Offsite Construction Priorities In India: An Exploratory Research

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Abstract

The rapid growth of the construction industry in India has influenced the adoption of alternative technologies that are more 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 an effective alternative to dealing with the under-supply and poor quality in the current age construction industry. This paper presents the priorities for offsite construction in India and presents an implementation roadmap for practitioner and academic community.

Keywords: Offsite Construction, Manufactured Construction, Indian Construction Sector, Implementation Roadmap.

1. Introduction

Offsite construction has been promoted as a new paradigm in construction with the ability to deliver a higher speed of construction, with improved quality, at a lower cost, with reduced labour requirements on-site (Mullens and Arif, 2006). It is important to look at the adoption of offsite construction worldwide. Japan has the world's largest uptake of offsite construction, with companies such as Sekisui Homes producing 70000 manufactured homes a year (Gann, 1996). In the USA there is a separate building code for offsite construction which is referred to as the Housing and Urban Development (HUD) Code for regulating the construction of manufactured homes. Other initiatives include the United Kingdom (UK), where the government identified manufactured construction as a key tenet for improving construction in the 21st century by its inclusion in the Egan (1998) Report. Similarly, the Australian construction industry identified manufactured construction as a key strategy for

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improving the industry over the next decade (Hampson and Brandon, 2004); and countries like Malaysia now have legislation in place which requires the use of offsite in construction projects (CIDB, 2006). This emphasis is growing, which in part may relate to empirical evidence, which suggest that the use of offsite techniques can result in 16% lower labour and material costs (Schuler, 2003). However, despite these benefits and increased global initiatives, the actual uptake and adoption of offsite construction is slow, with a market share in UK being reported to be below 6% (Taylor, 2010). Moreover, in the USA there are approximately 7 million occupied manufactured homes, which make up about 7% of the nation's housing stock (HAC, 2011). Given this, Taylor (2009) related this failure and lack of uptake to the inaccurate public assumptions regarding offsite construction, advocating that the implementation of offsite construction could benefit society in several ways, e.g. reduced build times and costs, better controlled built environments, reduced risks through factory production, enhanced computing and traceability of components, etc. This paper presents an analysis of the Indian construction sector and the roadmap for implementation of offsite construction in India. Rest of this paper is divided into four sections, the next section presents the research methodology, it followed by a section on the development of assessment framework. It is followed by a section on the priorities of the Indian Construction sector and the last section presents a summary of the findings.

2. Research Methodology

In order to develop the overall implementation roadmap it was important to first develop a framework under which the priorities could be documented. In order to set-up the priorities a series of webinars and expert workshops were conducted. Once the framework was complete, it was important to document the priorities for the Indian construction sector. The Indian data collection process included two workshops with senior academics and experts, which was conducted in India and in the UK as part of UK-India Education Research Initiative. The experts included Chief Executive Officers, senior managers and policymakers from both public and private companies. Innovation in most sectors is predominantly diffused through three central 'themes' of People, Process, and Technology (Davenport, 1992). These core themes were considered pivotal for the development of this study, as they embraced the three dominant paradigms drivers of offsite, along with their enmeshed relationships (see Figure 1).

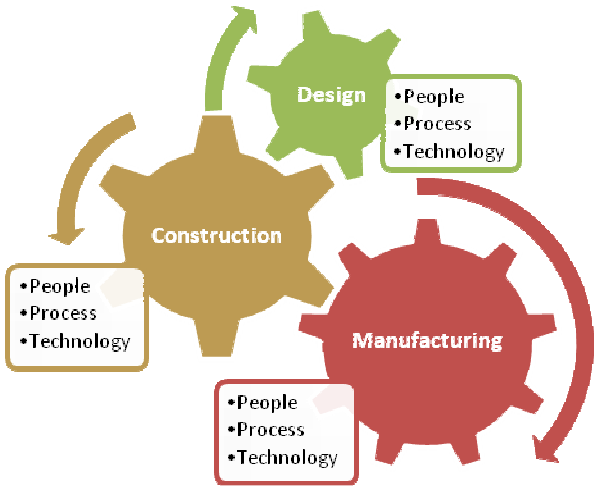

Figure 1: Assessment Framework

Figure 1 presents nine core areas, representing the three major dimensions of offsite construction: Process, Technology and People, and their impact on: Design, Manufacturing and Construction. These issues were informed by discussions in the three webinars. The webinars were also used to populate the nine areas and tease out specific issues within these categories. The framework was first introduced by Arif et al (2012).

