

State of offsite construction in India-Drivers and barriers

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Abstract. The rapid growth of the construction industry in India has influenced key players in the industry to adopt alternative technologies addressing time, cost and quality. The rising demand in housing, infrastructure and other facilities have further highlighted the need for the construction industry to look at adopting alternate building technologies. Offsite construction has evolved as a panacea to dealing with the under-supply and poor quality in the current age construction industry. Several offsite techniques have been adopted by the construction sector. Although, different forms of offsite techniques have been around for a while but their uptake has been low in the Indian context. This paper presents the perceptions about offsite construction in India and highlights some of the barriers and drivers facing the Indian construction industry. The data was gathered through a survey of 17 high level managers from some of the largest stakeholder organizations of the construction sector in India. The influence of time and cost has been highlighted as a major factor fuelling the adoption of offsite construction. However, the influence of current planning systems and the need for a paradigm shift are some of the prominent barriers towards the adoption of offsite techniques.

1. Introduction

Indian economy is growing at a rapid pace and construction industry is playing a significant role in this growth through an annual investment of \$70 billion i.e. projected annual growth of 15% [1, 2]. This growth in Indian construction has led to adoption of alternative technologies such as offsite construction [3]. The problem for infrastructure and housing has been a significant challenge faced by the governments worldwide. The concept of mass production of quick and quality building is being practiced extensively all over the world. Researchers and practitioners from developed nations have already highlighted that pre-assembly has a very important role to play in the future [4]. In the UK, the offsite construction industry has grown from £2.2 billion to £6 billion from 2005 to 2007 [5]. This is a significant jump. Malaysian construction industry has adopted industrialized building systems in order to achieve the housing programme targets promised under the Seventh Malaysia plan [6]. China, the manufacturing powerhouse, is implementing offsite construction extensively [7].

As India also started taking steps towards sustainability and waste minimization, offsite construction has been drawing significant attention. In this context, the authors explored the current state of offsite construction in India and highlighted drivers and barriers to its implementation. In order to achieve this aim, a round table conference was organized with senior level executives from major stakeholder organizations from the construction sector in India. A survey was administered to

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document their opinion of the Indian construction industry key players on offsite practices and analyze the challenges influencing the adoption of offsite techniques. This paper presents the findings of that survey.

2. Literature review

Manufacturing in construction, pre-fab construction, standardization and pre-assembly, off-site construction and Modern Methods of Construction (MMC) are some of the most commonly used terminologies used in the literature to describe offsite construction. There are definition of Offsite as “the manufacture and the pre assembly of components, elements or modules before installation into the final location” [5]. Different researchers have categorised and defined offsite techniques on the basis of the type of the product being manufactured into component sub-assembly, non-volumetric pre-assembly, volumetric pre-assembly, modular systems and hybrid systems.

Table 1. Levels of offsite [5, 7].

Level	Category	Definition
1	Component manufacture & sub-assembly	Items always made in a factory and never considered for on- site production
2	Non- volumetric pre-assembly	Pre-assembled units which do not enclose usable space (e.g. timber roof trusses)
3	Volumetric pre-assembly	Pre-assembled units which enclose usable space and are typically fully factory finished internally, but do not form the buildings structure (e.g. toilet and bathroom pods)
4	Modular Systems	Pre-assembled volumetric units which also form the actual structure and fabric of the building (e.g. prison cell units or hotel/ motel rooms)
5	Hybrid system	Consists of a combination of any two or more volumetric or non-volumetric systems. (extensively used in commercial and residential buildings)

Offsite techniques adoption is influenced by the type of project and the construction application. Some of the major applications of offsite have been in the areas of public/social housing, private housing, offices, hospitals/health, retail, schools, university / research, student accommodation, factories/ warehousing, hotels/leisure, restaurants/fast food, supermarkets, defence construction. Most used systems in different countries are framing systems, volumetric modular buildings, cladding systems, bath/toilet/ kitchen pods, building services, structural insulated panels, panellized roofing systems, foundation systems, precast load bearing wall panel, load bearing wall panel, load bearing block panel, form work, precast frame, precast floor and hollow core slab, steel frame [5, 6].

There are numerous benefits from the manufacturing association in construction. Blismas. et al. has discussed the advantages of offsite techniques in terms of time, quality, cost, productivity, people/manpower and process [8]. Further they have documented major benefits as speed of construction, higher quality, lower cost, increased certainty, less wastage, greater productivity, less manpower, health and safety risks, environmental impact and simplified construction process. However, the implementation or adoption decision of offsite is influenced by factors such as location, land use, density, volume, user needs, labour and environmental conditions [4, 6].

