

Mass-Industrialized Housing to Combat Consistent Housing Shortage in Developing Countries: Towards an Appropriate System for India

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Abstract

The quality of living is influenced by many factors. In the developing countries the housing problem are manifold and key factor in influencing quality living. The mainstream formal housing needs a faster production system of housing maintaining quality of houses and economy to overcome the huge shortage. Government's role has been changed to enabler from provider during last couple of decades and that is reflected in national plans. Overall 12% household (H/H) do not have livable house. Existing housing supply mechanism could not fulfill only 15% on an average of total housing need per decade including the backlog and additional need for population increase. National Housing and Habitat Policy (NHHP) mentioned about the necessity of a faster housing supply and focused on prefabricated system built housing. Scope for appropriate prefabricated building system to fulfill the housing shortage in India must be reassessed in present context. This paper analyses the housing shortage and supply system, identifies the need of a faster system of housing delivery and attempts to determine the appropriate form and process for industrialized housing, which can cater the need, in Indian context.

1.0 Introduction

The growing concentration of the people in the urban areas is an obvious thing, which is visible in the urbanization trend through out the world. Within the 50 years of development, the world has seen the manifold increase of urban population. Problem regarding the drinking water, sanitation, living environment, transport and electricity remained the main issue for increased urbanization. The problem of quality living is vital among those. Specially, in the developing countries the housing problem are manifold and key factor in influencing quality living. In India, there are huge numbers of houseless. Besides, a great portion of population lives in non-livable houses. A major portion cannot even afford a formal house. Economic condition forces them to live in an inferior housing environment. The mainstream formal housing needs a faster production system of housing maintaining quality of houses and economy to overcome the huge shortage. Appropriate solution to provide affordable, socio-culturally acceptable and environment friendly faster housing continues to be a serious challenge to public as well as private housing providers. Government's role has been changed to enabler from provider during last couple of decades and in national plans. National Housing and Habitat Policy (NHHP'98) mentioned about the necessity of a faster housing supply and focused on prefabricated system built housing. Scope for appropriate prefabricated building system to fulfill the housing shortage in India must be reassessed in present context. This paper analyses the housing shortage and supply system, identifies the need of a faster system of housing delivery and attempts to determine the appropriate form and process for industrialized housing in Indian context.

2.0 Housing Shortage, Supply and Issues

There is around 24.7 million-house shortage in India on an average (National Building Organization, NBO & NHHP 2007). Most of the shortage (99%) is for the lower income group (LIG) and economically weaker section (EWS) as per NBO and NHHP. The chronological situation of housing shortage is given below:

Table 1: Housing shortage analysis in India

		1961	1971	1981	1991	2001
Population (in cr)	Urban	7.89	10.91	15.95	21.76	28.61
	Rural	36.03	43.91	52.38	62.87	74.25
	Total	43.92	54.82	68.33	84.63	102.86
Housing Shortage in Crore, (10 million)	Urban	0.36	0.3	0.7	0.82	1.06
	Rural	1.16	1.16	1.63	1.47	1.41
	Total	1.52	1.46	2.33	2.29	2.47
Shortage as a percentage of Total H/H (in %age)	Urban	20.40	12.29	19.62	16.84	16.56
	Rural	16.58	13.61	16.03	12.04	9.78
	Total	17.35	13.31	16.96	13.41	11.86

Note: above shortage in housing includes houseless households as well as dilapidated houses, which need to be upgraded.
Source: Census of India, NBO, NHHP

Above table shows, that housing shortage in absolute number is not decreasing. i.e. existing gap in housing stock from 81, 91 to 2001 could not be filled up by conventional housing supply system. Whereas, housing shortage in urban areas is increasing. i.e. demand for new housing is growing at higher pace in urban areas and supply is not adequate (Fig. 1 below). Housing shortage in rural areas could be reduced in absolute numbers. Since combined effort from public as well as private housing providers could not fulfill the gap, existing housing supply have to be speedier to achieve the fulfillment of this additional shortage. Proportionately 1 out of 10 H/H in rural areas do not have livable house. Whereas for urban areas the corresponding figures is 1 out of 6 (Fig 2 below)

