Journal of Statistics Applications & Probability
An International Journal

http://dx.doi.org/10.18576/jsap/080302

Developing a Simulation Model for People's Participation in Housing for the Poor in India

Ritabrata Ghosh[*] *and Aditya Bandyopadhyay*

Department of Architecture, Town & Regional Planning, Indian Institute of Engineering Science & Technology, Shibpur, Howrah, 7111103, India.

Received: 2 Feb. 2019, Revised: 22 Mar. 2019, Accepted: 24 Mar. 2019.
Published online: 1 Nov. 2019.

Abstract: Community participation is one of the most effective tools for successful implementation of housing schemes for the poor in India as well as in all developing and underdeveloped countries. This article discusses the methodology of finding out relative weightage of factors influencing community participation in mass housing for the poor, which are already identified through extensive study of literature covering aspects like international experiences regarding people's participation in housing including experiences of World Bank as well as United Nations, study of various models of people's participation in housing for the poor prescribed in different publications, international best practices of community participation in housing for the poor, and so on. Few case studies of role of community participation in governmental housing programs for the poor in India have also been carried out and the factors identified are found out in the case studies in varied degrees of importance. Finally, a simulation model is developed through statistical analysis of data received through questionnaire feedback from experts in the field of housing in India. This model will facilitate determining degree of proper relative weightage to be given to various factors responsible for effective community participation while formulating a housing project for the poor in India for a particular location under a certain government program. Also, the model can be used effectively to prescribe relative importance to be given to factors influencing community participation while framing up guidelines of governmental housing programs for the poor in India.
Keywords: Housing, Housing for the poor, People's participation, Community participation, Factors influencing participation

1 Introduction

Housing is one of the most essential needs of utmost importance. Priority is required to be given to housing since on an average, a person lives two third of his life in a house. It is therefore essential to have access to safe, secure, durable & healthy shelter for all.

Government of India has framed its policy on 'Housing for All' in line with the declaration made in the 1996 UN conference at Istanbul (popularly known as Istanbul Declaration on Human Settlements), wherein the slogan emerged was - 'Adequate Shelter for All'. It is found that housing remains inaccessible mainly to Economically Weaker Section (EWS)and Low Income Group(LIG)categories in India. The household annual incomes as determined with effect from 2015 for these categories in India are (a) EWS – up to INR 0.3 million (USD 4200) and (b) LIG – INR 0.3 million to INR 0.6 million (USD 4200 to 8400).

As per National Buildings Organization (NBO) estimate, 75% of India's population lives in an inappropriate shelter out of which 48% are below poverty line. According to 2011 Census, India has 247 million housing stock with 62% permanent dwelling units, 53% have no sanitation facility, 33% have no electricity and more than 49% have no drainage facility (refer Figure-1). Lack of basic infrastructure in existing housing stock and shortfall indicate chronic shortage of dwelling units

[*]Corresponding author e-mail: rghosh51@gmail.com

with basic needs. It is estimated that India is face a chronic shortage of around 19 million dwelling units, out of which, shortage in the EWS category is 56% and LIG category is 39% (refer Figure-2).

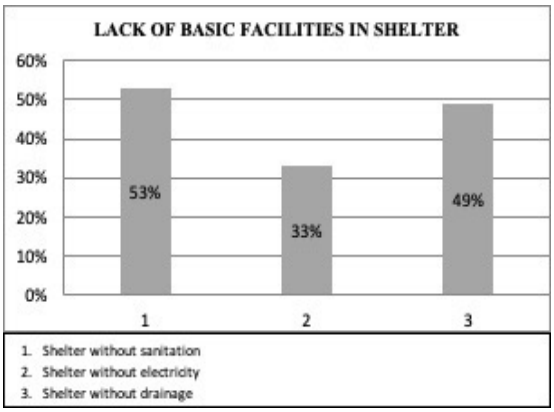

Fig.: Lack of Basic Facilities in Shelter

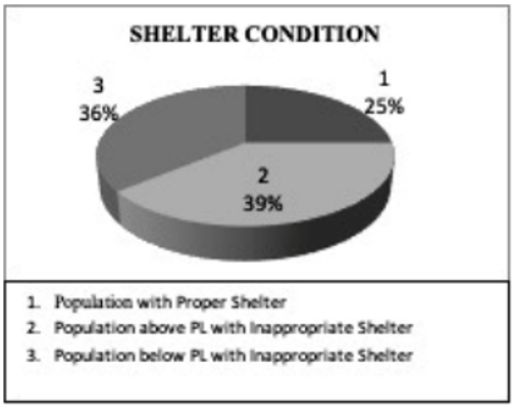

Fig.2: Shelter Condition

'Top down' approach is not the solution to sustainable development. It is often seen that the development organizations find it difficult to integrate common people in development works as existing planning practices fail to communicate with people. 'Bottom up' approach is the only solution for any sustainable development work.

National Urban Housing & Habitat Policy (NUHHP) 2007 intends to promote sustainable development of habitat in India with a view to ensure equitable supply of land, shelter and services at affordable prices to all sections of society. The policy is co-related with the people's participation so that models of participation could be understood and analyzed within the framework of the policy and the final model to be recommended would be in line with the Government Policy.

