Multi-Attribute Evaluation Methodology for Selection of Emerging Housing Technologies

सत्यमेव जयते

Ministry of Housing & Urban Poverty Alleviation
Government of India

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M. VENKAIAH NAIDU
Minister of Housing and Urban Poverty Alleviation,
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Message

With the aim of providing shelter to all by the 75th years of Independence, the Ministry of Housing and Urban Poverty Alleviation has launched PMAY "Housing for All" (Urban) Mission on 25th June, 2015. Based on the estimated shortage of houses about 2 crore houses are required to be constructed in seven year period. To achieve this goal, a multi-pronged approach is necessary including use of emerging alternate building materials and technologies.

Over dependence on the conventional building materials and technologies may not serve the cause of the mission due to shortage of materials, need for energy saving in manufacturing and use as well as the need for bringing speed and quality in construction. For selection of new technologies, a number of factors such as structural safety, environment-friendliness, functional utility, cost effectiveness etc., are required to be addressed.

I appreciate that the Building Materials & Technology Promotion Council under the guidance of Housing for All Mission Directorate has developed a Multi-Attribute Evaluation Criteria for Selection of Emerging Technologies. I have been told that BMTPC has consulted many experts. Mission Directorate has also circulated this document to the States and their comments have been duly factored in for enhancing the acceptability of this document.

This document, I hope, would be useful in evaluation and selection of alternate technologies by BMTPC and State government agencies for deployment in future mass housing projects in the country.

(M. Venkaiah Naidu)

BABUL SUPRIYO
Minister of State for Housing & Urban Poverty Alleviation
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Message

Use of Alternate emerging building materials and construction practices for construction of houses / building are inevitable in present scenario in the country. There is environmental threat in using energy intensive manufacturing process of conventional building materials. This need has further increased with the massive requirements of construction of about 2 crore houses under the recently launched PMAY "Housing for All" mission by the Ministry of Housing & Urban Poverty Alleviation.

A number of technologies, developed both, within the country and abroad are being considered for possible uses in mass housing projects in the country. A technology, however, cannot be simply selected, unless, it is studied in detail for their performance, adaptability to Indian conditions, cost effectiveness, etc.

Building Materials and Technology Promotion Council, in its endeavor to identify and promote emerging technologies has been doing excellent work by identifying and evaluating new technologies.

This Multi-attribute criteria developed by BMTPC for evaluation and selection of alternate technologies, addressing various factors essential for proper selection of any technology, is a good initiative by the Council to guide housing agencies.

I would like to appreciate the efforts being made by BMTPC in taking such initiatives.

(Babul Supriyo)

सत्यमेव जयते

DR. NANDITA CHATTERJEE
Secretary
Ministry of Housing & Urban Poverty Alleviation
Government of India

Message

The launch of the PMAY/ "Housing for All" (Urban) mission by the Ministry of Housing and Urban Poverty Alleviation, Government of India on 25th June, 2015, has led to an intensified need for use of new alternate building materials & construction technologies. Under the Mission, a Technology Sub-Mission has been set up to facilitate adoption of modern, innovative, green technologies and building materials for faster and quality construction.

Conventional construction practices of using burnt clay bricks and RCC have so far served the industry but with the increasing shortages of basic building materials, depleting natural resources, threat to environment by energy intensive manufacturing practices as well as shortage of manpower in urban areas, it is imperative to look for new alternate building materials and technologies.

BMTPC has been studying and evaluating technologies from all over the world for their possible use in Indian conditions. Any new materials and technologies must, however, fulfill certain requirements for their suitability in Indian conditions. Realizing this, Housing for All (Urban) Mission Directorate and BMTPC have developed a Multi-Attribute Evaluation Criteria, which include mandatory attributes as well as desirable attributes to serve ass a guide to all stake holders involved in mass housing projects.

The efforts in developing this "Multi-Attribute Criteria" for selection of emerging technologies is appreciated. It is hoped that this documentation will bring objectivity in technical appraisal and selection of the alternate technologies for mass housing.

(N Chatterjee)

Place: New Delhi
Dated: September 28, 2015

SANJEEV KUMAR
Joint Secretary & Mission Director (Housing for All)
Ministry of Housing & Urban Poverty Alleviation
Government of India

Foreword

PMAY "Housing for All" mission has been launched by the Ministry of Housing and Urban Poverty Alleviation on the 25th June, 2015. The mission inter-alia, envisages adoption of modern, innovative and green technologies and building materials for faster and quality construction.

