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Applicability of Building Information Modeling (BIM) in Indian Built Environment Sector

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Abstract: Building Information Modeling (BIM) also accustomed as virtual model technology is a process or technique implicating the propagation and administration of programmed embodiment of physical and utilitarian aspects of places. It is an avant-garde development that is rapidly transforming the Architecture-Construction-Engineering (ACE) industry. This work addresses the status of Building Information Models and the environment necessary for them to develop into more broadly used process including modularization and cost assessment. BIM helps project internal stakeholders to envisage what is to be built in a virtual environment and to ascertain any latent design, construction or outfitted issues. The paper presents an outline of BIM with center on its nucleus concepts, challenges, and applications in the all stages of project life-cycle and managerial issues among project stakeholders. The paper also depicts the role of government for the enlargement of BIM technology especially in India. Further, the paper concludes that comprehensive implementation of this technology by the ACE industry will acquire little more years.

Keywords: BIM, Construction Industry, Facility Management, Project, Virtual Model

1. Introduction

BIM is the compilation of all building data formulated into a structure database easy to access both in a "digital" and a "practical" way [1]. The concept of BIM started during 1970's but it became popular in 1990's only. Now many assets owners are becoming conscious of the remuneration of IT gears from explicit applications towards more immense solutions. The use of BIM goes ahead of the planning and blueprint phase of the project, approaching all through the building life cycle, sustaining processes together with equity management, infrastructure management, project management and facility management [2]. Autodesk's BIM is an intellectual 3D sculpts based process that garnish architectural, engineering and construction professionals with the approach and tools to more effectively plan, design, construct and manage infrastructure. Employing information systems in the construction industry has been a matter of great significance in order to augment the efficacy of construction projects right through their life cycle and across diverse construction business services [2]. However, the theory of information system in construction is very extensive and slanted.

2. Management of BIM

Scope of Building Information Modeling extends from conceptualization to possession stage [3, 4]. To ensure resourceful management of information processes during this period, a "BIM manager" might be selected. The BIM manager is preempted by a design team on the owner's behalf from the planning phase onwards to build up and to track the object oriented BIM against anticipated and deliberated performance objectives, aiding multiple complex building information models that cover scrutiny, schedules, impersonation and logistics [3]. Private firms are now actively making an allowance for developing BIM in a variety of levels of elements, in relevance of BIM; more or less detail is needed, and there is anecdotal modeling effort coupled with generating building information models at different levels of elements.

2.1. BIM in Construction Management

Employees in the construction process are relentlessly

challenged to convey booming projects in spite of tense budgets, inadequate manpower, overrunning schedules and inconsistent information. The major works such as architectural, structural and electrical designs should be well synchronized, as two works can't take place at the same location and time. Building Information Modeling helps in clash detection at the preliminary stage & identifying the precise location of disparity [5].

The BIM concept features virtual 2D and 3D construction of a facility before its actual substantial construction, in order to trim down ambiguity, perk up safety, sort out problems and imitate and scrutinize potential impacts. Contractors from every skill can put in decisive information into the model before opening construction, with freedom to pre-fabricate and pre-assemble a few systems offsite. Construction waste can be reduced on site and services are delivered on time rather than keeping an inventory at site.

Quantities and communal properties of services can be extorted easily. Scope of work can be secluded and clear. Systems, clusters and programs can be shown in a virtual scale with the entire facilities. BIM also prevents flaws by enabling divergence detection whereby the virtual sculpt visually highlights to the team where parts of the structure are faultily interconnected [5].

2.2. BIM in Facility Management

BIM can link the information gap allied with managing a project from design team, to execution team and to building's client by allowing each team to add all information they obtain during their period of input to the BIM model. This can cave in benefits to the facility owner (client) [2, 6].

For example, a facility operator may find indication of a trickle in the building. Rather than examining the actual building, he may see the virtual model and see the location of defect of any product. He could also access in the model the exact size, manufacturer details, model number and any other information. Such problems were primarily addressed when mounting a susceptibility representation of facility contents and intimidation for sustaining the detection of susceptibilities in building emergency.