As per NUHHP, 2007, the major roles of various stake-holders in housing activities with reference to a participatory approach, are as follows –

- role of Central Government: to act as a Facilitator or Enabler
- role of State Government: to act as a Facilitator or Enabler
- role of Urban Local Bodies/ Development Authorities/ Housing Boards: (1) to develop capacity building through training (2) to devise capacity building program at local level (3) to promote participatory planning and funding based on local level stakeholders and (3) to promote Residents' Welfare Associations for operation & maintenance and to check encroachment.
- role of Banks and Housing Finance Institutions: (1) to promote Self Help Groups (SHGs) for mobilizing savings and playing a significant role in housing finance sector and(2) to encourage potential EWS/LIG beneficiaries to form Co-operative Group Housing Societies (CGHS).

As per the provisions of NUHHP 2007, beneficiary-led housing development is to be encouraged and suitable percentage of land developed by public sector to be earmarked for co-operative group housing societies. It is suggested in the policy that revisions of Master Plans are to be done periodically with wide public participation. States are to be encouraged to adopt model co-operative housing act. Formulation of group co-operative housing societies of urban poor and slum dwellers are also to be encouraged for providing better housing service with basic amenities through thrift & credit-based Community Based Organizations (CBOs). NUHHP 2007 also recommends that the state level policy and plan is to indicate concrete steps for motivating, guiding and encouraging a participatory approach involving all stake holders.

Government agencies gradually become aware about the importance of community participation in settlement development schemes. They are getting convinced about the reality providing shelter to the poor is beyond their financial and administrative capacity and disappointing experiences with human settlement programs in developing countries make these agencies realize this fact. In fact, governments are gradually recognizing community participation as a human right, which can take charge of the lives of individuals in the community and they can participate in the planning, implementation and management of projects, which affect them.

As a result of the rapid pace of urbanization in many of the developing countries, community participation has been given more attention and has achieved new dimensions. Normally, community participation is considered as an instrument and bottom-up approach is used to bring about change, especially in low-income settlements. If the point is seen from the point of view of the community itself, the main issue does not enhance their capacity to participate in governmental programs, but rather to seek government as well as private sector support as facilitators in a systematic way to meet their developmental priorities. As per the perception of a common man, community is seen as a source of free labor for construction, which is popularly known as self-help, and as per this concept, members of a community are supposed to provide mainly unskilled labor component of a project. There is no doubt that this popular approach brings down the overall cost of construction, but at the same time, the community is excluded from the task of planning and designing, which are procured entirely from external professionals. In case the community does not identify the construction activity as a priority, the so-called self-help labor of the community might not be entirely voluntary and hence, interest in sustaining the developmental program would diminish, which would ultimately lead to failure of the program.

2 Factors influencing Community Participation in Housing for the Poor

Literature surveys have given an insight about community participation in development projects, community participation approaches, tools, steps in government-led participatory development planning process, challenges, risks, tips for effective participatory development, key areas in people's participation in planning, etc. Evolution of community participation both in international and Indian contexts, international best practices of community participation in housing for the poor, community participation in housing policies in India like National Urban & Habitat Policy (NUHHP) 2007 and others have also been studied in detail. Literature study has brought out the factors with respect to community participation, influencing the housing delivery system as detailed in Table-1 below.

Table 1: Factors influencing housing delivery system with people's participation.

Broad categories	*Resource-specific*	*User-community-specific*	*Agency-specific*	*Program design-specific*	*Environment specific/ External*
Factors	Resource centrality	Awareness	Locus of decision-making	Program Objectives	Legal factors
	Resource scarcity	Values and Beliefs	Delegation of Financial and Administrative Power	Program Instruments	Political Factors
	Gestation & Uncertainty	Socio-economic Structure	Qualities of Agency Personnel	Program Benefits and Their Distribution	Policy related Factors
	Excludability	Organization and Leadership			Corruption Factors
		Economic Status			
		Prejudices against Women			

2.1Brief Description of the Identified Factors

Brief description of twenty identified factors influencing community participation in housing for the poor under five broad categories are as follows:

2.1.1 Resource-Specific Factors

- Resource centrality: If the resource/resource product is critical to the survival of local people, they would participate in programs related to resource development and management.
- Resource scarcity: problem arises when demand for resource is more than supply. People's participation can optimise the use of resources, be it natural resources or any other resources.
- Gestation & Uncertainty: Longer waiting time (gestation) with higher degree of uncertainty brings down the level of motivation of local people to participate.

- Excludability: People do not generally agree to participate in collective management of resources unless they are confirmed of exclusive right to benefit from such collective resource management.

2.1.2 User-Community-Specific Factors

- Awareness: People do not feel the requirement of participation since they might not be aware of the seriousness of the problem and need for their intervention, about their roles in the program and also the benefits from their participation in the program.
- Values and Beliefs: Participants in housing projects identify many values and beliefs that promote co-operation, resource optimisation, including resolving conflicts, difference in opinion, etc. within the community as far as implementation of the program is concerned.
- Socio-economic Structure: very common obstacle found in people's participation is due to the heterogeneous socio-economic structure of a community with respect to caste, class, ethnicity, assets, income, etc.
- Organization and Leadership: It is very important to have a proper local leadership (individual or organizational) to organise people, liaison with government/ government organizations, mobilise resources, ensure people's access to the promised benefits etc.
- Economic Status: People's participation is greatly affected by the level of per capita income as well as its distribution. A poor person can hardly be motivated to take part in community participation since he or she cannot devote time, energy and money.
- Prejudices against Women: In a male dominated society in developing countries, women are not allowed to take decisions, take part in community activities for developmental programs and they are discouraged to participate in meetings, discussions, trainings, etc. in community activities, whereas they are very closely associated with many activities related to housing.

