Application of Building Information Modeling in Indian Construction Projects – A Critical Review

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Abstract: Building Information Modelling (BIM) is a standardized and digitalized technology by creating a common working platform for the major stakeholders contributing to the certain type of construction project. Nevertheless, much BIM studies has been done all through the world; no preceding exhaustive review has focused on BIM implementation specifically in India. This paper provides a mixed review of prior review and will also focus on giving a potential recommendation that could be applied throughout India and also encourage the Indian construction industry that applying building information modeling worth the costs and the need for experts which will be invested, when it compared to the benefits that we get from utilizing the system or the process. By the end of the day the results reveals although there has been a significant amount of research and development about the use of BIM during various project phases, little work has been piloted about how it could be applied in any kind of Construction, specifically in Indian Building construction Projects which was coved in this paper.

Keywords: Building Information Modeling**,** Indian Construction Industry, Model.

I. Introduction

A. Construction industry

The construction industry, unlike other industries, is widely acknowledged for its special characteristic which is unique. Meantime it has been criticized for conservative [1]. Another feature of the construction industry is information intensive due to the construction of complexity buildings [2]. The construction industry plays a major role in driving economies of a country. Not only it contributes to the country's economy but an innovative and efficient construction industry causes to create a stable global economy in macro level [3]. However, the industry has been blamed for notoriously conventional and for relatively slow adoption of changes. In particular, data transfer among project stakeholders is time consuming [4].

The Construction industry has remained slow in the adoption of innovative technologies although it has been proved with strong evidence that the information technology (IT) has a positive impact in the project performance [5]. New technologies provide several benefits to the industry by increasing the opportunities. Technology in a simple form refers to improvement in soft and hard methodologies [1]. IT applications provide the platform for the improvements in design and project monitoring. This has lowered the project cost and improved accuracy, speed and safety. Consequently, more benefits such as solution for uncertainties in a construction project and dispute resolution have been expected from an advanced form of IT [6].

Thus, there is a strong need of design and management data a design and management tool which can integrate all these by which we can establish better coordination and easy understanding of the project design, thus resulting high efficiency of the management process, increased productivity and quality, and optimizing overall cost and time of the project

B. Problems in the construction Industry

Building Information Modeling is basically concerned with information, it is about information related to building infrastructures or the one that are about to be built in particular. Information is crucial when it comes to building a certain kind of structure. That is why it is considered as an asset of a certain organization. If there is an absence of quality information all the planned activities will be detained from being properly implemented. Even planning any activities require some sort of information at the first place.

Nowadays the complete specifications as well as the legally binding contract description are still paper-based. Even if prepared electronically, a set of printed documents will be produced, which can then be signed by the contracting parties. Elaborate outlines can be found in [7], [8]. Since quite a number of these specifications have been produced at different locations, with different calculation tools, sometimes on the basis of different analyzing models, and often at very different times within the total planning phases, there is a high potential for contradictions [9].

On the other hand, the printing limits the amount of information which can be transferred on each detail of the work. In the past, more elaborate written detailing has been avoided, since further information can be taken from the national standards and from other regulative sources. Finally, the construction companies bring in their experience, their skills and their special knowledge. To a great part this is implicit knowledge, not written down, or at least not yet documented in such a way that it could be transferred to the client or anchored within the common Building Information Model.

II. Material and Methodology

A. Defining Building Information Model

Eastman and Teicholz defined Building Information Modeling as a modeling technology and associated set of processes to produce, communicate, and analyze building models. Building models are characterized by;

• Building components that carry computable graphic and data attributes, as well as parametric rules
• Components that include data that describe how they behave,
• Consistent and non-redundant data such that changes … are represented in all views …
• Coordinated data such that all views of a model are represented in a coordinated way [11]

B. The levels in Building Information Modeling

The gradual development of Building Information Modeling is demonstrated in a three dimensional digital representation. Level-1 deals with traditional two dimensional design process of drawings but level-2 enhances the design into 3D modeling. In contrast to 2D drawings where sets of lines and areas are illustrated through soft and hard intelligent features, data related to each object are stored by means of BIM in level-2. BIM is matured in level-2 where various professionals particularly designers involve collaboratively and they are able to model real life situations before construction commences [1]. Level-3 is considered to be more advance with the integration of 4D and 5D which are time and cost parameters respectively. Level-3 represents the most complex BIM with fully integration of all relevant information for the whole lifecycle of the project [12]. Figure 1 displays the maturity diagram of BIM at different levels.

