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Investigation of BIM Adoption in India

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***Abstract*:- Building Information Modeling (BIM) is one of the most promising intelligent 3-D based model which helps to improve the process of design management and construction. The built environment sector is one of the largest and fastest growing industries in India. But majority of the architects and designers in our nation are still in the transitional stage from traditionally practiced 2D software's like Autodesk to an integrated 3D digital interface. This study is aimed at assessing the current status of BIM adoption in India by the AEC (Architecture, Engineering and Construction) and how it is been implemented and the challenges faced by the BIM users. The author conducted semi-structured interviews in Bangalore architectural firms to exemplify the usage of BIM's application and to identify the constraints from industry professionals in order to determine the drivers and barriers in the application of this model.**

Keywords: Building Information Modeling (BIM); architectural firms, Indian architects

INTRODUCTION

The construction industry in India has played a leading role and a major contributor to the country's economy. It is an investment led sector and it contributes more than 5% to India's GDP. Developing an effective communication is a prerequisite and plays a vital role in successful execution of any projects, especially more so for complex real estate projects that involve large number of people in the project ecosystem. A vast majority of construction projects are highly fragmented with different teams working in silos, often with little or no synchronization or co-ordination. Creation of built environment assets and employment generation by the sector can significantly impact India's growth rate story in the field. However, there are several challenges being faced by the Indian built environment sector currently. It is flawed by delays, cost overruns, quality issues and other inefficiencies in the delivery process. This can be majorly attributed to the current work practices, inefficient processes and lack of information sharing among industry stakeholders. With the given volume of construction India has to undertake, it cannot be business as usual.

Two- dimensional drawings (manual or computer generated) and set of documents that are prone to errors and contradictions are the basis on which traditional construction is carried out. This has become an outdated paradigm due to the increasing complexity of the design, construction, operation and maintenance of modern built environment assets.

Globally, a remarkable development is being experienced in the built environment sector in the form of Building Information Modeling (BIM). BIM, which is also known as Virtual Design and Construction (VDC), is a process that uses smart and computable multi-dimensional model of the project to enhance its design, construction, operation and maintenance. BIM helps in reducing cost and time and increases other broader efficiencies and hence it is gaining popularity in the global built environment sector. BIM has managed to remain one of the hot topics among both practitioner's and researcher's community in the last decade. In between 2004 and 2014, 975 academic papers were published in the area of BIM, states a recent study. (Yalcinkaya& Singh, 2015). Impressed with the results, governments worldwide, especially those of developed nations, are taking stronger steps to increase the adoption of BIM. For example, the UK has prepared a BIM strategy for their Government Construction Client Group to help in reducing capital cost and the carbon burden from the construction and operation of the built environment by 20 percent.

With this type of potential for improvement, India too can gainfully deploy BIM for its built environment sector. This has been no such deployment as of yet. In spite of India standing to significantly benefit from it, BIM adoption has however, still remained low.

WHAT IS BIM?

As stated by the McGraw Hill Construction (2014), BIM helps in reducing rework and clashes. It also helps improve productivity and reduce the overall project duration. BIM has also been portrayed as a 'change agent' with benefits including added value to clients (McGraw Hill Construction, 2014). The rate at which BIM is being adopted varies globally. With India standing amongst the lowest, with just 10-18% being its BIM adoption rate as compared to 71% users of BIM in United states alone (Sawhney, 2014), it might not really be appropriate to apply the previous findings and data to the Indian context.

The use of 'smart' and 'computable' three- dimensional (3D) model of the project to enhance its design, construction, operation and maintenance is what BIM basically is. There are various definitions of BIM, but the latest and the most concise definition is by the UK Building Information Modeling Task Group that states, "BIM is essentially value creating collaboration through the entire lifecycle of an asset, underpinned by the creation,

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collation and exchange of shared 3D models and intelligent, structured data attached to them."