2.1.3 Agency-Specific Factors

- Locus of decision-making: In the changed scenario of participatory approach, it is realized that for securing and sustaining people's participation, it is necessary that all the operational decisions regarding implementation of housing programs are made by the local people themselves or by the community groups, in contrary to government organizations taking centralized decisions in earlier days.
- Delegation of Financial and Administrative Power: Historically, the characteristic of government organization is to keep financial and administrative powers centralized. Subsequently, the perception of government organizations towards exercising financial and administrative powers in projects with people's participation has changed.
- Qualities of Agency Personnel: Qualities of agency personnel like attitudes, values and professional skills influence people's participation to a great extent.

2.1.4 Program Design-Specific Factors

- Program Objectives: The objective of a particular program or the goal to be achieved from the program is a very important factor that influences the people's participation.
- Program Instruments: Program instruments include instruments identified for smooth implementation of the program including measures for effective people's participation like self-help approach in implementation of a program where beneficiaries themselves invest in terms of providing skilled/ unskilled laborin implementation.
- Program Benefits and their Distribution: People can only be convinced to participate when an informal cost-benefit analysis ensures him of higher benefits than his investments, which might be by cash or kind.

2.1.5 Environment Specific/ External Factors

- Legal factors: Legal factors like ownership of land, constitution of community groups, local acts affecting the project etc. play vital role in effective community participation for implementation of housing programs.
- Political Factors: Political leaders at local level try to take control of housing programs under their respective jurisdictions such as influencing the process of selection of beneficiaries.
- Policy related Factors: Policy for formulation/ implementation of a program has a great bearing on people's participation for successful implementation of the program.
- Corruption Factors: Corruption at grass root level causes negative impacts on participatory management in implementation of housing projects.

The presence of these factors in international best practices of community participation in housing, as studied, has been mapped. Similarly, few case studies of projects implemented under various governmental programs with people's participation have been carried out in different parts of India and presence of the identified factors in these projects have been identified with various degrees of relative importance.

3 Methodologies

Analytic Hierarchy Process (AHP) under Multi-Criteria Decision Analysis (MCDA) has been used as it is suitable in finding out relative weightage of factors. A simulation model has finally been formulated which provides the efficiency of a particular alternative of combination of factors with different relative rankings and by changing such ranking of one or all the factors, different efficiencies of alternatives can be derived. This will finally help in selecting the most efficient alternative with relative ranking of factors while formulating guidelines for a particular housing project for the poor with community participation.

The identification of factors has been done through literature survey, study of international best practices of community participation in housing for the poor and carrying out few case studies in Indian context as explained earlier. Feedback from experts in the field of housing and related matters have been taken and the data collected have been used to determine the relative weightage and ranking of identified factors through statistical analysis as per AHP.

Finally, a statistical simulation model has been formulated wherein by changing the relative ranking of the factors, various efficiency values of different alternatives with different combinations of importance levels of factors can be derived at. This model would facilitate in identifying the most efficient alternative with most suitable ranking of importance of the factors influencing community participation for formulation of a project under a particular governmental housing program for the poor or even formulation of policies and guidelines for governmental housing program for the poor with community participation.

Flow Diagram of Methodology analysis is given in Figure-3 below.

3.1Feedback from Experts

Questionnaires containing the list of factors identified through literature survey as well as study of international best practices and analysis of Indian case studies were sent to 79 experts in the field of housing and related areas in India. They were requested to put weightage in a constant sum scale of 100 point in such a manner that summation of weightage of all factors a respondent puts should be equal to 100. The filled in questionnaires were received from 61 experts. The details of composition of experts are indicated in the following Table-2.

Table 2: Composition of experts

Sl. No.	*Fields of experts*	*Questionnaire sent*	*Not Responded*	*Responded*
1	Government/ Government Bodies	9	2	7
2	Research institutions	8	0	8
3	Educational Institutions	23	6	17
4	Eminent Experts in Housing & related sectors	21	6	15
5	Financial institutions	5	1	4
6	Foreign Cooperation Agencies	1	0	1
7	Local Bodies	4	2	2
8	Technical Authorities	2	0	2
9	NGOs	6	1	5
	Total	79	18	61