Though there are benefits of offsite construction, the trend of offsite take-up in construction is different in different countries. Though pre fabrication is not a new technology the application, drivers and consequences are to be explored from a perception of current expertise and management practice [9]. These were investigated through various factors in the available literature. After a thorough review of the literature some of the articles were identified that presented a range of issues under drivers and barriers.

In order to investigate the drivers and barriers, studies have considered cost certainty, time certainty, on site duration minimization, high quality achievement, health and safety risk reduction, reduction in environmental impact during construction, environmental performance maximization during life cycle, restricted site specifics, addressing skills shortages, government promotion, revisions to building regulations, implementing as part of company strategy and client's influences [10]. In the context of a project, existing literature has examined the role of key players as drivers of offsite construction take-up. The key players identified are client, designer, contractor, architect, supplier and statutory authorities [6]. Offsite construction also needs to consider a long-term perspective. Economic, environmental and social contexts and perspectives influence the stature of offsite construction [7]. In the previous research the barriers were examined against a range of factors including nature of system and complexity, labour and skills, client's initiation, previous experience, legal influence and response to innovation. During this study the authors identified that skills shortage, client's influence and promotion were added to the list of factors influencing the adoption offsite construction and were included in the survey presented to the participants. In the previous studies cultural shift is noticed as a challenge to orient people towards offsite construction in developing economies [7]. This can be further dealt with attitude, education and motivation.

The above discussed factors were noticed in most of the past research. Recent studies have also stated that these factors can be contextualized for other countries [7]. Hence the current paper considered the existing literature to formulate questions that investigate drivers and barriers to offsite construction in India.

3. Methodology

The first step towards any advance study in building systems and technology should be initiated by knowing the current status [6]. In order to achieve the aim, a round table conference was organized in New Delhi, India in November 2011. The conference participants included 17 senior level executives who are influential key players in public and private sectors in India. A survey was administered to draw the opinion of the representatives on offsite construction practices and analyze the challenges that can influence the adoption of offsite techniques. The questionnaire was structured based upon the review of literature available for similar studies in other countries and presented earlier in the literature review section. In order to collect data, six questions were formulated that were intended to provide the current sector view of offsite construction in India. The six questions covered the main areas of offsite construction in India, types of offsite systems in practice, advantages, drivers and barriers to the adoption of these techniques in construction along with respondent information. On a 5 point scale participants were asked to rate 11, 12 and 30 factors addressing advantages, drivers and barriers respectively [strongly disagree (-2), disagree (-1), can't say(0), agree(1) and strongly agree(2)]. The findings of the survey are presented below.

4. Survey findings

The survey was administered to 17 participants. This survey results show the existing status of offsite construction practices in India.

According to the respondent information, out of 17 representatives, 10 are working in the field of offsite construction, 1 is currently not practicing any offsite technique and 5 did not answer. Participants were asked to identify the main areas of offsite construction in India. Amongst all, Public /social housing was identified as most potential area by 11 respondents along with factories/ warehousing (10 respondents). Restaurants, hotels/leisure, and other public projects have been identified as the least potential areas (2 respondents) (Figure1).

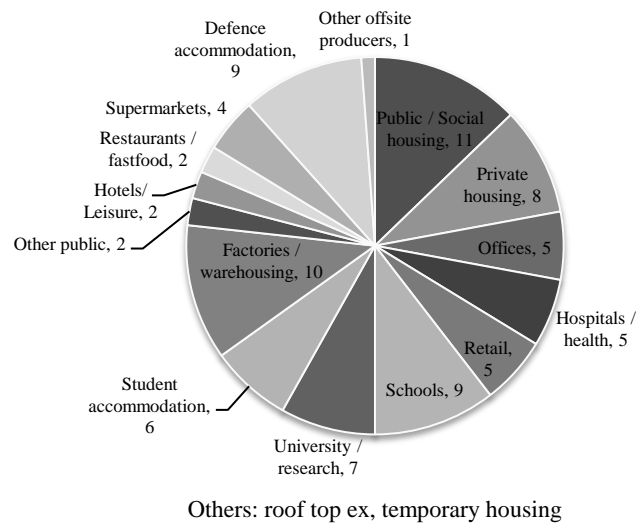


Figure 1. Main areas of offsite construction in India.

