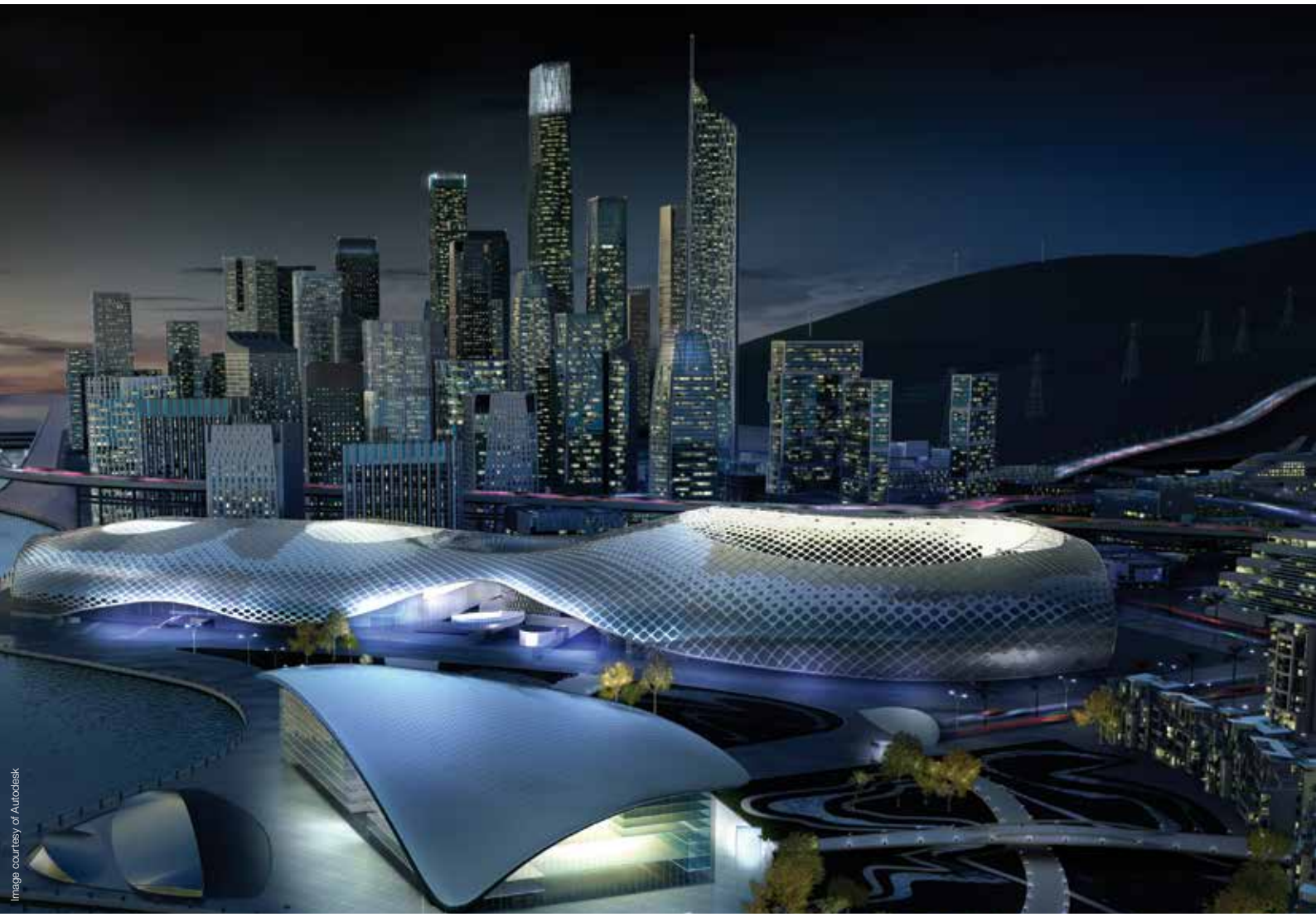
Research

RICS School of Built Environment
AMITY UNIVERSITY

May 2014

State of BIM Adoption and Outlook in India



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Acknowledgements

The built environment sector in India is one of the largest and most important sectors. For the country to grow and prosper, this sector is required to realise its full potential. All constituents must work in unison to embrace far-reaching sector-wide improvements. With this spirit, the research study received tremendous support from the industry. The authors would like to thank the interviewees and survey respondents (a total of more than 400 industry professionals and their respective organizations) for providing their valuable support, encouragement and advice, without which this study would not have been possible.

It is envisioned that this report will assist in drawing together the built environment 'community' in India, which is already benefitting from a more holistic approach to several issues affecting the sector. It will help forge new partnerships and encourage professionals to undertake studies that benefit individuals, organizations and the sector as a whole.

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Foreword

Building Information Modelling (BIM) is a remarkable paradigm that has recently engulfed the global built environment sector for the better. It has provided a catalytic means for "rethinking" how we design, construct, and operate our built environment. BIM offers the potential for many direct and indirect benefits to the built environment sector, including:

- improved information sharing across the entire value chain;
- time and costs savings;
- improved quality;
- transparency and accountability in decision making;
- increased sustainability; and
- improved end-user/customer satisfaction

Over 70 per cent of the built environment assets required in India is yet to be built. Such high volume of construction activity and ensuing urbanisation expected to occur in the coming years underlines the importance of increased collaboration in the sector to meet its ambitious goals in a sustainable manner. BIM may be the lever that the Indian built environment sector needs to attain the desired productivity gains. This study, entitled 'State of BIM Adoption and Outlook in India' aims to provide the sector with timely and clear understanding of global developments in this domain and compare it with the status of BIM adoption in India.

Can the Indian built environment sector use BIM to transform itself into an efficient, quality-centric, environment-friendly and bullish sector capable of successfully delivering the requirements of our nation? This study seeks to answer this important question through the results of an industry-wide study, which highlights the importance of BIM adoption in India. The industry must collaborate with the government and academia to explore the several opportunities and provide a platform to facilitate the desired change.

I am gratified that RICS School of Built Environment, Amity University and KPMG in India have conducted this timely study. Thanks to the authors' credibility, participants responded actively to the survey and provided valuable information.

Dr Prem C Jain
Chairman, IGBC
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Introduction

BIM is expected to emerge as one of the most fundamental changes that are likely to rapidly transform the Indian real estate and construction sector. For centuries, we have used symbols on paper (i.e. drawings and specifications) as the primary means to represent and communicate design intent for client approval, bidding, procurement, fabrication, construction and installation. These abstractions have no native intelligence in them and require human interpretation (i.e., reading) and manipulation (e.g. take-offs, redlines) to provide meaning and value. All other major capital- and knowledge-intensive industries (e.g. manufacturing and finance) have long since transitioned to data-rich environments that enable virtual and automated design, analysis, fabrication and communication. And they have reaped the rewards of higher productivity, accuracy, and quality and worker safety. The growing worldwide adoption and implementation of BIM for its powerful digital data-based modelling, visualisation, analysis and simulation capabilities represents the start of a transition to an integrated information infrastructure that will ultimately revolutionise almost all aspects of the construction industry.

This study—State of BIM Adoption and Outlook in India—presents findings from research conducted in 2013–14 about how real estate and infrastructure developers, architects, engineers and contractors in India are adopting, implementing and deriving value from BIM. The study also reveals the benefits that can be derived by BIM users, challenges being faced by them and their expectations. In addition to the research data in the report, several interviews exemplifying the breadth of BIM's application to solving real world business challenges are featured in this study. The study also provides industry leader insights with a global perspective on BIM adoption. We hope that readers would find this study useful in its bid to highlight BIM's potential for adding value.

Neeraj Bansal
Partner and Head of Real Estate and Construction
KPMG in India

Contents

1 Executive Summary

The built environment sector in India will continue to play a significant role in the nation's infrastructure and industrial development that is being driven by economic growth, industrialisation and urbanisation. Creation of built environment assets and employment generation by the sector can significantly impact India's growth story. However, the Indian built environment sector is currently facing many challenges. It is marred by delays, cost overruns, quality issues and other inefficiencies in the delivery process. Much of this can be attributed to current work practices, inefficient processes and lack of information sharingamong industry stakeholders. Given the volume of construction India has to undertake, it cannot be business as usual.

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

Globally, the built environment sector is experiencing a remarkable development in the form of **Building Information Modelling** (BIM). BIM, 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 is gaining popularity in the global built environment sector as it helps in reducing cost and time and increases other broader efficiencies. Impressed with the results, governments around the world, especially in developed nations, are taking strong steps to increase BIM adoption. For example, the UK has prepared a BIM strategy for the UK Government Construction Client Group for 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 can also gainfully deploy BIM for its built environment sector. This has not happened so far. While India stands to significantly benefit from it, BIM adoption has remained low. This study is aimed at assessing the current status of BIM adoption and determining the drivers and barriers to the use of BIM in India. To understand the status of BIM adoption in the Indian built environment sector, RICS School of Built Environment and KPMG conducted a study over the last eight months. An industry-wide online survey was conducted to obtain input from industry professionals. Semi-structured interviews were conducted by the study team members across major cities in India, including National Capital Region of Delhi, Mumbai, Bangalore, Hyderabad, Chennai, Ahmadabad and Pune. The online survey was taken by 365 respondents and 40 interviews were conducted.

The study found that 22 percent of the respondents currently use BIM; 27 percent respondents reported that they are aware and actively considering BIM usage. Surprisingly, 43 percent respondents claimed to be aware of BIM but are not sure about implementing it in their organisations in near future. Additionally, 8 percent respondents are not aware of BIM. Further, statistical and qualitative analysis was done by the study team, which returned the following key findings:

- BIM is gaining popularity among professionals/organisations within the Indian built environment sector.
- BIM is more popular among experienced professionals, possibly as they are more aware of its value proposition.
- BIM is largely in its 'experimentation' phase in India as compared to the developed world, especially when the maturity and level of implementation is taken into account.
- Several new players are considering BIM implementation on their projects; some private developers have mandated BIM on select projects.
- BIM popularity and usage appear comparatively weak in the eastern region of India.
- There is no market leader and there is some scepticism as success stories are not widely available
- Most BIM users are in the real estate sector with only a few in the infrastructure space.
- BIM users reported increased coordination, improved visualisation and faster construction cycle as main advantages.

