Adoption of Building Information Modeling (BIM) in India

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Abstract— The design communication is gradually being changed from 2D based to integrated 3D digital interface. Building Information Modeling (BIM) is a model-based design concept, in which buildings will be built virtually before they get built out in the field, where data models organized for complete integration of all relevant factors in the building lifecycle which also manages the information exchange between the AEC (Architects, Engineers, Contractors) professionals, to strengthen the interaction between the design team. BIM is a shared knowledge about the information for decisions making during its lifecycle. There is still much to be learned about the opportunities and implications of this tool. This study deals with the adoption of BIM application in India, to do that a survey has been designed to check the acceptance of BIM till date, while this application is widely accepted throughout the industry in many countries for managing project information with capabilities for cost control and facilities management.

Keywords: Building Information Modeling, Digital Interface, Survey

I. INTRODUCTION

Construction projects are temporary endeavors where a number of organizations come together and form a project team to deliver a project. Since a number of people such as architects, designers, project managers, contractors, sub-contractors etc. are working on a project at a time, it becomes important that there is a smooth and clear information flow between various parties. Project decisions and future plans are all based on the information available. It is important that the right information reaches the right persons at the right time. This will not only prevent conflicts but will also keep all the project members aware of the current state of play. It is important that required information is available to every party at different stages of a project. Hence flow of information plays an important role in project success. Most of the project information originates from the drawings and sketches prepared by architects. This information needs to be managed properly so that all decisions are based on updated and current information. This topic was chosen for research in order to find out how project managers perceive BIM as a potential tool of information and project management.

A. What is BIM?

"Building Information Modeling, or BIM, is a parametric 3D model that is used to generate plans, sections, elevations , perspectives, details, schedules- all of the necessary components to document the design of a building" (Krygiel et al. 2010).

It is regarded as one of the promising developments in AEC industry which allows better analysis and control throughout the various phases of a project. Eastman et al. (2011) define BIM in their handbook as a "modelling technology and associated set of processes to produce, communicate and analyse building models". Meridian Systems white paper (2008) defines BIM as a design technology with three facets. They are:

- Different systems and components of a building.
- Properties of equipment and material used.

BIM is a buzzword not only in the construction industry but also among various software developers. This usually leads to confusion about its definition. Models that provide 3D graphical representation only cannot be termed as BIM as they offer no intelligent information at object level. A BIM model essentially contains graphical information of different components of a building. In addition to this, it holds information about the material of the component, its properties, manufacturing details etc. Thus it provides a single point of information defining a building in terms of graphical representations, shape and size of components, schedules, construction time and other features.

The major difference between BIM and 2D drawings is that the latter only provides individual views of a building such as plan, elevation. 2D drawings are not efficient as Azhar et al. (2008)

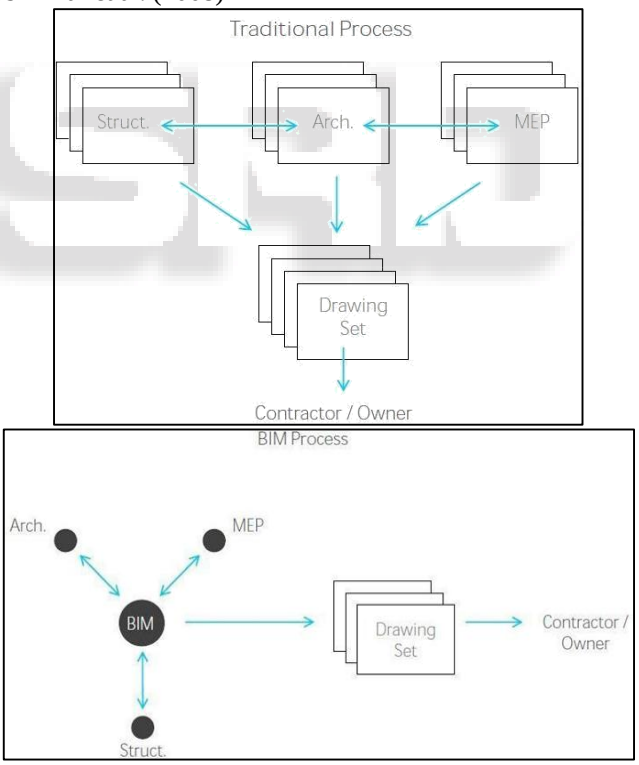

Fig. 3.1: BIM v/s traditional approaches (Source: Baker & Garrett, 2011)

Shows that making a change in one of these views will need a laborious effort to make the changes in other drawings. On the other hand any change made in any BIM object is automatically reflected to other views. With the help of BIM, 3D rendering of a building can be created. BIM also provides a common platform of information for all construction players. Figure 3.1 shows the difference between traditional approach and BIM approach. Traditional approach is more time consuming and can lead to conflicts. On the

other hand, in case of BIM, all the participants contribute towards the BIM and it acts as a common platform of information sharing

1) Different Maturity Levels of BIM

In order to understand BIM in depth, it is important to understand the various maturity levels of BIM. BIS developed a maturity model of BIM in order to understand the levels of competence expected from various professionals. It also helps to determine which level of BIM should be used to which project.

