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Structure Equation Model for the Successful Implementation of ICT / Automation in Construction Project Management in India

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Abstract

Each project is unique in nature and has its own complexities associated with it, and the management of construction projects requires effective and well-organized communication between all parties and stakeholders involved in the project. Coordination and collaboration between all stakeholders are the key to the success of any project. This is the sole importance among the team members of completing any given project on time and at the required cost. ICT is a technology that can be used to enhance communication between all the parties concerned working on specific or concerned projects, including stakeholders, etc. IT-based technology has many tools and software that have the tremendous ability to ease work related to the flow of information, data collection and storage, etc. The objective of current research is to identify and analyze the factors affecting the implementation of ICT / Automation in construction projects in India using structured equation modelling (SEM). The literature review has been carried out and some attributes have been identified regarding the benefits, barriers and enablers of ICT. These attributes were included in the questionnaire prepared to receive a response from industry professionals in the construction sector. The survey was conducted in the Indian construction industry and the response of various industry professionals from top-level management and middle-level management was recorded. The data collection was carried out and the response was further analyzed. Various factors affecting the use of ICT in construction project management have been analyzed using different statistical techniques (exploratory factor analysis, reliability analysis and structure equation model). The findings of the research provided a SEM model for the successful implementation of ICT in construction projects.

Keywords: ICT, automation in construction, construction management, project management, structure equation model

1. Introduction

Many building aspects reflect the significant benefits that the industry could reap from information and digital technologies: the vast quantities of knowledge to be handled, production focus and participant dissemination. Nonetheless, IT adoption in construction sector usually considered minimal and potential adoption predictions have proven optimistic (Fukao, Ikeuchi, Kim, & Kwon, 2016; Suryawanshi & Narkhede, 2015). While more champions were disappointed, the use of digital technology in construction has increased. The use of information and communication technology (ICT), also known as information technology (IT) has grown enormously in such areas as design and planning, cost control and budgeting, computer-aided facilities management, among others, thereby creating many opportunities for better and more efficient project execution within the industry. This study has the potential to offer some new insights

into ICT in the construction and context creation. The explanation is, because in developing economies such as India, what a company may see as major challenges in implementing and using ICT would be significantly different from those in a developed economy such as UK where the ICT Industry with various regulatory frameworks and cultural constraints (Jayasudha & Vidivelli, 2016; Kenley, 2014; Koseoglu & Nurtan-Gunes, 2018).

1.1. Objectives of the study

The objective of current research is to identify and analyze the factors affecting the implementation of ICT / Automation in construction projects in India using structured equation modelling (SEM).

2. Literature review

The use of information communication and technology is simple to handle different resources, including human resources. New techniques, such as BIM (Building Information Modelling), have totally changed the architectural point of view of the global market. The Internet is used internationally, and the projects are debated in several ways (Arayici et al., 2011). (Gu & London, 2010) has stated that there is a lack of education of these technologies and professionals in construction industry find it difficult to use and learn these technologies. The ICT based technology can only be adopted in construction sector if these technologies are adopted by large and big name organizations of a nation and set a benchmark for other organizations. The lack of efforts made by these organizations are a big barrier in the adoption of ICT. The awareness of technology and user education is required in the industry to improve the acceptance and adoption of ICT. The top management should be aware of these technologies and should adopt and promote so that everybody at middle and lower management takes it seriously (Arnold, Javernick-will, & Asce, 2013; Kang, Brien, & Mulva, 2013; Son, Lee, & Kim, 2015). The quality of tools or ICT equipment made available to the construction companies are also one of the barriers. During the use of these technologies some organization are also not convinced regarding the security these software or tools provide [3]. The use on building project performance has been recently evaluated through best practice and the direct impact on the project cost growth of use of 3D CAD, which means the cost outcome has a negative impact as the associations of project output and technological use at project and process level. The results indicate that the link between the technical usage and the project findings has been explored and that the cost and the timeline of the project will be greatly influenced by the data / intensive data / knowledge and management functions. The IT utilization enhances time-bound productivity and has a relatively low cost-effective impact (Dixit, Mandal, Thanikal, & Saurabh, 2019; Dixit, Sharma, & Singh, 2020; Dixit & Sharma, 2020)

3. Research methodology and data analysis

The research methodology used in the analysis is the compilation of primary data for ICT adoption in the Indian building industry. For data collection, a standardized questionnaire survey is used. The study targets are consultants, clients, investors, contractors, government officials, architects and other key players in the Indian construction market. The Likert five-point scale is used to identify respondents where one has the least impact and five has the greatest effect. The survey was conducted in the Indian construction industry and the response of various industry professionals from top-level management and middle-level management was recorded. The data collection was carried out and the response was further analyzed. Various factors affecting the use of ICT in construction project management have been analyzed using different statistical techniques fig. 1 and 2. Approximately 350 questionnaires were circulated and 88 correct answers were returned (Dixit et al., 2020; Shah et al., 2019).