Image courtesy of THE FIRM

- Mindset and cultural barriers were noted as key challenges.
- Lack of availability of skilled resources and costs associated with implementation are deterring the usage of BIM.
- Work practices currently followed by the sector are out-of-sync with the processes required to make BIM implementation successful.

Stakeholders expect the following changes to take place while driving BIM usage in the country:

- Broader vision and behavioural changes from all stakeholders to collaborate on BIM platform
- Capacity building, education and training for BIM implementation
- Well-articulated value proposition for all stakeholders
- Development of national standards and guidelines
- India-specific BIM product library and content

India needs a robust and locally-driven leadership model that can drive the BIM adoption process in a systematic and inclusive manner. Discussions with industry leaders highlighted the need for the National BIM Taskforce. Several professionals with whom we held discussions seemed eager to signup and volunteer on the proposed taskforce to drive sector-wide BIM adoption. 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. We must create tripartite centres of excellence—bringing government, industry, and academic institutions together—that can facilitate research, development and innovation to drive the pace of BIM adoption and adaption in India.

2 BIM — What is the Buzz all about?

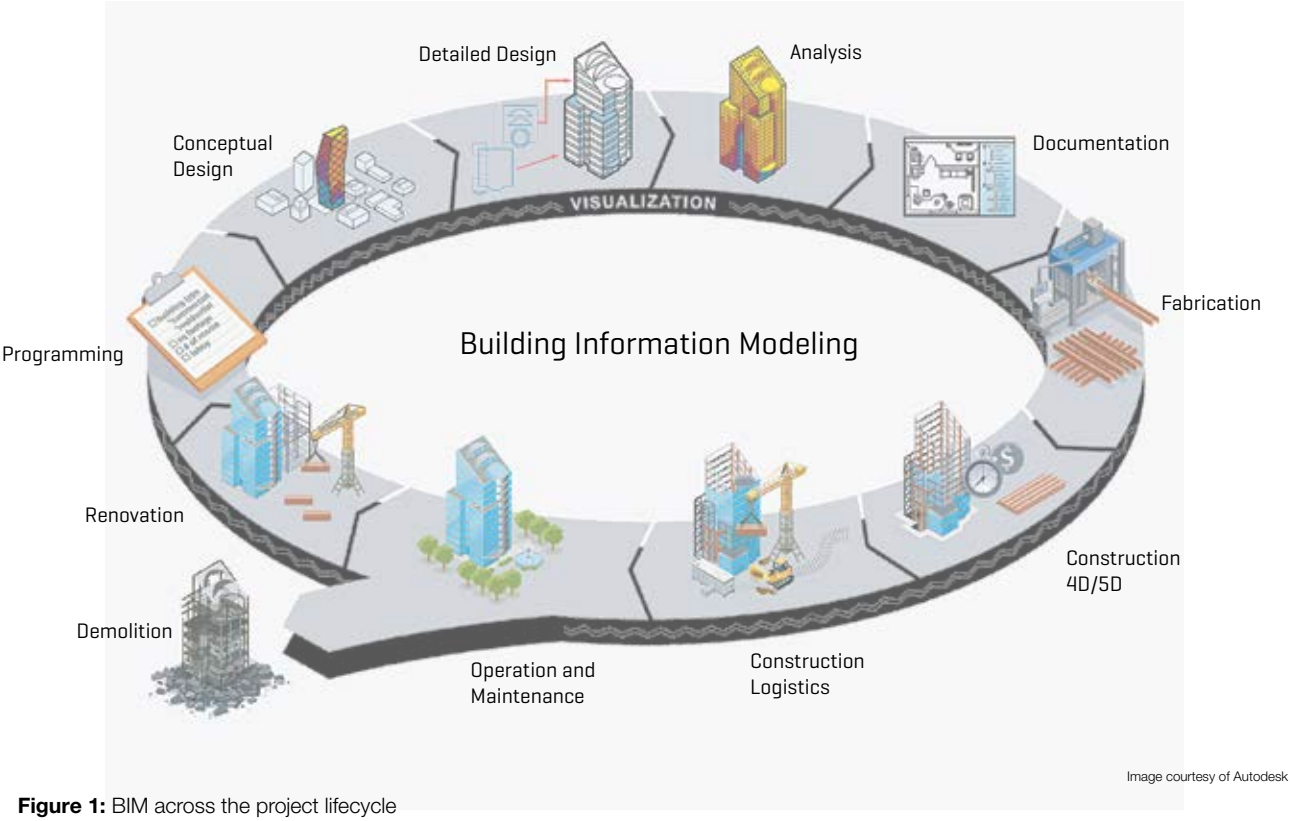

Figure 1: BIM across the project lifecycle

BIM is the use of **'smart'** and **'computable'** three-dimensional (3D) model of the project to enhance its design, construction, operation and maintenance. There are many definitions of BIM, but the latest and the most concise is by the UK Building Information Modelling Task Group that states, **"BIM is essentially value creating collaboration through the entire lifecycle of an asset, underpinned by the creation, collation and exchange of shared 3D models and intelligent, structured data attached to them.[1]"**

In the journey to continually improve design, construction, operation and maintenance of our built environment, BIM is playing a significant role in transforming industry landscape. BIM is helping with better visualisation and cognition of design by minimising design errors, aiding in better planning of construction activities, supporting the construction process and providing a data-rich platform for facility operation and maintenance. It is also a strong collaboration tool that helps the project team to work together and collaborate for delivering better built environment assets. The value proposition of BIM is that it integrates all lifecycle phases of the project and has the potential to benefit all project stakeholders. It enhances creativity and innovation of architects, designers, and engineers. Contractors and other stakeholders are able to derive benefits via model-centric planning and execution processes. Eventually, BIM also benefits the facility management team by allowing data-driven operation and maintenance of the asset throughout its life. Overall, the project sponsor or the client gains through reduction in capital and operating cost and the delivery of a better asset. Figure 1 shows the application of BIM across all lifecycle phases of a project, highlighting the importance of utilisation during the lifecycle to maximise gains.

BIM is not just a software tool or simply a technology that can be acquired and implemented. It is really a paradigm that combines technology with people and process issues of our industry to result in a tectonic shift in the way we deliver the built environment. Its adoption requires deep commitment and a holistic approach. While the potential benefits of BIM to people, projects, organisations and the overall sector are significant, it requires leaving behind archaic and deficient work practices and associated thought processes. BIM transforms the way we design, construct, operate and maintain our built environment.

3 Why is BIM Important for the Indian Built Environment Sector

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

Currently, the Indian built environment sector is facing many challenges. Lack of standards and low use of technology across the construction supply chain is one of the shortcomings, as highlighted by the Planning Commission. Numerous reports are available that demonstrate that the sector is confronted by many problems, including time and cost overruns, distrust among 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.

Traditionally, design in the built environment sector has largely relied on two-dimensional (2D) drawings (plans, elevations and sections). Reliance on this **"unintelligent"**, static, and error-prone information made design, construction and operation of buildings inefficient. Most industry players adopted and adapted their work practices and processes to optimise the delivery process within the constraints of these underlying inefficiencies. As one respondent in a recent survey conducted in the UK stated, **"All CAD drawings look great even if the content is nonsense"**[2]. Due to the complexity of the design, construction, operation and maintenance of modern built environment assets, this outdated paradigm is no longer tenable. **Projects frequently suffer from 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[3].**

BIM aims to change the situation for the better. In fact, BIM extends the capacity of the project team to start thinking about time, cost, quality, sustainability and other pragmatic parameters in the early stages of the project. It extends 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!).

1 http://www.bimtaskgroup.org/bim-faqs/

2 National BIM Report 2013 "http://www.thenbs.com/pdfs/NBS-NationlBIMReport2013-single.pdf"

3 Chuck Thomsen, Joel Darrington, Dennis Dunne, and Will Lichtig "Managing Integrated Project Delivery", Construction Management Association of America, Mclean, VA 22102-3307

4 Global Perspective on BIM

The global construction sector's output in 2013 was about US$ 7.2 trillion and it is poised to grow to US$ 15 trillion by 2025[4]. This growth is predominantly expected in emerging economies such as China, India, Brazil, Russia and Poland, taking the contribution of emerging countries from about 35 percent of the global construction output to 55 percent by 2020[5]. The construction sector in the developed world is rapidly embracing BIM as a catalytic agent for gaining operational efficiencies and to consider additional business avenues in the developing world using BIM as a business driver[6]. Developing countries are beginning to arrive on the scene—with India also showing movement in this direction. Overall, the progress of BIM in developing countries is far below expected levels, which may appear contradictory. Volume of construction is poised to increase and gains from the use of BIM in developing countries, such as India, can be significant. What is the reason for this contradiction? This study is aimed at finding out the drivers and barriers to the use of BIM in India. A majority of the construction industry stakeholders are intuitively convinced that BIM helps save time and significantly improves final quality. Moving forward, these stakeholders need to collaborate and create an ecosystem for the widespread adoption of BIM in India so that sector-wide operational efficiencies can be improved.