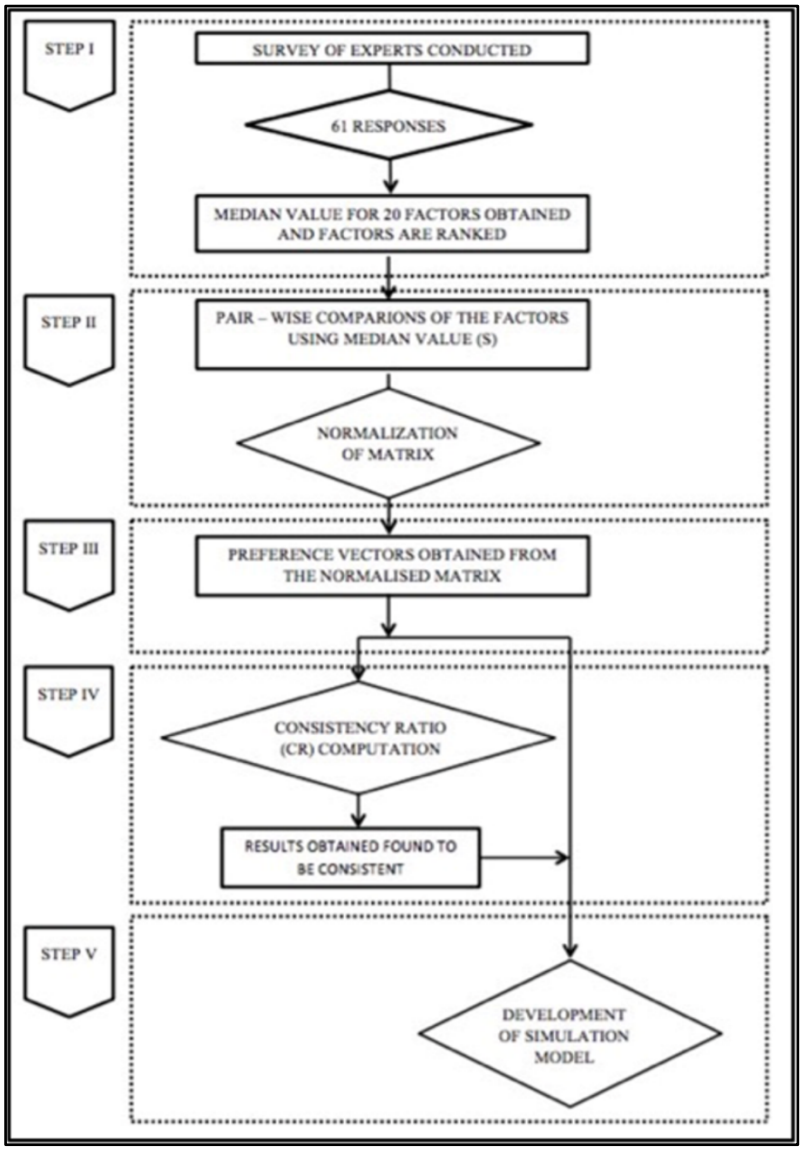

Fig. 3: Methodology of Data Analysis.

3.2 Analysis of Data

The responses of 61 experts corresponding to the 20 factors are analyzed. For each factor, there are 61 responses regarding its relative importance with respect to the other 19 factors. The median value of each factor was taken as opposed to the mean, reason is as following:

- The data set is not large, N<100; where N is the number of responses
- Ease of calculation.
- It is not influenced by outliers in the data-set.

The following includes the median values to be considered, corresponding to the 20 factors:

Table 3: Median values of factors

Sl. No.	*Factors*	*Medians*
1	Resource centrality (Resource-specific)	5
2	Resource scarcity (Resource-specific)	6
3	Gestation & Uncertainty (Resource-specific)	5
4	Excludability (Resource-specific)	3
5	Awareness (User-community-specific)	7
6	Values and Beliefs (User-community-specific)	3
7	Socio-economic Structure (User-community-specific)	5
8	Organization and Leadership (User-community-specific)	5
9	Economic Status (User-community-specific)	6
10	Prejudices against Women (User-community-specific)	2
11	Locus of decision-making (Agency-specific)	4
12	Delegation of Financial and Administrative Power (Agency-specific)	7
13	Qualities of Agency Personnel (Agency-specific)	3
14	Program Objectives (Program design-specific)	6
15	Program Instruments (Program design-specific)	4
16	Program Benefits and Their Distribution (Program design-specific)	7
17	Legal factors (Environment-specific)	4
18	Political Factors (Environment-specific)	5
19	Policy related Factors (Environment-specific)	4
20	Corruption Factors (Environment-specific)	5

AHP generates all criteria weighting and alternative preference within each criterion by eliciting these values from the decision maker through pairwise comparisons, as opposed to utilizing numerical values directly. The steps of AHP followed to analyze data are as follows -

- Step 1: Construct the problem hierarchy
- Step 2: Pairwise comparison of criteria/ factors
- Step 3: Normalizing of criteria/ factors
- Step 4: Finding out final weightage of criteria/ factors
- Step 5: Final ranking of criteria/ factors

Pairwise comparisons are undertaken between each pair of criteria/ factor using the median values of Table-3. An example of pairwise comparison of 4 x 4 matrix is given below:

Table 4: Example of pairwise comparison in AHP

Median*		5	6	8	3
		Factor-1	Factor-2	Factor-3	Factor-4
5	Factor-1	5/5	5/6	5/8	5/3
6	Factor-2	6/5	6/6	6/8	6/3
8	Factor-3	8/5	8/6	8/8	8/3
3	Factor-4	3/5	3/6	3/8	3/3
* Arbitrary median values taken against each factor					

Using the median values as in Table-3, a pairwise comparison of the factors is done to generate a 20x20 matrix as in Table-5.

