoons is specifically developed for the amphibious home. The house is built using prefabrication technology in combination with on-site construction.

In the beginning, the design team came up with four different designs for the amphibious house. Each of the design emerged out to serve the basic needs of Thai people possessing a usable internal area of approximately 65 sq. m., similar programs and construction cost. The differences in the four designs responded to the different needs of the habitant such as:

1. Natural Ventilation based design
2. Sun Path based design
3. Contemporary Thai design
4. Usage based design

After these four designs were developed, Site-Specific worked with the habitants of flood risk area such as Rojana community in Ayutthaya Housing Project. Site-Specific also sought advice from NHA's advisory committee consisting of researchers, engineers, and architects to choose one design to make further research and development. The final design consisted of selections of the best parts from each design and combined to create the final design for a prototype. The design concept is a combination of aesthetics and functions.

The prototype of NHA Amphibious House was built in Rajona, Ayutthaya Province. The construction cost was 2 million baht or 15,500 baht per sq. m. The construction period was 8 months, 2 months longer than planned due to the problem of labor skill.

The prototype house consisted of 2 stories, 68.5 sq.m., with sitting, cooking, dining areas, and a toilet downstairs and 2 bedrooms and a toilet upstairs, together with 60 sq. m. of external multi-purpose area.

After the construction was completed, NHA and Site-Specific Co. Ltd., conducted a test on the system operation for the amphibious house. From the record of testing, it was found that the house started to float at the water amount of 88,000 liters in the pit foundation. It was also found that the house floated up at 7-10 cm. at the water amount of every 10,000 liters filled. The water seeped out at the rate of approximately 1 cm per hour. The conclusion showed that the amphibious house was able to float with the rise of water effectively.

About the Author

Mr. Krishda Raksakul serves as the Governor of the National Housing Authority (NHA), Thailand since 2013. He joined NHA in 1978 as Engineer in the Design Division, Office of Slum Improvement, Research and Construction Department. In 2010, he became Director of Construction Management Department 3. Soon after, in 2011 he was promoted to Chief Engineer before becoming Deputy Governor in 2012.

One of his recent projects is the "Regional Forum: Capability Enhancement for Affordable Housing Development" where NHA in collaboration with the Asian Institute of Technology (AIT) brought together policymakers from ASEAN countries to learn and share innovative ideas related to overcoming some of the major challenges faced by ASEAN countries in terms of achieving sustainable, safe, and affordable housing.

A graduate of Civil Engineering from Khon Kaen University, Mr. Raksakul took his Bachelor's degree in Computer Science from Phranaknon Rajabhat University where he graduated with First Class Honor.