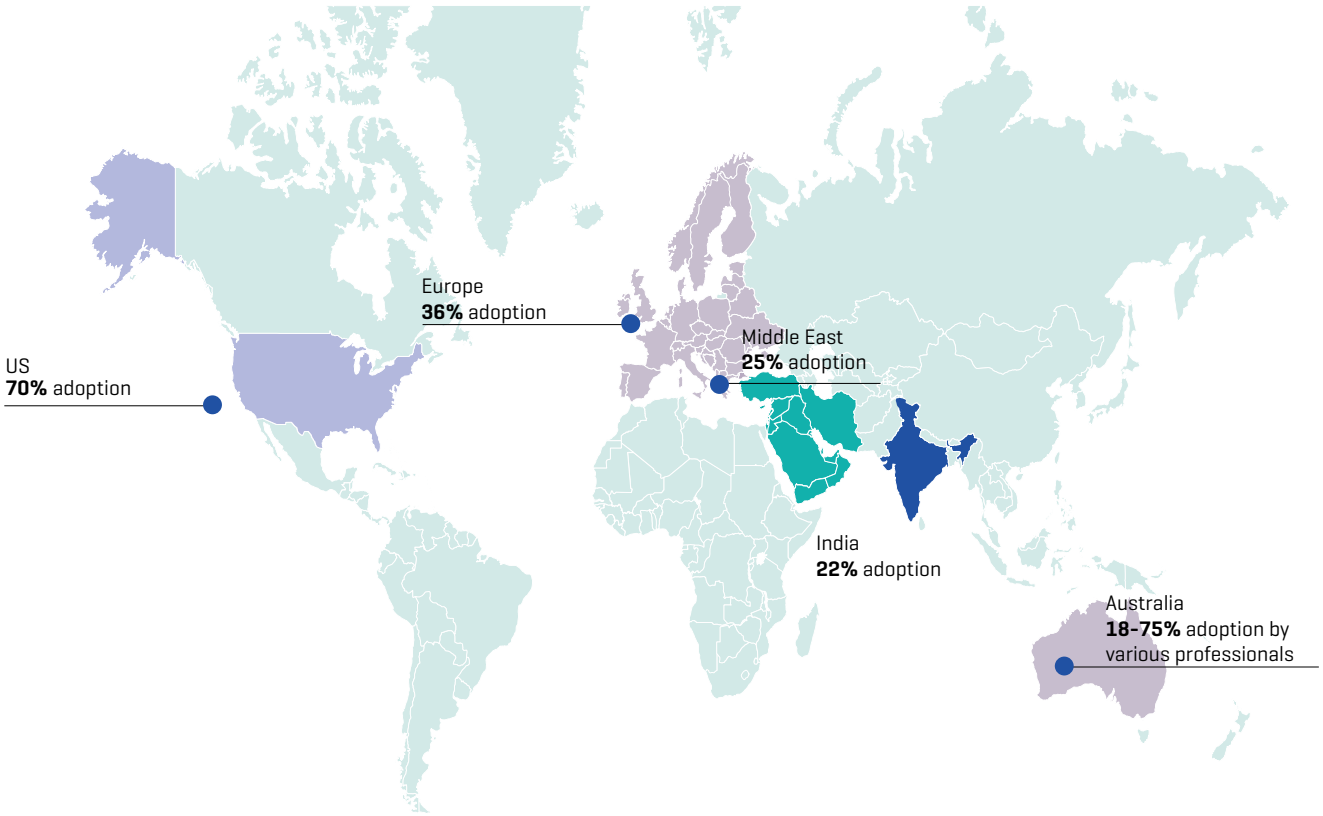

Figure 2: Global adoption of BIM

4 Global Construction Perspectives and Oxford Economics, Global Construction 2025 http://www.globalconstruction2025.com/
5 Global Construction Perspectives and Oxford Economics, Global Construction 2025 http://www.globalconstruction2025.com/
6 Growth through BIM, Richard G Saxon, report by UK Construction Industry Council

Silver Cross Hospital. Courtesy of Mortenson Construction and RTKL Associates Inc.

Globally, BIM is finding increased attention from the construction sector[7]. However, the level of maturity in using BIM differs in different regions. The United States of America continues to be the leader in BIM usage and it is evolving rapidly. Though the United Kingdom started late, it has picked up pace in BIM adoption. Adoption in Australia is also impressive with high usage reported by professionals. In Europe, BIM is used in almost a third of the projects. Emerging economies, such as the Middle East, China and India, are still lagging in BIM adoption and are facing similar challenges, including lack of experienced professionals and high cost. The following summarises the current status of BIM adoption globally:

- The United States of America: the USA appears to be at the forefront of global BIM usage. The McGraw-Hill Construction BIM survey conducted recently reveals that over 70 percent of the construction projects in the USA use BIM and almost all BIM users plan to improve adoption.
- Australia: the survey sponsored by Built Environment Innovation and Industry Council in 2010 revealed that the majority of organisations in Australia are using BIM in their projects.
- Europe: the European survey in 2010 conducted by McGraw-Hill Construction revealed that BIM adoption in Europe is about 36 percent. Adoption in the UK, France and Germany was 35, 38 and 36 percent, respectively.
- The Middle East: as per building SMART Middle East survey 2011, about 80 percent participants in the sector were aware of BIM technology. However, only 25 percent projects are executed using BIM. The key reasons for low BIM adoption include low availability of skilled staff and high cost of BIM implementation.

7 Business Value of BIM for Infrastructure—Addressing America's Infrastructure Challenge with Collaboration and Technology, SmartMarket Report by McGraw Hill Construction 2014

4.1 International Government-Led Initiatives

Following are some initiatives taken by governments globally:

- The United States of America: the General Services Administration (GSA) in the USA which pioneered the BIM adoption for public sector projects, has developed a suite of BIM guidelines and standards. It is believed by many that the efforts made by GSA have resulted in over 70 per cent of the projects in the USA adopting BIM.
- The United Kingdom: the UK's BIM Industry Working Group has prepared a BIM strategy to increase BIM usageby 2016. The initiative would primarily satisfy UK Government Construction Client Group demand to reduce capital cost and the carbon burden generated from construction and operation of the built environment by 20 per cent[8]
- Norway: In 2010, the Norwegian government stated its commitment to succeed in BIM adoption which has resulted in many organisations in Norway adopting BIM.
- Denmark: BIM is to be used for all the projects executed by Danish state clients, such as the Palaces and Properties Agency, the Danish University Property Agency and the Defence Construction Service.
- Finland: Finland's state property services agency, Senate Properties, has been using BIM for its projects since 2007.
- Hong Kong: Hong Kong's Housing Authority has set an ambitious target of using BIM in all of its new projects by the end of 2014. To support this initiative, it has developed a set of modelling standards and guidelines for effective model creation, management and communication among BIM users.
- South Korea: South Korea's Public Procurement Service has mandated the compulsory use of BIM for all private sector projects over US$ 40 million and for all public sector projects by 2016.
- Singapore has put in place plan and funding for BIM adoption. A budget of US$ 20 million has been set aside for BIM and related technologies for the Singaporean construction sector. Table 1 summarises these plans by the Singaporean government

Table 1: Singapore BIM Initiative[9]

Recognising the public sector as a catalyst for change, the Building and Construction Authority (BCA) has identified public sector procurement as an important strategy in the BIM Roadmap. To prepare the private sector agencies in leading the industry's use of BIM, BCA has taken three key approaches for this strategy:

- Partnering Government Entities: BCA has engaged major government procurement entities (GPEs), specifically the Housing and Development Board, the Ministry of Education and the Land Transport Authority in a partnership programs. This programme includes conducting hands-on training for GPE officers, initiating new BIM pilot projects to define standard BIM requirements, and organizing visits to study BIM usage in other countries.
- Training Public Sector Consultants: The BCA Academy has launched a number of BIM training programs to equip public sector consultants with BIM expertise. The programs will also be extended to contractors.
- Reaching out with Joint Industry Efforts: BCA has partnered the industry on initiatives that will make it easier for businesses and professionals to apply BIM in their projects. These include:
  - Developing BIM requirement guidelines – led by Real Estate Developers' Association of Singapore (REDAS) and major GPEs
  - Developing regulatory approval e-submission guidelines and templates – led by all government regulatory agencies
  - Developing project collaborations and object library standards – led by building Smart Singapore

8 http://www.bca.gov.sg/BIM/bimfund.html

9 http://www.bca.gov.sg/BIM/bimfund.html

5 Study of BIM Adoption in India

The goal of this study was to document the current status and outlook of BIM implementation in the built environment sector in India. To accomplish this goal it was important to not only study the current state of BIM implementation but also to gauge the mind-set of industry leaders with respect to the future of BIM in their respective organisations. Broadly this was done by first ascertaining the current state and then by focussing on: (a) drivers for BIM implementation in India; (b) barriers to BIM implementation in India; and (c) perceived benefits of BIM implementation. Guided by this over arching goal the study had the following key strands:

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

2. Purpose and level of BIM implementation: data was collected on the stated purpose of BIM usage and the functional aspects of BIM implementation adopted by the companies

3. Benefits of BIM usage: perceived benefits of BIM were identified from the sub-group of respondents who were either using BIM or were considering using BIM

4. Implementation problems and issues: For those who are using BIM and those who are refusing to use BIM identify major roadblocks and barriers to BIM implementation on Indian projects

5. Develop a broad vision for the future of BIM in India and develop recommendations for increasing usage and enabling more companies to implement BIM in projects

The study used a mixed method approach to meet the stated goal and objectives and collect data from the industry. The following three-pronged research methodology was adopted:

1. Desk research utilising national and international trends and indicators available via software vendors, online sources, and industry publications;

2. Industry-wide survey designed to document the current state of BIM adoption, perceptions surrounding BIM usage and other important indicators; and

3. Semi-structured interviews of identified industry leaders to determine "mind-set" issues in the industry

The survey was conducted using an online survey tool called SurveyMonkey[10]. Semi-structured interviews were conducted by 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 industry professionals the study team was able to collect useful information from:

1. Online survey in which over 365 respondents provided their input; and

2. One-on-one interviews with 40 industry experts spread across the country.

Data collected via online survey and interviews was carefully analysed. 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 along with qualitative information collected from the online survey was performed using NVivo[11] and SurveyMonkey[12]. Following sections provide respondent profile and key findings of the study.

10 http://www.surveymonkey.com/

11 http://www.qsrinternational.com/products_nvivo.aspx

12 http://www.surveymonkey.com/

6 Respondents' Profile

The online survey was completed by 365 industry professionals and 40 interviews were conducted as part of this study. These 405 respondents were from broad disciplines/backgrounds such as architects, developers, construction managers, structural engineers and contractors, as shown in Figure 3.