Table 5: Pairwise comparison of 20 factors using median values

	Resource centrality	Resource scarcity	Gestation & Uncertainty	Excludability	Awareness	Values and Beliefs	Socio-economic Structure	Organization and Leadership	Economic Status	Prejudices against Women	Locus of decision-making	Delegation of Financial and Administrative Power	Qualities of Agency Personnel	Program Objectives	Program Instruments	Program Benefits and Their Distribution	Legal factors	Political Factors	Policy related Factors	Corruption Factors
Resource centrality	1.00	0.83	1.00	1.67	0.71	1.67	1.00	1.00	0.83	2.50	1.25	0.71	1.67	0.83	1.25	0.71	1.25	1.00	1.25	1.00
Resource scarcity	1.20	1.00	1.20	2.00	0.86	2.00	1.20	1.20	1.00	3.00	1.50	0.86	2.00	1.00	1.50	0.86	1.50	1.20	1.50	1.20
Gestation & Uncertainty	1.00	0.83	1.00	1.67	0.71	1.67	1.00	1.00	0.83	2.50	1.25	0.71	1.67	0.83	1.25	0.71	1.25	1.00	1.25	1.00
Excludability	0.60	0.50	0.60	1.00	0.43	1.00	0.60	0.60	0.50	1.50	0.75	0.43	1.00	0.50	0.75	0.43	0.75	0.60	0.75	0.60
Awareness	1.40	1.17	1.40	2.33	1.00	2.33	1.40	1.40	1.17	3.50	1.75	1.00	2.33	1.17	1.75	1.00	1.75	1.40	1.75	1.40
Values and Beliefs	0.60	0.50	0.60	1.00	0.43	1.00	0.60	0.60	0.50	1.50	0.75	0.43	1.00	0.50	0.75	0.43	0.75	0.60	0.75	0.60
Socio-economic Structure	1.00	0.83	1.00	1.67	0.71	1.67	1.00	1.00	0.83	2.50	1.25	0.71	1.67	0.83	1.25	0.71	1.25	1.00	1.25	1.00
Organization and Leadership	1.00	0.83	1.00	1.67	0.71	1.67	1.00	1.00	0.83	2.50	1.25	0.71	1.67	0.83	1.25	0.71	1.25	1.00	1.25	1.00
Economic Status	1.20	1.00	1.20	2.00	0.86	2.00	1.20	1.20	1.00	3.00	1.50	0.86	2.00	1.00	1.50	0.86	1.50	1.20	1.50	1.20
Prejudices against Women	0.40	0.33	0.40	0.67	0.29	0.67	0.40	0.40	0.33	1.00	0.50	0.29	0.67	0.33	0.50	0.29	0.50	0.40	0.50	0.40
Locus of decision-making	0.80	0.67	0.80	1.33	0.57	1.33	0.80	0.80	0.67	2.00	1.00	0.57	1.33	0.67	1.00	0.57	1.00	0.80	1.00	0.80
Delegation of Financial and Administrative Power	1.40	1.17	1.40	2.33	1.00	2.33	1.40	1.40	1.17	3.50	1.75	1.00	2.33	1.17	1.75	1.00	1.75	1.40	1.75	1.40

Qualities of Agency Personnel	0.60	0.50	0.60	1.00	0.43	1.00	0.60	0.60	0.50	1.50	0.75	0.43	1.00	0.50	0.75	0.43	0.75	0.60	0.75	0.60
Program Objectives	1.20	1.00	1.20	2.00	0.86	2.00	1.20	1.20	1.00	3.00	1.50	0.86	2.00	1.00	1.50	0.86	1.50	1.20	1.50	1.20
Program Instruments	0.80	0.67	0.80	1.33	0.57	1.33	0.80	0.80	0.67	2.00	1.00	0.57	1.33	0.67	1.00	0.57	1.00	0.80	1.00	0.80
Program Benefits and Their Distribution	1.40	1.17	1.40	2.33	1.00	2.33	1.40	1.40	1.17	3.50	1.75	1.00	2.33	1.17	1.75	1.00	1.75	1.40	1.75	1.40
Legal factors	0.80	0.67	0.80	1.33	0.57	1.33	0.80	0.80	0.67	2.00	1.00	0.57	1.33	0.67	1.00	0.57	1.00	0.80	1.00	0.80
Political Factors	1.00	0.83	1.00	1.67	0.71	1.67	1.00	1.00	0.83	2.50	1.25	0.71	1.67	0.83	1.25	0.71	1.25	1.00	1.25	1.00
Policy related Factors	0.80	0.67	0.80	1.33	0.57	1.33	0.80	0.80	0.67	2.00	1.00	0.57	1.33	0.67	1.00	0.57	1.00	0.80	1.00	0.80
Corruption Factors	1.00	0.83	1.00	1.67	0.71	1.67	1.00	1.00	0.83	2.50	1.25	0.71	1.67	0.83	1.25	0.71	1.25	1.00	1.25	1.00
Column Total	*19.20*	*16.00*	*19.20*	*32.00*	*13.71*	*32.00*	*19.20*	*19.20*	*16.00*	*48.00*	*24.00*	*13.71*	*32.00*	*16.00*	*24.00*	*13.71*	*24.00*	*19.20*	*24.00*	*19.20*

Next, the matrix generated is synthesized wherein the each value is divided by the sum of that column. The average of each row is calculated to derive at the preference vector of corresponding factor as in following Table-6.

Table 6: Synthesized matrix

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Factor 11	Factor 12	Factor 13	Factor 14	Factor 15	Factor 16	Factor 17	Factor 18	Factor 19	Factor 20	Average (Preference Vector)
Factor 1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.052083
Factor 2	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.062500
Factor 3	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.052083
Factor 4	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.031250
Factor 5	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.072917
Factor 6	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.031250
Factor 7	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.052083
Factor 8	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.052083
Factor 9	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.062500
Factor 10	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.020833
Factor 11	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.041667
Factor 12	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.072917
Factor 13	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.031250
Factor 14	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.062500
Factor 15	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.041667

Factor 16	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.072917
Factor 17	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.041667
Factor 18	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.052083
Factor 19	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.041667
Factor 20	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.052083

Preference vectors for each factor as generated in Table-6 are listed in the following Table-7.

