PERSPECTIVE IN USING BUILDING INFORMATION MODELING TECHNOLOGY IN NEPAL

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Abstract: Building Information Modeling (BIM) is a model-based design technology, in which buildings will be built virtually before they get built out in the field. The design communication techniques are gradually changing from 2D based to integrated 3D based interface. This research is conducted to analyze the status of use of this technology in Nepalese Architectural / Engineering consulting firm, which ultimately helps professionals to understand the perspective of this technology in Nepalese context. The study may create awareness among professionals about opportunities and challenges of the BIM technology. This research deals with the obstacles in use of BIM application in context of Nepalese consulting firm. It also determines the efficiency of BIM technology in comparison to contemporary Computer Aided Design method of design development stage work. The study explores the use of BIM in professional practice for efficient result and benefit. Focus is more on design development phase of project and the efficiency was analyzed through case analysis.

Keywords: Building Information Modeling, Status, Obstacles, Case Analysis.

I. INTRODUCTION

Drawings are the medium of communication between the stakeholders of any project. To formulate those drawing various technologies were adopted. For now in Nepalese context, most of the Architecture/ Engineering (A/E) consulting firms formulate their design in conventional 2D drawing system using software product of Autodesk i.e. AutoCAD. There is the very important role of Computer Aided Design (CAD) in designing for proper communication within stakeholders. Computer Aided Design-CAD system is defined as the use of information technology (IT) in the Design process. CAD system consists of IT hardware (H/W) and specialized software (S/W) (depending on the particular area of application). The core of a CAD system is the S/W, which makes use of graphics for product representation and databases for storing the product model. Its use does not change the nature of the design process but enhance the efficiency in work of designer.

In this traditional design method it was tedious work in any amendments as per site condition which affects the overall project information such as quantity, cost estimate. To avoid those obstacles Building Information Modeling (BIM) technology can be adopted in any construction project.

II. BUILDING INFORMATION MODELING

Building Information Modeling (BIM) is now being popular in architectural/engineering consulting firms which are more informative in rich 3D modeling in compare to traditional 2D drawing. This technology might be accepted by numerous firms in future due to its ability to correct error in early design stage as well as in construction stage and facilitates easy solution for complex project in advocating their design alternatives (Azhar, et. Al. 2011).

BIM is a process of representation which creates and maintains multidimensional data-rich views throughout a project a project life cycle to support communication (sharing of data); collaboration (acting on shared data); simulations (using data for predictions); and optimization, (using feedback to improve design, documentation, and delivery (Mihindu and Arayici, 2008).

Generally, BIM technology allows an accurate virtual model of the facility to be constructed digitally. Completed computer generated models contains accurate and a well-defined geometry and pertinent digital data required to facilitate the construction processes such as, construction sequencing, fabrication, procurement activities, etc, which are necessary to realize the final building. BIM programs today are designed applications in which the documentation flows from and is a derivative of the process, from schematic design, construction and facilities management (Kuba, 2012).

III. PROJECT DESIGN PHASE

The Phase of the project involves the implementation of the project as it is described in the Contract Documents. For this design phase is one of the critical stages of the project which leads the project to its success (Elbeltagi, 2009) state that the Project design phase can be categorized by following:

- **Schematic Design**

During this phase of the architectural design process, designer takes the information to create design options for your consideration. Designer presents these options in the form of sketches, so you can visualize the project.

- **Design Development**

At this point, designers take the final schematic design, as well as any requested modifications, and revise the design as necessary. It includes the update of cost estimate and finalizes the details of the design before moving into the next phase.

- **Construction Documents**

By now, final design was done and will begin preparing drawings, notes, and technical specifications necessary for bidding, construction, and permit application. Contractors will use these detailed drawings and specifications to prepare for the next phase in the architectural design process.

- **Bidding**

List of qualified contractors for bidding were invited. It requires review of submitted bids, provide analysis, and help in compare the cost figures that you receive from your bidders. This phase will ensure the contractors for construction of project.

- **Construction Administration**

Finally, once selecting the contractor and construction is under way, and then start of fifth phase of the architectural design process – construction administration. During this phase, A/E administer the construction process to assure conformance with design intent, visit the site during construction, and address any field conditions as they arise.