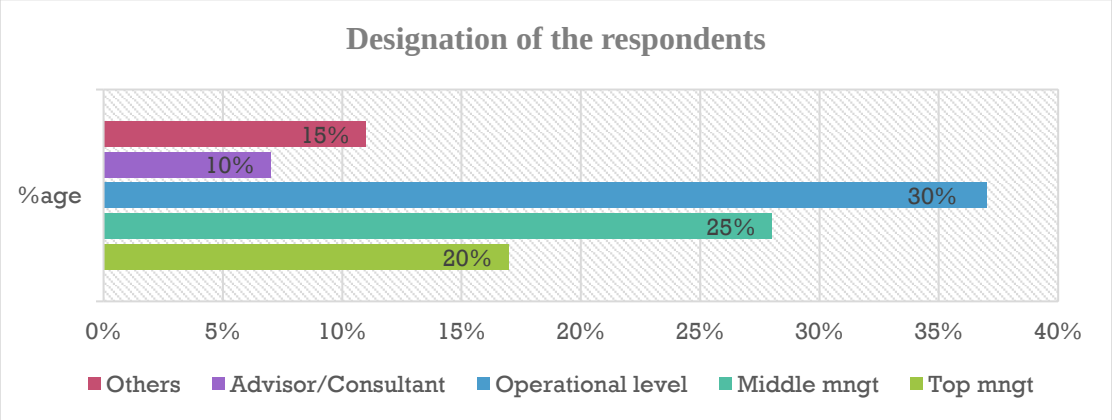

Figure 1. Position/Designation of the respondents

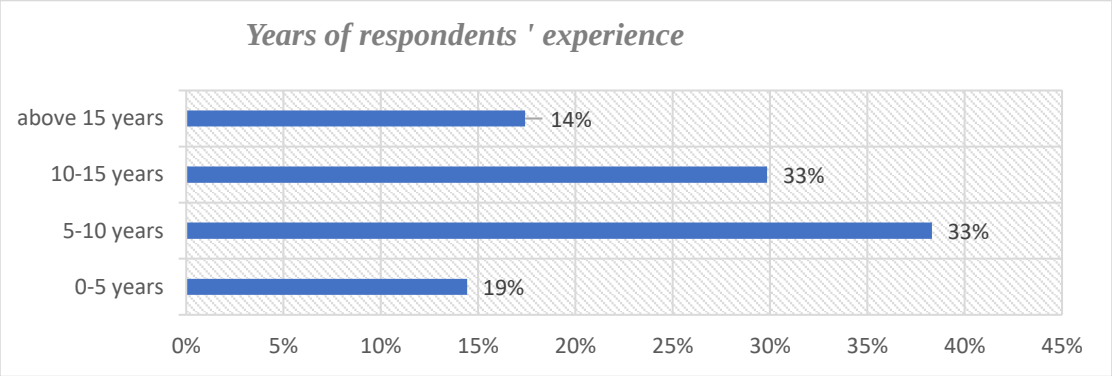

Figure 2. Years of respondents ' experience

3.1. Reliability analysis

Reliability refers to the degree to which a calculation provides accurate outcomes if measurements are replicated many times. The reliability analysis is called the reliability analysis. Reliability analysis is calculated by obtaining the ratio of the systemic variability by calculation of the correlation of the scores obtained from different administrations of the scale table 1. And, if the reliability measurement correlation is strong, the scale findings are consistent and therefore accurate (Hartmann, Meerveld, Vossebeld, & Adriaanse, 2012).

Table 1. Reliability analysis/Cronbach's alpha for different factors

Factors	Cronbach's Alpha	No. of attributes
Factor 1 (Site management)	0.82	06
Factor 2 (Leadership management)	0.81	05
Factor 3 (Project change management)	0.84	02
Factor 4 (Performance)	0.87	02

3.2. Exploratory factor analysis

Exploratory factor analysis is a statistical method used to decrease data to a smaller collection of summary variables and to investigate the theoretical framework underlying the phenomenon. The EFA has reduced the 19 attributes into 4 factors. All of the selected attributes have a factor load of more than 0.4. The cumulative quantity of variance explained by four factors are 57.25% which is above the minimum threshold (above 50%). All four factors from the EFA were shown in Table 2 below.