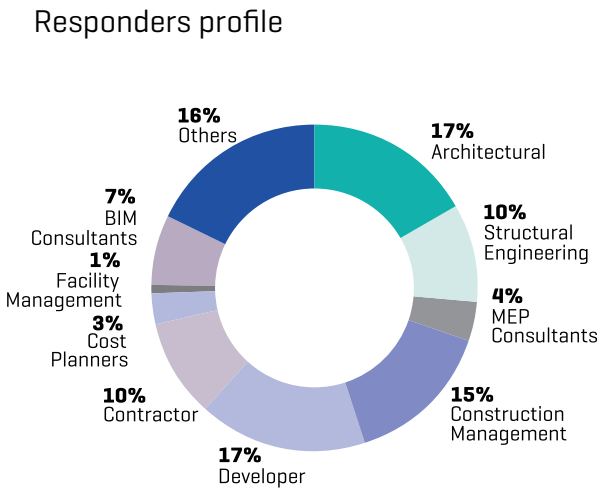

Figure 3: Profile of respondents

Participation was largely equal from all regions of the country except east. Besides strong participation from metro and tier 1 cities, participation was also recorded from tier 2 and 3 cities, as shown in Figure 4.

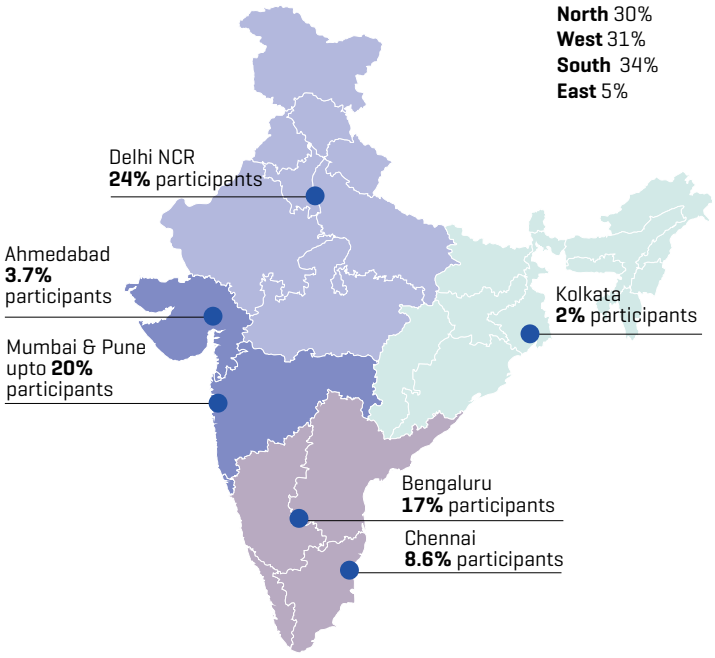

Figure 4: Profile of respondents

More than 80 percent participation was from professionals with at least 5 years of experience in the built environment sector. About 66 percent participants have more than 10 years' experience. Figure 5 shows the experience levels of all respondents for the study, including interviewees.

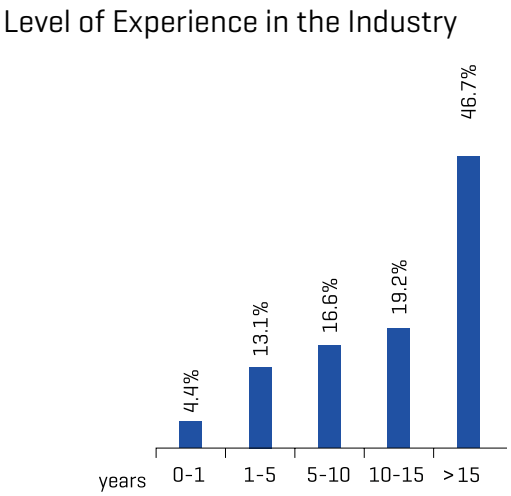

Figure 5: Experience level of respondents

The survey witnessed almost equal participation from different sizes of organisations, both in terms of revenue and number of employees. Figure 6 and 7 show the nature (annual turnover and number of employees) of the organisations that participated in the study.

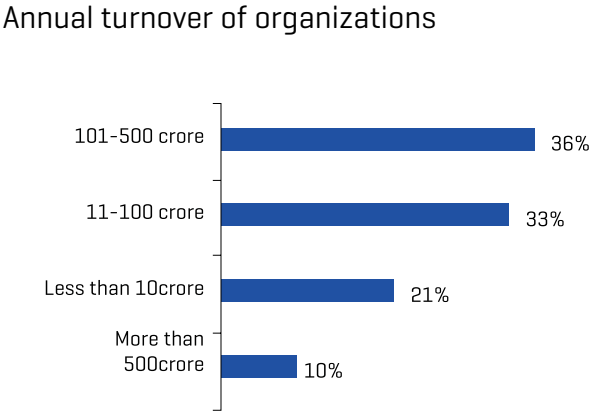

Figure 6: Size of the organizations in terms of annual turnover

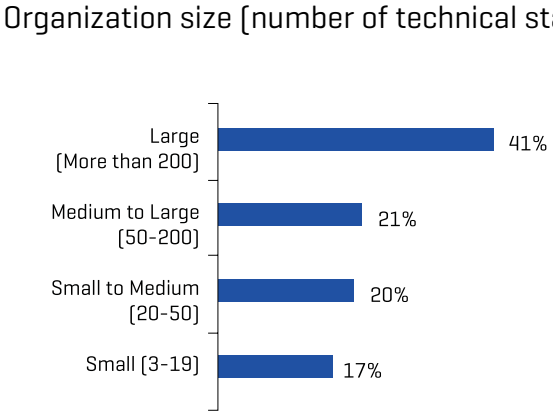

Figure 7: Size of organizations in terms of number of employees

7 Key Findings of the Study

The study resulted in the generation of a lot of information, which has been used to provide key findings. Table 2 provides a high-level summary of the key findings of our study.

Table 2: Major findings of the study

• BIM is gaining popularity amongst professionals within the Indian built environment sector
• BIM enjoys maximum popularity among experienced professionals since they have a better appreciation of the value proposition of BIM.
• BIM is more popular in large organisations, with a large strength of technical staff, hinting that BIM implementation is more beneficial in large and complex projects.
• BIM is largely in its "experimentation' phase in India as compared to the developed world especially when the maturity and level of implementation are taken into account
• Many new players are considering BIM implementation in their projects.
• BIM popularity and usage appears comparatively weak in the eastern region of India
• No single market leader has emerged and there is some scepticism as success stories are not widely available

Figure 8 shows a 'word cloud' generated from the interview transcripts and qualitative responses of the respondents of the online survey. This analysis may include basic words used in the English language but it provides an idea of the key themes that emerge from the study.

Figure 8: Initial themes from interviews and online survey

Using qualitative analysis tools, some important themes that emerge from the interview transcripts and qualitative responses of the respondents of the online survey in terms of word counts is presented in Figure 9. Figure 10 shows the word frequency analysis performed on the answers received from interviewees and qualitative responses of the respondents of the online survey when asked about the 'advantages of BIM'.