A number of new technologies are being studied by Building Materials & Technology Promotion Council (BMTPC), under Performance Appraisal Certification Scheme (PACS) for their possible use in mass housing programme. Some of these technologies have been developed and are successfully being used in other countries and are trying to enter Indian construction industry.

Any technology used must, however, be structurally safe under Indian hazard and geoclimatic conditions, be durable, fulfill the functional need of the occupants and should also be economically viable for the project.

Use of conventional building materials are backed by provisions in relevant Indian Standard Specifications & Codes and National Building Code (NBC) of India. Alternate materials, method of design and construction not prescribed by the Codes, are also permitted by NBC, provided they are found to be satisfactory and conforming to relevant provisions of NBC.

BMTPC, in consultation with "Housing for All" mission Directorate, has developed this Multi – Attributes Evaluation Criteria with other experts and professionals in the field. I would especially like to acknowledge the contributions from the RICS School of Built Environment, Amity University represented by Dr. Anil Sawhney, Associate Dean, Director and Professor of Construction, Shri V.P.S Nihar, Assistant Professor and Ms. Ridha Basu, Research Associate and Shri J.K.Prasad, Chief – BM, BMTPC. The initial draft was deliberated in Technology Advisory Group meeting comprising Dr. Shailesh Kumar Agrawal, Executive Director, BMTPC; Shri Jose Kurian, Chief Engineer, Delhi Tourism & Transport Development Corporation; Shri P.R.Mehta, Consultant (Architect); Shri Rajesh Goel, CMD, HPL and other professionals from IIT, Delhi and L&T.

It includes mandatory and desirable attributes to be considered for selection of alternate technologies. Criteria was circulated to States and UTs for their views / comments. There is general agreement on the content of the document by the states.

It is hoped that this document will serve as a useful tool for performance appraisal of emerging technologies under PACS by BMTPC and for all state agencies in selecting emerging technologies for their future projects in an objective manner.

I sincerely appreciate the efforts made by BMTPC in streamlining the process of use of new emerging technologies in government projects.

(Sanjeev Kumar)

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Introduction

Providing decent all weather shelter to all the citizen is a major challenge of the country. Government of India has on 25 June, 2015 launched the "Housing for All" (Urban) mission in order to assist States/UTs in achieving the goal of Housing for All. The estimated number of dwelling units to be built is about 2 crore. This massive task requires a multi-pronged approach including introduction of innovative, cost effective, environment friendly, fast track building materials and technologies.

In recent years, enormous advancement in construction technologies, from traditional site-based methods to a more dynamic combination of methods, has brought upon new possibilities of residential construction. A large number of innovative buildings and cost effective construction technologies have been developed world over through intensive research and development efforts and have been put to use for construction of housing stocks. Policy makers in India are also required to study these new technologies and construction systems for taking a decision on their deployment in their work area.

In theory, these innovative techniques and materials may satisfy functional requirements as well as specification of conventional materials and techniques. It is, however, required to study the technologies in detail with respect to their structural and functional performance in Indian conditions and also their suitability for specific region.

Conventional building materials and construction technologies are generally backed by Indian Standards and National Building Code (NBC) of India. For alternate materials, methods of design and construction, not prescribed by any Indian Standard Code, NBC has provision to allow their use, provided such alternatives are found to be, satisfactory and conforms to the provisions of relevant provisions of the NBC regarding materials, design and construction.

This implies that any technology identified must satisfy mandatory requirements of structural safety, durability, fire safety, weather resistance, thermal behavior, water tightness and acoustic, to allow its use. The selection of the most appropriate among emerging technologies fulfilling the mandatory requirements is, however, a complex process and depends upon many other factors like cost and time certainty, performance during life cycle, design flexibility, requirement of machineries, height restriction, energy requirements, etc.

Building Materials & Technology Promotion Council (BMTPC) has been identifying and evaluating new materials and construction technologies, not covered by any Indian Standard under Performance Appraisal Certification Scheme (PACS). PACS generally addresses mandatory requirements. During the process of appraisal under PACS, it is realized that it will be convenient if all the criteria are listed at one place to avoid referring to different sections of NBC to know these requirements.

Realizing the above, it was felt necessary to develop a multi-attribute evaluation methodology for selection of alternate emerging technologies, giving both mandatory criteria and other desirable criteria. The multi-attribute criteria given in this document has been prepared in active consultation with experts in this field.