Table 2. EFA table

Attribute/variable name	Factor loading	%age of variance explained
Site management		21%
Less handling and managing charges	0.6	
Helps to improve collaborations and coordination	0.8	
Improve swift communication	0.8	
concurrent construction management	0.6	
Efficient procurement of materials	0.8	
Helps in contract management	0.6	
Leadership management		14.50%
Metadata information availability to the management	0.4	
Efficient query resolution mechanism	0.5	
Project change management		12.30%
Streamline flow of accurate information	0.5	
Project information is stored precisely in a better way	0.7	
ICT refines the productivity of organization		
Real time project information availability	0.6	
Effective project change management	0.6	
Performance		9.45%
On time completion of project	0.4	
Within budget completion of the project	0.6	
		57.25%

3.3. Structure Equation Modelling (SEM)

Structural Equation Modeling involves a number of mathematical models, computer algorithms and computational methods that are suitable for networks of data structures. SEM contains confirmatory factor analysis and composite confirmatory analyzes, path analysis and partly least square path modeling and latent growth modeling. Models of structural equation are also used to test 'latent' structures that can not be observed. The use of SEM in social sciences is generally justified because the relationship between unknown structures (latent variables) is defined by observed variables. The review of literature and CFA grouped the 19 attributes into 4 main significant factors are: Site Management (SM), Project change management (PCM), Leadership management (LM), And Performance (PR) of construction projects the following hypothesis are formed (refer conceptual model) fig. 3:

- Site management (SM) factors are having a significant impact on performance (PR) of construction projects
- Project change management (PCM) having a significant impact over productivity (PR) of construction projects.
- Leadership management (LM) is having a significant impact on productivity (PR) of construction projects.

3.4. Findings of the study

The findings of the SEM results concludes that the most significant factor impacts the performance of the construction projects is site management (SM) (Abbott, 2013; Allen, 2016; Bröchner & Olofsson, 2012; Rivas, Borcherding, González, & Alarcón, 2011) followed by Project Project change management (PCM) and Leadership management having a significant value of 0.03, 0.05, and 0.01 respectively (table 3 and 4).

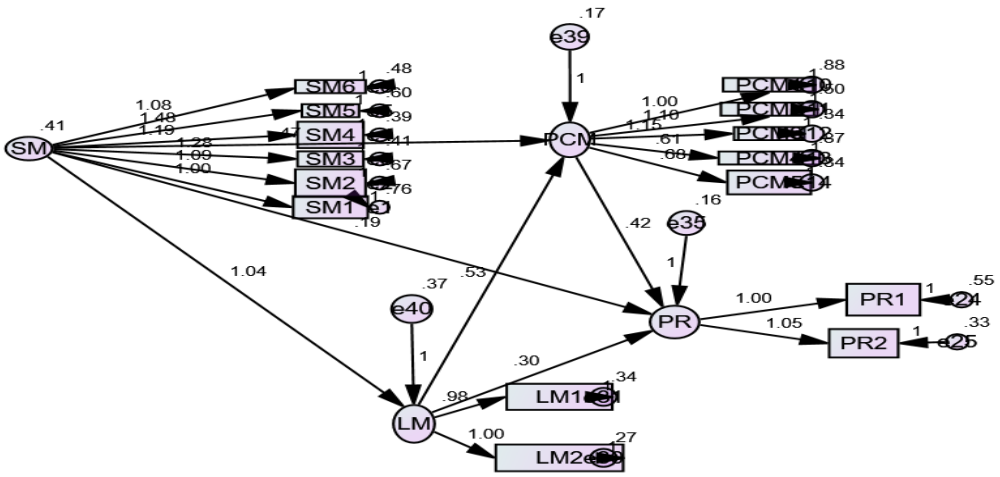

Figure 3. SEM model

Table 3. Measure for the goodness of fit (GOF)

Measure for the goodness of fit (GOF)	*Initial model values*	*Final model values*
χ^2/DOF	3.25	1.98
Comparative fit index (CFI)	0.62	0.85
Goodness of fit index (GFI)	0.58	0.84
Tucker-Lewis Index (TLI)	0.61	0.94
Root mean square error of approx. (RMSEA)	0.13	0.09
Incremental fit index (IFI)	0.65	0.79
Normal fit index (NFI)	0.73	0.80

Table 4. Hypothetical path and their influences

Hypothetical path and their influences	Path coefficient	Sig. (p)	Interpretation
H1: PR ←PCM (expected -ve impact)	0.42	0.05	Accepted
H2: PR ←LM (expected +ve impact)	0.30	0.01	Accepted
H3: PR← SM (expected +ve impact)	0.53	0.03	Accepted

4. Discussion and conclusion

The progress of any project depends on good communication and understanding between all project participants and stakeholders. Good communication is the secret to the success of any project. In the construction sector, projects need very good communication management between all parties which can be accomplished through the adoption of ICT or ICT technology. The study identifies various attributes affecting the adoption of ICT in the Indian built environment. Large organizations and policy agencies have to take care of that, and guidance and regulations are needed to make the best use of these technologies, which definitely will help other professionals, our services, our organizations and companies. In order to compete world-wide and to aspire to be an established construction industry and nation in the eyes of the global world (Aguilar & Hewage, 2013; Forcada, Fuertes, Gangolells, Casals, & Macarulla, 2013; Kim, Park, Lim, & Kim, 2013; Zeng, 2020), the industry will have to accept change and with the new age we will welcome these optimistic changes with open hands. In this regard, the governments and big corporations in our industry need definite help, so that small businesses can see them as a model and follow their footsteps (Fadiya, Georgakis, & Chinyio, 2015; Ikediashi, 2014).

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