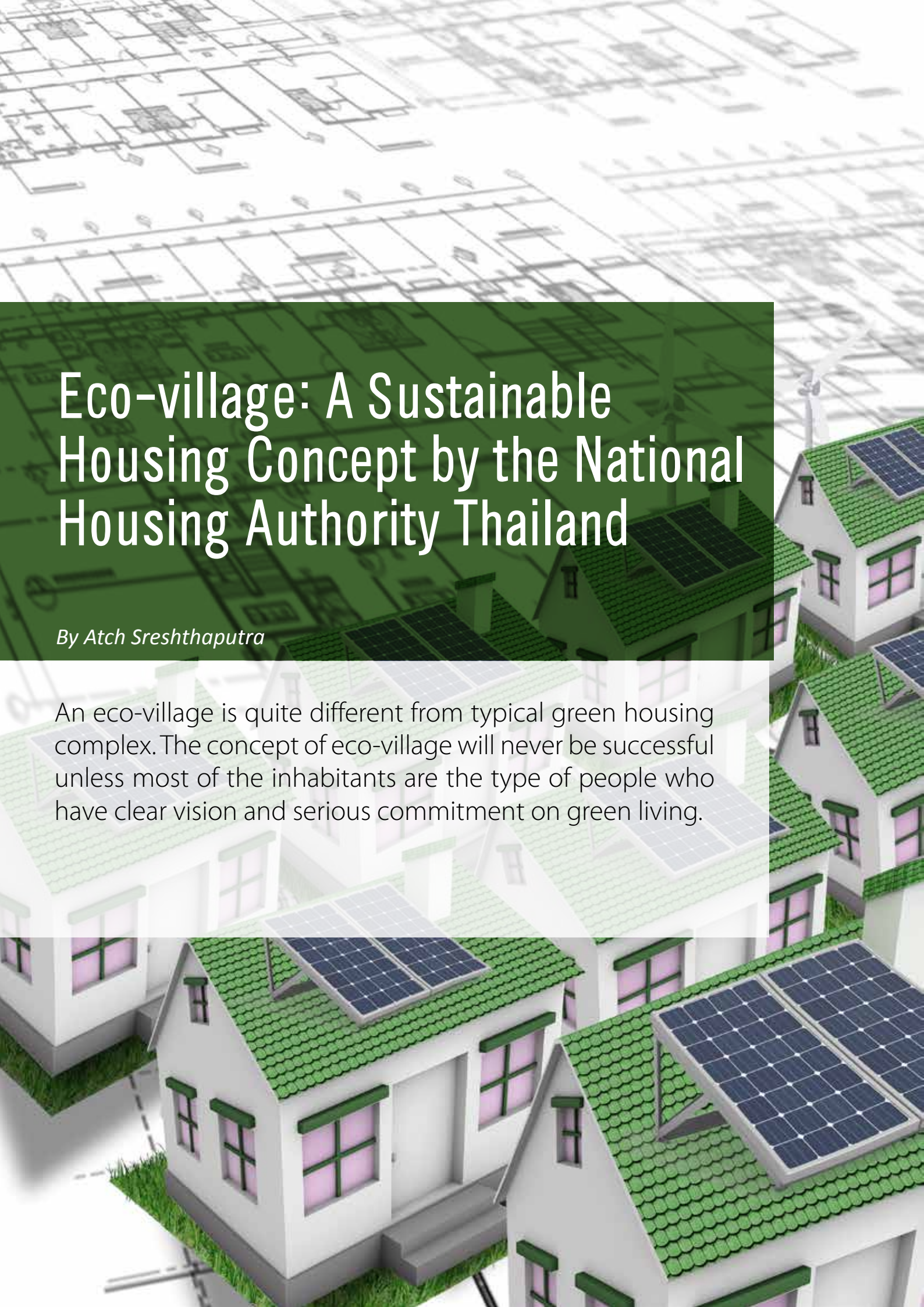
About NHA Thailand

The National Housing Authority (NHA) is a state enterprise attached to the Ministry of Social Development and Human Security. It was established on 12 February 1973 and currently operates under the National Housing Authority Act (B.E. 2537). NHA strives to be the national agency responsible for developing, supporting, and encouraging residential security and urban development of the country; raising the quality of life of community members; and creating a solid, high-quality, livable, and sustainable society.

Eco-village: A Sustainable Housing Concept by the National Housing Authority Thailand

By Atch Sreshthaputra

An eco-village is quite different from typical green housing complex. The concept of eco-village will never be successful unless most of the inhabitants are the type of people who have clear vision and serious commitment on green living.



Eco-village: A Sustainable Housing Concept by the National Housing Authority Thailand

What is Eco-village?

When talking about what an eco-house is, people would think about a house with abundant green area and healthy soil where inhabitants can grow vegetables. The roof might be installed with solar panels that generate electricity and hot water. The building walls are insulated with Styrofoam; windows glazed with energy-efficient double paned glass; and toilets flushed with water reused from bathtubs or harvested rain water. However, an eco-village is not only a housing complex full of eco-houses, but it also needs to have central facilities that serve the community. The essential elements of eco-village include wastewater treatment systems, solid waste disposal, storm water management, reuse/recycle programs, landscape irrigation, and access to public transportation.

The United States Green Building Council (USGBC) suggests that an Eco-village be located on the site where there is no sensitive natural environment such as wetlands, endangered species or breeding grounds of wildlife animals. Then, by this definition, eco-villages should not be built in the most abundant natural environment. It is even better and greener to build an eco-village in a previously contaminated site i.e., Brownfield area, where developers can re-develop the whole area and make it greener. The USGBC even suggests that green buildings are not necessarily new buildings, even renovated abandoned buildings to save resources is considered green already. The idea of cutting down existing trees to pave the way into sensitive forest for new building construction would not be called green. Also, facilities that provide services to non-green human activities should not be called green buildings.