3. The Elements of the Assessment Framework

The nine elements of the framework and the topics within each of these elements are as follows:

3.1 Design-Technology

- Technology embedded in the product (in the factory);
- Technology underpinning the business process;
- E-readiness of organisations (and the supply chain) – holistic implications on the business;
- BIM for offsite (product and process) – potential to exploit.

3.2 Manufacturing-Technology

- Justifiable automation - how much is enough? (optimisation, business case, payback etc);
- Product and process design – DfM (software and systems development,
- Decision Support System,
- Integrated product delivery etc);

- Supply chain management – MRP & ERP expensive (inflexible and somewhat limited);

- Modelling and simulation – training needed (systems analysis, discreet event simulation and modelling etc).

3.3 Design-Process

- Adding value to the business process (multiple perspectives);

- Process Protocol – lifecycle processes, tried and tested (concentrate on the most important ones);

- Stakeholder analysis is needed;

- Understand the impact of design and process (with business and technology).

3.4 Technology-Construction

- Need to understand what information is created, used and exchanged (Product Modelling Ontology, W3C etc) - common tools from different vendors (integration and interaction); BAE/BAA/IBM systems approach. Granularity of product data could be used better - detailed information e.g. installation, storage, size, mass, lifting requirements, health and safety issues etc. (BIM is important here). Risk needs to be understood more e.g. existing product/process in established application areas;

- Existing product/process in new application areas;

- New product/process in established application areas;

- New product/process in new application areas [as all carry different risk.

3.5 Manufacturing-Process

- Procedures need to be defined to cope with the variables – will a one-size-fit all model work?

- Need to look at other industries regarding their business models (not just efficiency over productivity, but also pre and post occupancy);

- Integration of suppliers into companies needed (and teams). What a business model would look like? Sustainable business models can be flexible (and business concepts could also be added).

- We have to consider what to adopt and what not to adopt e.g. automation v non-automation (is there a happy medium?). Flexibility needed (variable product line).

3.6 Construction-Process

- Important to consider business models – which ones?, what remit e.g. house builders, SME's etc. (more than 100 systems and >500 suppliers). How can integration be achieved? (through RFID?);

- Performance of process - hard data needed (Cost Benefit Analysis etc);

- Interfaces between OSP and manufacturing (do we have the right skills?). ISCS report on the future of house building. Focus on UK or overseas? (global agreed). Emphasis on onsite or offsite construction? 5 years, 10 year roadmap (up to 2050 agreed). Flexibility needed with elements of standardisation (economies of scale).

3.7 Manufacturing-People

- Multidisciplinary or interdisciplinary? Mind-set training needed (look at projects rather than products);

- Decisions have to be modelled in an integrated way (incorporating risk etc.);

- Shop-floor approach needs to change and benefits need to be made clear;

- Link to disaster management? Haiti house? (along with cultural issues);

- Mass customisation – service parts (how to address the markets);

- Job roles and functions need re-defining. Integrating people into the model.

3.8 Design-People

- Traditional v non-traditional - new ways of working require new skills (esp. product modelling.), new thinking, greater collaboration, reassessment of discipline areas, change in individual and company behaviour. OJT and learning needed (industry & academia collaboration);

- New approach needed to design (key USPs need to be sold regarding suppliers, assemblers, transport operations etc.);

- Design for Manufacture and Assembly is an important part of this, along with logistic integration into the design process;

- ManuBuild (design process, manufacturing process, construction process, sales office) - link to the supply chain and the customer ("buy-in"); (for more details on ManuBuild see www.manubuild.org);

- Product catalogues, smart connections etc are available.

3.9 Construction-People

- Up-skilling of personnel

  i) so that a site labour or a new person to the industry could work in the factory;

  ii) so that they know how to install prefabricated products and modules on site (this would require training/investment);

- Healthy and comfortable working conditions could be a key USP (Health and Safety, better working environment, standardised production system etc);

- Sustainability - social benefits, continuity of employment, economic - stable and long term employment, transportation - pick zones (reduced emissions etc);

- Productivity - greater efficiency and productivity, no weather disruptions etc;

- New workforce – greater attraction because of better working conditions, resolution of unskilled labour, no age limit or pre-requisite skills for entering the sector.