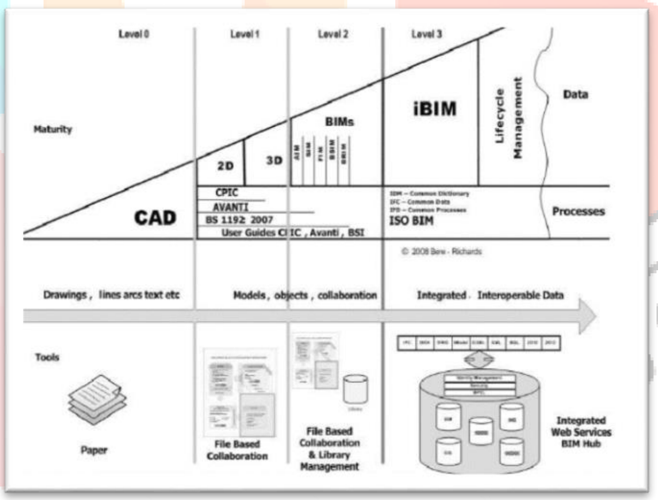

Figure 1: BIM maturity levels (Department for Business Innovation & Skills- BIS, 2011)

3. BIM as management tool

Building information models are files (often but not always in proprietary formats and containing proprietary data) which can be exchanged or networked to support decision-making about a place. Current BIM software is used by individuals, businesses and government agencies who plan, design, construct, operate and maintain diverse physical infrastructures, such as water, wastewater, electricity, gas, refuse and communication utilities, roads, bridges and ports, houses, apartments, schools and shops, offices, factories, warehouses and prisons. Hence improving the efficiency of planning and scheduling any project which in return improves the project management (Hamil 2010) in their research papers. But none of this definition were successful to include time cost and quality concept in the defining BIM. International Alliance for interoperability (IAI) and Associated General Contractors (AGC) are mainly the two bodies which have been very active in recommending the use of BIM in the construction Industry (Hamil, 2010). It is worth to mention that there is significant distinction between Buildings information Modeling and Building information model (NIBS- NBIMS Project Committee, 2006). Building Information Modeling refers to process by which models are generated; while Building information Model refers to representation of the building at a specific time in any given time. There has been lots of argument over BIM is tool or is it a process.

B. **Application of BIM to the construction Industry**

In a 3D world, BIM is the glue that holds design and construction together. In my experience, there are a lot of firms out there that aren't sure what goes into a successful BIM project. In this article, I will sort through the steps that a firm normally takes to go from design through construction using BIM.

The process of using BIM models for collaborative purposes, leading up to and through construction is a lengthy one. It involves a real investment on software and employees. In the firm I work for, we utilize Revit Architecture, MEP, and Structural, as well as Navisworks, 3D Studio Max, and AutoCAD.[6]

In predesign, it is determined if BIM is going to be used on the project. Assuming that BIM is the approved method, the Architect gets started on the schematic model, either by using masses or real elements in a BIM environment. Once the schematic architectural model is prepared, a presentation will be given to the owner. A walkthrough or renderings is a necessity for this presentation. 3D Studio Max, in conjunction with Revit, helps in this task. The owner will then offer thoughts on the design, tweaks will be made, and the model is ready to enter into the design phase. (Hamil, 2010).

During schematic design, scheduling (4D) and estimating (5D) really start to get involved. Scheduling must make sure that this building can be built in the time allotted and estimating needs to make sure that they constantly track the cost of the project. How can BIM help with this? The BIM models need to be set up correctly from the start. For scheduling, the model has to be built with building in mind. The firm I work for is a design-build firm. We have begun to use Navisworks in the field. So, there are some modeling practices that we use that an A&E firm would not. We build our model for the schedule. [6]

For instance, our floors are modeled by the sequence of how they will be poured. We need to do this so the Navisworks schedule can be built correctly. For estimating, Project Parameters need to be added to the models.