BIM maturity model is defined on a scale of zero to three (0-3). BIM maturity model and various levels are explained as below.

1) Level 0: this level represents zero maturity level. Here the main source of information exchange is paper drawings with little or no use of CAD.
2) Level 1: at this level of maturity, CAD managed two dimensional or 3D drawings are used as per BS1192: 2007. However no integration is present at this level and data is usually managed by different software's. Some standard data formats for information exchange may exist.
3) Level 2: this level represents a well-managed 3D representation as well as building data. The data at this level may be managed by an ERP. This level may have 4D or 5D models which include programming and cost data respectively. There is proper integration of data with the use of different middleware.
4) Level 3: this represents the highest level of maturity with complete data integration. Data integration may be carried out with different web services and conforming to IFC/IFD standards. This level is called as iBIM or integrated BIM level. It contains comprehensive material and component details. This model can be used in contract document and for full project coordination.

B. Importance of BIM Adoption

The potential of using BIM in all phases of the project life cycle is evident from Burcin Becerik- Gerber (2010) where the author from the survey identified, the positive impact research topics that are 'adopting BIM throughout the project life cycle', 'sustainable practices for design and construction', 'information management using BIM', 'management and organizational issues' and 'impact of ROI on Investment (ROI)'. The topics of interests that were identified by the practitioners and students for the design, construction and FM stages of the project life cycle were summarized in this paper. Practices to develop a strategy to fully integrate BIM through a framework and IPD were also specifically addressed by the practitioners that could address the interoperability in the adoption of BIM in the construction sector. Vinoth Kumar J et al (2009) analyzed the causes for starting BIM where 80% of the attendants agreed that BIM is helpful for process improvement, Application areas that were currently used in the firm where AutoCAD and Revit led with 91% and 64% respectively with 44% of the attendants agreeing BIM as a better design tool [9]. Brittany K. Giel (2013) presented a study to show a positive ROI (Return on Investment) while adopting BIM in construction projects overcoming its high initial investment cost. The benefits of adopting BIM is studied by Azhar (2011) based on the questionnaire survey attended by AEC professionals. The key findings are positive impact (82%), improved outcomes (79%), winning projects (66%) and increased usage (62%) The most frequent applications of Facilities Management responded in online surveys and face to face interviews from the survey conducted from Burcin Becerik-Gerber (2012) where 'Locating building components', the primary application identified by the BIM users (91%) and Non BIM users (69%), followed by the areas involving clash detection, maintenance of data, digital documentation, space coordination, feasibility analysis for the expansion of facility, energy analysis & monitoring and training & development.

II. Objectives of the Study

- To determine the current awareness of BIM among PMs and their attitude towards BIM.
- To identify technical and non-technical factors affecting its adoption and implementation.

III. Literature Review

Kumar and Mukherjee, (2009) states that the Building Information Management (BIM) is the documentation process. Consisting of various information's about different phases of any project like design and planning. BIM is used to major construction applications. Such as estimating, scheduling, design coordination and operational visualization. Visualize the works like mechanical, electrical and plumbing (MEP) in the building systems may possible. In India by conducting the various survey and analysis reports the BIM is gaining acceptance by the owners, architects, engineers, and builders. Barlish and Sullivan, (2012) this research was carried out to establish metrics and benchmarks to assess overall performance and benefits derived from BIM. By evaluating resultant information to quantify benefits and costs with BIM utilization, through established return and investment metrics (Design and Contractor cost). In a project trying to determine if BIM will benefit for construction industry. This research results present a valid framework methodology and baseline. The metrics for collection presented in the study provide a starting point for the stakeholders to begin their analysis in BIM based constructions. Koniget al, (2012) this paper revivals simulation approaches to support construction scheduling by Building Information Modelling (BIM). Different kinds of planning data have to be analyzed and integrated. To perform the realistic and suitable simulation, like building information models, bill of quantities, framework schedules, delivery dates, or available resources. Major challenge in specification process is error-prone and often small variations of the input data lead to extensive modifications. BIM makes an intelligent concept to store interdependencies between activities in order to reuse them for handling modifications and different alternatives. Finally the correctness of the interdependencies can be checked and visually highlighted. Sainiet al, (2013) this paper states that, the Architecture, Engineering and Construction (AEC) industries have long sought techniques to decrease project cost, increase productivity and quality, and reduce project delivery time. So AEC makes effective planning is one of the most important aspects of a construction project and influences the success of