Framing systems is the most used type of offsite system among the participants, and a volumetric modular building is rarely considered. Formwork and cladding systems were also selected by 9 and 8 participants respectively (Figure 2). One reason could be the relative ease of transportation of these non-volumetric systems on Indian roads. For transporting volumetric and modular buildings better road network and heavier cranes are needed on the construction site. This is not always possible under Indian conditions, especially if the construction site has to be accessed or is in the neighbourhood of heavily built-up area.

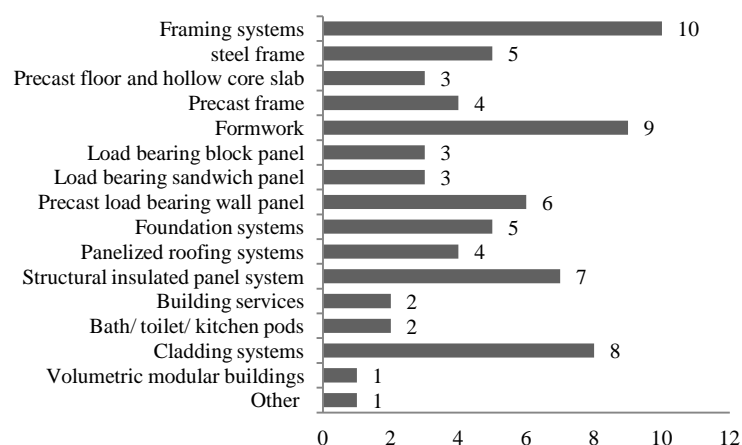


Figure 2. Types of offsite systems used in India.

The biggest advantage of offsite construction is considered to be the decreased construction time. All the 17 participants have agreed with this factor. Further, increase in quality has been identified as the second major advantage by 16 participants. On the other hand, 10 participants have disagreed with reduction in initial cost and greater customization options as an advantage of offsite construction (Figure 3).

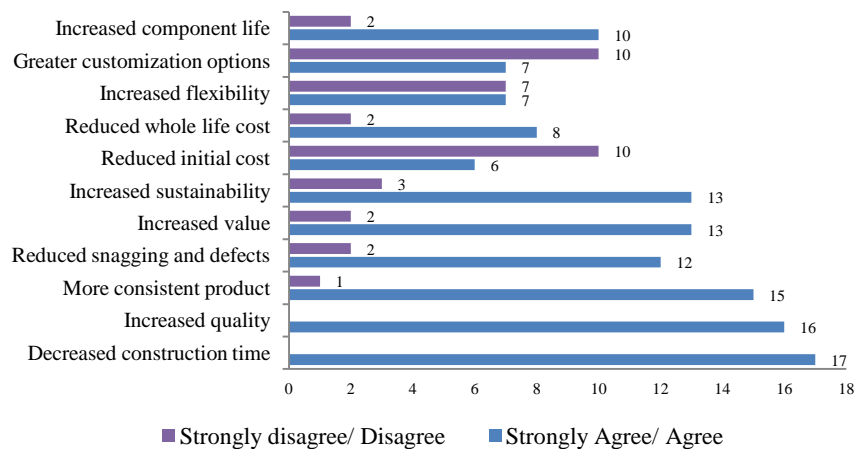


Figure 3. Advantages of offsite construction.

Respondents were asked to rank the drivers for using offsite techniques in construction. Figure 4 shows the frequency of expressed responses in numbers. The most important drivers were considered to be ensuring time and cost certainty. 15 participants have agreed to the time influence and 14 participants have agreed with cost certainty. On the other side government promotion, client's influences and restricted site specifications are less highlighted by the respondents.