This is important for two reasons. The schedules need be filtered correctly so estimating can utilize the model to help in their estimates. Also, the elements in the project need to have enough information so that estimating knows what type, size, etc… of element they are estimating. This is especially important in projects that are heavy on the process side. It is very laborious for estimating to try and count all of the elements of a process project from a 2D plan. BIM has enabled the design and construction process to be a totally collaborative effort. Typically, this is why a design-build firm can take less time from schematic design through construction of a project than an A&E firm that doesn't have estimators or CM's on staff. [8]

During detailed design, collaboration is key. It is imperative that weekly coordination meetings take place in order to ensure that everyone is on the same page. In these meetings, the architects and engineers, project manager, estimator, scheduler and Construction Manager are in attendance. In this phase of the design process, Interference Checks and Coordination Reviews are done weekly. This is an obvious step to take, but a lot of firms don't utilize the collaborative tools that BIM provides. Firms usually don't think they have enough time to run Interference Checks or Clash Detections. What they don't realize is that they will spend a lot more time and money fixing the mistakes in the field that could have been caught early in the design phase if they just would have spent the time.

Throughout design, there are certain modeling practices that need to be followed. For one, if you're going to the trouble of modeling the project, it is more efficient to have the model used for more than just plan work. Scheduling, sections, elevations, and walkthroughs are just some of the coordinated processes that can make your BIM model more efficient and, if done correctly, can save time and money. Another important factor is ownership of elements. When we talk about ownership, we are referring to which discipline originally modeled an element. (Hamil, 2010).

The owner is also referred to as the Model Element Author (MEA). When it comes to copy/monitor, the disciplines that copy/monitor an element from a linked model may have input into that element, but are not the owners of that element. Therefore, the owner of an element needs to pay extra attention to the coordination of that element. One of the best uses of BIM's efficiency is one in which every element type is modeled only once. If there are multiple instances of the same element stretched across disciplines, this can be a headache for coordination and collaboration between models.

After the design is completed, construction is ready to begin. As discussed, throughout design, estimating and scheduling were updating their respective processes. This means that long-lead items have been purchased and the schedule has been modified to ensure project completion by the due date.

Also, site work has already been started and foundations are ready to be poured. During the construction phase, Navisworks will be available in the field and the design models may have been replaced by models from the subcontractors. The Construction Manager and field superintendent will work with the design team to make sure that the design intent is followed, and they will run their own Clash Detections on all models. With Navisworks monitoring and workflow tools, identified problems can be reported and tracked through resolution. Construction can be simulated to make sure everything is being built on time. This process was made easier by the fact that BIM was used early in the design phase. We have found that there are significantly less RFI's when BIM is used correctly in all phases of a project. Along with that, the owner has actually seen what he/she is getting with the aid of walkthroughs and accurate renderings. BIM has created a solid connection between design and construction that had never been felt before. Instead of asking how we can get architects, engineers, and construction managers to collaborate efficiently, we are now asking how we can use BIM to make the process even faster and more efficient.

1. BIM as a product

BIM is a product which represents the model of a digital representation of data about the project (NIBS, 2007). In order for software to qualify as intelligent it should not just be 3D representation of project, but it should possess properties and information beyond the graphical representation (CRC Construction innovation, 2009).

2. BIM as a process

Generic term used to describe advanced 3D CAD technology for modelling and managing buildings and information related to them. BIM models are differentiated from traditional CAD systems in that the software objects in a BIM model are intelligible to computer programs as representations of real-world building components, unlike the graphic objects in a two-dimensional CAD file". The American Institute of Architects (AIA) defines BIM as "a model-based technology linked with a database of project information".