An eco-village is quite different from typical green housing complex. Inhabitants may not really know that they are just living in a green building complex; not eco-village if the definition is just landscape or housing packed with energy-saving featured. Of course, it is not arguable that vegetated areas are not important in an eco-village; however, tree is not the only factor. There are a lot more for a green housing to be called eco-village.

It is About The Inhabitants

Recently, the National Housing Authority (NHA) Thailand has been actively involved with design and construction of eco-villages. When using the word "Village", it should be portrayed as a closely-knit community flourished with good relationship between inhabitants, rather than a housing complex with sophisticated green technology showcases. For eco-village, the inhabitants are the main constituents. Unlike typical green office buildings in the city where the occupants are educated in a passive way about how to properly operate their hi-tech green office, the inhabitants of an eco-village will be more actively involved with the direction and operation of their own communities. The concept of eco-village will never be successful unless most of the inhabitants are the type of people who have clear vision and serious commitment on green living.

A simple checklist for inhabitants to see if they should live in an eco-village: would the inhabitants always recycle the garbage?; would they ride bicycles to work if it is possible?; would they reuse wastewater to flush toilets or to feed the lawn?; would they grow their own organic vegtables?; would they spend free time on producing organic fertilizers for the garden?; would they carpool with neighbors to groceries?; and most importantly, would they spare some weekends with neighbors to discuss about how to improve the environmental performance of the community?. If the answers are 'No' in most of the questions, they should not live in an eco-village, but they can still live in a GREEN housing complex.

The essential elements of eco-village include wastewater treatment systems, solid waste disposal, storm water management, reuse/recycle programs, landscape irrigation, and access to public transportation.

Author:

Atch Sreshthaputra, Ph.D.
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Chulalongkorn University
Thailand

Today, with higher price of gasoline together with impacts of Urban Heat Island phenomenon, it is obvious that only the 'real' green can save the city from consequences of climate changes.

The Fall of Bangkok: The Driving Force of Eco-Village

Due to climate changes, Bangkok has been affected by heavy thunderstorms in the rainy season especially during the rush hours. There is no way to escape the rain, flooding, and of course, traffic jam in downtown. Unfortunately, most Bangkokians seem to accept this reality—heavy rain in late afternoon followed by instant flooding and then severe traffic jam for hours. When looking at the cause of traffic jam, it is not just the rain or flooding, but it is the people in the city. Taxis and public vans stop and wait for their passengers at subway stations, thus occupying the whole left lane of the roads. Alternative transportations do not exist.

Figure 1: *Bangkok flooding* **(Source: Reuters)**

Whose fault is it that there is no taxi drop-off area at those subway stations? How does the government manage thousands of passengers on rush hours without providing exclusive space for taxi drop-offs? The Bangkok Metropolitan Administration (BMA) will have to begin realizing that it is a design flaw for not providing enough space for the required function. If enough drop-off areas and some automated queuing systems were provided for taxis to come and pick up passengers on public places, there would be less traffic jam in Bangkok. BMA should not expect people to be always environmentally responsible. If BMA wants people to live sustainably, it should not only give incentives or provide guidance or enforce the laws, but it must also utilize technologies that help them save the planet without noticing that they are changing their lifestyles way too far. This is 'Social' sustainability.

Clean air and quiet environment in the outskirt of Bangkok is what the people who could not tolerate downtown congestion are looking for. The word 'commuter' is used to describe middle-class people who can't afford cars and gasoline. As far as expressways can go, real estate developments would go after, and Bangkokians would commute if a higher cost of transportation can be traded with cleaner air and more green areas. This phenomenon has happened everywhere else in the world. It is called 'Urban Sprawl'. It is what people are trying to grasp what they think is green for themselves, not knowing that they are destroying the 'greenness' of the whole. How many trees have been cut down to pave the way to the suburbs? How many 'natural' green has been destroyed and replaced with 'artificial' nice-looking green? This kind of development has led the way for the country for decades.