IV. IMPORTANCE OF SOFTWARE IN FORMULATING DESIGN DEVELOPMENT

AUTODESK was the first vendor to offer a Personal Computer (PC) based CAD system the AUTOCAD (beginning of 1980). The first applications were for 2D-Drafting and the systems were also capable of performing only 2D modeling. Even today 2D-drafting is still the main area of application (in terms of number of workplaces) (Rehak, 1981).

Later, (mid-1980), following the progress in 3D modeling technology and the growth in the IT, H/W, 3D modeling systems are becoming very popular. For this nowadays BIM based software becoming more popular in AEC firms around world. The first software tools developed for modeling buildings emerged in the late 1970s and early 1980s, and included workstation products such as Chuck Eastman's Building Description System and GLIDE, RUCAPS, Sonata and Reflex. The early applications, and the hardware needed to run them were expensive, which limited widespread adoption. ArchiCAD's Radar CH, released in 1984 was the first modeling software made available on a personal computer (Eastman et al, 2011).

Due to the complexity of gathering all the relevant information when working with BIM on a building project some companies have developed software designed specifically to work in a BIM framework. These packages (e.g.: Bentley AECOsim Building Designer, ArchiCAD, MagiCAD, Tekla Structures, Autodesk Revit, Synchro PRO, VectorWorks, Trimble SketchUp) differ from architectural drafting tools such as AutoCAD by allowing the addition of further information (time, cost, manufacturers' details, sustainability and maintenance information) to the building model (Eastman et al, 2011).

V. CAD. VS. BIM

Building Information Modeling efficiently describes the process of designing, building and operating a building collaboratively using one system of computer models rather than separate sets of drawings. BIM gives experience of the relevant building data rather than interpretation from drawings as lines, numbers and symbols. The different disciplines of the construction industry use different systems to create models, but it is possible combine them all using Open BIM Comparing traditional design process and the BIM can be defined basic differences between them (Rancane, 2014):

CAD is:

- Drafting a depiction of construction intent
- Fragmented process of multiple files
- Tool for creating construction documentation
- Requires manual coordination of a project set

BIM has different functions during design phase than CAD:

- Database of information about a building for design, construction and lifecycle maintenance
- Analytical and quantifiable
- Requires a change of workflow
- Requires internal and external education to maximize efficiency and use

Research about "The Five Fallies of Building Information Modeling (BIM)" assessed that; The BIM platform assembles all information into one location and cross-links that data among associated objects. There is no linkage between the data created by CAD. Efficiency of BIM in comparison to CAD is being referred in Table 1.

Table 1: Efficiency comparison between CAD and BIM in design phase

S.N	Task	CAD (Hours)	BIM (Hours)	Hours Saved	Time Savings
1	Conceptual Design	190	90	100	53%
2	Design Development	436	220	216	50%
3	Construction Documents	1,023	815	208	20%

(Source: Rundell, 2007)

From table 1, it can be said that the time savings is more than 50% which ultimately reduce the expences of the project. It can also be said that due to use of BIM technology there would be the time and cost efficiency (Rundell, 2007).

VI. METODOLOGY

BIM has shown strong acceptance potential here. To establish this claim quantitatively research methodology was adopted. Quantitative research is often contrasted with qualitative research, which is the examination, analysis and interpretation of observations for the purpose of

discovering underlying meanings and patterns of relationships, including classifications of types of phenomena and entities, in a manner that does not involve mathematical models (Kothari and Garg, 2014).

The primary data were based on survey (Questionnaire, structured interview) with professionals of AE consulting firm. The questionnaires were based on research objectives and research questions were mailed to 135 consulting firm among the 618 firm through Google Form in online medium and 68 responds to the mail. Out of 68 respondent firms 16 uses BIM technology. The scheduled questionnaire and key informant interview was done to 14 out of 16 user firm of BIM technology using snowball sampling. To analyze the efficiency, five major function of design process was adopted by Drafting of Plan, Elevation and Section with 3- Dimensional view of Building and also the Quantity Estimate of Building was done of residential and commercial building.

RESEARCH OBJECTIVES

- To explore the status of use of Building Information Modeling technology.
- To identify the obstacles in use of Building Information Modeling technology in Nepalese context.
- To determine the efficiency due to use of Building Information Modeling technology during design development phase.