Table 7: Preference vectors

Sl. No	*Factors*	*Average/ Preference Vector*
1	Resource centrality (Resource-specific)	0.05208
2	Resource scarcity (Resource-specific)	0.0625
3	Gestation & Uncertainty (Resource-specific)	0.05208
4	Excludability (Resource-specific)	0.03125
5	Awareness (User-community-specific)	0.07292
6	Values and Beliefs (User-community-specific)	0.03125
7	Socio-economic Structure (User-community-specific)	0.05208
8	Organization and Leadership (User-community-specific)	0.05208
9	Economic Status (User-community-specific)	0.0625
10	Prejudices against Women (User-community-specific)	0.02083
11	Locus of decision-making (Agency-specific)	0.04167
12	Delegation of Financial and Administrative Power (Agency-specific)	0.07292
13	Qualities of Agency Personnel (Agency-specific)	0.03125
14	Program Objectives (Program design-specific)	0.0625
15	Program Instruments (Program design-specific)	0.04167
16	Program Benefits and Their Distribution (Program design-specific)	0.07292
17	Legal factors (Environment-specific)	0.04167
18	Political Factors (Environment-specific)	0.05208
19	Policy related Factors (Environment-specific)	0.04167
20	Corruption Factors (Environment-specific)	0.05208

3.3 Validation of Consistency of Decision

Consistency Ratio (CR) measures the degree of inconsistency in the pairwise comparisons. CR is actually the ratio of Consistency Index (CI) and Random Index (RI). Hence, CR = CI/RI.

Decision maker uses pairwise comparison to establish the preferences using the preference scale. In case of many comparisons, the decision maker may lose track of previous responses. Responses have to be valid and consistent from a set of comparisons to another set. To arrive at the Consistency Index (CI), first Weighted Sum (WS) for each factor is computed by multiplying each value in every row of Table-5 (Pairwise comparison table) to the corresponding preference vector for the factor as obtained in Table-6 & 7 and adding up all the 20 figures obtained through such multiplications. By doing so, WS for each factor is derived at in column 3 of Table-8 below. Now in column 4 of Table-8, the value of (WS/PV) for each factor is calculated by dividing Weighted Sum by corresponding Preference Vector. The average of the (WS/PV) values of all the 20 factors has been calculated as λmax at the bottom of Table-8. Eventually, (WS/PV) value of all the factors are 20 and therefore λmax = 20.

Table 8: Weighted Sum (WS) values

Sl. No.	*Factor*	*WS*	*WS/PV*
1	2	3	4
1.	Resource centrality (Resource-specific)	1.041666667	20
2.	Resource scarcity (Resource-specific)	1.25	20
3.	Gestation & Uncertainty (Resource-specific)	1.041666667	20
4.	Excludability (Resource-specific)	0.625	20
5.	Awareness (User-community-specific)	1.458333333	20
6.	Values and Beliefs (User-community-specific)	0.625	20
7.	Socio-economic Structure (User-community-specific)	1.041666667	20
8.	Organization and Leadership (User-community-specific)	1.041666667	20
9.	Economic Status (User-community-specific)	1.25	20
10.	Prejudices against Women (User-community-specific)	0.416666667	20
11.	Locus of decision-making (Agency-specific)	0.833333333	20
12.	Delegation of Financial and Administrative Power (Agency-specific)	1.458333333	20
13.	Qualities of Agency Personnel (Agency-specific)	0.625	20
14.	Program Objectives (Program design-specific)	1.25	20
15.	Program Instruments (Program design-specific)	0.833333333	20
16.	Program Benefits and Their Distribution (Program design-specific)	1.458333333	20
17.	Legal factors (Environment-specific)	0.833333333	20
18.	Political Factors (Environment-specific)	1.041666667	20
19.	Policy related Factors (Environment-specific)	0.833333333	20
20.	Corruption Factors (Environment-specific)	1.041666667	20
		λmax (Average of WS/PV)	20

Formula for CI = (λmax – n)/(n-1), where n is number of compared elements, in this case number of compared factors i.e. 20.

Hence, CI = (20 - 20) / (20-1) = 0, since λmax=20 and n=20

For different values of n, the Random Index (RI) is referred from a standard table. Value of RI for different values of n are obtained from the Saaty scale as given Table-9 below.

Table 9: Extract from Saaty scale - Value of RI for n>15.

n	16	17	18	19	*20*	21	22	23
RI	1.5978	1.6086	1.6181	1.6265	***1.6341***	1.6409	1.6470	1.6526
n	24	25	26	27	28	29	30	31
RI	1.6577	1.6624	1.6667	1.6706	1.6743	1.6777	1.6809	1.6830
n	32	33	34	35	36	37	38	39
RI	1.6867	1.6893	1.6917	1.6940	1.6962	1.6982	1.7002	1.7020

Thus for n=20, RI is 1.6341.
CR = CI/RI = 0/1.6341 = 0

A perfectly consistent decision maker should always obtain CI=0, but small values of inconsistency may be tolerated, in particular, if CI/RI< 0.1 (Saaty, T.L., 1980).