Compelling information about the building, such as signal and security analysis of the building, can also be integrated within BIM software to support building repair, maintenance and operation (RMO) procedures.

2.3. BIM in Property Management

BIM can possibly offer some payback for managing layered complex spaces in metropolitan environments. The first advantage would be boosting visual communication of convolute, mutilated and complex living spaces for non-professionals. The affluent amount of dimensional and syntactic information concerning physical structures inside models can assist conception of cadastral restrictions, providing an unequivocal demarcation of possession, constitutional rights, errands and precincts. Moreover, using BIM to administer property information could press forward current land paperwork systems from a 2D based cognate data into a 3D programmed, intellectual, collective and vibrant system [14, 17]. BIM could also release value in the cadastral information by forming a link between that information and the reciprocal lifecycle and supervision of buildings. BIM is implemented in many construction facilities or domains as shown in Figure 1:

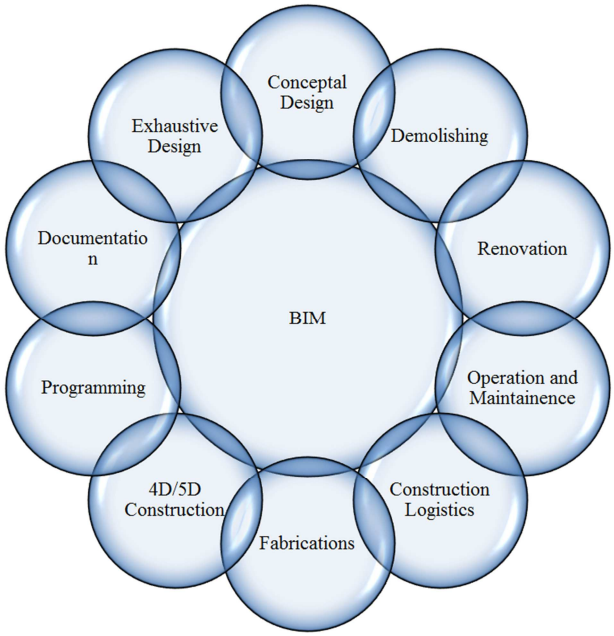

Fig. 1. *BIM services in construction industry.*

3. Adoption of BIM in Modular Construction

Modular construction or sectioned prefabrication cut down on-site manual labor expenditure and time and escalate precision in a good class construction. There are many tools and techniques voluntarily available in an illicit environment of the worksite to execute tasks more accurately, and less expensive in a shorter interlude of time [8]. Prefabrication desires effective design and field precision [3].

BIM can offer this point precision together with the stipulation, schedules, detailing and the 3D illustration for each module [5]. On the other hand the construction team must confirm that the BIM is compatible with the software used by prefabrication team. Like this the constructor can use BIM and create information for the manufactured modules in their fabrication software. Once the information is approved, the modules can be fabricated using machines and robots. Besides, the construction manager must manage the procurement program of the products and make sure that prefabricated modules must be shipped to the jobsite on the dot.

Complex steel structures can be welded offsite; the welding of these diminutive composite elements prior to steel erection can save time and capital. Additionally BIM helps to timely amend designs to eradicate or reduce the conflicts

between mechanical or electrical team [7]. Prefabricated beam perforation would save remarkable time, budget and exertion in evaluation to onsite beam perforations. Ceilings, walls, blocks and apartments can be virtually planned and constructed with Building Information Modeling. These walls, floors and apartments can be prefabricated with adumbrate automatic electrical and mechanical components. Ultimate MEP (mechanical, electrical and plumbing) connections can be completed after the prefabricated components are amassed onsite.

BIM can be used to improve the information transfer of the goods between collaboration [6]. Moreover, it is used to virtually synchronize the position & steering of the products. Based on these instructions, the commodity can be detailed using the fabrication software.