DATA ANALYSIS

The survey questions listed a number of criteria to evaluate BIM solutions. For each of these criteria, respondents indicate their preference by rating it on a 5 point likert scale, where 1 indicates "strongly disagree" and 5 indicates "strongly agree." Respondents are supposed to identify any additional important criteria/comment that is not mentioned in the questionnaire. The data which were collected from the questionnaire were analyzed through MS Excel, SPSS software's where the outcomes were presented in graphical way for ease of objective regarding scope of BIM in Nepal. Since the study is a descriptive type simple frequency distributors can be used as an analytical tool in the form of different charts and tables. The multiple choice research variables were analyzed through frequency analysis. The perception level of the respondents to this survey about the research variables was assessed by using the mean score (MS) and Relative Importance Index (RII) computed by the following formulas: (Chan and Kumaraswamy, 1996)

$$MS = \sum(fxs) / N \quad (1 \leq MS \geq 5) \qquad \text{……..Equation 1}$$

$$\text{Relative Importance Index (RII)} = \sum w / (A*N) \ (0 \leq RII \geq 1) \qquad \text{……...Equation 2}$$

VII. ANALYSIS OF RESPONSE

a) Status of use of Building Modeling Technology

From 68 respondents only 16 respondent firms use BIM technology to formulate their design development phase of construction project. Out of 68 respondents 16 (23.52%) were the user of BIM technology. From Table 2 out of 16 BIM users it indicates Autodesk Revit was being considered to be used in majority (81.25%) of the respondent's Organizations as a BIM application followed by Graphisoft ArchiCAD (18.75%) and the rest were considering tarditional applications. This indicated that Autodesk Revit was known to the majority of the respondents to be used as a BIM application.

Table 2: User of BIM Based Software

BIM Based Software	Respondents	%
Autodesk Revit	13	81.25%
ArchiCAD	3	18.75%

b) Obstacles in use of Building Information Modeling technology

In response to five multiple choice research variables on 'Obstacles in use of Building Information Modeling (BIM) technology' among 52 non BIM technology users, the main reason for not using the BIM applications is due to "Lack of Training and institutional Education" as per the mean score (MS) of 3.84 as shown in Table 3. Whereas other reasons or variables 'Ease of Traditional Method', 'Lack of Idea', 'BIM Require Change in Work Flow', and 'Concern About Software Limitation' were also accepted by the respontents with mean score of above 3.5. The research variables of 'Obstacles in use of Building Information Modeling (BIM) technology' remain open for others probable obstacles according to respondet's but not any obstacles are recorded.

Table 3: Obstacles in use of BIM technology

S.N.	Research Variables	Mean Score (MS)	Standard Deviation
1	Lack of Training and Institutional Education	3.84	0.94
2	Ease of Traditional Method	3.76	1.14
3	Lack of Idea	3.65	1.00
4	BIM Require Change in Work Flow	3.55	0.95
5	Concern About Software Limitation	3.52	1.01

To test the relaibility of data regarding obstacles in using BIM technology, t-test was done and Cronbach's alpha was calculated to determine the internal consistency.

Table VII: Cronbach's alpha value of Obstacles

No. of Items (Obstacles)	Cronbach's Alpha	Internal Consistency
5	0.718	Acceptable

Here, alpha value lies between 0.7 and 0.8 so it lies in acceptable level of relaibility.

According to table 4.6, there is the comparison of ranks for obstacles in use of BIM according to working experience of respondent in technical field based on Relative Importance Index (RII). Respondents experience above 10 years ranked 'Lack of idea', 'Lack of Training and institutional Education' on a top as a obstacles in use of this technology in construction project, respondent's experience of 4-7 years ranked 'Ease of Traditional Method' on top, whereas respondent's experience of 8-10 years ranked 'BIM require change in work flow', 'Lack of Training and institutional Education' as on top obstacles in using this technology.