In the journey of continuous design improvement, construction, operation and maintenance of our built environment, BIM is playing a significant role in transforming the industrial landscape. BIM is also helping aid with better visualization and cognition of design by minimizing design errors, facilitating in better planning of constructional activities, supporting the process of construction and providing a data-rich platform for facility operation and maintenance. It is also serves as a strong collaboration tool that helps the project team in working together and collaborating to deliver better built environment assets. The propositional value of BIM is that it integrates all the lifecycle phases of a project and has the potential to benefit all stakeholders linked with the project. It enhances creativity and innovation among architects, designers, and engineers. Eventually, BIM will also benefit the facility management team by allowing data-driven operation and maintenance of the asset throughout its lifetime. BIM is not just a software tool or simply a technology that can be acquired and implemented like various other software's. It serves as an exemplar that combines technology with people and processes issues of our industry to establish a result in the tectonic shift of the way we deliver in the built environment. The adoption of BIM requires deep commitment and a holistic approach. While the numerous potential benefits of BIM to people, projects, organizations and the overall sector are significant, it also requires the leaving behind of archaic and deficient work practices and that are usually associated with thought processes. BIM helps transforms the way we design, construct, operate and maintain our built environment.

WHY IS BIM IMPORTANT TO THE INDIAN BUILT ENVIRONMENT SECTOR?

The Indian built environment sector serves as one of the key pillars of the Indian economy. It is the second-largest employment generator as it acts as a major stimulant of growth across the nation and this sector considered to be an important component for India's infrastructure and industrial development, and possesses the ability to grow further due to economic development, industrialization, and urbanization. As per the Planning Commission, the contribution of the sector towards the GDP has increased from 6.1 percent in the year 2002 to 6.9 percent in the year 2006 and has been above 8 percent since the year 2007 despite the global slowdown. Over the next decade, India should continue to be among the fastest growing countries worldwide, in terms of construction output.

Currently, the Indian built environment sector is facing many challenges. The lack of standards and low use of technology across the construction supply chain is one of the many shortcomings, as highlighted by the country's Planning Commission. Numerous reports are available that demonstrate how the sector is confronted by many problems, including time and cost overruns, distrust among the industry stakeholders, inefficiencies in the delivery process and skills deficit. Faced by these problems, there is a need for the sector, government and academia to collaborate to identify and enforce major systemic improvements that would help eradicate these problems.

Traditionally, design in the built environment sector has always relied largely on two-dimensional (2D) drawings (plans, elevations and sections). Its reliance on this "unintelligent", static, and error-prone information has made design, construction and operation of buildings inefficient. Due to the complexity of the design, construction, operation and maintenance of modern built environment assets, this outdated methodology is no longer tenable. Projects frequently suffer from factors like adversarial relationships, low productivity rates, high rates of inefficiency and rework, frequent disputes and lack of innovation, resulting in time or cost overruns in several projects.

BIM aims to change the situation for the betterment of project delivery. In fact, BIM extends the capacity and influences the project team to start thinking about time, cost, quality, sustainability and other pragmatic parameters in the early stages of the project. It expands the project teams' line-of-sight beyond 3D, augmenting the three primary spatial dimensions (width, height and depth) with time as the fourth, cost as the fifth, and sustainability as the sixth dimension (visionaries now predicting it to the 'nth' dimension!).

GLOBAL PERSPECTIVE ON BIM

Globally, BIM is finding an increase in attention from the construction sector. However, the level of maturity in using BIM differs from region to region. The United States of America continues to be the leader in the usage of BIM and is evolving rapidly. Though the United Kingdom started late, it has picked up its pace in BIM adoption. Adoption in Australia is also impressive with the high usage reported by professionals. In Europe, the use of BIM is seen in almost a third of the projects. Emerging economies worldwide, such as the Middle East, China and India, are still lagging behind in BIM adoption and are facing similar challenges, including lack of experienced professionals and high cost. The following summarizes the current status of BIM adoption globally:

STUDY OF BIM ADOPTION IN INDIA

The main objective of this study was to ascertain and to understand the current status of BIM adoption in India. For the purpose of investigation the author not only to analyze the current state of BIM implementation but also to assess the mind-sets of the industrial experts with respect to the future of BIM in their respective organizations. Broadly this was done by first establishing the current state and then by focusing on: (a) drivers for the implementation of BIM in India; (b) barriers faced while implementing BIM in India; and (c) perceived benefits of BIM implementation. Guided by this over-arching goal the study arrived at the following key aspects:

1. Extent of current BIM usage in India: data was collected relating to "who is using BIM" by identifying: (a) type of companies; (b) size of companies; and (c) location of the companies

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2. Purpose and level of BIM implementation: data was collected on the declared aim of BIM usage and the functional aspects of BIM implementation adopted by the companies
3. Benefits of BIM usage: considerable benefits of BIM were identified from the sub-group of respondents who were either using BIM or were considering the use of BIM
4. Problems and issues in the implementation: For those who are using BIM and those who are refusing to use BIM identify major roadblocks and obstacles to the implementation of BIM on Indian projects
5. Developing a broader vision for the future of BIM in India and developing recommendations for increasing usage and enabling many more companies to implement BIM in their projects.

The study used a mixed method of approach to meet the declared aim and objectives and collected data from the industry. The following is the three-pronged research methodology was adopted:

1. Desk research employing national and international trends and indicators are available via software vendors, online sources, and industry publications.
2. Industry-wide surveys designed to document the rate of current state in the adoption of BIM, perceptions surrounding the usage of BIM and other important indicators.
3. Semi-structured interviews of identified leaders in the industry to determine the "mind-set" issues faced in the industry.

This survey was conducted using an online survey tool called SurveyMonkey10. Semi-structured interviews were carried out by the study team members across major cities in India including National Capital Region of Delhi, Mumbai, Bangalore, Hyderabad, Chennai, Ahmadabad and Pune. With the support of professionals in the industry the study team was able to collect useful information from:

1. An online survey in which 40 respondents provided their inputs
2. One-on-one interviews with 2 industrial experts (1 architect and the other was BIM expert)

The data collected via online survey and interviews was carefully analyzed. Statistical analysis of survey data was performed using standard analysis software. Interview transcripts were documented in a word processing tool. A qualitative analysis of these transcripts alongside qualitative information collected from the online surveys was performed using NVivo11 and SurveyMonkey12. Following sections provide respondent profile and key findings of the study :

RESPONDENT'S PROFILE

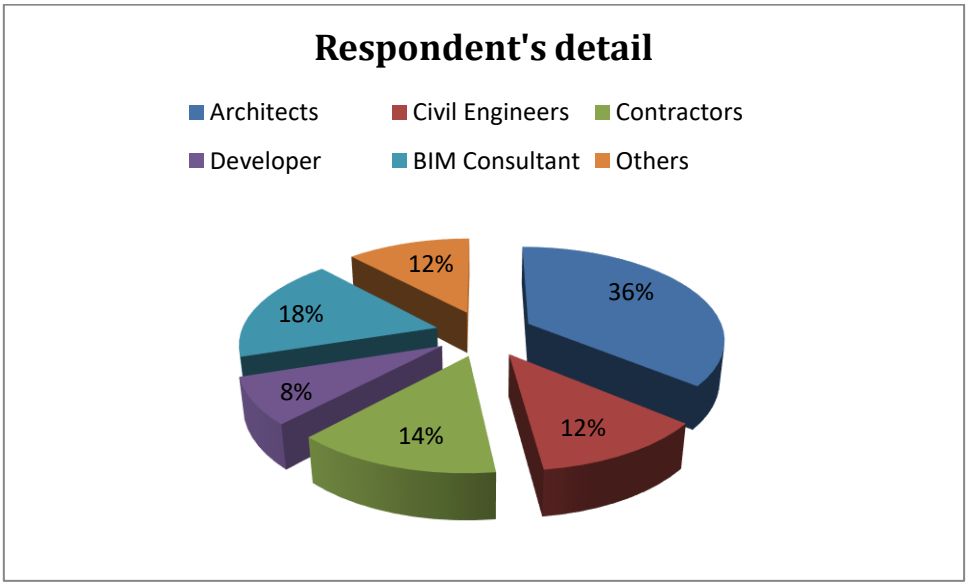

Fig. 1 shows the respondents detail (Source: authors survey)