a project. Utilization of 4D modelling is the integration of a 3D model with a construction schedule in order to visualize the sequence of activities. Through the various analyses, finding the BIM based construction is an effective method. BIM based schedule promotes interaction and collaboration among the project team members from different fields of construction. Elbeltagiet al, (2014) in this paper, a comprehensive cost estimating and monitoring model is presented and integrated using BIM. To provide the user with the capability of visualizing actual cost expended in different building elements and compare it with that budgeted at different time intervals. BIM depends on using commercial software packages such as Microsoft Project and Microsoft Excel. Microsoft Excel provides the capabilities needed to reduce and analyze of the input data and output results.

So the proposed system will be able to perform the estimate and monitor at different levels. A visualized cost estimate/cost control model provides reliable features to architects, owners, engineers and contractors in the construction industry. Smith, (2014) the main objective of this study is focus on the implementation strategies that are being successfully used by countries leading in the construction field. BIM evolves and construction process increasingly become automated the role of construction professionals will need to adapt accordingly to provide more sophisticated services that incorporate 3D, 4D time, 5D cost modelling and 6D facilities management and sharing cost information data with the project team as part of the BIM integrated delivery approach. Investigation was to determine best practices and innovative approaches being used around the globe. BIM has better position in capabilities and initiatives to evolve. Tizani and Mawdesley (2011) suggest that construction industry is continuously trying to improve efficiency by increased use of computers and IT systems. However the adoption of new technologies to handle data has been different within different groups of construction industry. This may be due to specialised need of each group or some groups are reluctant to move away from traditional method of working. On the other hand, a project manager has to manage data emerging from different parties involved in a construction project. This is not an easy process and project managers must spend a lot of time and resources to gather this data and manage it efficiently. In order to assist project managers in this task, various project management systems are being used. Various softwares are used to manage projects which involve use of Gant Charts, PERT (Project Evaluation and review technique) and Critical path Method (Kerzner, 2009). According to Wu and Hsieh (2012), these available tools can be divided into two categories. One includes commercial softwares developed by different companies such as Microsoft Project, Oracle's Primavera and so on. Other types include those that are developed by companies themselves to suit their particular needs. However these tools have certain shortcomings which can affect the work of a project manager. Interoperability of data between different software's may not be possible and thus adds to problems.

IV. RESEARCH APPROACH

Naoum (2007) points out that qualitative research can be classified into exploratory and attitudinal methods. He argues that exploratory method should be adopted when researcher has limited knowledge of the topic and needs to discover new ideas. While as attitudinal method should be adopted when a subjective view or perception about an object is required. By taking into account the aim of this study, which is identify the challenges involved in the implementation of BIM among project managers and the perception of PMs towards BIM, attitudinal method appears to be most appropriate.

In order to address the objectives of this research a survey questionnaire was drafted based on the lines of attitudinal method. However some of the questions appear to be exploratory in nature, the aim of such questions is to identify the issues more precisely.

V. DATA ANALYSIS & INTERPRETATION

The questionnaire was sent to Various Project Managers working in different construction companies. Out of these a total of 45 responses were received within the two weeks of the survey. However it was found that only 38 responses were complete and qualified to be used for analysis. Thus 38 complete responses out of 110 puts the response rate at 35%. This response rate is very encouraging considering the busy work environment of the industry and the time frame given. It was decided that no reminder would be given to the rest of the sample as a reasonable response rate was achieved within the stipulated time. The respondents are all project managers belonging to different organisations within the construction industry.

It was necessary to obtain varied data so that project managers working within different organisations such as Project management Consultancies, Contractors etc. can be represented in the sample. The response rate and the demography of the respondents is represented in the following figures.