Today, with higher price of gasoline together with impacts of Urban Heat Island phenomenon, it is obvious that only the 'real' green can save the city from consequences of climate changes. Real green does not mean 'for here & now', but actually 'for all & forever'. This notion seems related to the term 'sustainability'. People can grow new trees that will mature in 10-20 years, but they cannot build a new ecosystem. The fact that new suburban residential projects are growing rapidly and still do not urge authorities to put more stringent regulations on land development, such as keeping a portion of existing trees or setting the maximum distance of housing complex from nearby community services.

Currently, as traffic jam has started moving to suburban Bangkok, the rise of Urban Sprawl has been halted, although not completely stopped. The cost of commuting 100 kilometers a day to and fro to go to work could eat up one-third of a commuter's household income. Because today commuters spend 3-4 hours a day in their cars, suburban housing schemes are not really popular because potential buyers want to own homes that are close to their downtown workplaces in order to save time and gasoline. This situation has opened the way for downtown development, especially in areas near MRT subway and BTS Skytrain stations. The concept has been known as 'Smart Growth' where 'TOD or Transit Oriented Development' has been in focus worldwide as a newer and greener scheme of housing development. Eco-village is a by-product of this new concept.

Eco-village Case Study

One of the best examples of Eco-village mentioned in every publication is BedZED or Beddington Zero Energy Development housing complex in suburban London. It is designed by a group of architects, engineers, and scientists using techniques of green buildings to build a village that meets specific needs of inhabitants.

Every green bible mentions the concept of 4Rs -- reduce, reuse, recycle, and renew. However, doing 4Rs is not really easy. For BedZED, the builders seemed to realize that they need to reuse/recycled materials to build the house or renewable energy from solar cells to help offset the energy used by the inhabitants. To be successful with 'Zero Energy', the house needs to be designed with a technique called 'passive solar heating' to reduce the heating needed during the winter by collecting solar heat in the daytime and store for nighttime use.

As a result, the design of the living space is set with a requirement of large glass windows at the south direction. The south windows are the parts of the 'sunspace' where solar heat is trapped inside the glass and stored in very thick concrete walls. Concrete walls are used for storing as much solar heat as possible and the heat will be released back to the living rooms at night. With this technique, the house would need no heating at all, thus helping the village come closer to 'Zero Energy' one. For cooling, fortunately, it is not really needed for houses in London and if ventilation is needed to cool the inside, an interestingly good-looking wind cowl is installed in each unit to induce natural ventilation of fresh air. The shape and form of the wind cowls follow aerodynamics so it guarantees to provide maximum airflow rates whenever it is needed. Space heating and cooling are then supplied quite naturally, The next thing to consider is how to provide enough energy for lightings, household appliances, water heating, and cooking. It is impossible to ask people not to turn on the lights at night. Then, energy supply for that purpose must be carefully thought out from the beginning.

BedZED has many PV solar panels on the rooftop of each house. However, without batteries to store the electricity generated during the daytime, there is no way to use solar energy at night. Battery is not really a green technology as electronic waste will cause more troubles for future disposals. Then, BedZED has looked for other green technologies to generate electricity for use during the night. It is electricity generated by solid waste from the village. This technology is called CHP or Combined Heat and Power co-generation. It sounds complicated for non-technical people, but for green people, this technology has been around for more than a decade. BedZED uses solid waste available in the village to produce heat and electrical energy. Produced heat is used for domestic water heater and electrical power is used for lightings and other household appliances.

All the design features and innovations have brought BedZED to come closer to not only 'Zero Energy' village, but also 'Zero Discharge' as most of the solid waste and wastewater can be reclaimed and almost all energy is produced and used on site. BedZED has showed that eco-village is not out of reach. However, it cannot be so successful if there is no integration of designers' knowledge and good wills, appropriate use of green technology, and of course the inhabitants who are willing to change their lifestyle. The same amount of money people paid to own a unit in BedZED could have bought a bigger and more comfortable house that wastes a lot more energy and resources, however is it really sustainable? BedZED has led a way for many eco-villages around the world including that of Thailand.

To be successful with 'Zero Energy', the house need to be designed with a technique called 'passive solar heating' to reduce the heating needed during the winter by collecting solar heat in the daytime and store for nighttime use.