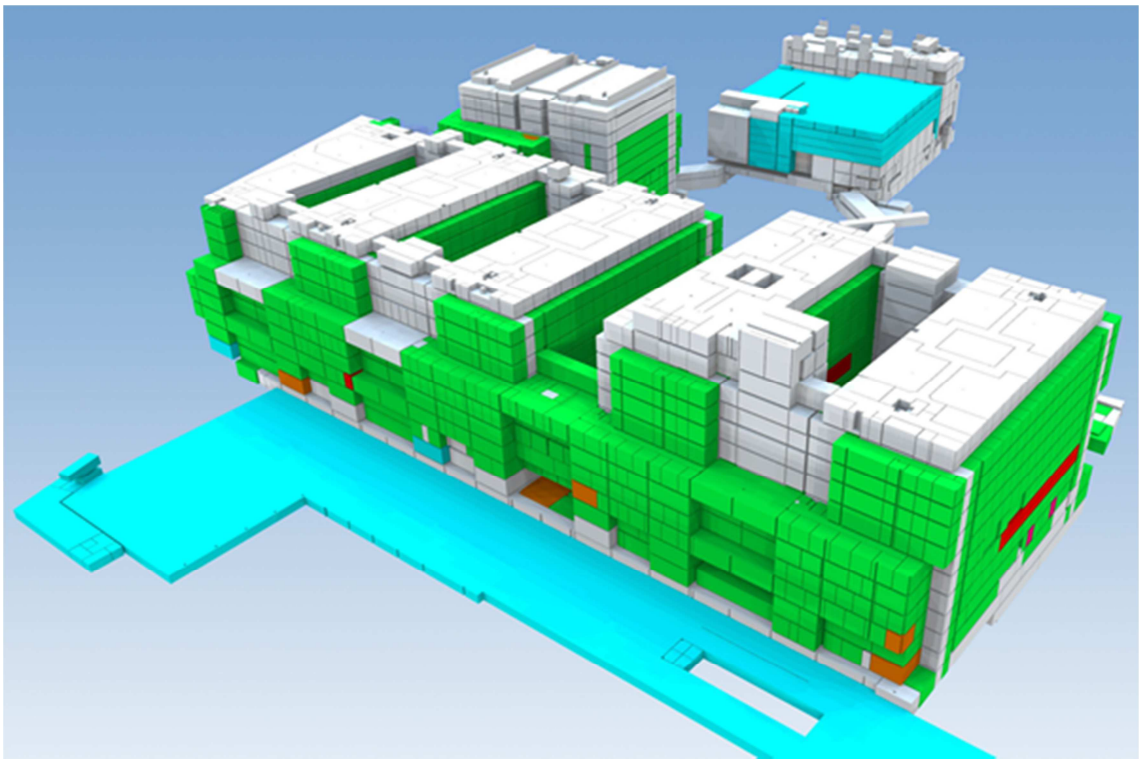

Fig. 2. *Modular Construction using BIM (Source: Skanska Group).*

4. Cost Assessment Using BIM

The two major rudiments of a cost guesstimate are quantity determination and price determination [3].

Quantities from a BIM can be extricated to a cost catalog or a MS excel file. Though, price cannot be obtained from the model.

Cost assessment requires the proficiency of the budget estimator to scrutinize the working of a material and how they get equipped. If the price for a definite activity is not accessible in the catalog, cost estimator may need an additional distribution of the component for more exact pricing. For example, if concreting of any structural member is taking place, then the BIM may describe the detailing regarding reinforcing bars, steel mesh, grade of steel, type and size of formwork, grade of concrete etc., but not embrace it as part of the quantity impression [9, 11].

Budget estimator may require this level of facet from the building information model to decipher the unit price which subsists of the unit item cost, unit manual labor cost, operating cost and revenue. The unit labor cost is calculated by the recruitment and setting up durations and the labor income while the unit item cost is the summation of the material costs used for the commotion per unit. Once the unit price is obtained, the cost of the complete activity can be calculated by multiplying the total amount derived from BIM and unit price.

In Building Information Modeling, the information output is as superior as the information input [10]. It is considerably imperative to have the contractor and the designer to concur on constituent definitions. For example, if a planner is using concrete slab to show the ceiling for illustrating purposes, the roof material details will not be exactly accounted for quantity drawing out purposes in the BIM. On the whole the BIM concept is an immense process to ameliorate the productiveness of the estimators in the course of quantity eradication from the model particularly if the creation team and design team works in collaboration [10].