Majority of the respondents were from Bangalore and Chennai. Others were from Mumbai, Pune, Kerala and Delhi.

LEVEL OF EXPERIENCE IN THE INDUSTRY

As shown in Fig. 2 Almost 50% of the participants came from the professional background with a minimum of 15 years' experience. The following bar chart shows the experience levels of all participants of the study, including the interviews.

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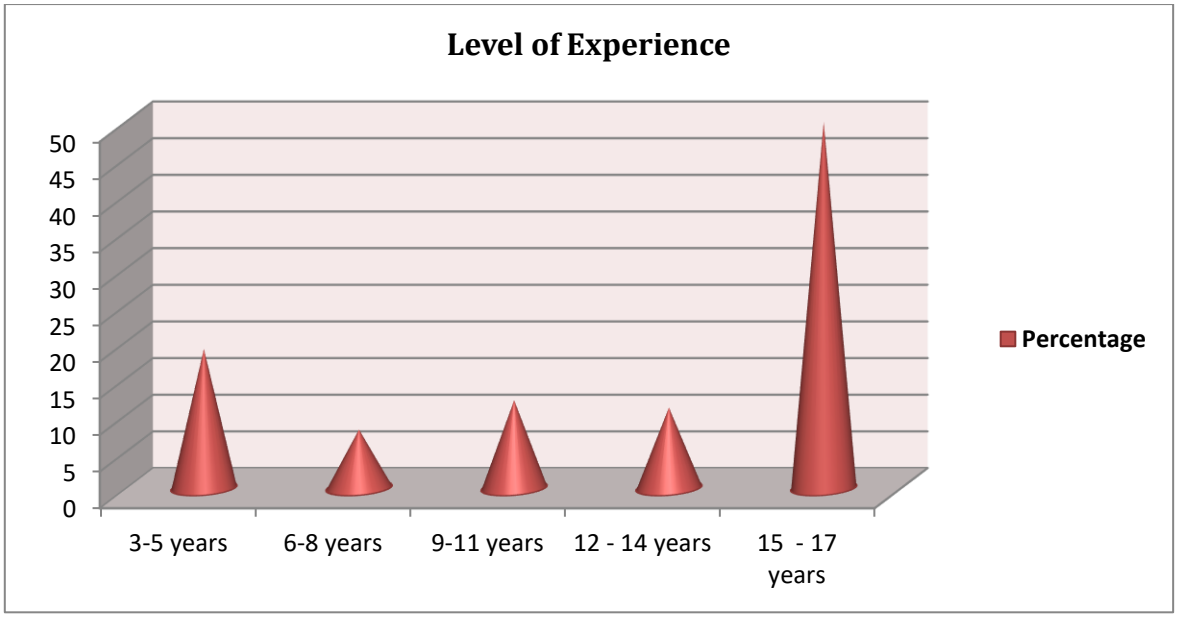

Fig. 2 shows the experience level of the professionals (Source: authors survey)

ORGANIZATION SIZE

The survey was conducted with organizations of different size. The size was determined by the number of people working in the organization. From the survey it is very evident that 40% of the respondents from the organization of larger size.