Figure 2: *BEDZED, London* **(Source: https://en.wikipedia.org/wiki/BedZED)**

NHA Eco-village

As a key player responsible for Thailand's housing and urban development, one of the major achievements envisioned by the National Housing Authority (NHA), is to create a sustainable, environmentally friendly housing project. The created community's growth should be attained through adoption of 'self-sufficiency' as a main course of development. In order to achieve such goal, guidelines for sustainable eco-village were compiled, through findings from careful study and research. The guide is to cover aspects of design, material selection and construction method, including innovative strategies to minimize building energy use and waste released to natural environment and negative impact to the society. Moreover, the guide would encourage the project's inhabitants to participate in saving energy and the environment, thus a 'Sustainable Community' could be created. The concept of social enterprise where the community produces its own commodities through methods with minimum disturbance/ negative impact on the environment is also adopted.

An evaluation principle to guide and direct the designs and management of the authority towards the previously mentioned measures to attain community's comfort and sustainability was therefore, composed by NHA. Through collaboration between NHA and researchers from Chulalongkorn University led by Dr. Atch Sreshthaputra, this research's main purpose is to review and adapt the existing green building rating systems (e.g., TREES, LEED ND, Green Mark) and to develop more suitable guidelines for NHA housing complex. As a result, NHA has attained an evaluation principle, which could be used as a guide for 'Sustainable Comfortable Community' design. With the new guidelines, housing projects and communities, could be developed towards a self-sufficient, eco-friendly, sustainable community with low-energy consumption conforming to the authority's main mission.

Figure 3: *NHA Housing Complex* **(Source: www.bangkokbiznews.com)**

Research Objectives

The aims of the research are:

- To review previous research relevant to the design and construction of eco-housing.
- To develop the NHA's Eco-village as a sustainable community evaluation tool.
- To organize a group discussion amongst the NHA's architects and engineers.
- To organize a seminar for related parties including design and construction practitioners, on how to apply the obtained principles to their practices.

Research Methodology

- Review of case studies of local and international building design evaluation systems.
- Review of academic publications regarding sustainable design principles and standards for hot-humid climate.
- Analysis and revision of the existing green building rating tools through collaboration with NHA's staff members and other relevant bodies.
- Recommendation on how to adjust the existing eco-village and disseminate further application in design practices.
- Study of potential impacts resulting from the implementation of the principles in terms of surrounding environment, natural ventilation, daylighting, comfort condition, energy saving, and construction costs.
- Arrangement of group discussion for NHA's staff members and other involved parties on the draft of the Eco-village tool, to determine a guide with thorough consideration and integration of all relevant aspects.
- Arrangement of focus group discussion with participation of specialists of all relevant fields, in order to acquire a complete edited guide with academic legitimacy.
- Arrangement of training session for NHA's personnel, to provide understanding of the Eco-village tool, objectives and implementations.
- Arrangement of a public seminar for authorities, organizations, specialists and other parties related to residential constructions, to disseminate the obtained Eco-village user's manual and to acknowledge comments and suggestions regarding Eco-village evaluation system.
- Publication and distribution of Eco-village's User Manual

Results and Outcome

According to the methodology discussed previously, the research team has contemplated results from case studies and academic paper reviews, group discussion with the NHA personnel, and focus group discussion among related field experts in order to rectify and finalize the Eco-village rating system which has findings as follows;