5. Stake of BIM in Construction Industry

BIM is gaining reputation on a slow pace especially in developing countries like India, Sri Lanka and Iran. In developed countries like Canada or England, BIM stake has been two folded in the past ten years [13]. 3D visualization

has grown from 4D to 5D and even 6D in some expanding cities across the world.

Complication of the project is connected to the class of construction such as residential, commercial, industrial, hospitality, R&D or public project construction. Building information modeling for repetitive residential construction can be uncomplicated. For IT, petroleum, R&D and power projects, BIM would necessitate superior dexterity due to the amplified MEP connections and paraphernalia required for the job [15, 16].

For government or public projects, state level PMC's (project management consultancies) and central defense forces requires the BIM. On the whole, class of construction could be a vital and root feature deciding the applicability of BIM.

Fig 3 and fig 4 shows the proportion use of BIM by diverse construction professionals & diverse facilities in construction respectively.

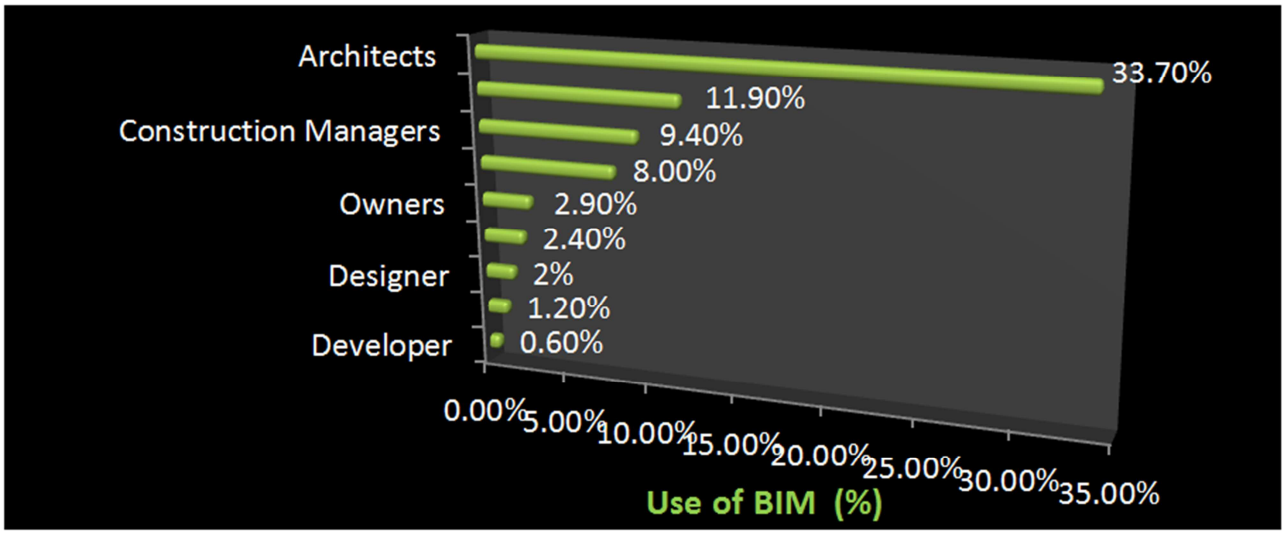

Fig. 3. *BIM used by different construction professionals [3].*

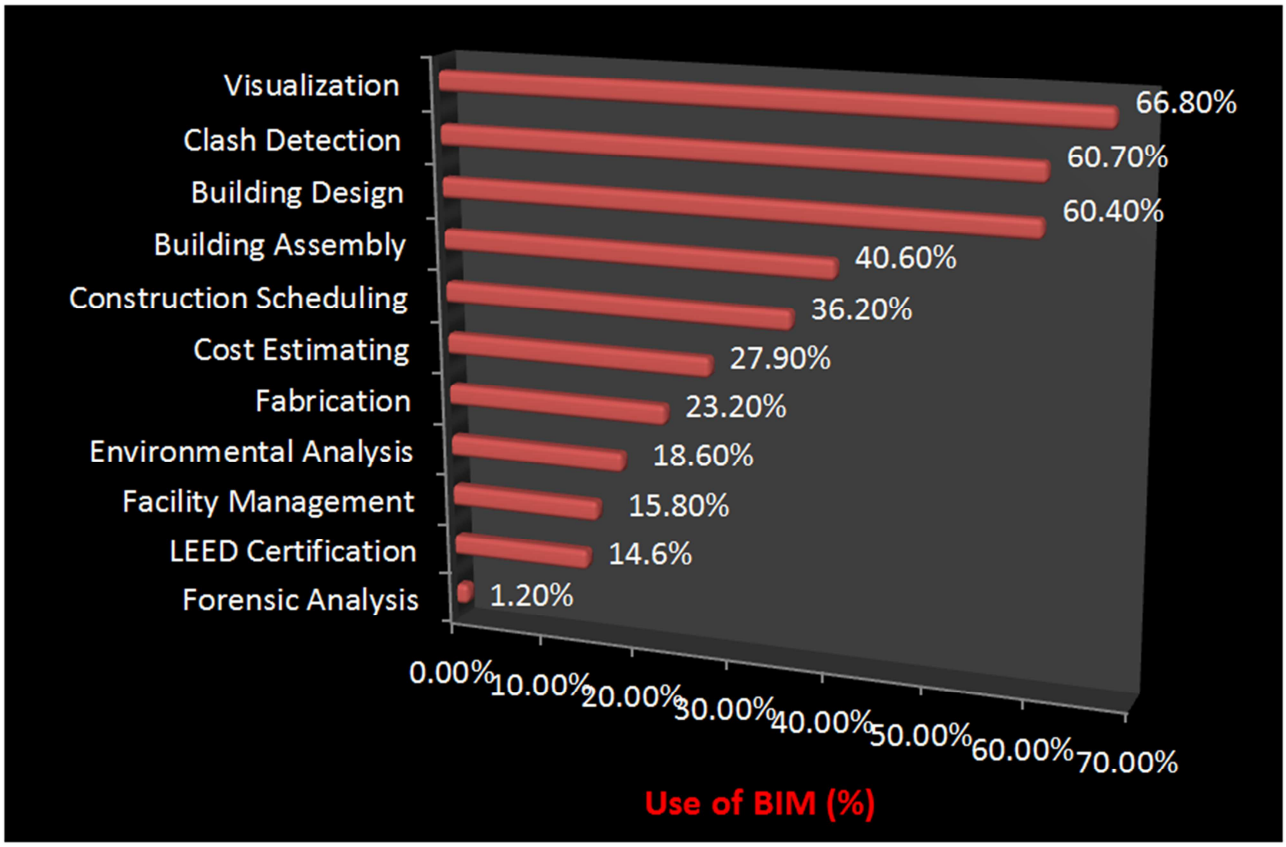

Fig. 4. *BIM used in different construction works [3].*

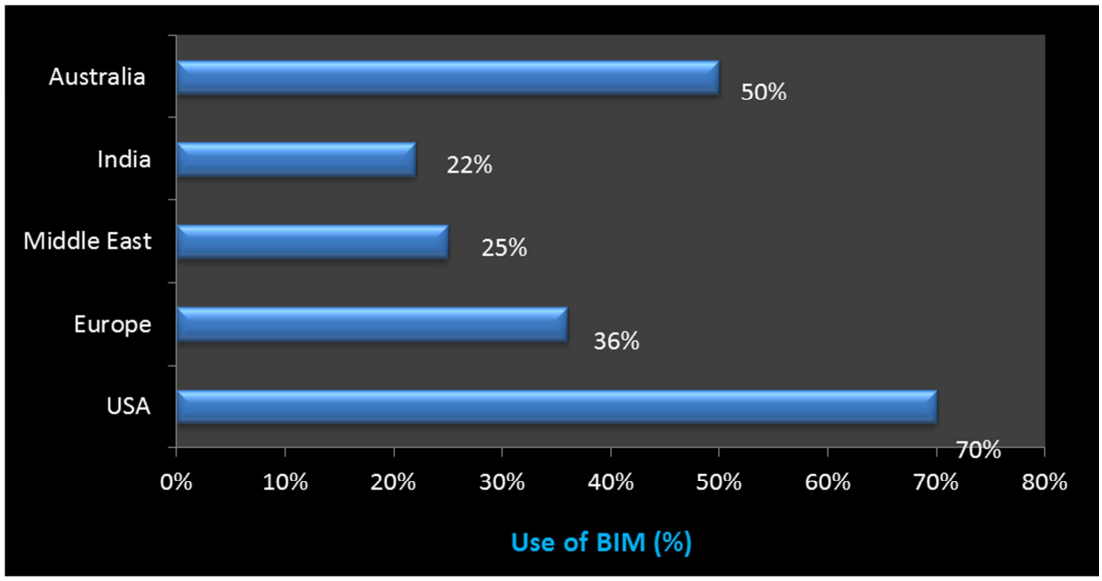

Fig. 5. *BIM used in different countries (RICS Report 2014).*

6. Adoption of BIM in India

A range of BIM softwares are accessible worldwide. Generally Autodesk products are preferred and used by most BIM users in India. BIM users have access to multiple softwares as shown in fig 6 below. Online teamwork and synchronization tools are not used in India, which shows that BIM practice in India is lesser than several established markets like USA and UK.

In India, BIM is being generally used throughout the design and advance stage, pursued by the construction stage. BIM is seldom used in facility management or facility operation of Indian construction projects. Fig 7 shows the practice of BIM in India along diverse stages of a project's lifecycle.

Key Advantages of BIM in India

- BIM has the prospective to be deployed in the Indian construction sector to offer noteworthy operations efficiencies to different stakeholders [20].
- Cost and time reductions can be achieved on projects through model-oriented processes that BIM permits.
- It develops harmonization among diverse stakeholders such as architects, contractors, supply team and project team etc.
- BIM allows perceiving clashes, maintains precision in quantity assessment & timelines, allows superior cost examining and control, waste cutback, helps to sort out operational & maintenance problems.
- These advantages effects in enhanced overall output and precision of project's metrics.