4. The Implementation Roadmap for India

Using the same assessment framework used for the developed world, a roadmap for Indian offsite construction was carried out. The summary of the Indian data is presented in Figure 2. In order to identify any issues that were not covered in the framework, participants were given an opportunity to add any issues they felt needed to be included or excluded.

From a People Driver perspective, the main focus was placed on “Design:People” [High], followed by “Manufacturing:People” [Medium], then “Construction:People” [Low]. The “Design:People” category was classed as high priority and should be addressed within the timeframe of 0-5 years. Participants realised that there was a need for an altogether different kind of design paradigm. This area was perceived to be behind the developed countries, and more awareness needs to be created for this area to progress. Within this, the three areas of focus were: P1 Importance of DfMA and logistics; P2 Need for new approach to design; and P3 Need for new skills. The “Manufacturing:People” category was classed as medium priority and should be addressed within the timeframe of 6-10 years. Within this, the three areas of focus were: P1 Improving integrated decision modelling, P2 Maximising training impact, and P3 Alignment of new job roles (to new requirements). The “Construction:People” category was classed as a low priority and should be addressed within the timeframe of 6-10 years. Within this, the three areas of focus were: P1 Promoting sustainability, P1 Upskilling personnel, and P3 Improving Health & Safety. There was consensus of opinion that there needed to be a significant increase in the training and educational provision of the country in order for this area of prosper.

From a Process Driver perspective, it can be seen that the main area of focus was placed on “Design:Process” [High], followed by “Manufacturing:Process” [Medium], then

“Construction:Process” [Low]. The “Design:Process” category was classed as high priority, but was placed within the timeframe of 0-5 years as respondents classed this as an important area to address. Within this, the three areas of focus are: P1 Adding value to the process, P2 Improving the impact of design/technology, and P3 Better lifecycle process analysis. This sequence is exactly same as that of the developed countries. The “Manufacturing:Process” category was classed as medium priority and should be addressed within the timeframe of 0-5 years. Within this, the three areas of focus were: P1 Learning from other industries, P2 New business models needed, and P3 Identifying breakeven point for automation. The sequence of priorities was also the same as that identified for the developed world. The “Construction:Process” category was classed as low priority and should be addressed within the timeframe of 6-10 years. Within this, the three areas of focus were: P1 Integration of process with BIM, P2 Greater flexibility needed, and P3 Improving the interface of OSP.

From a Technology Driver perspective, it can be seen that the main area of focus was placed on “Design:Technology” [High], followed by “Manufacturing:Technology” [Medium], then “Construction:Technology” [Low]. Whilst the “Design:Technology” category was classed as high priority, which should be addressed within the timeframe of 0-5 years. Within this, the three areas of focus were: P1 Enhanced design improvements, P2 Greater BIM adoption, and P3 Clearer supply chain benefits. Design technologies will also have regulatory impacts and involvement of regulatory bodies would be important. The “Manufacturing:Technology” category was classed as medium priority, which should be addressed within the timeframe of 6-10 years. Within this, the three areas of focus were: P3 Simulation and modelling tools needed (to help predict outcomes), P2 Business cases needed for software (selection), and. P3 Optimisation of manufacturing payback. The “Construction:Process” category was classed as high priority, respondents determined that this should be addressed within the timeframe of 6-10 years. Within this, the three areas of focus were: P1 Identification of technology support tools, P2 Better understanding of risk analysis, and P3 Improving product modelling flow. The priorities are summarised in figure 2 below.