The document was also circulated to all the States and UTs for comments. There is general agreement about the various criteria mentioned in the document for selection of emerging technology by the State Governments. It is also being considered by the Technical Committee of Bureau of Indian Standards for suitable inclusion in National Building Code (NBC).

Any technology, for acceptance under PACS or otherwise, is required to fulfill mandatory criteria. The other desirable criteria may be considered for taking appropriate decision regarding use of emerging technology by the State construction agency, based on the specific requirements for any region or project. These mandatory and desirable criteria should be studied and adapted by implementing agencies to suit their needs.

1 Mandatory Attributes (PA[1])

1.1 Strength and Stability Requirements (SA[2])

Definition: The structural adequacy of a housing technology, in terms of strength and stability, is an important attribute in the selection of the technology. The system used for construction should be capable of withstanding the design loads calculated as per Indian Standards (IS). Following tertiary attributes are used to make a determination for this mandatory secondary attribute.

1.1.1 Stability against Vertical Loads (TA[3])

Definition: The ability of a structure to maintain its integrity without failure, both in during construction phase and post construction phase, when placed under vertical loads calculated as per IS Codes. Loads which are to be considered for checking the load bearing strength of the system can be of two types:

- Dead Load (DL): Calculated as per IS 875 (Part 1) or whatever as applicable
- Imposed Load (IL): Calculated as per IS 875 (Part 2) or whatever as applicable
- In order to ensure optimal structural stability, the response of the system is also to be checked for combination of DL and IL (i.e. DL+IL) as described in Clause 8.1 of IS 875 Part 5

1.1.2 Stability against Lateral Forces (TA)

Definition: Ability of the structure to sustain its function namely safety and serviceability against earthquake and wind forces. Structure should be designed for earthquake exposure and wind forces both in during construction and post construction phases.

- The Earthquake Load/seismic load (EL) is to be calculated as per IS 1893 (Part 1) 2002.
- Wind Load (WL) is to be calculated as per IS 875 (Part 3)
- As per IS 875 Part -5, the response of the system is to be checked for:
  - DL+IL+WL
  - DL+IL+EL

1.1.3 Performance of Joints (TA)

Definition: It refers to the finished quality and serviceability of joints and connections of building elements. For example, beam-column junctions, connectivity between precast members and cast in situ members, connections between sub-structure and super-structure, and host elements such as doors and windows.

- Assess joint stability – probability of rupturing, losing equilibrium etc.
- Assess performance of joints

1.2 Performance and Statutory Compliance (SA)

Definition: The proposed system has to be checked for overall performance and compliance against statutory provisions prevalent at the time and location of application. Following tertiary attributes are

[1] PA is Primary Attribute in the Evaluation Framework
[2] SA is Secondary Attribute in the Evaluation Framework
[3] TA is Tertiary Attribute in the Evaluation Framework

used to make a determination for this mandatory secondary attribute.

1.2.1 Violation of statutory provisions (TA)

Definition: Compliance of the building system and technology with all the statutory regulations at national, state and local level as applicable (if any) such as MOEF, Bye-laws etc.

- Declaration should be given by the technology providers stating that the system shall not violate any statutory provisions applicable.

1.3 Fire Resistance (TA)

Definition: It refers to property of building elements to satisfy for a stated period, resistance to collapse, resistance to penetration of flame and hot gases, resistance to temperature rise when subjected to fire. Performance of the system against fire is to be checked in the following aspects.

- Compliance with IS 3809:2002
- Fire rating as per the current National Building Code (NBC)

1.4 Thermal Comfort (TA)

Definition: It is measured by the thermal resistance offered by the technology, i.e. the heat flow through a building that depends on the temperature difference, the conductivity and the thickness of the elements. Thermal comfort offered by any system can be assessed by:

- Comparing the thermal transmittance loss of the system with that of traditional construction
- Compliance with IS 3792:1978

1.5 Acoustic Performance (TA)

Definition: Acoustic performance refers to the reduction or elimination of external noise or decrease the transmission of unwanted noise in the constructed dwelling. Selected technology should restrict the reflection of sound thereby inducing privacy in the rooms of the constructed dwelling. Following are the criteria on which the acoustic performance of a system can be evaluated:

- Sound Transmission loss as per IS 1950 :1962
  - 30 dB or less – Poor
  - 40 dB – Fair
  - 45 dB – Good
  - 50 dB - very good
  - 60 dB - Excellent
- Compliance with MOEF norms: 55 dB at day time and 45 dB at night time
- Compliance with IS 1950: 1962: 65-80 dB for heavy traffic area and 60-70 dB for other areas