Fig 1: Absolute housing shortage: Urban, Rural and Total

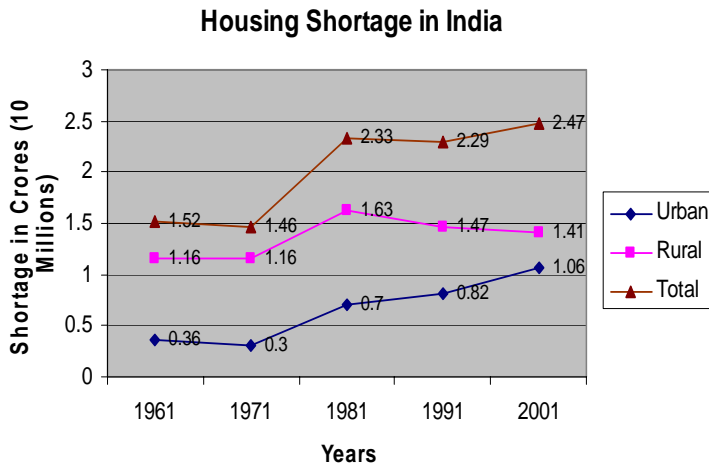
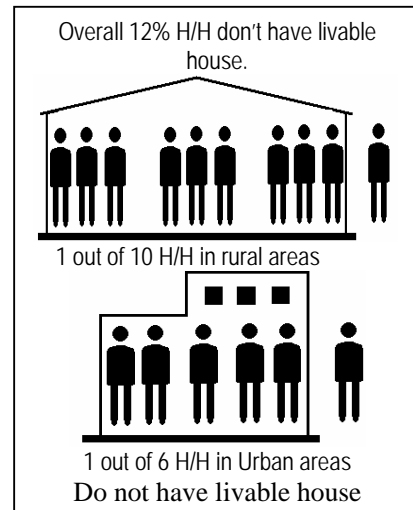


Fig 2: Share of Population not having livable house: rural and urban



3.0 Housing Shortage, Need and Stock

Exact data on supply of housing stock is not available. However to calculate for convenience of study housing supply is calculated from the following simple equation and presented in the table. It may be mentioned that for determining additional requirement of housing additional population is divided by average household size. Hence, the figure is indicative and based on average household size of recent plan period.

Assuming, Initial shortage at year = HI_x ,

Additional requirement in the year $y = HA_y$,

Total housing need in the year $y = H_y$,

So, $H_y = HI_x + HA_y$ & if, Housing shortage at year $y = HI_y$

Therefore increase in housing stock during year $x-y$ (considering the creation of new houses and decrease of housing stock due to dilapidation) = $HS_{x-y} = HI_x + HA_y - HI_y = H_y - HI_y$

Table 2: Housing Shortage, Need & Increase in Housing Stock during National plans

Time period	Total housing need including backlog in cr.			Housing shortage in terminal year HI_y^1	Increase in Stock HS_{x-y}
	Initial shortage $(HI_x)^1$	Additional requirements for new population $(HA_y)^2$	Total need $H_y = (HI_x + HA_y)$		
1961-71 Third and fourth plan	1.52	0.221	1.741	1.46	0.281
71-81 Fifth and sixth plan	1.46	0.277	1.737	2.33	-0.593
81-91 Sixth and seventh plan	2.33	0.334	2.664	2.29	0.374
91-2001 Eight and ninth plan	2.29	0.374	2.664	2.47	0.194
2001-11 10 th and 11 th plan	2.47	0.183**	2.653	--	--

Source: ¹NBO, NHHP, ² Calculated on the basis of number of dwelling unit i.e. census population divided by H/H size

Existing housing supply mechanism could increase the stock for only 15% on an average of total housing need including the backlog and additional need for population increase in a decade. Even during fifth and sixth plan, absolute housing supply, which was far below the combined need and newly dilapidated houses, which increased manifold, resulted a negative increase in housing stock. The successive years could not ensure more supply and it definitely shows that faster system of housing delivery has to be envisaged to overcome the total shortage.