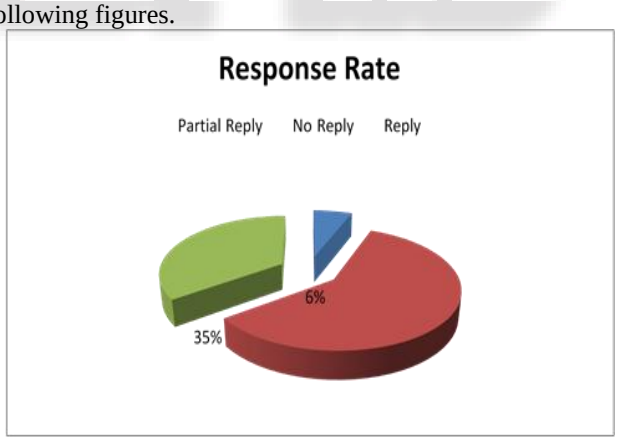

Fig. 4.1: Rate of Response

In order to classify the respondents, a question was asked about the level of experience they possess. This was done in order to ensure that the respondents represent both junior as well as senior level project managers. This would help to contrast the responses on the basis of experience. The organizational distribution of the respondents is represented as below:

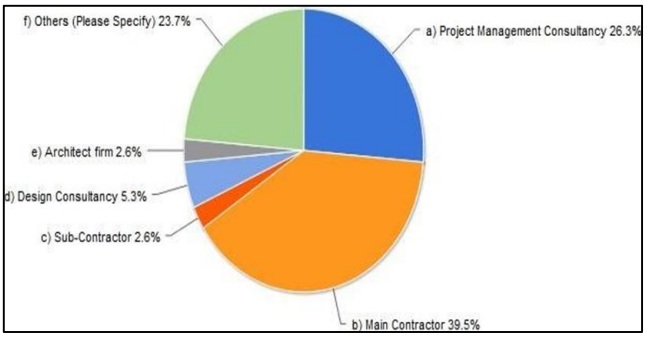

Fig. 4.2: Organisational distribution of respondents

Thus the highest number of respondent PMs work for main contracting companies (39.5%) followed by Project Management consultancies (26.3%). Sub-contractor PMs represent the lowest number of respondents at 2.6%. The word "others" in the figure represents the project managers working within client groups, government departments or as freelance project managers. In this way the sample represents PMs from different organisations and it would be very helpful to draw an overall picture of BIM implementation within the Indian project management practice. The respondents are also classified on the basis of their experience in figure 5.3. It shows that a majority of the respondents (71%) are senior project managers with a work experience of more than 10 years. However there are respondents with a medium level of experience and those with low experience as well. This makes the sample more realistic and will help to analyse the subject matter in more appropriate way.

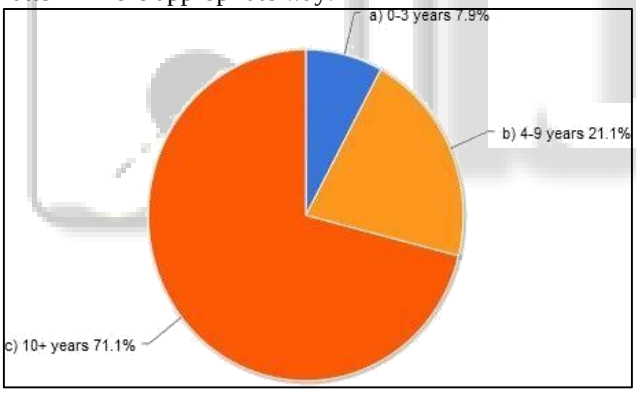

Fig. 4.3: Experience levels of the Respondents

A. BIM Awareness among PMs

The questionnaire was divided into various sections, each section aiming to answer each research objective. Section B of the questionnaire contained questions to understand the awareness of BIM and the UK BIM strategy among project managers. The first question asked about the awareness of BIM within their respective organisations. Three options were provided for this as mentioned in appendix B. Out of the 38 respondents; 28 were "aware of BIM but not using" it while as only 9 were "aware and using BIM". Only one respondent was not aware of the BIM at all. In other words, there is a good awareness of BIM among project managers but a large proportion (73%) is not using it although being aware of BIM. The results are shown in the table 5.1. The results of this investigation support the findings of NBS survey (2011) where it indicates that only 31% are currently using BIM.

Awareness	Count	Percent	Statistics
Aware and using BIM	9	23.7%	Total responses = 38
Aware but not using BIM	28	73.7%	
Not aware about BIM	1	2.6%	

Table 4.1: BIM Awareness

However the figure quoted in NBS survey (2011) represents whole of the industry involving other professions as well. The same figure stands at 24% when only PMs are considered. This also supports the RICS (2011) findings that project managers are lagging behind in the adoption of BIM.