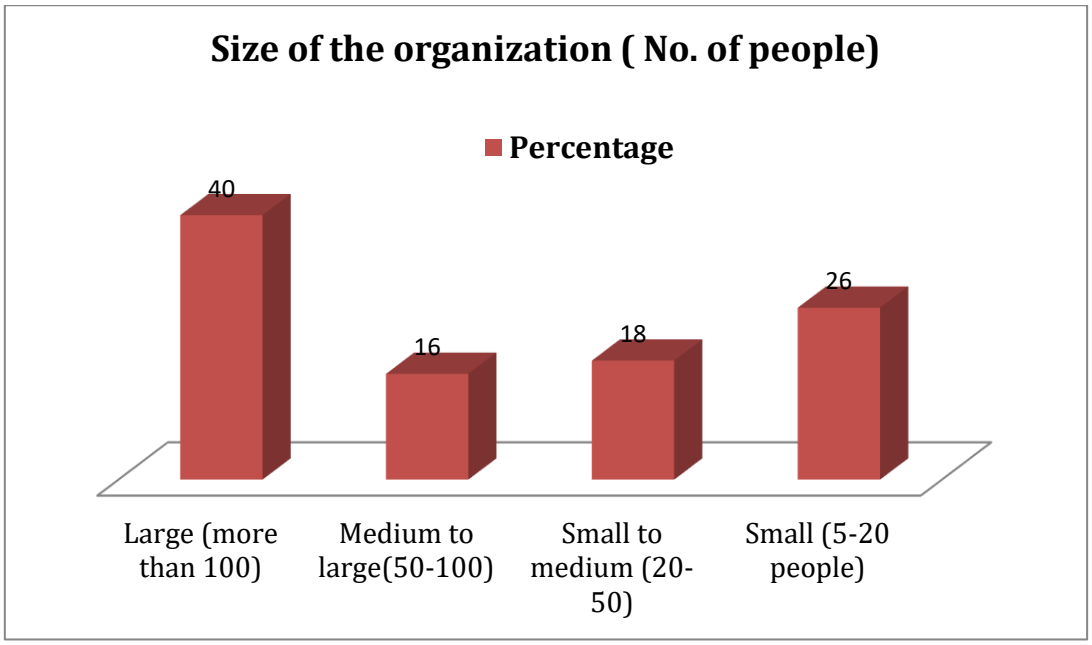

Fig. 3 shows the size of the organization where survey was conducted (Source: authors survey)

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KEY FINDINGS OF THE STUDY

BIM Awareness and Usage Awareness

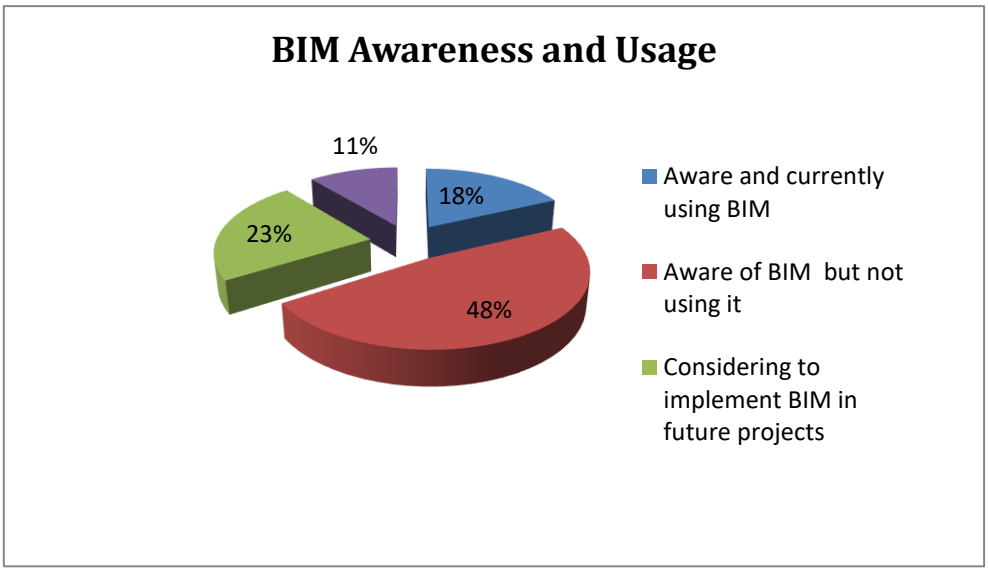

Fig. 4 shows the respondents feedback on the awareness and usage of BIM application (Source: authors survey)