4.0 Public Policy and Programmes for Housing

To analyze the barriers and issues in public policies and programmes for achieving housing for all it is necessary to have an overview of past policies for housing and urban development. Below is the major policy envisaged in the national plans and national housing policies.

Table 3: Plans, public policies, and its outcome

Year	Policy	Outcome and experience
1951-61 First & Second Plan	Finished social housing Subsidized housing scheme for industrial workers Housing for LIG (1954) Housing for plantation workers 1956 Establishment of NBO Slum clearance and rehabilitation	Poor benefited least Downward filtration Unaffordable public housing Supply is very less w. r. t the need Lengthy land acquisition procedure Non availability of alternative land for slums Reluctance to move
1961-74 Third & Fourth plan including non-plan period (66-69)	Financial assistance as loan State government for acquiring and developing land housing Rental skeleton housing Housing for dock labor Plantation labor housing ' creation of housing boards Housing for LIG and MIG Rental housing for state government employees Slum clearance and improvement Stress on prefabrication pf building components Housing for agricultural labor Private sector was emphasized for mass production of building materials, components Provision for establishment of cellular concrete plant Emphasis on water supply and sanitation	Lengthy and time consuming acquisition Lesser affordability of slum dwellers Problem in land acquisition

1975-85 Fifth & Sixth plan	State housing board and development authorities started housing for HIG, MIG, LIG and EWS in large scale Emphasis on R and D Enactment of ULCRA Private sector and NGO were give role Setup- of national Housing Bank, BMTPC Network of building centers Housing activity in small, medium and intermediate towns Modification of building byelaws Avoidance of direct subsidies Sites and services schemes	Poor benefited least 85% for HIG/MIG from Housing board Only 7% and 8% for EWS and LIG Institutional and socio economic barriers Downward filtration Downward filtration
1985-90 Seventh plan 1988, 1990 NHP draft	Self help housing Minimum need programme for rural areas EIS programme IDSMT scheme started More financial responsibilities to individuals Suggested amendment to ULCRA Economic development as income augmentation	Government as facilitator More responsibilities to market and private developers
1992-2002 Eighth & Ninth plan 1994 NHP 1998 NHHP, 2002-07 Tenth Plan, 2007 NUHHP	Legislative, fiscal and financial system framed Night shelter housing IAY as part of JRY as rural housing scheme Land market reform Home loan account scheme Government as enabler Encourage private & cooperative sector Self help housing 100% FDI permitted in private housing Repeal of ULCRA as a major land assembly tool 28 HFI s under NHB, VAMBAY PPP in housing projects	

Through the national plans and policies, it has been observed that government is taking out its role as direct provider of housing. It is focusing more on facilitating private developers as well as joint ventures to create more housing. Except for some state like West Bengal, where housing board took a role of housing provider as well as facilitator to keep the housing market steady and within the affordable limit for the general people. Still jointly central and state government is yet to frame a comprehensive action to overcome incremental housing shortage. Analyzing the above, the issues cum barrier behind the non-achievement of target housing supply for each decade are discussed.

5.0 Key Issues in non-Achievement of Housing Supply in Public Plan & Policies

Based on the study of performance during 5 year plans the key issues are identified as below and a marking has been done based on the analysis during the specific plan period. Major issues have been enumerated from 20 to 10 according to qualitative assessment during plan period. Accumulating the whole, speedier housing system and affordability resembles the most prominent issues, which need to be addressed.