Another question was asked to know at which level, those professionals currently using BIM, stand. The investigation showed that only 10% were currently using BIM at level 2; the level required to be adopted by 2016 according to the UK BIM strategy. While as 84% were still at level 1 or level 0. This means that although some project managers are using BIM, but mostly are not present at the level what the UK BIM strategy demands.

B. Perception and Attitude of the PMs towards BIM

A question in the survey asked whether the project managers consider BIM as an effective management tool. The results show that 46% of the respondents strongly agree with the view that BIM can be highly useful to deliver projects successfully and it can be a highly useful tool.

Another 38% of the respondents also agree that BIM is highly useful for project managers. Only 4% of the respondents disagreed with the statement while as 5% showed neutrality towards the usefulness of BIM. The results are shown in figure 5.4.

An interesting finding here shows that those who are currently using BIM strongly agree to this statement (6 out of 7 those currently using BIM) while as those not using BIM currently either agree or they are not in a position to determine its usefulness at the moment. Only one respondent currently using BIM disagreed with the view.

One of the important things the investigation revealed is that the respondents who reported that they are currently using BIM are of the opinion that BIM is highly useful for Project Managers. The table 5.2 below shows the cross comparison between those who use BIM and how useful they find BIM. The results show that out of 8 users, 7 strongly agree with the statement.

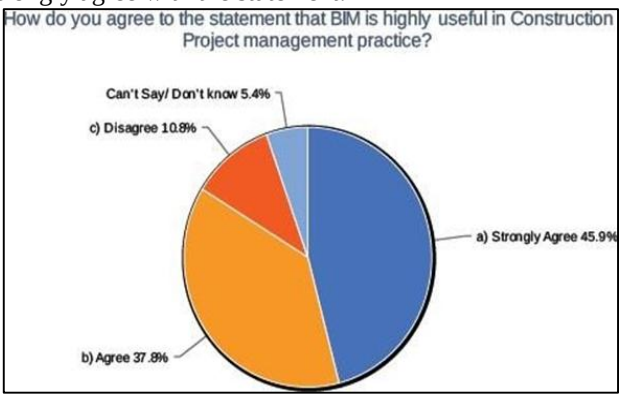

Fig. 4.4: Usefulness of BIM in Project Management Practice

How much do you agree to the statement that BIM is highly useful in Construction Project Management practice?						Total
Level of awareness about BIM	Strongly Agree	Agree	Disagree	Strongly Disagree	Neutral/ Can't say	38
Aware and using BIM	7	1	1	0	0	9
Aware but not using BIM	11	13	3	0	1	28
Not aware about BIM	0	0	0	0	1	1

Table 4.2: How BIM users rate utility of BIM

A number of statements were provided in the questionnaire and the respondents were asked whether they agree or disagree with the statements. Table 5.3 shows the list of statements along with the percentage of agreement or disagreement between the respondents. The table depicts that a vast majority of the respondents are of the opinion that BIM will improve the productivity and profitability of projects. This is in agreement with Yang et al. (2011) that IT tools can improve productivity of the projects. This also supports the view of Shen and Chua (2011) that BIM can improve profitability by providing better project control and effective planning and scheduling.

The investigation shows that project managers employed by main contractors seem to disagree to some extent that BIM improves collaboration and removes errors and conflicts. Out of 14 PMs Working for contractors, 5 are of the opinion that BIM doesn't help to remove errors. On the other hand PMs working in consultancies tend to agree more that BIM is useful.

BIM attribute	Strongly Agree	Agree	Disagree	Strongly Disagree	Neutral/ Can't say	Total (38)
Using BIM will improve productivity and profitability	28.9% 11	47.4% 18	10.5% 4	5.3% 2	7.9% 3	38
BIM is just a buzzword and really not necessary	2.6% 1	10.5% 4	50.0% 19	31.6% 12	5.3% 2	38
BIM is too expensive at the moment	13.2% 5	34.2% 13	42.1% 16	2.6% 1	7.9% 3	38
I would rather not adopt BIM	5.3% 2	5.3% 2	47.4% 18	34.2% 13	7.9% 3	38
BIM is not needed for Project Managers.	5.3% 2	7.9% 3	47.4% 18	31.6% 12	7.9% 3	38