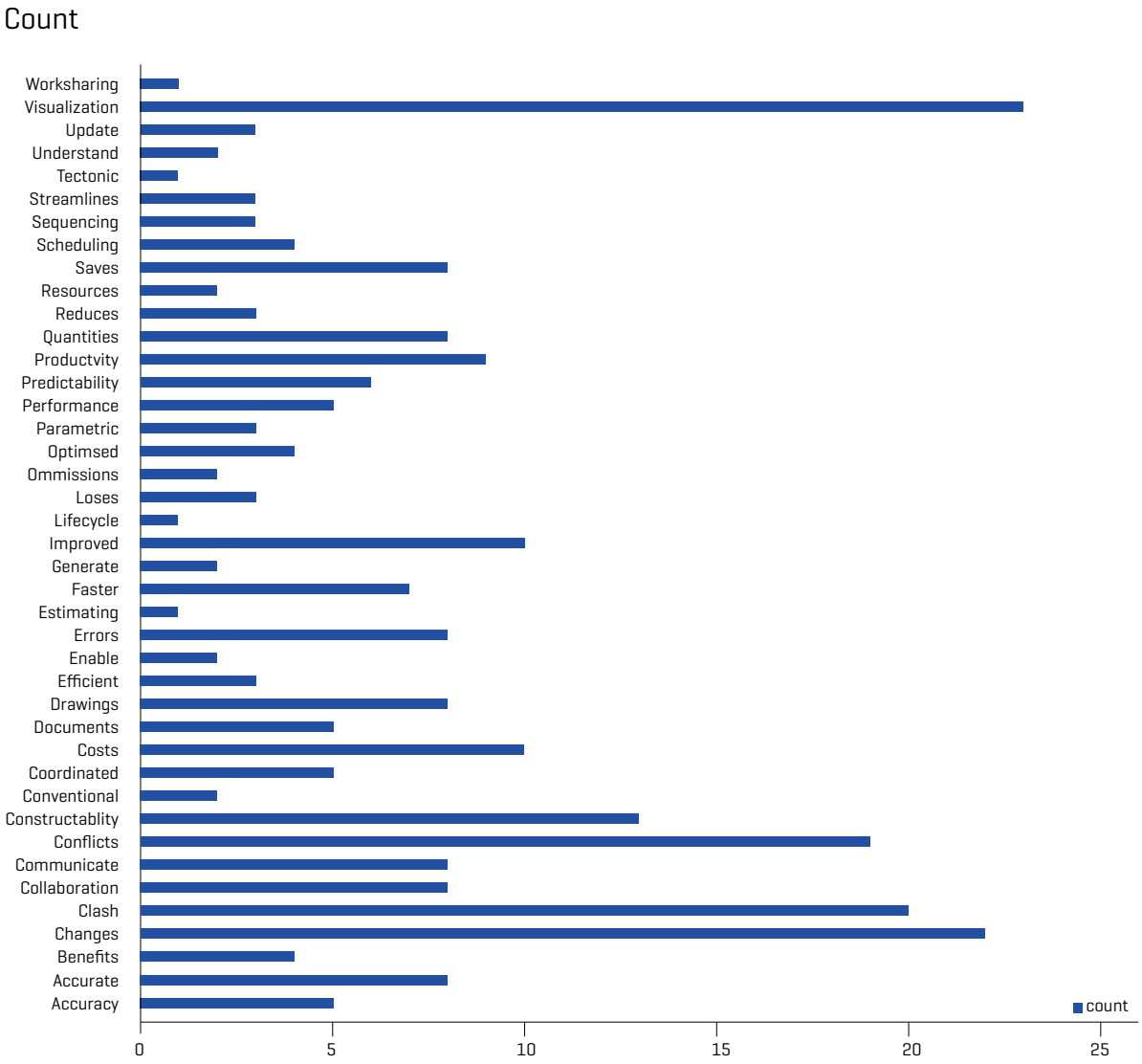

Figure 9: Important themes from interview transcripts and online survey

Word frequency

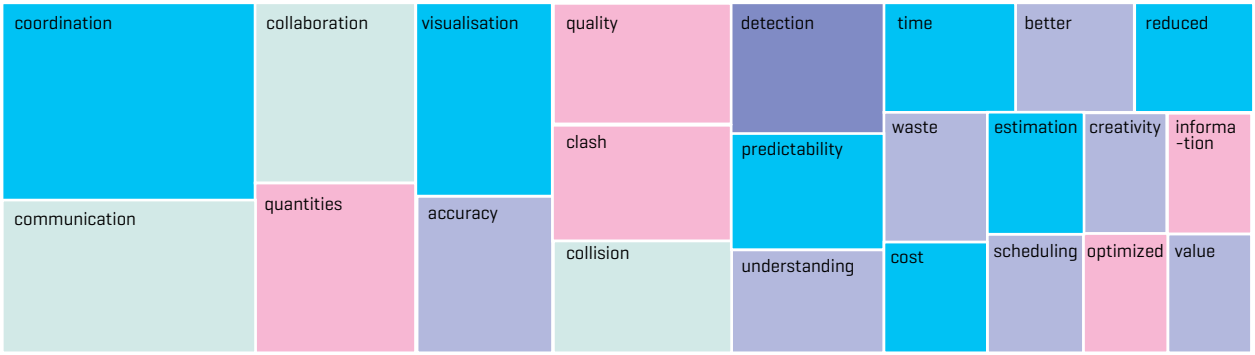

Figure 10: Word frequency analysis of BIM advantages

Some strong themes emerged from the preliminary analysis. Respondents focussed their thoughts on issues pertaining to visualisation, coordination, clash detection, quantity take-offs, change management, and conflict resolution. A similar qualitative analysis was conducted to capture the response of the respondents pertaining to disadvantages, barriers and drivers for BIM usage in India. We present the findings of the analysis based on the following key areas:

1. BIM awareness, usage and capability
2. Software used for BIM implementation in India
3. Key advantages of BIM as perceived by respondents
4. Challenges and barriers to BIM implementation in India
5. Expectation from industry

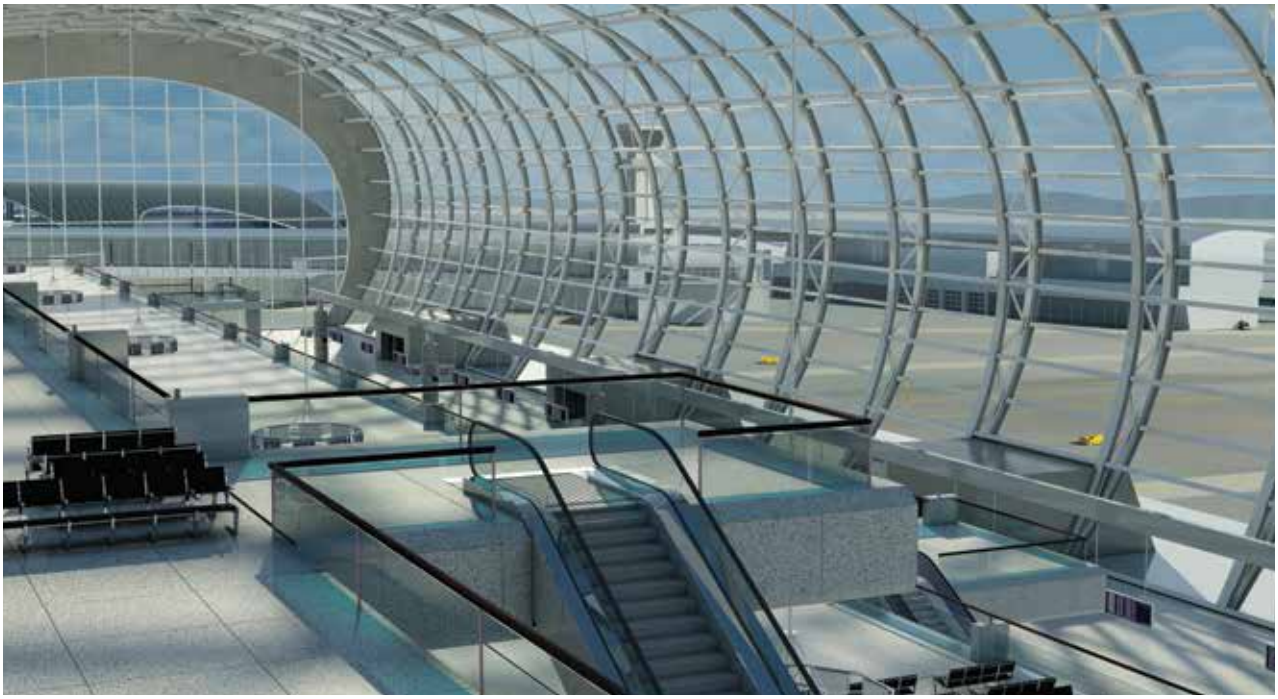

Image courtesy of Autodesk

7.1 BIM Awareness, Usage and Capability

Before assessing BIM awareness and capability among the built environment sector firms in India, we tried to understand the current usage of Computer Aided Design (CAD). We found that most professionals use CAD in some form. However, we were encouraged by the number of people using 3D CAD (more than half the respondents use 3D CAD). High usage of 3D CAD suggests that the built environment sector is advancing steadily on the usage of BIM, since 3D CAD is often described as a starting point on the BIM journey. In Figure 11, CAD usage among respondents is measured. Less than 9 percent professionals who participated in the study reported that they did not use CAD at all, with 54.1 percent using 2D and 3D CAD.

Current CAD usage by professionals in India

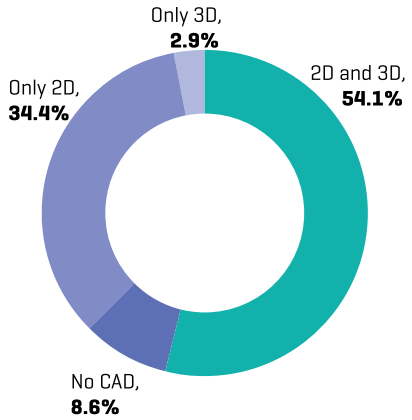

Figure 11: Current CAD usage

On the key question of BIM usage, 22 percent respondents reported BIM usage while 27 percent respondents reported that they are aware and are actively considering BIM usage. Surprisingly, 43 percent respondents claimed to be aware of BIM but are not sure about implementing it in their organisations in near future. Additionally, 8 percent respondents are not aware of BIM. BIM usage is shown in Figure 12. Table 3 shows the nature of organisations/ professions of the respondents implementing BIM on their projects. It is important to note that 18.25 percent of these respondents are BIM consultants who may also be performing international outsourced projects.

Current CAD usage by professionals in India

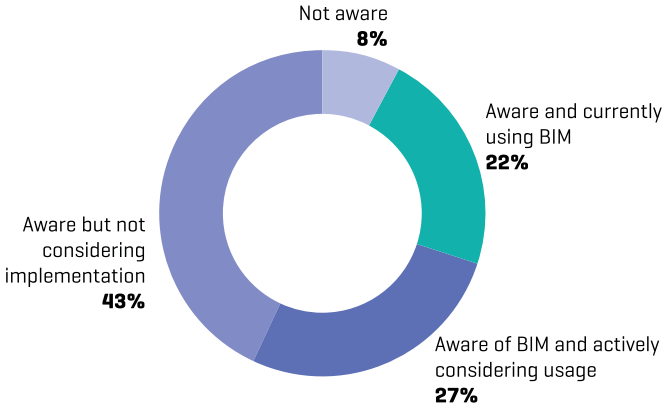

Figure 12: BIM awareness in India

Table 3: BIM users by organization type

Architectural firms	26.25%
Structural engineering consultants	13.50%
MEP consultants	8.75%
Construction management consultants	11.25%
Real Estate and Infrastructure Developer	12.50%
Contractors	7.50%
Cost planners	1.25%
MEP Subcontractor	0.25%
Facility Management	0.50%
BIM Consultants	18.25%
Total	100.00%

Survey respondents who reported BIM usage or awareness of BIM further reported the usage of 2D and 3D technologies at varying levels as shown in Table 4.

Table 4: Usage of technology for those who use BIM or are aware of BIM

Answer choices	Responses
No CAD	2.50%
2D only	16.25%
3D only	3.75%
2D and 3D	77.50%

Table 5 shows the level of usage of the respondents who are currently using BIM.

Table 5: Level of usage amongst BIM users

Answer choices	Responses
Just experimenting (beginner usage)	24.36%
Good experience (moderate usage)	29.49%
Advanced usage	24.36%
Expert usage	21.79%
	100.00%

BIM usage has grown recently. About 19 percent participants started using BIM in the last one year, while 46 percent have been using BIM for the last five years. BIM has gained significant popularity over the last five years with the number of professionals using BIM almost doubling during this period (as shown in Figure 13). Over the next three years, about 78 percent respondents who are aware of BIM expect to start using BIM with 34 percent who want to start using BIM in next one year (as shown in Table 6).

Organizations experience in using BIM solutions and applications

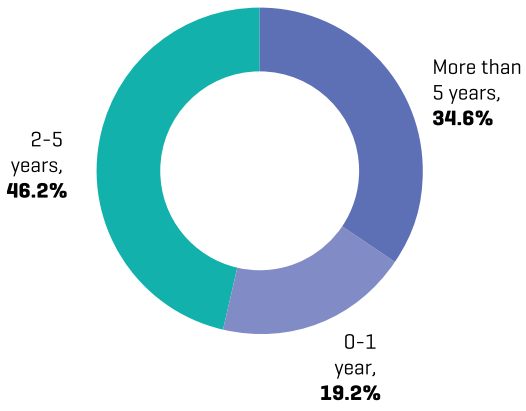

Figure 13: BIM experience amongst users

Table 6: Adoption timeframe of respondents aware but not using BIM

Table 6: Adoption timeframe of respondents aware but not using BIM

Answer Choices	Responses
Within 1 year	34.44%
1 to 3 years	43.33%
3 to 5 years	10%
More than 5 years	12.22%

BIM capability, experience and expertise in India are still gaining ground, with only 45 percent participants responding either as experts or advance users of BIM. With BIM being a relatively new concept, most participants are still experimenting or using BIM moderately and only a third of the participants use it in more than 60 percent of their projects (some of these are BIM consultants with CAD only outsourced projects). This is shown in Figure 14 and Figure 15.