Table 5: Comparison of Ranks for Obstacles in use of BIM according to Experience

S.N.	Research Variables	Year of Experience	Mean Score (MS)	RII	Rank
1	Lack of Idea	0-3	3.86	0.77	2
		4-7 yrs	3.30	0.66	4
		8-10 yrs	3.69	0.74	3
		Above 10 yrs	4.31	0.86	1
2	Ease of Traditional Method	0-3	3.77	0.75	1
		4-7 yrs	3.45	0.69	4
		8-10 yrs	3.69	0.742	2
		Above 10 yrs	3.69	0.74	3
3	BIM require change in work flow	0-3	3.55	0.71	4
		4-7 yrs	3.65	0.73	3
		8-10 yrs	3.77	0.75	1
		Above 10 yrs	3.69	0.74	2
4	Lack of Training and institutional Education	0-3	3.86	0.77	2
		4-7 yrs	3.65	0.73	3
		8-10 yrs	3.62	0.72	4
		Above 10 yrs	4.31	0.86	1
5	Concern about software limitation	0-3	3.41	0.68	4
		4-7 yrs	3.58	0.723	1
		8-10 yrs	3.50	0.70	3
		Above 10 yrs	3.60	0.72	2

c) Efficiency due to use of Building Information Modeling technology during design development phase

To determine the efficiency level of BIM technology, work comparision was done in between the conventional method and BIM technology based software for drafting work of construction project. For this two case were selected one is residence of 1350.53 sq.ft builtup area and commercial building of 9320 sq.ft builtup area as this level of work are common in A/E firms in nepalese context. All cases were drafted on both technology based sofeware and the efficiency was determined as shown in table 5 and 6.

Table 6 Efficiency of BIM in comparison to conventional method in case analysis – I (residential building)

S.N	Task	CAD	BIM	Time Saved	Time Savings (%)
1	Drafting of Plan	2hr.15min	1hr.30min	45 min	34%
2	Drafting of Elevations	1hr.30min	0	1hr.30min	100%
3	Drafting of Sections	45 min	0	45 min	100%
4	3-Dimenssional Modeling	2hr.15min	0	2hr.15min	100%
5	Quantity Estimation	2hr	1hr.30min	30 min	25%
Total		8hr.30min	3hr.	5hr. 30min	65%

From table 5, researcher concluded that upto 65% of time savings can be achieved through the use of BIM based software for design development of residential building of 1350.53 sq.ft builtup area, which ultimately reduce the expences for the professionals and the cost of the project.

Table 7: Effiiency of BIM in comparison to conventional method in case analysis-II (commercial building)

S.N	Task	CAD	BIM	Time Saved	Time Savings (%)
1	Drafting of Plan	2hr.45min	3hr.20min	-35 min	(34%)
2	Drafting of Elevations	1hr.40min	0	1hr.40min	100%
3	Drafting of Sections	1hr	0	1hr	100%
4	3-Dimenssional Modeling	3hr.15min	0	3hr.15min	100%
5	Quantity Estimation	2hr	1hr.30min	30 min	25%
Total		10hr.40min	4hr.50min	5hr. 50min	55.5%

From table 6, researcher concluded that upto 55.5% of time savings can be achieved through the use of BIM based software for design development of Commercial building of 9320 sq.ft builtup area.

Table 7 indicate the average efficiency for design development of residential and commercial building as per year of experience of respondents. From this higher efficiency was identified on 4-7 yrs experience group with 57.83% average efficiency in residence and 59.53%average efficiency in commercial building.

Table 8: Average Efficiency as per Year of Experience of Respondents

Year of Experience	Avg. Efficiency in Residence	Avg. Efficiency in Commercial
0-3	53.39%	54.60%
4-7 yrs	57.83%	59.53%
8-10 yrs	53.00%	53.80%
Above 10 yrs	56.50%	57.50%

VIII. CONCLUSION

This research mentions the status of using Building Information Modeling Technology and also describes the possibilities of adopting various new technologies to create drawings of construction project for proper communication among various stakeholders. A/E consulting firms are coming under huge economic and technical competition and this driven up them for upgrading their working level and their implementation. From this research it is found that the status of using this technology is quite low but those who are using it are satisfied and found to be more efficient. Most of the respondents indicate time saving as the major benefit of this technology, but lack of institutional education and training become prime obstacles in using it. Its major benefit of reducing time can be seen from the case analysis done in this research; in an average better time and cost saving for firms can be achieved in compare to conventional CAD system for drafting of any construction project during design development phase. It was also found those young professionals are willing to use this software as they are in the phase of knowledge development and career enhancement. Elder professionals resist new changes as they are satisfied with their simple way of work process. Thus it can be concluded that the charm of using this software is high among young professional. Hence, this BIM technology shows its time and cost efficiency in compare to current technology used by most of the consulting firms of Nepal but the status in using this technology is comparitvely low. The findings of this research could be used to create awarenwss among the professionals to use this technology in their A/E consulting firms.

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