Thus, it is a perfectly consistent decision.

4 Simulation Model

A simulation model is a mathematical model that calculates the impact of uncertain inputs and decisions we make on outcomes that we care about, such as profit and loss, investment returns, environmental consequences, and the like. Such a model can be created by writing code in a programming language, statements in a simulation modelling language, or formulas in a Microsoft Excel spreadsheet. Regardless of how it is expressed, a simulation model includes:

- Model inputs that are uncertain numbers -- we call these uncertain variables
- Intermediate calculations as required
- Model outputs that depend on the inputs -- we call these uncertain functions

From the previous analysis we have obtained preference vectors for the twenty factors as in Table-6& 7. This is the model input in the simulation model.

Using the preference vectors as inputs, the simulation model proposed below would generate scores of different alternatives with different combinations of weightages/rankings of factors influencing community participation. Three arbitrary alternatives (A, B & C) are taken with various arbitrary combinations of rankings from 1 to 20 for the factors and the simulation model would generate scores for the alternatives. The alternative with highest score would be considered as the most efficient alternative in terms of relative rankings of the factors influencing community participation and the same can be adopted for implementation of a housing project for the poor for a particular location under a governmental housing scheme.

Scores of A, B and C are obtained by summing up the figures derived by multiplying each factor's rank as assigned with its corresponding preference vector. Different alternatives can be ranked against each other for implementing a scheme or project. The model can be iterated in different ways to prioritize certain factors to get the final score. The details of the simulation model are described in the following Table-10.

Table 10: Simulation model

Preference Vectors		0.05208333	0.0625	0.05208333	0.03125	0.07291667	0.03125	0.05208333	0.05208333	0.0625	0.02083333	0.04166667	0.07291667	0.03125	0.0625	0.04166667	0.07291667	0.04166667	0.05208333	0.04166667	0.05208333
		P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	P_{17}	P_{18}	P_{19}	P_{20}
Factors		Resource centrality	Resource scarcity	Gestation & Uncertainty	Excludability	Awareness	Values and Beliefs	Socio-economic Structure	Organization and Leadership	Economic Status	Prejudices against Women	Locus of decision-making	Delegation of Financial and Administrative Power	Qualities of Agency Personnel	Program Objectives	Program Instruments	Program Benefits and Their Distribution	Legal factors	Political Factors	Policy related Factors	Corruption Factors
	Ranking of Factors	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	R_{11}	R_{12}	R_{13}	R_{14}	R_{15}	R_{16}	R_{17}	R_{18}	R_{19}	R_{20}
Alternative A		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Alternative B		2	3	10	11	13	7	1	6	5	8	9	16	17	19	4	12	15	14	18	20
Alternative C		3	10	2	13	11	7	6	1	8	5	16	9	19	4	17	14	12	15	20	18

	Score		Rank	
Score of Alternative A	10.4479	#	2	# Score of Alternative A = $(P_1*AR_1)+(P_2*AR_2)+\ldots\ldots\ldots\ldots+(P_{20}*AR_{20})$
Score of Alternative B	10.6146	#	1	# Score of Alternative B = $(P_1*BR_1)+(P_2*BR_2)+\ldots\ldots\ldots\ldots+(P_{20}*BR_{20})$
Score of Alternative C	10.2292	#	3	# Score of Alternative C = $(P_1*CR_1)+(P_2*CR_2)+\ldots\ldots\ldots\ldots+(P_{20}*CR_{20})$

5 Validation of Simulation Model

In order to validate the simulation model, a couple of ongoing case study project sites of governmental housing project for the poor would be chosen. The validation process of simulation model would be carried out in three stages, brief of which is as follows:

Stage 1: Preliminary Survey

A questionnaire survey would be conducted amongst the beneficiaries of the projects to find out:

- the degree of impact of the listed 20 factors in the respective project;

- the factors having strong presence and hardly require any attention; and
- The factors having very weak presence, for which attention is needed to be given to improve the efficiency of the project as far as community participation is concerned.

The survey would also reveal that there might be some factors having nil or negligible impact on the respective project. The factors found to have weak presence are required to be taken care by putting them higher in the priority list of factors in order to make implementation process of the respective project efficient with effective participation of community.

Stage 2: Ranking of alternatives through application of Simulation Model
Various permutation of *n* number of weak factors with different relative rankings (rank 1 to rank *n*) would be prepared, and total number of alternatives would be $n! = n * \ldots\ldots * 3 * 2 * 1 =$ say x. Now, the scores of x number of alternatives would be generated through the simulation model and ranking of alternatives from 1 to x is to be worked out, from higher to lower score, alternative with highest score meaning the most efficient alternative to be adopted.

Stage 3: Validation through second survey
A second survey would be conducted at the case study projects amongst randomly chosen set of beneficiaries, preferably a different set, as far as possible, from the respondents of preliminary survey at stage 1, regarding acceptance of best suitable alternatives for the particular project. In the survey, the respondents would be requested to choose best five alternatives as per their individual perception and rank them from 1 to 5 out of x number of alternatives; the best alternative is to be given 5 marks and the fifth best to be given 1. After adding up the marks obtained by each alternative, the ranking of alternatives as per second survey can be prepared with alternative obtaining highest marks to be the most preferred alternative and lowest marks as the least preferred one. This ranking, which would envisage out of the perception of the beneficiaries through the second survey, would then be compared with the raking of alternatives finalised through scores generated by simulation model in stage 2.