Table 4: Analysis of major issues and barriers in mass public housing delivery

Issues/Barriers	1961-71 Third and fourth plan	71-81 Fifth and sixth plan	81-91 Sixth and seventh plan	91-2001 Eighth and ninth plan	2001-11 Tenth and Eleventh plan	Total marks
Housing finance and affordability	20	20	20	15	10	85
Institutional and policy framework	15	15	10	10	10	60
Availability of land for housing	10	20	15	15	10	70
Advancement and availability of building materials	15	10	15	20	20	80
Speedier technology and housing system	20	15	15	20	20	90
Supply of skilled and unskilled labor	10	10	15	10	20	65

It is seen from the table that speedier technology and housing supply is the prime barriers (90) followed by the affordability and availability of housing finance (85). In developed as well as developing countries, prefabricated system of housing has been envisaged as a viable option for speedier supply of housing since it offers cost effective and faster production of housing. In the country like India problem remained in various aspects, which needs due attention. Below the prerequisite for prefabricated housing and its Indian suitability has been discussed.

6.0 Industrialized System of Housing

Generally, industrialized systems building may be defined as the total integration of all subsystems and components into an overall process fully utilizing industrialized production, transportation and assembly techniques. This integration is achieved through the exploitation of underlying organizational principles. Irrespective of the definition, the system includes a balanced combination between the software and hardware components. The software elements include system design, which is a complex process of studying the requirement of the end user, market analysis, development of standardized components, establishment of manufacturing and assembly layout and process, allocation of resources and materials and definition of a building designer conceptual framework. The software elements provide a prerequisite to create the environment for industrialization of building.

Whereas, the hardware elements are categorized into three major groups. These include (a) frame or post and beam system (components are also used in an integrated way), (b) panel system (2D structural elements), and (c) box system (3D elements). The framed structures are defined as those structures that carry the loads through their beams and girders to columns and to the ground whilst in panel system load are distributed through large floor and wall panels. The box systems include those systems that employ three-dimensional modules (or boxes) for fabrication of habitable units are capable of withstand load from various directions due to their internal stability.

6.1 Characteristics of the System

It is required to review the prerequisite characteristics for the successful implementation of industrialized building system. Each of them is briefly discussed below.

6.1.1 Closed System

A closed system can be classified into two categories, namely production based on (i) client's design and production based on (ii) precaster's design. The first category is designed to meet a spatial requirement of the client's that is the spaces required for various functions in the building as well as the specific architectural design. In this instance, the client's needs are paramount and the precaster is always forced to produce a specific component for a building. On the other hand, the production based on precaster's design includes designing and producing a uniform type of building or a group of building variants, which can be produced with a common assortments of component. Such building includes school, parking garage, gas station, low cost housing, etc.

6.1.2 Open System

In view of the limitations inherent in the closed system, an open system, which allows greater flexibility of design and maximum coordination between the designer and precaster has been proposed. This system is plausible because it allow the precaster to produce a limited number of elements with a predetermined range of product and at the same time maintaining architectural aesthetic value. In spite of many advantages inherent in an open system, its adoption experiences one major setback. For example, joint and connection problem occur when two elements from different system are fixed together. A solid and authentic works in modular coordination can minimize that joint and connection problem.

7.0 Prerequisite for Industrialized Housing & Indian Situation

To explore the opportunity to increase housing stock by industrialized housing system the main considerations lies in the process and appropriate form of housing package for different groups. It has to be analyzed thoroughly. Suitability of prerequisite in Indian situation is discussed below:

7.1 Availability of Bigger Land for Mass Housing:

Until 2000, bigger land parcels were scarcely specially in urban areas. Recently repeal of Urban Land Ceiling Regulation Act (ULCRA) has been enforced in various states. This has made possible the availability of bigger land. On the other hand where ULCRA is still in enforced, like West Bengal, public private joint venture made large parcels of land available. However, the availability of land for big scale mass industrialized housing is not a barrier now.

7.2 Private Investment Possibility:

After liberalization and consecutive permission of 100%, Foreign Direct Investment in the large infrastructure and housing projects the investment in housing is also not a big problem. For componentized construction, even smaller manufacturers of building elements can participate. While major real estate projects are meant for higher Income group (HIG) and middle-income group (MIG), recent trend in real estate development shows that developers are keen to invest in housing for MIG and LIG since there is ready demand whereas demand for HIG is in a semi-saturated state in major cities.