- It is found that most green building rating tools used in Thailand such as TREES, LEED, and Green Mark are not suitable for use in housing complex in Thailand. They are intended for commercial buildings.
- Eco-village is developed on a purpose of promoting communities' living qualities while minimizing environmental impacts. Therefore, the rating system would be suitable for an application to residential community projects comprising a group of houses or buildings which are connected with pedestrian walkways, drive ways, and open spaces encouraging outdoor activities and socialization.
- The Eco-village rating system needs to have 2 paths for 2 different types of housing projects; 1) low-rise projects consisting of a group of buildings lower than 4 stories (e.g., detached house, semi-detached house, and row-house) and 2) high-rise projects consisting of a group of buildings of 4 stories and above (e.g., flat, condominium, and apartment).
- Typical green building rating tools assumed buildings are air-conditioned most of the time. There is no specific guideline about passive design for hot-humid climates. Eco-village has addressed this issue seriously.
- Most inhabitants in typical NHA housings use less energy especially for cooling. Air-conditioners are installed but not frequently used. The inhabitants prefer housing with good natural ventilation, sun shading, rain protection, and enough green spaces.
- Since passive design is preferred, building designs for natural comfort are more important than high-efficient equipment. Solar orientation, wind orientation, and window shades are very important credit requirements.
- It is found that the OTTV (Overall Thermal Transfer Value) equations developed by the Ministry of Energy cannot be applied for residential buildings in the tropics as the occupants use air-conditioners mostly at night. Therefore, this study proposed a new OTTV equation that is more suitable for this type of buildings.
- As the Eco-village tool is for 'Village' and not a single residential building, the tool needs to add specific requirements about site planning. There are credits relating to community garden, edible landscape, bicycle lanes, cul de sac street system, integrated pest management (IPM), and universal design (UD) in the Eco-village credits.
- Regarding the incremental cost of buildings, the study suggested that there is no additional cost associated with the implementation of Eco-village at the entry level (i.e., Certified level). However, NHA's architects and engineers including project management team will have to focus more on passive design for hot-humid climates. Special training courses are needed.
- Additional cost for building construction would be needed for higher levels, especially in terms of energy efficiency. Shading devices, ceiling insulation and higher energy-efficient glass will be needed. The construction cost could be increased by less than 10% with a payback period of about 7 years.
- There will be additional cost associated with higher land price as the Eco-village suggests selecting locations surrounded by existing community services, transportations, and previously developed lands where the cost of land is always higher than that of typical NHA projects. The Eco-village credit requirements also include basic facilities such as fresh markets, schools, sport complex, and some medical clinics to be inside the village.
- Since the site planning and design of Eco-village suggests more open spaces of green areas and pedestrian walkways, wider streets for bicycle lanes, and large trees, there will be additional cost as the land use will become less dense and the inhabitants would have to pay more for central facilities maintenance.

Eco-Village Credits and Categories

There are 2 types of credit requirements in the Eco-village rating system:

- Prerequisites – Projects must satisfy requirements of all prerequisite at a minimum in order to be eligible for further Eco-village evaluation.
- Credits – Projects shall earn points from achieving credit requirements. Each credit shall differ in awarded points varying to its environmental, economic, and social impacts. Total awarded points shall be used to determine projects' certified level as follows:

Less than 50 points	**Disqualified**
50 - 59 points	**Certified**
60 - 69 points	**Silver**
70 - 79 points	**Gold**
80 - 100 points	**Platinum**

The full score is 100 which are distributed into the following 5 credit categories;

	Low-rise	High-rise
Site planning and landscape	28	28
Building design	43	42
Building systems	14	15
Project management	10	10
Innovation	5	5
Total	100	100

Further Suggestions

Throughout the study, the research team has realized a need for NHA policy planning which is vital to promote and develop Eco-village evaluation system continuously. Several noteworthy aspects are as follows:

- NHA might consider assessing its ongoing projects during planning or preliminary design to seek opportunity to integrate Eco-village principles. This should be incorporated throughout the project planning, design, construction, and pre-occupancy in order to evaluate impacts from implementations.
- It is noticeable from the public seminar that a number of private sectors are interested in applying Eco-village to their residential projects. Therefore it might be beneficial to establish a responsible unit to administer Eco-village project registration and certification to promote and encourage developments of sustainable residential communities. For initial stage, NHA may consider setting up a labeling scheme which is a collaboration between NHA and private sector. Results from the scheme shall be advantageous to assess further impacts from implementations according to Eco-village since the evaluation system was initially developed by NHA and the academic research team.
- With the collaboration from private sector, impact evaluation of the implementation can cover broader aspects such as economics, marketing, society which may be beyond the NHA common practices. Moreover, NHA shall be able to use these pilot projects to publicize Eco-village. Ultimately, Eco-village evaluation system should be revised from time to time continuously due to the impact assessment and developed practices.
- In addition, NHA may consider arranging further internal training for NHA staffs. The contents shall focus on Eco-village evaluation system but not limited to other basic sustainable design criteria in order to build a strong understanding which shall be enhanced to an ability to apply Eco-village principles thoroughly. Consequently, the trained NHA staffs shall be able to expand the Eco-village and sustainable design knowledge to other related parties and practitioners as a key player responsible for wellness and healthfulness of Thailand's housing and urban development.