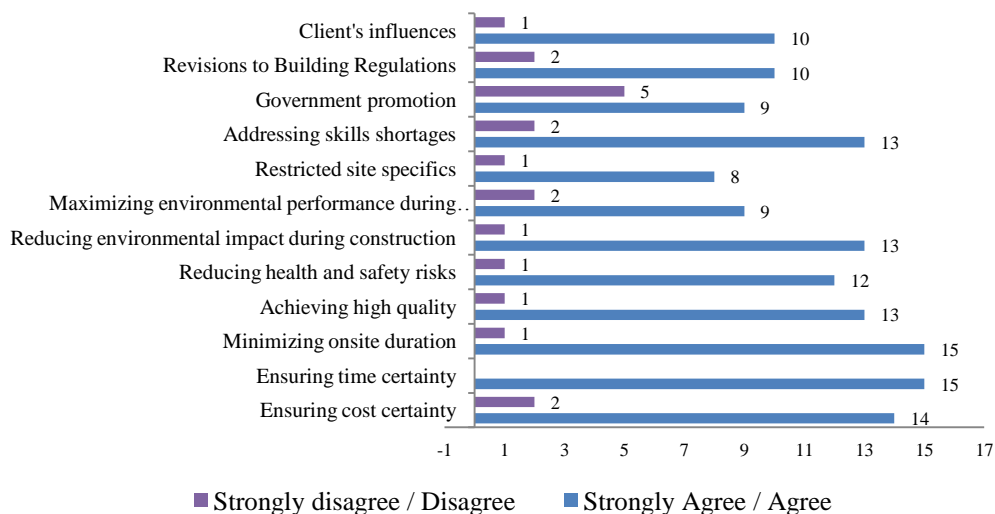


Figure 4. Drivers for using offsite techniques in construction industry, India.

Respondents were asked to choose one or more barriers from a list of 30 factors derived from previous literature. Participants considered that few codes/ standards available and nature of the planning system in India are the significant barriers against the use of offsite techniques in the Indian construction industry. In addition, respondents also agreed to factors like fragmented industry structure, lack of guidance and information, higher capital cost and restrictive regulations as barriers. On the other hand, 11 participants have disagreed as reduced quality being a barrier towards adoption of offsite techniques in Indian construction industry (Figure 5).

5. Discussion

Survey results revealed that there is significant offsite usage in Indian construction industry. The current practices being implemented include framing systems and alternative frame techniques as the substitute to conventional methods. Further, there is more potential for cladding systems and precast wall panels. The advantages of offsite techniques such as decreased construction time and increased quality are well acclaimed by more number of respondents. This supports other views that offsite technologies could improve both quality and speed of construction. Increased quality was also highly ranked in the previous offsite studies [5, 10]. On the other hand highlight that participants do not consider initial cost reduction and greater customization as major advantages in the Indian context. This could be because of the lack of awareness and skills to implement and plan for construction projects using offsite construction. Previous research documented that savings in labour cost and material cost are the major advantages in offsite construction industry in Malaysia [5]. However, in order to actually realise this gain in labour and material cost savings availability of knowledge, skills and effective planning system is needed for India. In general, most of the advantages identified for India are similar to the results discussed in the literature representing other countries as well.

As documented in the literature review, the survey reflected similar factors as drivers to offsite construction in India. Majority of the respondents agreed to the assurance of time and cost certainty (Figure 4). This again proves that construction industry is time and cost driven having a third factor quality. The survey results further stress the need to address time, cost and quality while implementing alternative technologies in construction industry.

The results pointed that standards and data scarcity such as code of practice and guidance is acting as major barrier against offsite construction implementation in India. In the context the respondents also highlighted that the nature of planning system in India is hindering the speed of offsite market. The belief “offsite is more expensive than conventional systems” has high occurrence in literature review but surprisingly this factor was not highlighted by the present respondents (Figure 5). Reduced quality, longer lead-in times and reluctance to innovation were strongly disagreed as barriers which mirrors the findings of previous researchers [5].

This paper has highlighted major issues involved in the implementation of offsite construction in India. Authors documented the current practices in construction industry and discussed drivers and barriers. Future researchers can use these findings for an in depth investigation.