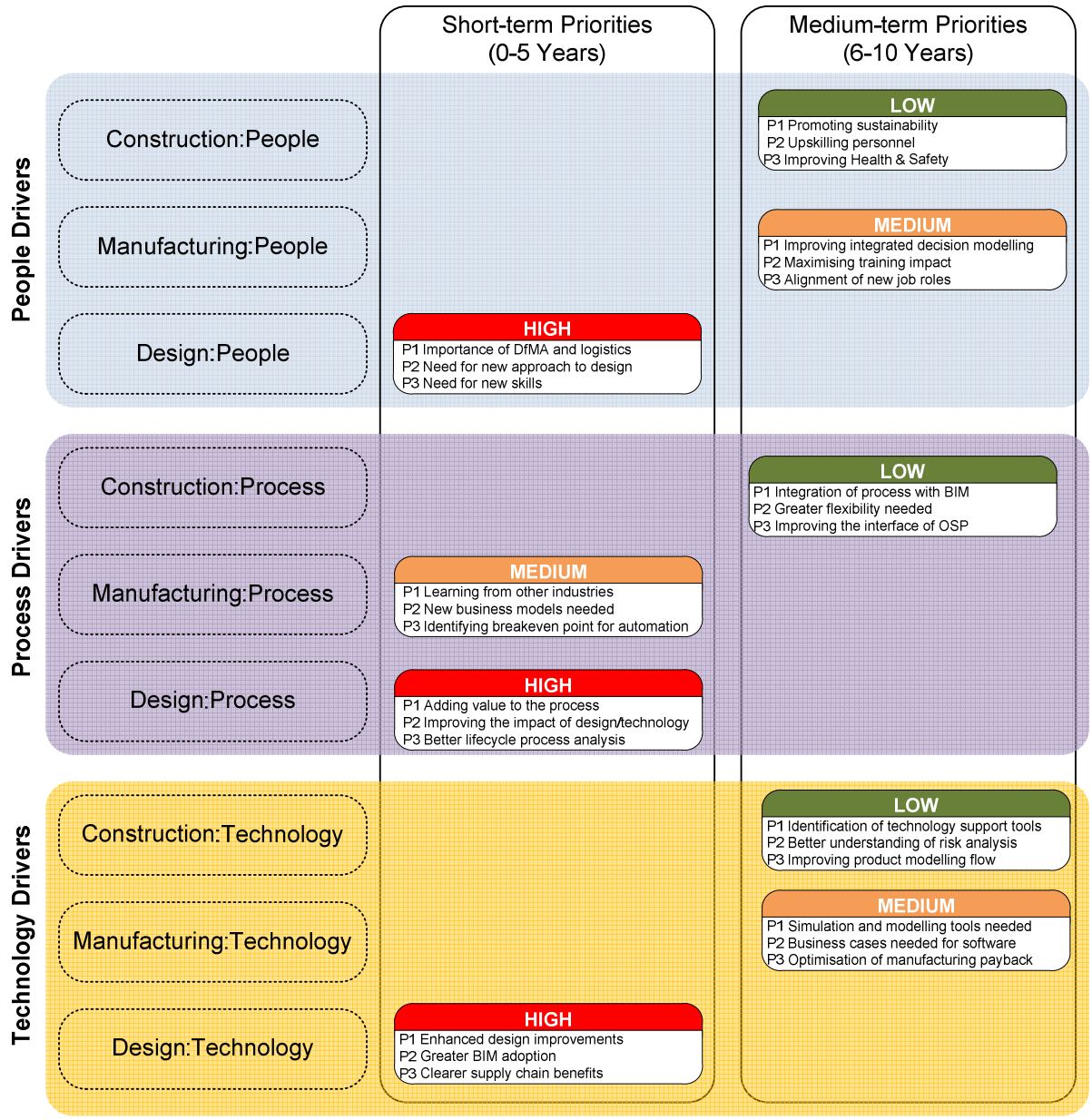

Figure 2: Prioritised Offsite Production and Manufacturing Research Roadmap for India

5. Discussion and Conclusions / Recommendations

In summary, the roadmap presented in Figure 2 presents the industry with a series of focal areas that need to be addressed over the short to medium term. Short-term priorities should therefore focus on disentangling all the three dimensions of Design: people, process and technology. For Design:People category the top priority is the emphasis on communicating the importance of DfMA and logistics. This new way of thinking is important for realising efficient 'manufacturable' designs. Architects and designers should therefore be cognisant of this. The second priority is to understand other issues to keep in mind when designing for manufactured construction. The last among these is the development of new skills and hence the need for newer educational and training programmes in this area. Design:Process is another important short term priority. For this category the priorities in their order of importance are adding value to the process, improving the impact of design/technology, and

better lifecycle process analysis. Design: Technology is the other dimension of design that was regarded as high priority in the short term. For this category priorities in their order of importance are enhanced design improvements, greater BIM adoption, and clearer supply chain benefits. Other short-term priority need to focus on “Manufacturing:Process”, regarding learning from other industries, identification of new business models to operate manufacturing in the construction sector and the least important among this category priorities being the identification of the breakeven point for automation. Given the availability of cheap labour in India, this particular item is rated lowest among the manufacturing process priorities.

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