1.6 Weather-Resistance (TA)

Definition: Weather-tightness of a building is the resistance of a building to the weather conditions both prevalent and extreme. An emerging technology should by its design and through its construction detailing provide for 'Deflection'; 'Drainage'; 'Drying'; and 'Durability' conditions of the building. Weather-tightness attribute allows the building to be evaluated against weather elements of heat, wind,

dust, rain, and snow as applicable. Following criteria is to be considered for evaluation:

- Qualitatively, is the proposed technology is comparable or more effective against weather conditions, when compared with traditional system?

1.7 Water Tightness (TA)

Definition: It refers to the overall water tightness of the building system both externally and internally, especially along in the sunken portions and along the joints (and connections) between components. This ensures resistance of the building technology against leakage in a variety of prevalent weather and climatic conditions. Following aspects should be checked in waterproofing.

- Requirement of additional waterproofing.
- Effectiveness of waterproofing.
- Chances of fungal growth or contaminants on building elements.

2 Preferred and Desired Attributes for Evaluation of Emerging Housing Technologies (PA)

2.1 Functional Requirements (SA)

Definition: Secondary desirable attribute for assessing the technology or system against generally accepted functional requirements of housing.

2.1.1 Design Flexibility (TA)

Definition: Design flexibility is defined as the ability of the technology to reconfigure the design of the houses as per the requirements with an understanding of possibility of changes as per the functional uses. In simpler terms, it is the ability of a building system to adjust and adapt to changes during the design, construction, and use phases with minimum disruption in process and with minimum cost impact.

The design flexibility should be checked in two following aspects:

- Degree of difficulty in incorporating changes during construction phase
- Provisions for post-construction expandability

2.1.2 Restriction on Number of Floors (TA)

Definition: It indicates the height restriction for construction due to structural safety and stability issues or construction process related issues. This attribute determines any restriction on the maximum number of floors (storeys) that can be constructed using the system.

- Limitation on number of floors that can be constructed using the technology under consideration.

2.1.3 Service Life and Durability (TA)

Definition: Service life and durability is about end users' realistic expectations that, subject to less maintenance, a building technology will last for a specified number of years. It also deals with the susceptibility of the technology to different environmental conditions. As it is quite difficult to get data about the average service life of all the systems, especially because many of them are

newly introduced, durability can be judged by considering the following parameters:

- Suitability/Limitations for using in all environmental conditions
- Performance under accelerated environment test
- Expected service life of the system with respect to conventional system

2.1.4 End-user-friendliness (TA)

Definition: It is defined as the ability of the system to meet the specific requirements of the end users. End-user-friendliness indicates the customer satisfaction and also suitability of the system for building Indian houses across regions and states. It includes criteria cultural and social criteria such as "nailability", provision for adding fixtures like coolers, air conditioners, etc. Following criteria is to be considered for evaluation:

- Suitability of the constructed building for adopting changes after construction by the occupant.

2.2 Constructability (SA)

Definition: Constructability, similar to design for manufacture and assembly, is defined as the relative ease of construction given a selected building design. It is the extent to which a building design with a chosen technology provides for ease of construction while meeting the overall requirements of the building. Using the construction expertise, during the design phase, steps are taken to optimize parameters like build-ability, cost effectiveness, resource efficiency, time schedule, quality, safety and overall project goals.

2.2.1 Simplicity in Execution and Versatility (TA)

Definition: Steps required during construction and complexity of the process required for the building technology defines simplicity in execution and versatility during construction. With a view to increase productivity and efficiency of the overall system, it is desirable that the method of execution should be simple, otherwise extensive training and retraining of labour, increased requirement of skilled labour and delays due to system complexity might affect both construction cost and time. Following criteria are to be checked for this attribute:

- No of components for the assembly.
- Ease of construction (such as fixing reinforcements, placing of concrete, fixing building services, assembly and erection procedures, etc.).
- Provision for using any particular element of the system to serve different functional requirements.