Providing Structural Engineering Software Solutions for Over 20 Years

Structural Engineering is the art and science of developing systems and solutions to realize almost all types of physical infrastructure and the built environment. It involves conception, planning, analyzing, designing and detailing. Most of these activities, specially analysis and design are heavily computing intensive, and these days, relying on the appropriate application of software. ACECOMS was established to assist the structural engineers in the development, understanding, and application of state-of-the-art computing tools and software and to develop networks with peers.

***ACECOMS** is one of the pioneers in the region in developing and promoting software for engineering applications*

The development of software applications for structural engineering has revolutionized the way structural engineers conduct their analysis and design. Structural engineering software applications have simplified the process of evaluating the performance of a structure besides saving a lot of time. The 2D and 3D images that are generated from the software application provide a better understanding about the strengths and weaknesses of the structure to engineers and especially to clients who may not be proficient in structural engineering.

Established in 1995 as a center of excellence at the Asian Institute of Technology (AIT), Thailand, the Asian Center for Engineering Computations and Software (ACECOMS) is one of the pioneers in the region in developing and promoting software for engineering applications. Celebrating its 20th anniversary this year, ACECOMS was launched and headed by the current AIT President, Professor Worsak Kanok-Nukulchai as the Founder and Director of the center. Dr. Naveed Anwar, Executive Director of AIT Consulting, who started ACECOMS together with Prof. Worsak Kanok-Nukulchai, was later appointed as the center's second Director and continued the responsibility for leading the center to become a self-sustaining center.

Dr. Naveed Anwar, Director of ACECOMS and Prof. Worsak Kanok-Nukulchai, AIT President

Some of the major services ACECOMS provided in the past twenty years include: developing and promoting software for engineering applications especially for civil/structural engineering, conducting professional training and education, conducting research and consultancy, associating and networking, and publishing technical articles, journals, and magazines.

Associated Software

PERFORM-3D	Nonlinear Analysis and Performance Assessment for 3D Structures (CSi)
ETABS	Integrated Analysis, Design, and Drafting of Building Systems (CSi)
CSi COL	Design of Simple and Complex Reinforced Concrete Columns (CSi)
SAP2000	Integrated Software for Structural Analysis and Design (CSi)
SAFE	Integrated Design of Flat Slabs, Foundation Mats, and Footings (CSi)
CSiBRIDGE	Integrated 3D Bridge Design Software (CSi)
GEAR	A suite of structural and geotechnical program (ACECOMS)
GRASP	2D analysis of frame and truss (ACECOMS)
Strand7	Finite element analysis (G+D Computing)
PROKON	A suite of over 40 structural analysis, design and detailing program (Prokon Software Consultants)
BATS	3D analysis of building systems (ACECOMS)
SDL Series	Analze: RC Column, RC Beam, ISOFoot and CombFoot (Technosoft)

ACECOMS coordinates its efforts with several esteemed institutions and organizations in Asia. These institutions, known as Associates and Associate Centers, act as key partners that support in jointly organizing various activities including localization of software, trainings, research, technology transfer and sharing, and information dissemination in their respective regions. At present, there are Associates in the Unites States, UK, and Australia and many active Associate Centers in countries including Bangladesh, Bhutan, Cambodia, India, Indonesia, Pakistan, Philippines, Sri Lanka, and Thailand, with more in the development stage. This coordination among various institutions and individuals in the region has resulted in a regional network of academic institutes, professional organizations, public sector departments, and private sector firms and individuals.

The Computers and Structures, Inc. (CSi), USA, a pioneering leader in software tools for structural and earthquake engineering is one of ACECOMS' international partners. ACECOMS is actively involved in the regionalization, regional promotion, and support of high-quality professional software developed by CSi such as SAP2000, ETABS, SAFE, and CSiCol. ACECOMS and CSi organized two Performance-based Design seminars held in Thailand and the Philippines, attended by more than 500 engineers across Asia and the Pacific.