C. Need of BIM in construction industry

Nowadays the complete specifications as well as the legally binding contract description are still paper-based. Even if prepared electronically, a set of printed documents will be produced, which can then be signed by the contracting parties. Elaborate outlines can be found in [7], [8]. Since quite a number of these specifications have been produced at different locations, with different calculation tools, sometimes on the basis of different analyzing models, and often at very different times within the total planning phases, there is a high potential for contradictions [9].

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To a great part this is implicit knowledge, not written down, or at least not yet documented in such a way that it could be transferred to the client or anchored within the common Building Information Model.

Many construction companies see this incompleteness of information as one major business goal for their business. While doing work preparation, it gives them the freedom of disposition and flexibility to act in order to look for the most efficient way to do the works for the contracted price [10].

The construction industry is often criticized for its traditional methods and it had been one of the major problem of the construction industry for sticking it with its traditional methods of construction and that's has been one of the main effect for causing various delay cost overrun as well as time overrun. So there has been a need to have a paradigm shift in the construction sector with lean production, Offsite construction as well as BIM acting as an agent for the change in the construction sector.

Henderson and Jordan (2009) defined "The BIM paradigm" as the preference of companies in the construction sector to use newer methods of construction over the traditional methods to achieve the delivery time, reduced the cost of projects and also to provide higher quality to the client. Covey (2004) described paradigm as an single phase frame of mind during resolving the problem and similar thing is happing with construction industry as well so there should be new solution to old ones in order to resolve the various problems, a new way of thinking; a process which is thought outside the confine box of traditional methods can be term as Paradigm shift (Covey, 2004).

Camps (2008) states BIM will require professional in industry to do more in the very limited time; it should be implemented in students who will be handling it future given a strong educational background. A study carried out by Azar et al., (2010)

The construction divisions especially in mechanical, plumbing and electrical arrangement because of ability of BIM to detect clashes and its ability to produce visual details. Currently around 50% of industry is using BIM and companies which are Using BIM require student who are capable and comfortable in BIM process, they don't require software expertise but understanding of BIM as a process. The Inclusion of BIM in the Contraction industry will very beneficial for the preparation of the future employees for the construction industry (McGraw Hill, 2009). The Implantation of BIM in the education curriculum will provide a strong background for students who will be using it in the future.

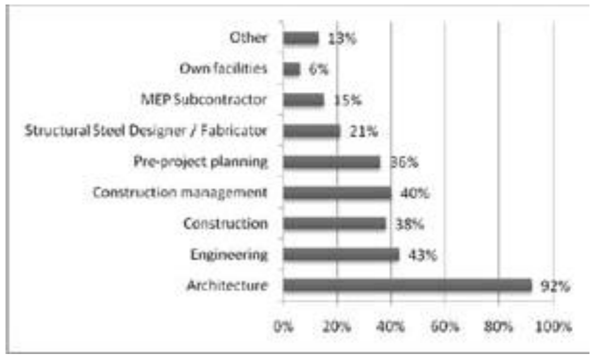
III. Results and discussion

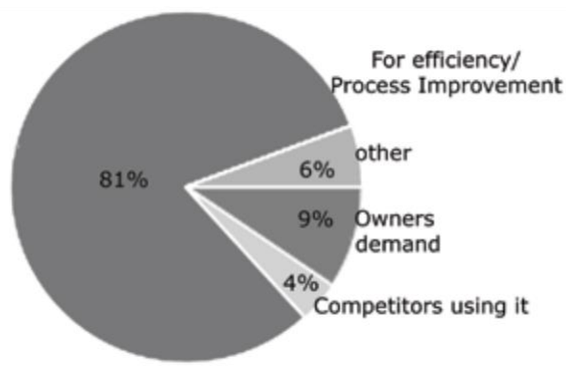
B. BIM in India

BIM application has received different levels of acceptance in different countries. In US this is not only accepted but also made compulsory to large extent. The General Service Administration (GSA) of US has initiated a requirement in 2007 for the planners to produce a BIM model for spatial program validation as an open standard if they are applying funding for their projects, (Holzer, Dominik (4)). Despite being new to the Indian construction scenario, BIM has shown strong acceptance potential here. To establish this claim quantitatively, survey methodology has been adopted.