Organizations BIM capability

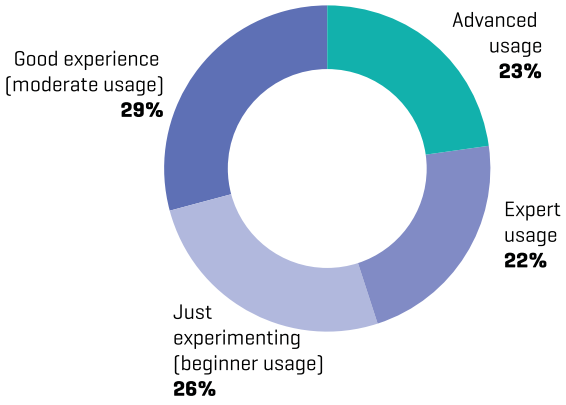

Figure 14: Level of BIM usage amongst users

Percentage of projects being done using BIM

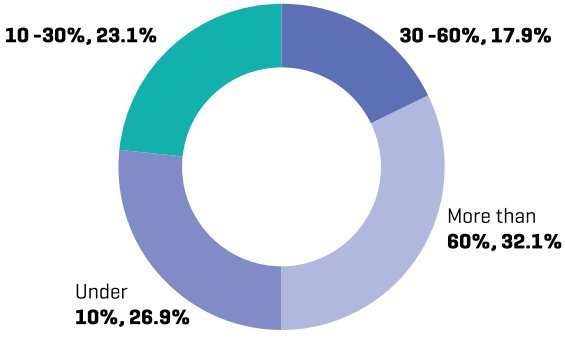

Figure 15: BIM projects amongst users

Currently, BIM is being used in a variety of subsectors of the built environment in India. However, we witnessed significant inclination towards real estate, particularly residential real estate projects. The usage of BIM in the infrastructure and industrial development domains is still low. Among industry players reporting BIM usage, about 68 percent reported using BIM on residential projects and the lowest usage was recorded in infrastructure sectors (Figure 16).

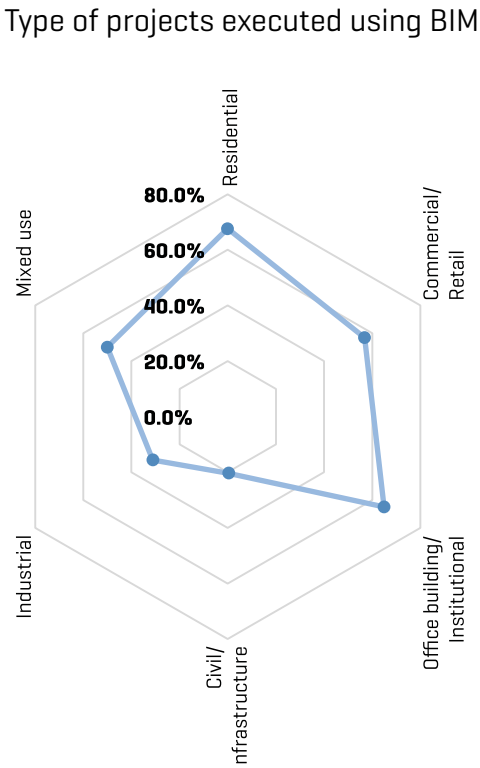

Figure 16: Usage of BIM in various sub-sectors of the built environment

In India BIM is being mostly used during the design and development stage followed by construction stage. BIM is barely used in facility operation or facility management stage of Indian projects. Figure 17 and Figure 18 show the usage of BIM in India along the project lifecycle phases.

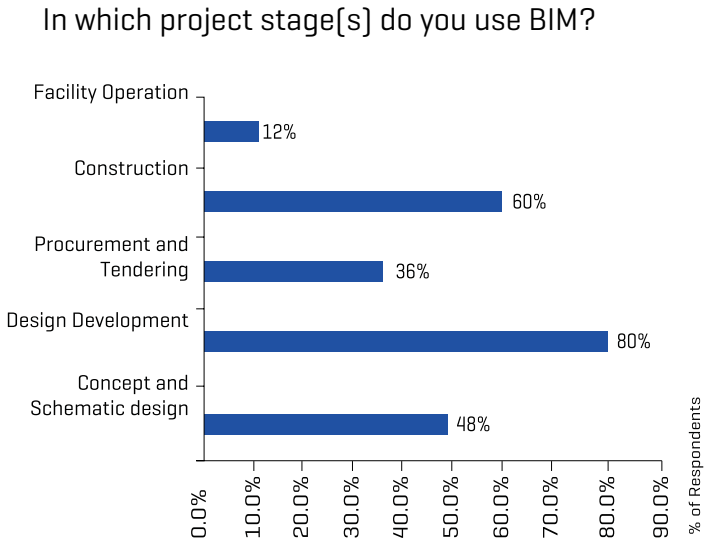

Figure 17: BIM usage by project phase

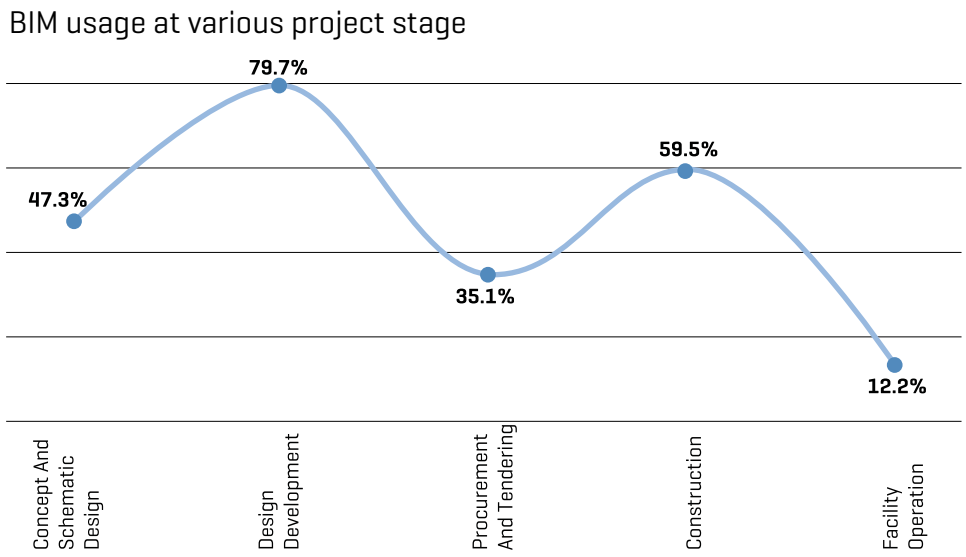

Figure 18: BIM usage in various project phases

Professionals find BIM most useful for improving coordination and detecting clashes/collisions. BIM is also used as a tool to reduce waste, as a significant number of professionals use it to measure material quantity and control cost. Owing to high adoption within the real estate sector, BIM is also used widely for 4-D scheduling and visualisation. Its usage is the lowest for environment sustainability, safety, and facility management. Figure 19 shows the main functions for which BIM is used in India. The top three functions are: (1) design coordination; (2) clash detection; and (3) quantity measurement. This points to the fact that the maturity level of BIM in India is low i.e. BIM is not being used to drive collaboration and coordination through the value chain and along the entire project lifecycle.