Only 18% of the respondents were aware and using BIM in their projects. Whereas 50% of the survey shows that professionals are aware of BIM but not using it. Only 11 % of the people are not aware and the others are considering the implementations of BIM

TYPE OF PROJECTS EXECUTED USING BIM

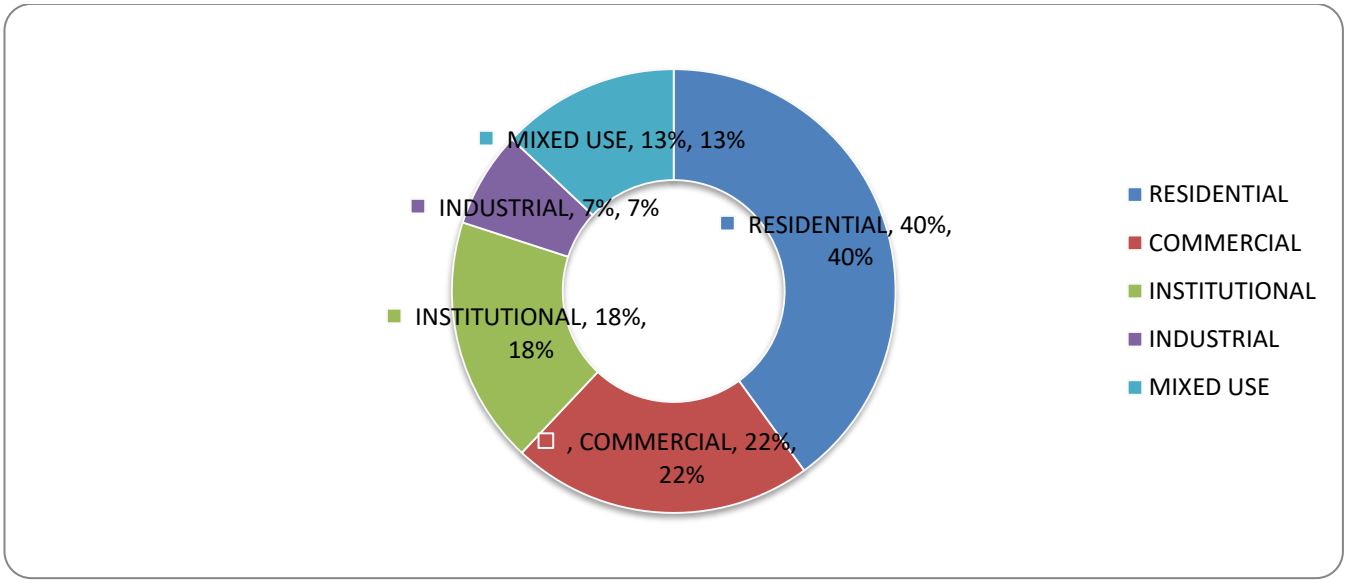

Fig. 5 shows the types of projects executed in BIM (Source: authors survey)

From Fig. 5 it is evident that BIM has been widely used in the real estate sector, particularly in residential projects and the usage of BIM seems to be low in the industrial sector.

ONLINE COLLABORATION:

The following was the question put forward by the author to the respondents and the respondents reply was given in Fig.6
Do you use and online collaboration and coordination tool?