Most of the discussion and data's are taken from the (J. Vinoth Kumar and Mahua Mukherjee (2009)) 165-169 and other few sources and results has basically been derived from these basis.

Fig. no. 2(a), (b), (c) and (d) provide base information about the respondents.





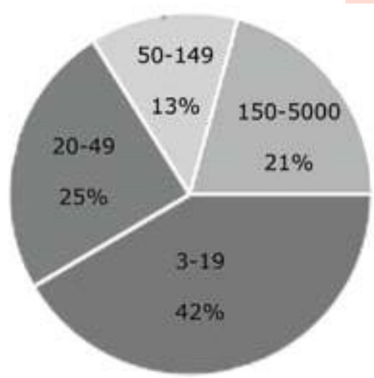


Figure 2 (a). Disciplines practiced by the respondents Firm.

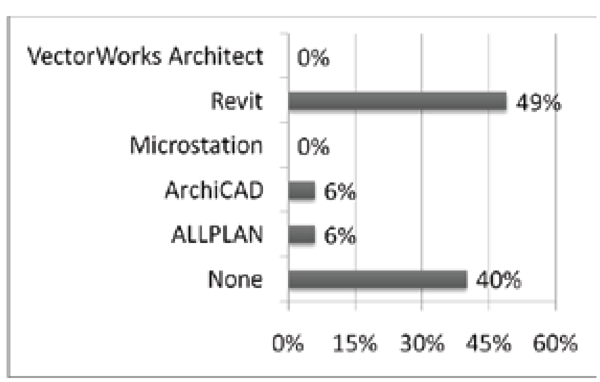


Figure 2 (b). Firm Size of the respondents.

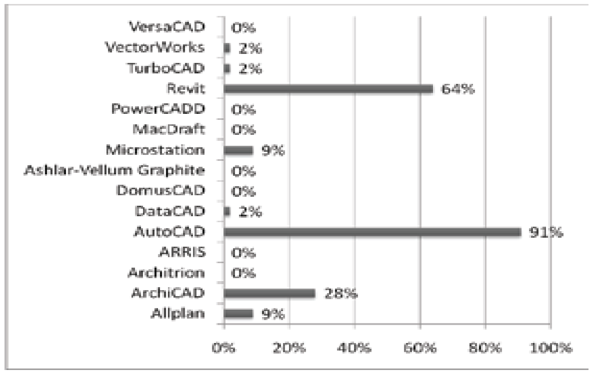


Figure 2 (c). BIM Application used in the Firm.
Figure 2 (d). Primary CAD Application practiced in the firm.
Fig. no. 3(a), (b), (c), (d), (e) and (f) provide information on reasons for non-adoption of BIM at present.

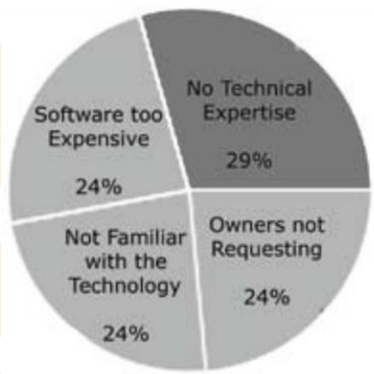
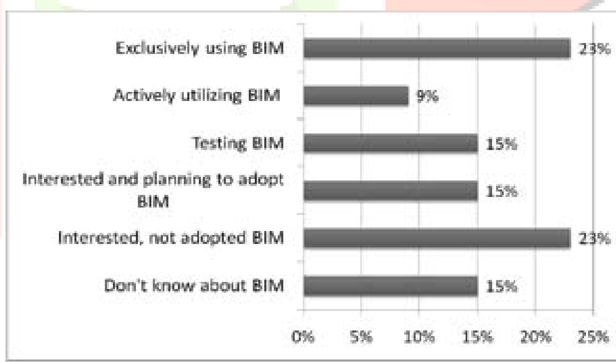


Figure 3 (a). Causes for starting BIM.
Figure 3 (b). Reasons for not using BIM.