Table 4.3: Perception of BIM among PMs

The table also shows that the professionals are ready to adopt BIM. The results show that 81% of the respondents disagree to the statement that they would rather not adopt BIM. This is in contrary to such views which suggest that project managers do not want to do away with traditional style of working and are reluctant to accept new ideas. However few of the respondents seem to be very reluctant to try new ways of working. But most of the respondents hold a very positive attitude towards BIM. Some of the comments of the respondents that are beneficial to this discussion are mentioned below. These comments show the contrasting attitude of the professionals towards BIM. Project manager with more than 10 years of experience in project management commented as: "Within my organisation there is a very positive attitude towards implementing BIM. BIM provides an excellent tool to make the whole construction process more efficient"

Project manager with more than 10 years of experience working for a large contacting company: "you cannot build by numbers, just because a computer says it will fit and will take X hours, does not work in real time, buildings are bespoke with a transient workforce and therefore trying use production and manufacturing logic and technology will not work. Same is the case with BIM"

Senior client project manager with extensive experience of project management: "There is no money in construction for a new unproven method of working. So I do not agree BIM can be used or implemented in such circumstances".

Main obstacles and Challenges Identified by the Indian PMs Whenever a new technology is introduced into any industry, it is always accompanied by various challenges that need to be overcome. However according to Tizani and Mawdesley (2011) the process of overcoming challenges is important as it makes the technology simpler and easy to use and adopt. One section of the questionnaire (appendix B) comprised of questions that were asked to understand the problems perceived by PMs in the path of holistic BIM adoption among them. A number of statements were provided regarding various difficulties or obstacles that were identified from the literature review. The respondents were asked whether they agree or not about the mentioned statements. Table 4.4 shows the list of statements along with the respondent answers.

Obstacle	Strongly Agree	Agree	Disagree	Strongly Disagree	Neutral / Can't say	Total
High cost of investment for software & hardware	31.6% 12	44.7% 17	21.1% 8	2.6% 1	0.0% 0	38
Lack of required Training	39.5% 15	39.5% 15	21.1% 8	0.0% 0	0.0% 0	38
Lack of standards and Protocols	36.8% 14	26.3% 10	26.3% 10	5.3% 2	5.3% 2	38
Interoperability of	31.6%	28.9%	26.3%	2.6%	10.5%	38

different software	12	11	10	1	4	
Lack of client demand	28.9% 11	44.7% 17	26.3% 10	0.0% 0	0.0% 0	38
Lack of management Support	23.7% 9	34.2% 13	34.2% 13	7.9% 3	0.0% 0	38
Reluctance to adopt new methods	21.1% 8	28.9% 11	39.5% 15	10.5% 4	0.0% 0	38
Legal requirements and Intellectual property issues	7.9% 3	28.9% 11	55.3% 21	5.3% 2	2.6% 1	38

Table 4.4: Major obstacles in adopting BIM

C. Lack of Training

From the above table it can be seen that "Lack of required training" has been identified as the biggest obstacle with 39.5% respondents strongly agreeing to it and an equal percentage agreeing to it.

One of the respondents from a project management consultancy mentioned "the time and effort required to master BIM by CAD technicians is a major challenge. In some cases the company is not ready to invest for training while in others the technicians are not ready to give up old CAD".

The findings show that there is a lack of education, training and support for practitioners in order to move towards integrated BIM working. The results are also in agreement with Yan and Damian (2008) that the construction professionals have a habitual resistance to change as some of the PMs are happy to continue with their own way of working and are sceptical about the benefits BIM can bring.

D. High Upfront Cost & Lack of clear evidence about BIM benefits

It can also be seen that the second and the third major obstacles identified include high initial cost for BIM and lack of client demand respectively. The respondents were also asked to mention any other specific obstacles which they believe are major issues. Some of the respondents mentioned "culture of the industry", "lack of tangible data about BIM benefits" "clients lack awareness", "mind-set", "commercial restriction due to contracts" and "interconnection with other PM processes" as major challenges.

One of the comments of a senior project manager worth mentioning here is "There is a difficulty in identifying tangible savings to be derived from the use of BIM. In a market where cost is king it takes something of a leap of faith to invest in BIM. Sadly it's possible to see the upfront cost of BIM but the real saving is against risk in that you eradicate clashes and building constraints i.e. the benefit is expressed as savings against costs you would have expended but for BIM".

This comment supports the argument of Barlish & Sullivan (2012) that the benefits derived from the utilization of BIM have not been clearly established yet and the case studies mentioned in literature are not easy to compare. Gerber and Rice (2010) also mention that the literature available about the outcomes of BIM fail to examine and establish the costs and benefits of using BIM on a project. According to Yan and Damian (2008) many industry members are not able to ascertain the benefits that BIM is capable of bringing. It appears that the construction industry is not ready to put money in BIM because there is not tangible evidence available about the financial benefits of

BIM. Thus it gives rise to situation where the professionals are not able to decide whether to adopt BIM or not. The investigation shows that most of the PMs perceive BIM as costly technology which requires a lot of finance, time and effort to be implemented. McGraw Hill (2009) survey tried to overcome this problem by emphasizing to record the ROI (return on investment) on BIM. However according to Gerber and Rice (2010) the results are still not useful as they are not present in tangible form and are not easy to evaluate and compare.

