A Multi-Dimensional Subcontractor Evaluation Framework for Nonconventional Housing Systems

Riddha Basu*, VPS Nihar Nanyam, Anil Sawhney

RICs School of Built Environment, Amity University, Sector 126, Noida, India
Department of Built Environment, Liverpool John Moores University, Liverpool, UK

Abstract

For any building construction project, it is crucial at the outset to select an appropriate subcontractor to achieve the objectives in terms of affordability and quality. But selection of a competent subcontractor becomes even more important when it comes to housing-construction with non-conventional materials and technologies, as their implementation requires unique skills and proficiencies. In the first phase of this research, the subcontractor selection attributes were identified. Apart from literature review, divergent stakeholders of Indian real-estate value-chain were also surveyed for identification of subcontractor selection attributes. While some of the identified attributes are generic, others are specific towards selection of subcontractors for building construction with new materials and technologies. However, the identified attributes can be broadly classified into five categories: “technical experience”, “financial competency”, “resource adequacy”, “job quality and safety” and “local and other factors”. In the next phase of the research, a multidimensional framework was developed using Analytical Hierarchy Process (AHP) for evaluation of subcontractors based on the identified attributes. The developed framework can also be used as a decision making protocol for selection of subcontractors for non-conventional building construction. The developed framework was validated by implementing it for subcontractor selection in a residential project site where emerging construction technologies were being implemented.

Keywords: analytical-hierarchy-process; emerging-housing-technologies; multi-dimensional-evaluation-framework; subcontractor-selection;
constructed in urban India [1]. By 2022, the need for urban housing units will further increase by 26 to 29 million [2]. Evidently, provision of houses to urban population has become both a great opportunity and a critical challenge in India. But Indian housing value chain is quite complex. Over the last few decades, housing construction philosophy in India has changed radically. In modern Indian cities, tall buildings have supplanted individual villas and row-housings. Today, both government and private housing initiatives focus more on construction of mass housings rather than catering to individual dwelling units. To strike a balance between speed and quality, building constructors must take resort to non-conventional materials and innovative technologies (like rapid wall system, speed floor system, monolithic concrete construction with aluminum formwork, light gauge steel frame structure, modular coordination, prefab-construction etc.) as viable and cost-effective alternatives of conventional building techniques.

But unfortunately while there is no dearth in availability of alternate building systems, in India their adoption remains still low. One of the key reasons behind this is the risk of failure associated with the implementation of these technologies. Like all other construction projects, building construction projects are also labor intensive. About 90% of the total project value is executed by outsourcing in construction projects [3]. So the implementation of any building system (both conventional and emerging) largely depends upon the skills and efficiency of the labor involved in its implementation. So it is axiomatic that selection of an appropriate subcontractor is of utmost importance for successful completion of any building project in terms of time, cost, quality and safety. But selection of a competent subcontractor becomes even more important when it comes to implementation of innovative and alternate building systems as it involves unique skills and proficiencies. In other words, potential savings in time and cost, or the enhanced construction quality expected from the emerging/ alternate building systems can only be realized when competent subcontractors are engaged in their implementation.

However, still now in India evaluation of the subcontractors (especially labor contractors) is done in a subjective and rather intuitive way. In many organizations the work contract is awarded primarily based upon the financial quotation of the subcontractor. Other factors like technical experience, adequacy of resources required or the quality of work that the subcontractor is capable of rendering, are often not taken into account or given very less importance in the time of decision making. Consequently many projects fail to realize the fullest benefit of the building construction systems they adopt. Driven by the motive of rationalizing subcontractor-selection-process for non-conventional building systems, this research work aims at developing a holistic framework for evaluation of building subcontractors.

2. Literature Review

Researchers across the globe have extensively worked on rationalizing the evaluation and selection procedure of subcontractors. Almost all the previous researchers have tried to capture the dynamics in subcontractor selection process by identifying the factors that should be taken into account for evaluation of subcontractors. Marzouk et. al. identified forty attributes that should be considered for selection of suppliers and subcontractors [4]. They categorised these attributes in ten principal factors: time, cost, quality, safety, tender, dispute and risk, insurance, repair and warranty for employees and equipment, experience of the company, staff’s behaviour and experience and others (like site proximity, ongoing work commitment, relationship with client etc.). In a study conducted in Singapore, Hartmann et al. found that out of the four major factors of subcontractor selection, namely price, technical knowhow, quality and cooperation, the most important factor is price. But it is usually accepted that both price and quality should be taken into account for selection of subcontractors [5]. Based upon these attributes, many researchers have already developed quantitative decision support systems for increasing the objectivity in the subcontractor selection process. To name a few, Fong and Choi developed a model using the Analytical Hierarchy Process (AHP) with a view to establish a trade-off between time, cost and quality while selecting the subcontractors [6]. Yin et al. applied a data envelopment analysis for the evaluation of subcontractors [7]. Abbasianjahromi et al. developed a model which calculates a parameter called FPSI (Fuzzy Preference Selection Index) for selection of subcontractors [8]. But as suggested by Lavellie et. al. the selection procedure for subcontractor’s, in terms of both the selection criteria and their weightages, varies largely with the project dynamics [9]. For instance, in their study Oluwaseyi et. al. suggested that in building construction projects of Lagos state, Nigeria availability of required equipment is a major factor for
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