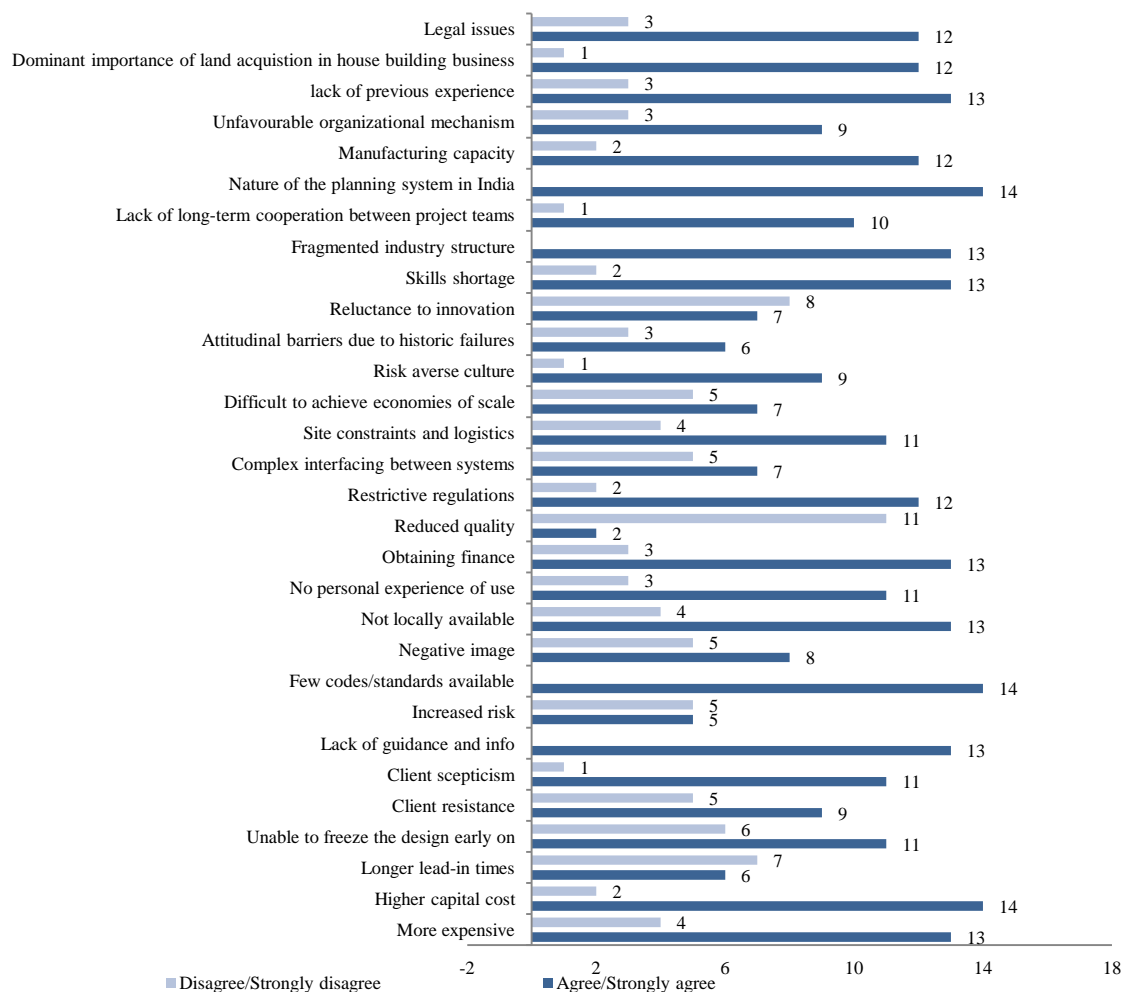


Figure 5. Barriers against the use of offsite techniques.

Acknowledgments.

The work described in this paper has been funded in part by the Building Materials and Technology Promotion Council (BMTPC) of the Ministry of Housing & Urban Poverty Alleviation, Government of India. The views published in this paper are those of the authors' and do not reflect the views of BMTPC.

References

- [1] Arif M, Egbu C, Haleem A, Kulonda D, and Khalfan. M 2009 "State of green construction in India: drivers and challenges" *J of Eng, Design and Tech.* 7(2) 223-34
- [2] Sawhney A, Iyer K C, Doloi H and Rentala S 2011a Latent Variables and Their Impact on Time Performance of Indian Construction Projects, *Project Management Research & Academic Conference (NICMAR, Pune, India, 9-10 December 2011)*
- [3] Sawhney A and Mund A 2011b Evaluating Affordable and Sustainable Housing Technologies and Systems in India (*17th Asia Construct Conference, New Delhi INDIA 2011*)
- [4] Gibb A G F and Isack F 2003 "Re- Engineering through pre-assembly: client expectations and drivers" *Bldg Research & Information* **31**(2) 146-60
- [5] Goodier C and Gibb A G F 2007 "Future opportunities for offsite in the UK" *Const. Mng. and Economics* **25** 585-95

- [6] Badir Y, Kadir M R A and Hashim A H 2002 “Industrialized Building Systems Construction in Malaysia” *J. of Arch. Eng.* **8(1)** 119-23
- [7] Arif M and Egbu C 2010 “Making a case for offsite construction in China” *Eng. Const. and Arch. Mng.* **17(6)** 536-48
- [8] Blismas N, Pasquire C and Gibb A G F 2005 “Benefit evaluation for off-site production in construction” *Const. Mng. and Economics* **24** 121-30
- [9] Gibb A G F 2000 “Standardization and pre- assembly- distinguishing myth from reality using case study research” *Const. Mng. and Economics* **19** 307-15
- [10] Pan W, Gibb A G F and Dainty A R J 2007 “Perspectives of UK housebuilders on the use of offsite modern methods of construction” *Const. Mng. and Economics* **25** 183-194