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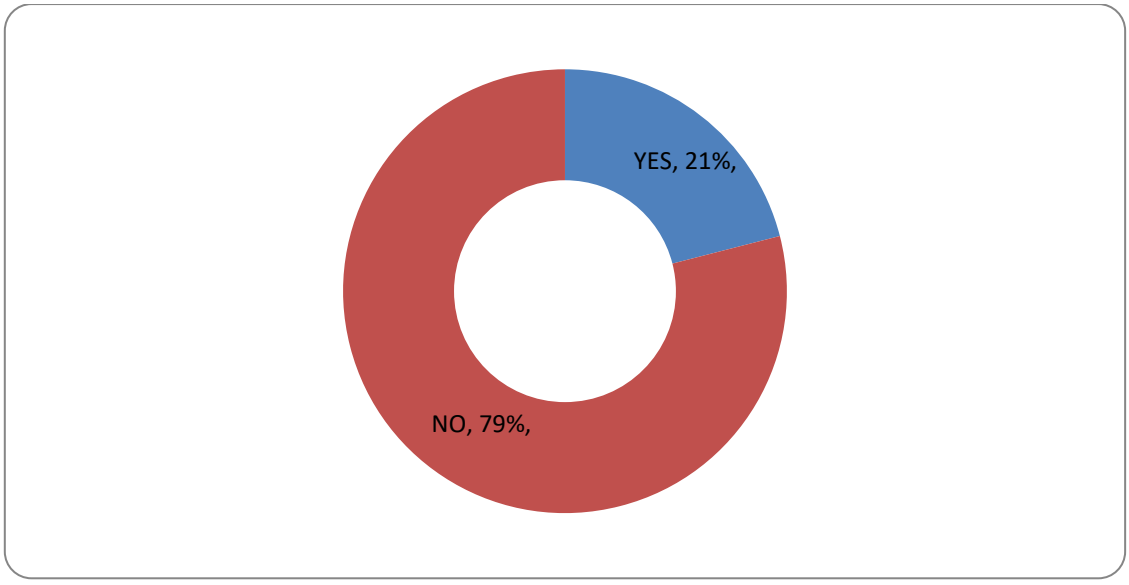

Fig.6 shows the respondents feedback regarding the usage of BIM as online tool (Source: authors survey)

ADVANTAGES OF BIM:

Based on the conducted study, the various advantages of BIM have been listed below:

• **Increased and improvised coordination**: BIM results in the improvised coordination among various disciplines involved in various phases of a project. For instance, through BIM, a structural designer can use a model created by an architect. It can also be used by MEP consultants or facade consultants for their respective domain- specific design and engineering tasks. Associating the input from all of these disciplines as the design evolves, leads to the easy identification and addressing of potential clashes or collisions. This can be later used by contractors to make manufacturing or fabrication plans, hence increasing coordination among various stakeholders

• **Faster construction cycle**: BIM helps in improvising construction cycle by reducing duplication of work, identifying standard and repetitive components and eradicating issues before the construction process commences.

• **Improved visualization:** 3D visuals generated via BIM provide a sense of clarity on the product to the various stakeholders involved, thus providing them with sufficient visibility of the practical challenges.

• **Clash detection and less construction surprises:** a major issues that are usually observed during the construction stage are clashes between the various disciplines, which require significant rework of the design or the construction. BIM helps in the identification such issues at the design stage itself and, in case of the occurrence any clash, it allows a collaborative and coordinated process for resolution. BIM also helps in highlighting other construction related issues, such as constructability, material usage and timelines and also allows value engineering exercise to be conducted.

• **Reduced wastage:** BIM users can also resolve coordination issues, produce a near 'zero-defect' design and predict the material required more accurately, leading to the reduced wastage on site during the construction and maintenance processes.

• **Cost reduction and control:** BIM helps in the reduction of duplication of work, helps in reducing wastage and also in keeping a check on the cost.

• **Increased accuracy of the end product:** BIM also guarantees a better certainty of the end product over the traditional CAD technology.

• **Improved project monitoring:** With BIM, a user can also keep a check on the progress of the project across all the phases of design development to construction to project operations and the maintenance phase.

• **Change management:** BIM is useful in managing the changes that occur in a project. It also allows the visualization of changes more effectively. Change propagation in the model is way easier in BIM as compared to 2D documentation.