Ashraf Habibullah, CSi President, during the PBD seminar in Bangkok

Ensuring that engineers are well-informed with recent developments in computing and other aspects of their profession, ACECOMS provides professional training and education for engineering practitioners from different countries intended to provide both theoretical background and hands-on practice on the effective use of computing tools and software. Some of the areas covered in these trainings include: Performance-based Design; Modeling, Analysis, and Design of Buildings; Modeling, Analysis, and Design of Bridge Structures; Finite Element Modeling and Analysis of Structures; Computer Applications in Civil and Structural Engineering, among others.

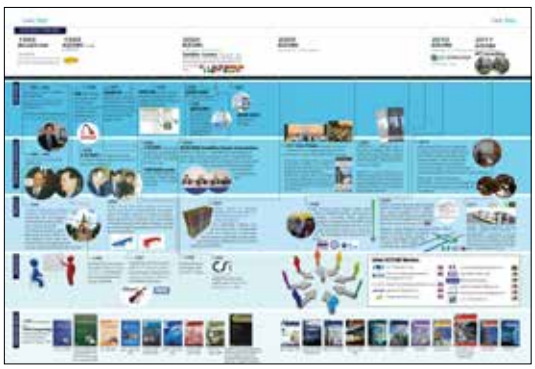
ACECOMS provides professional training for engineering practitioners from different countries

Since 1995, ACECOMS has been publishing *Civil Computing,* a magazine that highlights the engineering and technological developments of the region. The magazine eventually changed to *Technology* magazine in 2013 to cover more diversified areas and to be an avenue to share new research findings and latest developments in engineering and technology with an Asian perspective.

In 2011, ACECOMS officially joined AIT Consulting (AITC), established at AIT to offer integrated solutions in technology, engineering, environment, development, and management that bring a successful sustainable growth strategy to the rapidly developing world. ACECOMS and AITC, which is now known as AIT Solutions, function symbiotically, collaborating on projects covering software applications, seminars, and capacity building programs.

Over 100 seminars and trainings from more than 20 organizations and institutions in different countries were organized and attended by 3000+ engineers.

ACECOMS timeline was featured in the inaugural issue of Technology magazine which can be downloaded at AIT Consulting website: *www.consulting.ait.asia*



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Founded in 1975, Computers and Structures, Inc. (CSI) is recognized globally as the pioneering leader in software tools for structural and earthquake engineering. Software from CSI is used by thousands of engineering firms in over 160 countries for the design of major projects, including the Taipei 101 Tower in Taiwan, One World Trade Center in New York, the 2008 Olympics Birds Nest Stadium in Beijing and the cable-stayed Centenario Bridge over the Panama Canal.

CSI produces five primary software packages: SAP2000, CSiBridge; SAFE, PERFORM-3D, and ETABS. Each of these programs offers unique capabilities and tools that are tailored to different types of structures and problems, allowing users to find just the right solution for their work.

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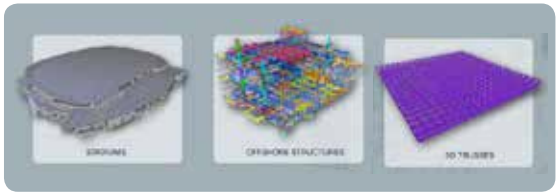

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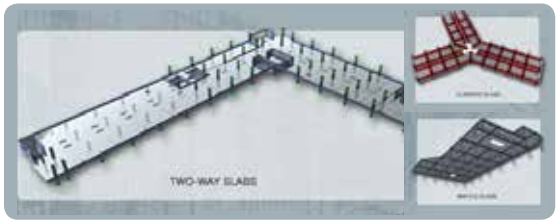

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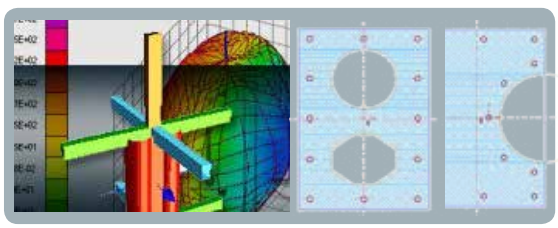

ACECOMS and AIT Consulting (now AIT Solutions) are providing support to CSI for development of design tools, particularly for the ETABS software package. These modules include section designer, wall designer, column designer, footings and steel connection. The developed ETABS modules will be used by engineers in building and structure design of multi-story commercial and residential structures.

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