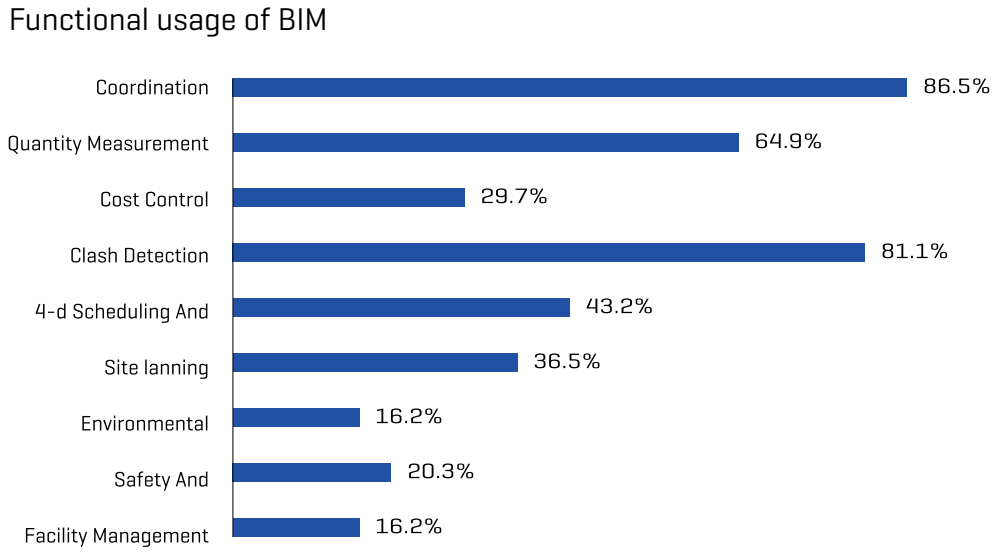

Figure 19: Main uses of BIM

7.2 BIM Software Used in India

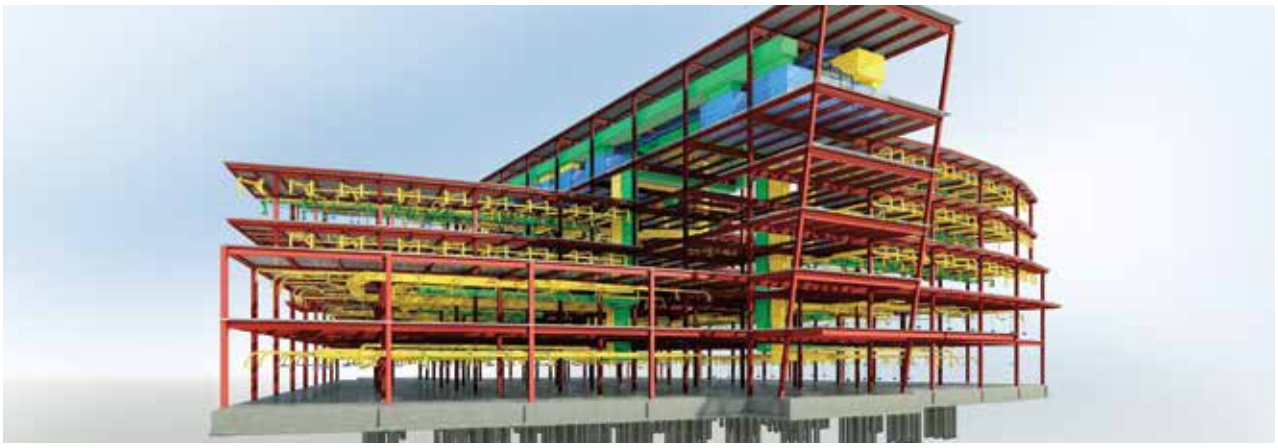

Image courtesy of Autodesk

A variety of BIM software are available globally. This study found that Autodesk products are used the maximum by BIM users in India. About 80 percent respondents use Autodesk Revit, followed by Autodesk Naviswork. SketchUp is also popular with about 40 percent respondents using it for BIM-based coordination and clash detection. Trimble Tekla products are popular among specialist consultants and constructors involved in complex structural configurations. Figure 20 shows the usage of BIM software in India.

Surprisingly, online collaboration and coordination tools are not popular among BIM users in India (as shown in Figure 21). This shows that the maturity level and sophistication of BIM usage in India is lower than other mature markets, such as the USA and the UK. Collaborative technologies that allow sharing of the BIM model and other project-related information is needed for effective and efficient usage of BIM. The non-adoption of such technologies in India points to the need to improve BIM maturity levels in the country.

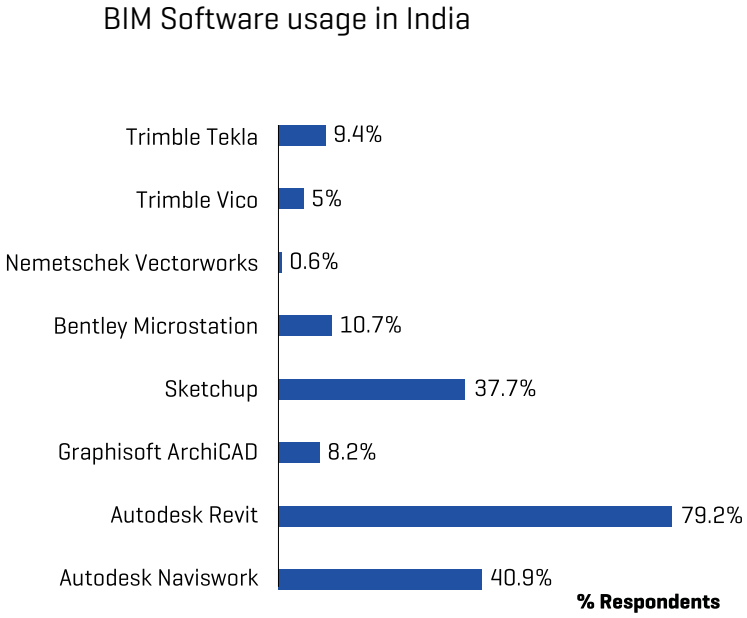

Figure 20: BIM software used by respondents

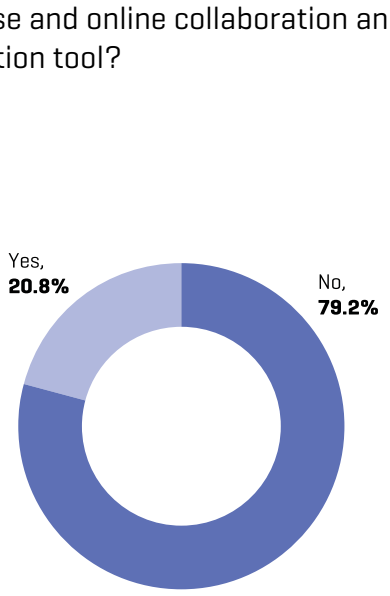

Figure 21: Usage of online collaboration tools by BIM users

7.3 Key advantages of BIM

Based on the survey response and interviews conducted, BIM has the potential to be deployed in the Indian built environment sector to provide significant operational efficiencies to various stakeholders. Most respondents feel that significant cost and time savings can be accomplished on projects through model-centric practices that BIM allows. A significant number of professionals using BIM reported that it helps improve coordination among different stakeholders, such as architects, contractors, suppliers, and other downstream project team members. Viewing the model of the facility in the beginning itself, as the design and engineering process evolves, helps detect construction and occupancy issues beforehand, such as detecting clashes, accuracy in quantity estimation, timelines, managing changes and operation and maintenance issues. These advantages result in improved overall productivity and accuracy of project metrics, improved cost monitoring and control, faster construction cycle and waste reduction.

Some key words and terms that were highlighted from the interview transcripts and survey responses to qualitative questions have helped in the creation of a revised 'word cloud', as shown in Figure 22. Advantages such as better coordination, collaboration, communication, class detection, visualisation and quantity take-off emerge as some of the top themes among respondents who are using BIM or are aware of the process.

Figure 22: Key advantages from interview and survey responses

While planning our study, it was decided that questions pertaining to advantages (and disadvantages) of BIM will be kept open-ended. Respondents were asked to provide information in the form of comments rather than selecting from a pre-determined list. Table 7 shows some of the respondents' comments.

Table 7: Views of respondents revealed after the qualitative analysis

Respondents	
90% of the respondents	listed coordination as an advantage of BIM
86% of the respondents	stated visualization during the design and construction stage as important
82% of the respondents	accurate quantity take-off and estimates
81% of the respondents	better MEP coordination
70% of the respondents	constructability analysis can be performed
69% of the respondents	value engineering can be performed
67% of the respondents	better change management
60% of the respondents	waste reduction is possible
60% of the respondents	better understanding of design
56% of the respondents	improved collaboration and coordination for design team
48% of the respondents	information available at one location/model
47% of the respondents	clash and collision detection is enhanced
45% of the respondents	modelling and simulation for sustainable design is possible
43% of the respondents	management of information
40% of the respondents	changes easy to visualize
32% of the respondents	cost control is more reliable
25% of the respondents	4D modelling helps project phasing decisions
24% of the respondents	progress monitoring is enhanced
19% of the respondents	billing and site management is more reliable
12% of the respondents	facility management can be made more efficient

Image courtesy of Abraham John Architects

Based on our study, the advantages of BIM usage in India are listed below:

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

- **Faster construction cycle:** BIM helps improve construction cycle by reducing duplication of work, identifying standard and repetitive components and removing issues before the construction process commences.

- **Improved visualisation:** 3D visuals generated via BIM provide clarity on the product to various stakeholders, thus providing them sufficient visibility of the practical challenges.

- **Clash detection and less construction surprises:** a major issue that is usually observed during the construction stage is clashes between various disciplines, which requires significant rework of the design or construction. BIM helps in identifying such issues at the design stage itself and, incase of any clash, allows a collaborative and coordinated process for resolution. BIM also helps highlight other construction issues, such as constructability, material usage and timelines and allows value engineering exercise to be conducted.

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

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

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

- **Improved project monitoring:** With BIM, a user can 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 changes in a project. It allows visualisation of changes more effectively. Change propagation in the model is easier in BIM as compared to 2D documentation.

7.4 Challenges and Barriers to BIM Implementation

Implementing BIM on a project or at an organisational level is not simple. In addition to the deployment of resources, efforts at the strategic, operational and tactical levels must be expended. Pronouncing BIM adoption and then delegating the actual implementation to those who cannot influence change on their own can lead to unsatisfactory results. Due to the nature of BIM adoption, stakeholders face numerous challenges. From the responses received by us, the top 16 challenges are identified and provided in Table 8.

Table 8: Challenges in BIM adoption

Requires overcoming mind-set barrier
Needs changes to work processes in an environment that resists change
Initial effort and time needed for BIM is more
Not all stakeholders are using BIM
Does not provide all inputs and outputs needed by the industry
Lack of government support
Initial hardware and software cost is high
Training and learning curve issues persist
Management reluctant to use BIM
Contracts, current practices and fee structures are not tuned to the use of BIM
BIM requires more effort upfront and team discipline
Policy changes at the business level are needed
Takes too much time to incorporate changes much easier in 2D CAD
Use of BIM makes some stakeholders feel threatened
Low awareness levels and significant misconceptions on BIM in India
Difficult and expensive to implement

These challenges highlighted by the interviewees and the survey respondents are streamlined and discussed below:

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

- **Difficulties in adapting to frequent changes in design:** one of the challenges frequently cited by Indian professionals is the need to expedite producing of project documentation especially in the face of frequent changes that Indian projects encounter. Psychologically, these professionals find it easier to make such changes in a 2D environment. Not many professionals are willing to question the reason for such ad hoc changes and the quality of the revised documents produced in the face of these changes. Due to the lack of standards and well-laid-out 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 embraced BIM. Even in a perfect scenario where a client and designer are willing to adopt BIM, lack of availability of specialist consultants who are willing to use BIM makes implementation challenging. This was a recurring theme in most interviews and survey responses.

- **Compatibility between software platforms:** one of the biggest issues with early adaptors of BIM is the issue of inter-product compatibility. This interoperability issue is not limited to different software platforms; due to the rapid development of the BIM software industry, newer versions of programmes within the same platform can have interoperability issues and this is causing heartburn among industry players. This issue emerged repeatedly in interviews, especially among specialist consultants.

- **Availability of skilled resources:** respondents find the lack of a BIM savvy workforce to be one of the biggest challenges. People in the construction industry lack expertise and knowledge to fully put into practice this new concept—finding modellers for various project domains is another major challenge reported by most respondents. Project managers face challenges concerning incorrect modelling procedures as a result of the lack of experience in using 3D modelling tools.