E. BIM in the Future

BIM in the next two years

The final section of the questionnaire asked the respondents to identify, what in their opinion are the main drivers to implement BIM in project management practice and what can promote BIM more rapidly. The first question in this section asked whether the respondent organisation is going to adopt BIM in the next two years or move to a higher level of BIM. The results show that 58% of the respondents are going to adopt BIM or move up the level in next two years. On the other hand 16% responded negative and another 26% are not sure about it. It means that just a bit more than half of the professionals are going to adopt BIM in the coming years. Thus adoption of BIM still remains a challenge for almost half of the respondent PM professionals. An interesting correlation here is that out of the 9 respondents who regarded lack of management support as a strong barrier, only 2 respondents believe that they will adopt BIM in the next two years whereas 7 of them would not implement BIM. Thus the overall attitude of the organisation and senior management plays a very important role and needs to be supportive for rapid implementation of BIM.

Another question was asked to determine the opinion of the professionals about the gap in adoption between PMs and other construction professionals. The respondents were asked whether they believe or not that the PMs can close this gap in the next two years. The results are somewhat similar to the above question. Only 53% respondents believe that PMs can close the gap of adoption while as 29% are of the opinion that PMs will not be able to do so. Another 18% of the respondents replied that they cannot say about it. Thus there is still a lack of long term policy and vision in order to adopt BIM. One of the vital comments about the future adoption of BIM made by a senior Project manager is as follows:

"In some respects the argument for BIM ought to be the opportunity cost of not adopting and consequently being excluded from future public procurement. Business leaders

need to trust their instincts and run with BIM, everything points to BIM having a positive impact on construction so back it and look to see what programme savings, risk reduction and general efficiency benefits arise from its use". Here again the respondents who feel lack of management support are of the view that PMs will not be able to close the gap in adoption in the next two years. Thus the results are in somewhat agreement with Chwelos et al. (2000) who believes that internal readiness is of utmost importance in order to adopt a new technology. This is also in agreement with the view of Arayici et al. (2011) who argue that management support is critical for the implementation of BIM.

F. Main Drivers of Adoption

A number of drivers for promoting the adoption of BIM were identified from the literature review and were presented in the questionnaire. The respondents were asked to what extent they agree or disagree about the said drivers as being main drivers for pushing the rate of adoption of BIM. Table 4.5 below shows the survey results.

Driver for Implementation of BIM	Strongly Agree	Agree	Disagree	Strongly Disagree	Neutral/Can't say	Total
Better integration & Collaboration of project teams	39.5% 15	39.5% 15	10.5% 4	5.3% 2	5.3% 2	38
Improved information flow and communication	39.5% 15	39.5% 15	10.5% 4	5.3% 2	5.3% 2	38
Better planning and Scheduling	31.6% 12	44.7% 17	13.2% 5	5.3% 2	5.3% 2	38
Reduced conflicts and errors	42.1% 16	26.3% 10	21.1% 8	5.3% 2	5.3% 2	38
Govt. push due to BIM strategy	39.5% 15	28.9% 11	23.7% 9	2.6% 1	5.3% 2	38
Client demand	21.1% 8	31.6% 12	28.9% 11	13.2% 5	5.3% 2	38

Table 4.5: Main Drivers for BIM

From the table above, it is clear that "better integration and collaboration" and "improved information flow and communication" are the considered as the main drivers for implementing BIM. Also 42% of the respondents believe that BIM can "reduced errors and conflicts" is one of the important drivers. This is in agreement with the findings of McGraw Hill study (2010) about BIM in Europe.

The investigation also shows that client demand is least effective as a driver to implement BIM. This also supports the earlier findings of this study where lack of client demand is seen as an obstacle to use BIM in project management practice. It can also be realised from some of the comments of the respondents working as project managers for clients:

- A senior client PM commented: "I work for client organisation and this (BIM) is not very well known. There is lack of knowledge among clients about what BIM is and what it does"
- Another PM working for a client: "There is a pseudo claim that it (BIM) increases costs and creates interconnection issues with other PM processes. So my client never asked to use BIM".