2.2.2 Design Compatibility (TA)

Definition: Compatibility with architectural design or architectural design flexibility allowing expression of form, function and aesthetics in design evolution. Following is the criteria for evaluation:

- Ability to make curved surfaces (e.g. curved walls, domes, arches)
- Concealed piping electrical and plumbing services and provision for incorporating the mechanical, electrical and plumbing services within the proposed building component thickness
- Ability to make sunken floors

- Suitability for wet areas
- Ability to make sunshades and other appurtenances required for a typical house in the regional context

2.2.3 Foundation Type (TA)

Definition: This attribute captures the type of foundations required for erecting the building with the selected technology. Following criteria are to be evaluated for this aspect:

- Requirement of shallow or deep foundation for erecting the technology.
- Requirement of Heavy or light foundation for erecting the technology.

2.2.4 Skilled Labour (TA)

Definition: It refers to projection and identification of trained work force required for adopting housing technology for construction. Following criteria are to be considered for this attribute:

- Type of labour required (such as skilled/ semiskilled/ unskilled)
- Level of training required

2.2.5 Equipment (TA)

Definition: It refers to identification of appropriate equipment related to each stage of construction such as hoist, batching plant, cranes, and any other specialized equipment while adopting a particular technology. Following criteria should be checked for equipment:

- Type of Equipment required, such as heavy/light or standard/specialized.
- Requirement of manufacturing plant and if it is required then, whether is it centralized or on-site?

2.2.6 Construction Safety (TA)

Definition: Safety deals with the identification and elimination of hazards associated with the technology thereby resulting in zero accidents, and zero lost time injury. The performance of a system against this attribute may be evaluated by:

- Comparing the degree of risk/hazard involved in the system with that of conventional construction method.

2.2.7 Temporary Services Requirement (TA)

Definition: It refers to the requirement of temporary services for the implementation of the housing technology i.e. mainly the requirement of water, power & other services during construction phase. The performance of a system against this attribute may be evaluated by:

- Requirement of initial power for implementing the technology
- Requirement of water for implementing the technology

2.3 Economic Viability (SA)

Definition: Economic viability of a chosen technology is its economic competitiveness in the present market conditions and business environment. The technology under consideration must be economically

viable for all the stakeholders.

2.3.1 Initial Cost (TA)

Definition: It pertains to the overall cost of construction involved in labour, materials, plant and machinery and overheads. For evaluating the systems on this attribute, the Capital Costs are to be compared with that of conventional system.

2.3.2 Speed of Construction (TA)

Definition: Speed of construction is linked to the time taken to complete all construction steps and processes for a given technology. Time savings during construction is significant to all stakeholders, therefore, the following criteria needs to be considered for assessing the attribute:

- Evaluating the speed of construction in comparison with traditional construction.

2.3.3 Economies of Scale TA)

Definition: This attribute deals with the Economic feasibility of adoption of housing technology for constructing any number of dwellings so that the component of fixed cost is least variant with the number of dwellings. Following criteria is to be checked for this attribute:

- Minimum number of dwellings to be constructed using the technology.

2.3.4 Lead Time (TA)

Definition: Lead time is the latency (delay) between the initiation and execution in adopting the technology for construction of dwellings. Following criteria is to be considered for evaluating the attribute:

- The lead time involved for the technology in comparison with that of conventional system.

2.3.5 Efficiency of Design (TA)

Definition: Land being a scarce resource calls for a need to optimize the utilization of spaces. While evaluating emerging construction technologies, space savings and land utilization also becomes an important factor to consider as availability of space is also a constraint for modern construction. The optimal use of space can be measured by taking into account the following consideration:

- The efficiency of design which is given as the ratio of the built-up-area to carpet area.

2.3.6 Supply Chain Reliability (TA)

Definition: Construction projects typically involve series of inter-related activities in which successful completion of any particular activity is dependent upon that of its predecessor activities. Thus the failure of even one supplier may lead into the collapse of the entire system. It is always preferable that while selecting suppliers for any housing technology, practitioners should always look for only highly reliable organizations (HROs) in order to ensure delivery of most suitable technologies at the most suitable prices and in the right time. Following consideration is to be assessed for evaluating the attribute:

- The availability of reliable suppliers for a particular construction technology in the very initial stage.

2.3.7 Technology Transfer Possibility (TA)

Definition: This attribute pertains to dissemination of technical know-how, skills, resources and production techniques of adopted housing technology from its origin to broader sphere of use. Following criteria is be used for evaluation of this attribute:

- The possibility of producing the adopted technology in India using local resources.

2.4 Maintenance (SA)

Definition: This attribute deals with the ease with which the regular and periodic maintenance can happen for the adopted technology so as to attain the maximum life
period of the constructed building.