- **High hardware and software cost:** A roadblock in BIM adoption is the perceived price of hardware and software and incompatibility with software that are being used by some stakeholders—especially small and medium enterprises. The perceived high initial cost of implementing BIM has deterred many industry professionals from putting technology into practice. This, coupled with the lack of a clear value proposition for project stakeholders, is making implementation challenging. Stories of 'BIM can solve all your problems' in India have led to some failed BIM implementations.

- **Unavailability of process implementation guidelines:** Unlike other countries, India does not have any national standards or guidelines for BIM. Moreover, Indian projects generally do not start with a BIM implementation and execution plan, causing confusion and discrepancy in project team members' expectations.

- **No mandate from government for BIM implementation:** the General Services Administration (GSA) in the USA is a pioneer in advocating the adoption of BIM for public sector projects. It has also developed a suite of BIM guidelines. The BIM Industry Working Group in the UK has prepared a BIM strategy to increase BIM use over a five-year period by 2016. However, the Indian government has not defined any policies that mandate the implementation of BIM.

- **Lack of practical knowledge:** the survey revealed that engineers and architects lack practical knowledge and model developing skills related to BIM. The skill set of engineers and architects is still oriented towards CAD and BIM understanding is limited. Lack of skills leads to inefficient usage of BIM and making a perfect recipe for less than optimal BIM utilisation on projects.

The state of affairs can be fairly judged by the statement made by one of the respondents:

"BIM is unable to provide all forms of output that the industry is used to obtaining from 2D CAD. BIM needs to evolve to a level, where quality construction drawings, shop drawings can be generated for use on site. Unless BIM becomes a credible replacement for 2D, it will remain a 'nice to have', instead of a 'must have', tool."

Using qualitative analysis the interview transcripts and the qualitative responses provided by survey respondents were mined. A mind-map of the reasons for not adopting BIM in India was prepared using this analysis as shown in Figure 23.

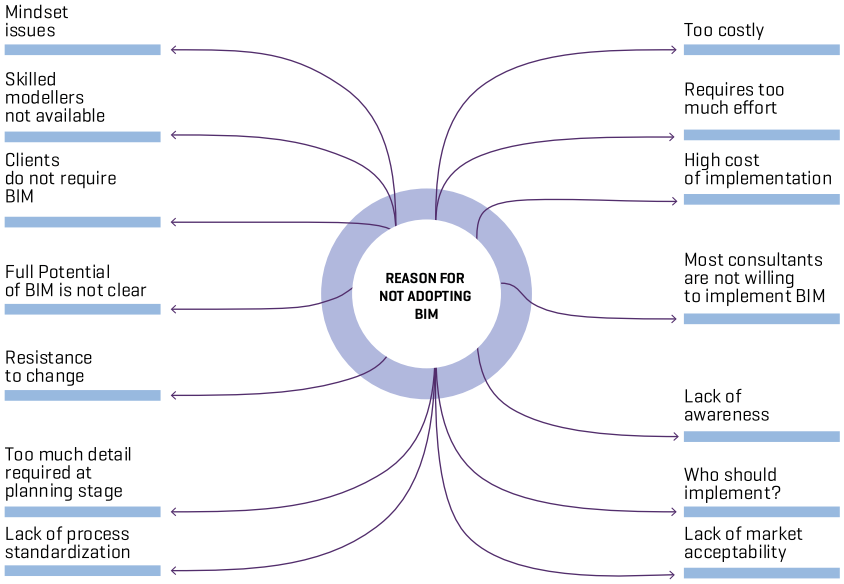

Figure 23: Main barrier to BIM implementation in India

7.5 Expectations of Industry Players

Interviewees and survey respondents provided key insights into the ways with which BIM adoption rates in India can be increased. The question **What is the single most important factor that would make your company want to adopt BIM?** yielded interesting insights into the expectations of industry stakeholders. Using qualitative analysis techniques a mind map, shown in Figure 24, was developed. Main drivers to BIM implementation came to the forefront through this analysis. It becomes evident from this figure that the respondents are keenly aware of the three-pronged issues pertaining to **technology, people and process** that must be addressed conjointly to allow meaningful penetration of BIM in the Indian built environment sector.

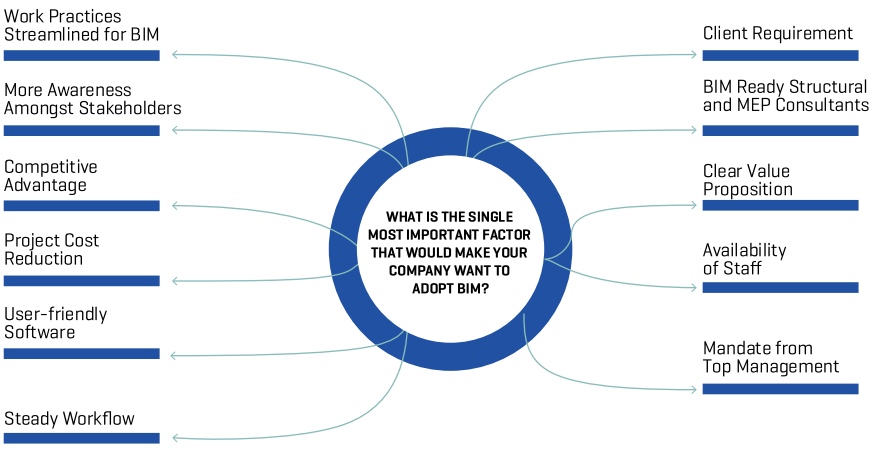

Figure 24: Important drivers to adoption of BIM in India

The interviewees and survey participants expect the following measures from major stakeholders in the built environment sector:

- **Broader vision and behavioural changes from all stakeholders to collaborate on the BIM platform:** Adoption of BIM requires holistic changes to the processes and practices currently followed in the built environment sector. This shift requires leading government agencies, industry players and their senior management to play leadership roles in the transformation. It also requires behavioural change as lot of cohesion and sharing is required amongst various stakeholders and project teams. Shift in the mind-set of key stakeholders is a must—without it the BIM adoption may remain superficial and may even decline

- **Capacity building, education and training for BIM implementation:** Educational institutions and those engaged in providing continuing education to professionals must start looking at innovative models of awareness, capacity building, education and training in the area of BIM. Possibly a certificate in BIM implementation and management for industry professionals with the fundamental knowledge and understanding of the principles, terminologies, tools and techniques of BIM can be deployed in the Indian context. For example, RICS has recently started the **RICS Certification for Building Information Modelling Manager.** The Construction Sector Skill Council of India, under the aegis of the National Skill Development Council, can embrace this type of certification and provide it on a pan-India basis.

- **Better value proposition for all stakeholders:** Clear, concise and well-documented value proposition for the built environment sector stakeholders is required. Measuring return on investment for BIM implementation can challenging. This is especially true for public sector projects in India. Documenting successful BIM implementation efforts in India is, therefore, crucial to building a storyline for value-add from the point of view of various stakeholders. This will help in setting the right expectations.

- **Development of national standards and guidelines:** Perhaps it may be too soon to expect government intervention or mandate for BIM adoption in India. In countries such as China, Singapore and Australia, national efforts are underway to develop national BIM standards and guidelines with or without government support. India also needs to move in this direction. This will help all stakeholders to access neutral, open, and flexible standards and guidelines allowing forward-looking stakeholders to move ahead with their BIM implementation plans. Information and best practices on issues such as procuring BIM services, developing a project-specific BIM implementation plan, contractual issues, and delivery and fee schedule, already available globally, need to be assembled for the Indian built environment sector.

- **Sharing of information via BIM model needs to be made more convenient and accessible:** As BIM is fundamentally a collaborative process; it requires that sharing of the model and information encapsulated in the model becomes easier and no information is lost. BIM software needs to be more user-friendly, flexible, and localised. Information exchange and technology that underpins it also need to mature. Fundamentally if a secure and easy-to-use information-sharing platform is provided to all project stakeholders, a sharp uptake in BIM is possible. BIM software must also become more integrated, flexible and open.

- **India-specific BIM product library:** BIM model for a project is internally represented as a large number of objects, such as walls, columns, beams, doors, windows, lighting fixtures, pumps, generators, escalators, elevators, pipe racks and cables. Successful development of a model, therefore, depends on the availability of standard objects or product models in 3D. Product manufacturers need to develop 3D object models for their products. These object models should be hosted on national-level open source library for the project stakeholders to use. For example, in the UK, NBS National BIM Library is an online repository of product manufacturer supplied BIM objects. In India, such an effort is required to take BIM adoption to any meaningful level

- **Lifecycle view for BIM implementation:** BIM models associate additional information about project components along with geometry in a structured way. This lets us build project documentation in a more structured and collaborative manner. BIM-enabled workflow allows this information to be shared by different project participants and also among different stages of design, construction and operation. This whole-of-lifecycle view is crucial if full benefits have to be gained from BIM

8 Way Forward—Future of BIM in India

BIM has the potential to provide significant benefits to the Indian built environment sector. Considering the high volume of real estate and infrastructure construction activity India is witnessing, BIM, if deployed appropriately, can provide significant savings, enhance the quality of the built environment that gets delivered and allow the industry to make expected contributions to the growth of the country. Much of this potential remains untapped.

BIM as a phenomenon cannot be ignored. The message is loud and clear. BIM is here to stay–**it's not a case of 'if' but 'when'.** BIM will help professionals to do their jobs better, with greater collaborative input. Companies must empower project teams to seize the opportunities that BIM provides through dedicated guidance and training. Regardless of cost or learning curve, many teams have already proven that its benefits outweigh the teething problems that accompany BIM implementation.

To leverage BIM, it is essential that government agencies and clients lay stress on the usage of BIM in their procurement processes and contracts. As more benefits surface, and as more owners see—and share—higher profits, BIM is expected to find full traction and reshape the Indian built environment sector. 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 signup 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.

Professionals and organisations that 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. Those who feel that the less things change the better, may find themselves scrambling for BIM adoption and rushing into perhaps ill-advised choices once 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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RICS - Royal Institution of Chartered Surveyors

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