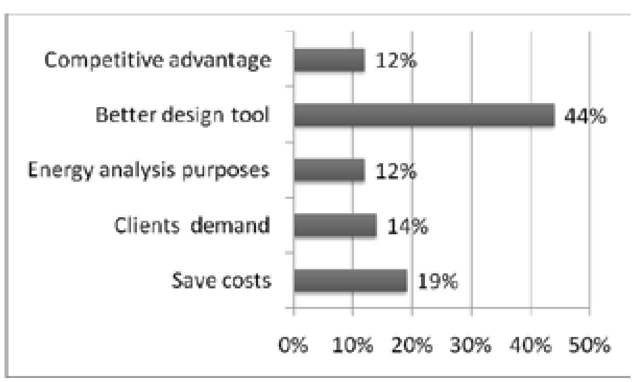
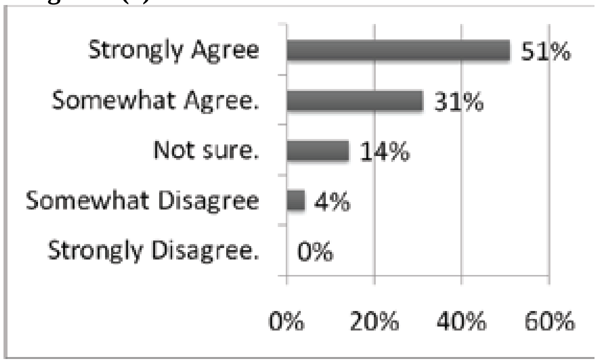
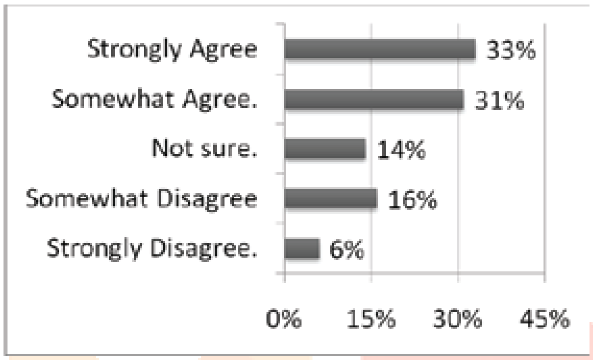
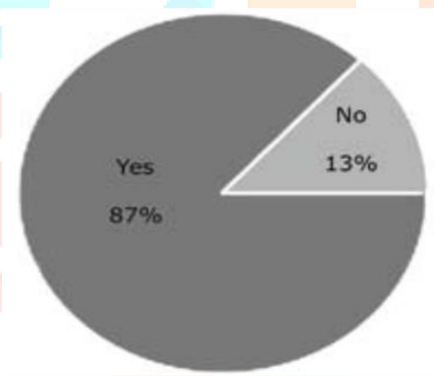


Figure 3 (c). Firm Leaders interest towards BIM.
Figure 3 (d). Reasons for the interest towards BIM.







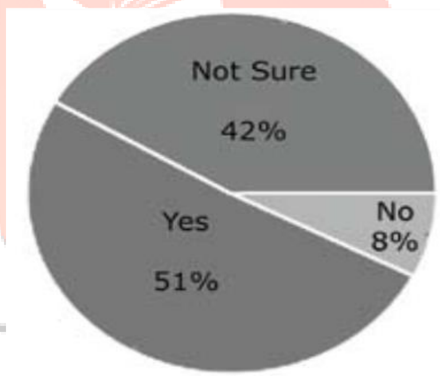
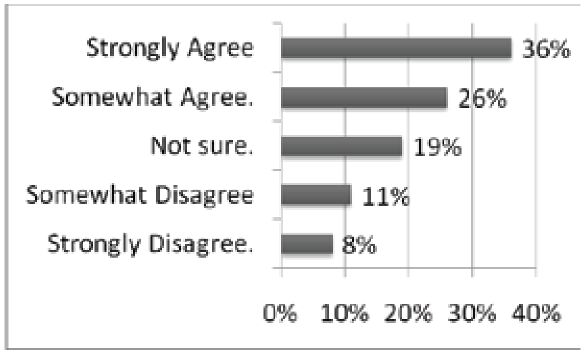


Figure 3 (e). Interested in adopting BIM workflow.
Figure 3 (f). Adopting BIM in Architecture field leads to better pay.