6 Conclusion

The simulation model helps in following manner:

Formulation of Housing Project for a location – In case of formulation of a housing project for the poor with people's participation for a particular location under a particular governmental program, strong points and weak points with respect to the identified 20 factors can be accessed through initial survey in form of feedback from prospective beneficiaries and other stakeholders etc. For example, it may be found that factors like awareness, values and beliefs, economic status, etc. are very strongly present at the proposed location of the housing project whereas factors like Qualities of Agency Personnel, Legal Factors etc. are very weak there. Few factors may be found to have negligible impact for a project at a particular location. In that case, while formulating the scheme at that location, factors which are strongly prevalent may not be given more weightage whereas weak factors can be given more importance so as to improve those factors to make the scheme more viable. According to the survey findings, a rough ranking of factors having strong or weak presence can be done, 1 being the factor to be given the most attention. With combination of such rankings of factors, one score can be generated through the simulation model. Now, different alternative combinations can be worked out by changing the relative rankings of the factors and the Model would generate different scores for such different alternatives. Finally, the alternative with highest score can be chosen, which would finally prescribe the most preferred rankings of factors to make the particular alternative the most efficient one from the angle of community participation for the project to be implemented for that particular location.

Formulation of Governmental Housing Program for the Poor - While formulating guidelines at Government level, both at National as well as State Government levels, the Simulation Model can be applied to incorporate proper relative weightages in terms of rankings of the identified factors to incorporate the same suitably in the guidelines.

Reference

[1] Alonso, Lamata (2006). Consistency in The Analytic Hierarchy Process: A New Approach. International Journal of Uncertainty., 14(4). 445−459, 2006.

[2] Brunnelli, M. (2015). Introduction to the Analytic Hierarchy Process, Springer.

[3] Chapter 28 Housing, paradox on Indian economic growth,http://mospi.nic.in/sites/default/files/Statistical_year_book_india_chapters/HOUSING%20-

%20WRITEUP.pdf, accessed 15th December., 353-357, 2015.

[4] Gaikwad, V et al. Decision making using the analytic hierarchy process (AHP), Department of Mechanical Engg. Konkan Gyanpeeth College of Engineering, Karjat.

[5] Ghosh, R and Bandyopadhyay, A (2018), Community Participation in Housing - understanding the concept through case studies, Shelter (ISSN 2347-4912)HUDCO Ltd., **19(2)**, 90-99, 2018.

[6] Housing, Household Amenities and Assets - Key Results from Census 2011, Office of Registrar General of India, Ministry of Home Affairs.

[7] Istanbul Declaration on Human Settlements, http://www.un.org/ga/Istanbul+5/declaration.htm, accessed 10th February 2013.

[8] Lotfi, F.H et al. (2013) An improved method for ranking alternatives in multiple criteria decision analysis, Applied Mathematical Modelling,January 2013., **37(1–2)**, 25-33, 2013.

[9] MoHUPA (2007). National Urban Housing and Habitat Policy 2007, Ministry of Housing & Urban Poverty Alleviation, Govt. of India, New Delhi.

[10] Mu, Enrique and Pereyra-Rojas, Milagros (2017), Practical Decision Making: An Introduction to the Analytic Hierarchy Process (AHP) using Super Decisions v2., **2**,12-15, 2017.

[11] Report of The Technician Group on Urban Housing Shortage (TG-12) 2012-17, National Buildings Organization, Ministry of Housing & Urban Poverty Alleviation.

[12] Saaty, T.L. (1980). The Analytic Hierarchy Process, New York: McGraw-Hill.

[13] Simulation Tutorial – Models, https://www.solver.com/simulation-models, accessed 28th August 2018

[14] State of Housing in India – A Statistical Compendium (2013), Government of India, Ministry of Housing and Urban Poverty Alleviation, National Building Organization.

[15] The Istanbul Declaration on Human Settlements, Population and Development Review.,**22(3)**, 591-594, 1996.

[16] Triantaphyllou, E and Mann, S.H. (1995) Using the Analytic Hierarchy Process for Decision Making in Engineering Applications: Some Challenges, Inter'l Journal of Industrial Engineering: Applications and Practice.,**2(1)**, 35-44, 1995.

[17] United Nations (1996), Report of the United Nations Conference on Human Settlement (Habitat II) (Istanbul, 3-14 June 1996).

[18] United Nations, UN (1996) Istanbul Declaration on Human Settlements Documentation. UN.

Ritabrata Ghosh is a Ph. D. scholar in the Department of Architecture, Town and Regional Planning at Indian Institute of Engineering Science and Technology, Shibpur, India. His areas of interest are Housing, Housing for the Poor, Urban Planning, Regional Planning, Sustainable Planning etc. He holds the degrees of Bachelor in Architecture, Master in Town & Regional Planning, Post Graduate Diploma in Human Resource Management.

Aditya Bandyopadhyay received the Ph. D. Degree in Architecture, Town and Regional Planning at Indian Institute of Engineering Science and Technology, Shibpur, India. His research interests are Urban Planning Models, Regional Planning Models, Urban Planning, Regional Planning, Sustainable Planning, Housing, Historical aspects of Architecture, Theoretical aspects of Architecture. He has published research articles in reputed international journals.