7.3 Formulation, Enforcement of Building Code and Inspection Mechanism for Quality Control:

In a country like India this is something for which a radical strategy and change has to come. The present building regulation and National Building Code (NBC) need more enforcement on behalf of public body. To maintain safety in built environment it will be wiser to start with componentized construction to full-scale industrialization since quality control in componentized construction is much easier than full-scale 3D or 2D unit prefabrication.

7.4 Offsite Road Infrastructure:

The present condition of road infrastructure in India based on national, state and district high ways. Whereas other than national highways and some selected roads in major state capital cities, largely roads are not capable of taking load of full-scale houses and its careers. Hence, panelized/componentized construction conforms to the road situation, since both of them needs much lesser space, volume and weight. However, componentized construction would be feasible for smaller settlement-road networks, which cater semi urban and rural areas.

7.5 Dimensional Coordination and Research in Related Area of Housing Module:

The present housing market plays within a wide range of dimensions having little regards to the NBC where a modular dimension of 100 mm (1M) has been proposed. However, appropriate dimensional coordination and R/D in modular coordination must be first step for componentized construction. Similar R & D in 2D or 3D unit load bearing prefabrication more skilled, trained labor is required. Indian scenario does have plenty of unskilled/semiskilled labor, who can be engaged in componentized construction after little or no training.

8.0 Suitability of Prerequisites in Indian Situation

Considering the above situation, the suitability of appropriate system (as discussed in 6.0,) of industrialized housing must be explored. A matrix analysis among the various systems (3D Blocks, 2D panel, and framed-components) with the prerequisites as discussed above (8.0) may be useful to find the appropriate form.

Table 5: Comparative weight-age of system of industrialized housing in Indian situation of prerequisites

prerequisites	Weight-age for Suitability of specific system in India condition		
	3D full scale structural elements	2D full scale panelized elements	Componentized construction based on frame structures.
characteristics	Closed	Open/closed	Open
Availability of bigger land	3	3	3
Private Investment Possibility:	1	2	3
building code an inspection mechanism for quality control:	1	2	3
Offsite road infrastructure	1	2	2
Dimensional Coordination and Research in Housing Module:	2	2	3
Skilled manpower requirements	1	2	3
Total score	9	13	17

Note: Scores have been provided as 3-most suitable, 2-suitable, 1-less suitable

Thus, the above chart shows that the framed structures made of prefabricated components are most useful in Indian situation followed by panelized construction.

9.0 Recommendations and way forward

Considering the present Indian context regarding the prerequisites listed above it is proposed to have an open industrialized system housing consisting framed structures and made of prefabricated components to achieve a speedy, cost effective and socially acceptable housing supply. The prefabricated components may be structural like beams, columns, slabs and for walls and other building elements. For providing housing to Economically Weaker Sections and Lower Income Group who mainly forms squatter, slums or unauthorized construction in urban areas, the housing supply options need to be integrated with economic rehabilitation of the specific group. Use of prefabricated components like load bearing panel alternatively for walk up apartments in an open system would optimize and facilitate the process. Incremental housing process for the EWS must be considered. Accordingly, to make an affordable formal option a skeleton housing having minimal floor area and common sanitary connection may be thought of along with economic rehabilitation facility.

It must be mentioned that without a complete prior system of dimensional coordination and modular coordination the use of prefabrication would not be possible. Hence, the further research required in the field of dimensional coordination and development of appropriate module/options for each economic groups, considering open system and allowing vernacular building materials.

In framed-componentized open building system, people can add building elements in later stage with the increase of income also. So incremental housing, which is a natural phenomenon, may also be addressed accordingly. For infrastructure, development in housing cross subsidization may be considered. Higher Income Group (HIG) and Middle Income Group (MIG) need to be given customization options within affordable limit. An integrated dimensional coordination and modular coordination can offer this within a computer software operated process, linked with prefabricated housing element components factory, maintaining the scale of housing, cost and time performance.

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