This supports the argument of Mitropoulos and Tatum (2000) that lack of information keeps the constructional professionals away from using new technology and the lack of client demand is also highlighted by RICS survey (2011).

G. How to increase the adoption of BIM? Need of More Awareness

The last question in this section of the questionnaire investigated the opinion of the respondents about the steps that can be taken to promote BIM and assist in its rapid uptake within project management practice in the UK. The investigation shows that the respondents believe that there is a need to spread more awareness about BIM. 35 out of the 38 respondent project managers either agreed or strongly agreed that more awareness about BIM will promote its uptake. In order to overcome the obstacles it is important to demonstrate the potential benefits of BIM to the project managers.

H. Training

There is a need to provide proper training also. 47% of the respondents strongly agree to the statement that better training can promote BIM within PMs and another 37% also agree to this view. Most of the professionals perceive BIM as a difficult tool to master. In order to overcome this issue, it is important to demonstrate in a way described by Arayici et al. (2011) as "learning by doing". Thus in order to implement this change successfully, there is a need of training inside and outside the organisation.

I. Proper Roadmap and Funding

The respondents also identified that there is a need of funding to promote adoption of BIM. This is especially important for small and medium sized organisations which may not be able to see the benefit in investing money for the upfront software and hardware cost as well as training costs.

The author supports the view of Shen and Chua (2011) who suggested that financial considerations are more critical for small players in the industry. The respondents believe that a proper roadmap for each individual organisation can help to promote BIM and improve the chances of implementation. However this approach needs a strong and dedicated leadership backed by full support of higher management. The investigation shows that the respondents rate funding requirement and a proper road map equally important. A comparison between organisations will small number of employees and organisations with large number of employees shows that both equally feel the need of a proper road map. Table 5.6 shows the comparison between various organisations. This again points out that top

management has a vital role to play in the successful adoption and uptake of BIM in the coming years.

How much do you agree that a proper roadmap will best promote or has promoted the adoption of BIM in your organisation?					
No. of employees in your organisation	Strongly Agree	Agree	Disagree	Strongly Disagree	Neutral / Can't say
0-49	4	4	1	0	0
50-199	3	2	3	0	0
200-499	0	2	2	0	0
500+	7	11	1	2	0
Total	14	19	7	2	0

Table 4.6: Need of Proper Roadmap

VI. CONCLUSIONS

This research examined the implementation of BIM among project managers in the Indian construction Sector. BIM has been around for a while now and many construction projects have been delivered successfully with the help of BIM. It is a technology which has a potential to integrate the fragmented construction industry and improve productivity and collaboration among the industry players. This research set out to find the current status of implementation of BIM among PMs, identify the current opinion and attitude of PMs towards BIM, determine technical and non-technical factors affecting its implementation and suggest some measures to improve adoption among PMs.

This research has explored the current state of awareness and attitude towards BIM among the Indian projects managers. The survey focused on projects managers only because they have been lagging behind in BIM adoption as compared to other construction professionals. The study shows that a majority of the respondent PMs are aware of BIM and the Indian government BIM strategy. Although considering BIM as highly beneficial in project management practice, the study shows that only a small proportion of the professionals are using BIM. The findings show a mixed attitude towards BIM with majority having a positive attitude while as a few considering it as an immature technology. The comments of the respondents show that there is a high level of agreement among the respondent PMs that BIM improves integration, promotes collaboration and reduces errors and conflicts. Those using BIM at the moment describe it useful in promoting collaboration, information flow and flawless working.

The study reveals that the most critical factors affecting the adoption of BIM include the perception of high upfront software and hardware cost, absence of proper training, inadequate management support and lack of demand from the construction clients. The response of the respondents clearly shows that absence of quantitative benchmarking about BIM benefits and lack of management support are among the biggest hurdles that need to be overcome. The top management does not find a strong business case in BIM due to lack of quantitative data about the benefits that can be derived from it. It also shows that the respondents working for smaller companies are more concerned about the cost of hardware, software and training required to adopt BIM.

The research indicated that in order to increase the rate of adoption of BIM and promote it widely among the project managers, there is a need of systematic efforts. These efforts primarily include spreading more awareness about the potential benefits of BIM, providing training to new graduates and existing professionals, developing stronger business case of BIM for the higher management of construction companies and provision of financial incentives for smaller companies. There is also a need to benchmark the benefits of BIM which can be easily understood by the potential users. It can be concluded from the findings that PMs can close the gap in adoption of BIM with other professionals if they are provided with financial backing and proper management support.

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