The main reason for not using BIM here, is the lack of technical expertise, the professional who has heard about this doesn't know how to use it, and most of them is not even aware of this methodology.

Fig. no. 4(a), (b), (c), (d), (e) and (f) provide information on BIM user's reasoning's behind the preference.



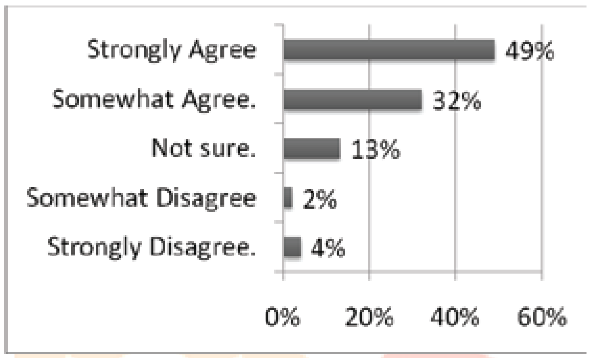
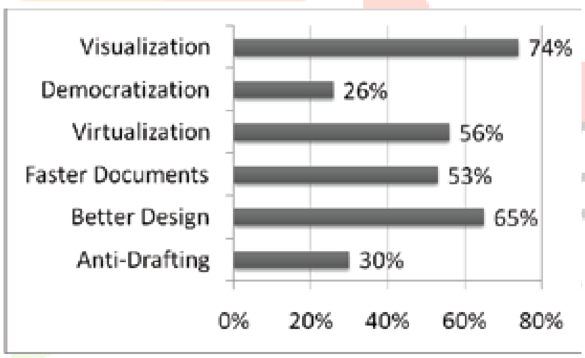


Figure 4 (a). Adoption of BIM in architecture will increase societal value for architects.
Figure 4 (b). Adopting BIM workflow will lead to better architectural works.
Figure 4 (c). Adopting BIM leads to greater efficiency.
Figure 4 (d). 2D is inefficient to true BIM workflow in the working drawing phase than 2D CAD.



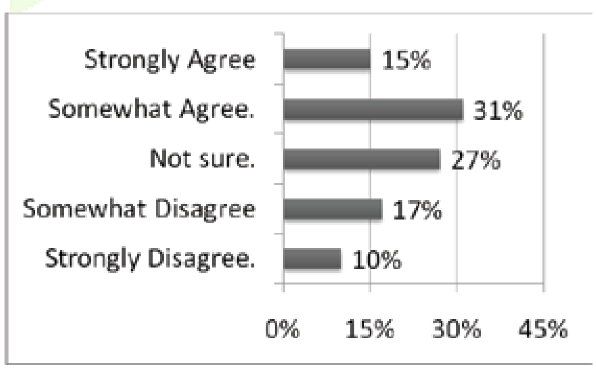


Figure 4 (e). Aspects of BIM that appeals most.
Figure 4 (f). BIM is too complex and should make it simpler.

The survey respondents also identified the barriers to incorporate BIM in their firms, like complexity of BIM, inertia to explore new technology, lack of support from clients and contractors, unwillingness to change the traditional practice, and uncertainty about BIM platform (Revit, Bentley or something else). Finally about 87% of the survey respondents volunteered that, at their respective firms, they are interested in adopting BIM.

IV Conclusion

The findings of this study suggest that there is strong perception that the application of BIM is in a very initial stage and much work need to be done. The major problems arises from lack of interest to upgrade the current trade in the construction industry. The researcher highly suggests that the concepts and practice should be associated with the curriculum in different related departments throughout the country and all the firms and stakeholders should inhabit in the concepts of Building Information Modeling, since it have to offer and it worth the few cost and extra time that will be invested to apply to the day to day construction activities and finally Building information will no longer be a future of the construction industry rather it is becoming a compulsory practice and India should be among those who uses effectively and efficiently all the benefits that obtained from it.

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