2.4.1 Maintenance Cost

Definition: It refers to the life cycle cost of the system which includes the recurring cost of maintenance as well as the replacement cost at the end of the service life of the system. The following costs are to be compared with that of conventional system:

- Cost for periodic maintenance of the system
- Replacement cost at the end of the service life of the system.

2.4.2 Frequency of Maintenance (TA)

Definition: It refers to the interval between two successive maintenances, such as regular or occasional required for the adopted technology. Following criteria is to be considered for assessment:

- Requirement of regular or occasional maintenance and corresponding time interval

2.4.3 Type of Maintenance (TA)

Definition: It refers to the severity of maintenance activities needed for the adopted technology. Following criteria is to be considered for evaluation:

- Requirement for major or routine maintenance.

2.4.4 Ease of Maintenance (TA)

Definition: It refers to the degree of difficulty involved in carrying out maintenance works for the adopted technology. Following considerations are to be used for assessment:

- Availability of workmen needed for maintenance works.
- Availability of tools and technologies needed.
- Availability of materials needed etc.

2.5 Sustainability (SA)

Definition: Sustainability ensures a better and more sustainable future for the human race and the planet earth at large. It includes those technologies that use less virgin material, less energy, cause less pollution and less waste without compromising on the project's economic viability and the comfort, safety and other requirements of its occupants.

Fig: Balancing Parameters of Sustainable Construction

It is desirable that while evaluating several housing technologies in order to select the most appropriate one, following aspects of sustainable construction practices should also be taken into consideration:

2.5.1 Eco-friendly Construction (TA)

Definition: It has been seen that building construction often affects the surrounding environment and its natural resources in a negative way. The term eco-friendly construction refers to those construction technologies which are conducive to the principles of sustainable development in terms of use of local and renewable materials, energy efficiency, less emission of hazardous materials and pollutants etc.

Following criteria should be considered for evaluating eco-friendliness of construction technology:

- Use of local materials as otherwise the required transportation causes pollution and consumption of fuel which in turn is a scarce resource in present-day context.
- Use of Non-renewable resources in production.
- Use of waste products.
- Recyclability of material.
- Waste generation and utilization of waste generated.
- Emission of pollutants/ hazardous materials.

2.5.2 Embodied Energy (TA)

Definition: It refers to the total non-renewable energy consumption in acquisition of raw materials, their processing, manufacturing, transportation to adoption of housing technology. It

is an indicative of the building technology's overall impact in the environmental context. Selection of technology and procedure of construction should be done in such a way so as to create a proper balance between climatic conditions, material availability, transportation cost etc.

- However in absence of appropriate data, the exact embodied energy for any system may be judged subjectively.

2.6 Finish Quality (SA)

Definition: Choice of methods and materials greatly affect the workmanship quality and thus the ultimately the finish quality of construction. So while evaluating the technologies of construction, one shall take into account the desired quality of finishes also. Finish quality includes bulging and waving of surfaces, hollowness, surface cracking, thick plastering requirements etc. Broadly the different aspects of finish quality are classified into:

2.6.1 Exterior Finish Quality (TA)

Definition: It refers to the finish quality of exterior surfaces (both horizontal and vertical) including exposed concrete surface, masonry, glazing and claddings, different types of sidings, brick exteriors and stuccos etc. obtained using the adoption of housing technology. The term exterior finish quality deals with issues like surface cracking, spalling, bulging and waving of exterior surfaces, hollowing, dampness, and other anomalies etc. Following criteria are to be used to evaluate the attribute:

- Quality of finish obtained in terms of high, medium, low.
- Requirement of finishes.
- Compatibility with surface finishes such as putty, paint etc.

2.6.2 Interior Finish Quality (TA)

Definition: It refers to the finish quality of interior surfaces (both horizontal and vertical) obtained using the adoption of housing technology. The term interior finish quality deals with issues like surface cracking, bulging and waving of interior surfaces, hollowing, dampness, and other anomalies etc. Following considerations are to be used to evaluate the attribute:

- Quality of finish obtained in terms of high, medium, low.
- Requirement of finishes.
- Compatibility with surface finishes such as putty, paint etc

3 Summary & Conclusions

The key outcome of this work is an efficient and yet "easy-to- implement" set of attributes which will also serve as a Decision Support System (DSS) for the emerging technologies of housing. This set of identified and defined attributes will aid the concerned agencies to select the most appropriate technologies for residential building construction from the perspective of affordability and sustainability.

Appendix A

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Appendix B

List of Attributes for Evaluating Emerging Housing Technologies

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