CHALLENGES TO BIM IMPLEMENTATION

The challenges listed below were highlighted by the survey respondents regarding the usage of BIM.

• **Mind-set issues:** implementation of BIM requires a change in the process and practice by all the stakeholders involved. Resistance to change, turf issues, and hesitancy in being the first to embrace change are some of the common mindset barriers faced. Senior management of most organizations are adamant to see the instant benefits making it a perfect 'chicken and egg' like story.

• **Difficulties in adapting to frequent changes in design:** one of the challenges frequently cited by Indian professionals is the need to accelerate the production of the project documentation especially in the phase of frequent changes that the Indian projects encounter. Psychologically, these professionals find it easier to make such changes in the 2D environment. Not many professionals are willing to question the reason for such impromptu changes and the quality of the revised documents produced during the face of these changes. Due to the lack of standards and presence of well-laid-out

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processes, ad hoc changes lead to below satisfactory results for which BIM is blamed.

• **Unavailability of specialist consultants:** structural and mechanical, electrical, and plumbing consultants in India have not yet embraced the concept of BIM. Even in a perfect scenario where a client and the designer are willing to adopt to BIM, the lack of availability of specialist consultants who also are willing to make use of BIM make its implementation challenging. This was a recurring theme in most of the recent interviews and survey responses.

• **g**: one of the biggest issues with the earliest adaptors of BIM is the issue of inter-product compatibility. This compatibility issue is not limited to different software platforms. Due to the rapid development of the BIM software industry, newer versions of programs within the same platform can have interoperability issues and this is causing heartburn among many industrial players. This issue had emerged repeatedly in interviews, especially among the specialist consultants.

WAY FORWARD - FUTURE OF BIM IN INDIA

BIM has the potential to provide significant benefits to the Indian built environment sector. BIM as a phenomenon cannot be ignored. BIM will help professionals to do their jobs better, with greater collaborative input. Regardless of cost or learning curve, many teams have already proven that its benefits outweigh the teething problems that accompany BIM implementation.

To be successful and to be competitive it is essential that government agencies must modernize their legacy system and should adopt BIM technology in their procurement processes and contracts. BIM is expected to gain immense traction and reshape the construction industry. Our research shows that the Indian built environment professionals, academics, organisations and the sector as a whole along with government must consider the following:

1. India needs a robust locally-driven leadership model that can drive the BIM adoption process in a systematic and participatory manner. During discussion with industry leaders, the need for India National BIM Taskforce emerged. Several professionals with whom we held discussion were eager to sign up and volunteer on the proposed taskforce to drive sector-wide BIM adoption.
2. India must deploy its globally recognised Information and Communication Technology (ICT) leadership to bolster the rapid growth required in the built environment sector. Indian modellers, who model the world's largest projects under an outsourcing regime, can now begin modelling the next generation of Indian projects and provide the much-needed operational efficiencies to project teams in India. This issue emerged in many interviews that were held by the study team.
3. India must create centres of excellence to drive innovation, creativity and collaboration in the Indian built environment sector. India needs tri-partite centres of excellence—bringing government, industry, and academic institutions together—that can produce the much-needed research, development and innovation that will drive the pace of BIM adoption and adaption in India.
4. India needs to strengthen small and medium enterprises so that an environment of creativity and innovation is enabled. This will lead to the creation of new revenue generation models that is likely to drive the BIM adoption process in the positive direction. Specialist consultants and small construction companies must be provided incentives to embrace this paradigm and fully participate in the model-centric project delivery.

CONCLUSION

Professionals and organizations should gear up now—or at the least make themselves aware about the value of BIM, or how a BIM-enabled organisation might better serve the industry—would soon be in high demand. BIM becomes a key requirement, be it for economic, environment or other reasons. It is important to realize that BIM, at its core, is not just software, but a human activity that ultimately involves broad process changes in the built environment sector.

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