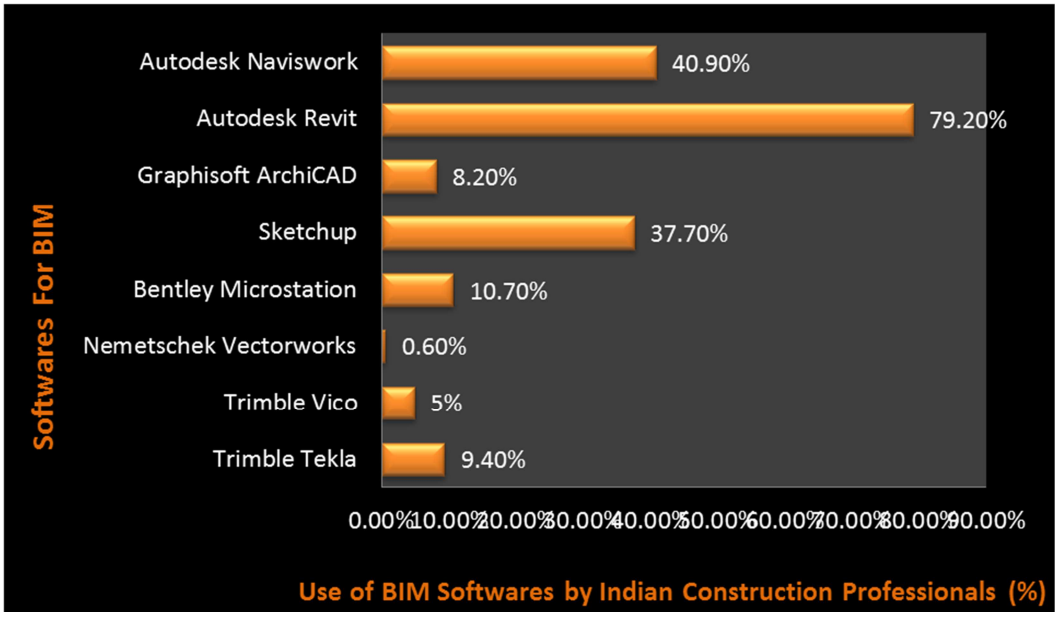

Fig. 6. *BIM softwares usage in India (RICS Report 2014).*

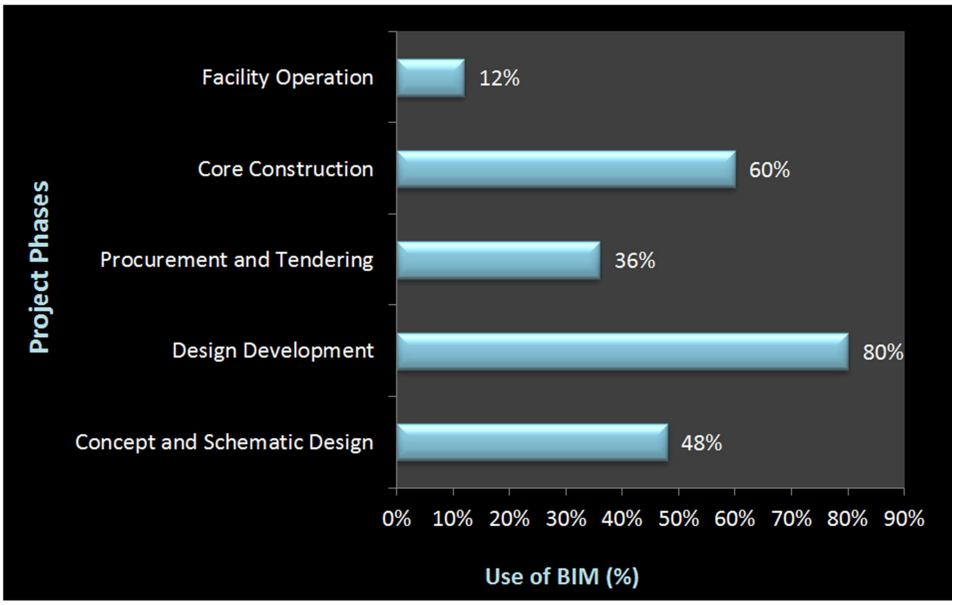

Fig. 7. *BIM usage in India by project phase (RICS Report 2014).*

7. Enforcement of BIM in India

Role of Indian Government:

The responsibility of government is decisive in the realization of BIM in any countryside [18]. Indeed, in some nations the government is one of the chief drivers for the accomplishment of BIM. India is an untie economy where the key supplier to the economy is the private segment and this includes the construction and real estate industry. It can be anticipated that any new development or the prologue of new technology would presumably come up from the private sector [13]. The same is the case with BIM which until now is being principally developed by the private sector in India. There is a high possibility that its deployment will significantly boost in the years to come as BIM has no drawbacks but its application can be apparent only because of confrontation to amendment and accomplishment [14]. In this case, the Government of the India is desired to play a "down to business" role in amending the implementation of BIM in the architectural, construction and engineering industry of India. In order to prepare a stratagem for regulating the deployment of BIM solutions, necessary steps must be taken by the government for promoting the performance of BIM as mentioned below:

Policy and course of action:

The government needs to ascertain the explicit policy of endorsing BIM on all novel and innovative projects. The proposal for the accomplishment of BIM could be recognized under the label e.g. India BIM Curriculum. Policy should contain all the specific and desired guidelines which should be followed by Indian construction professionals.

Open definitive ontogeny:

The BIM policy should persuade open customary software improvement in relation to BIM. At present, there are few contending BIM developers/hawker. Their hard work needs to be rationalized and the Indian central government is in a healthier position to manage coactions of assorted challenging BIM software systems in the industry. Indian Government can take a practical role by providing an swap over policy for congregation the aid from BIM professionals and collaborator.

Design data assessment:

The BIM policy should propose that the design instructions should be unambiguous and made accessible to associates so that the design objective can be easily understand and assess.

BIM enforcement ministry:

In order to put into practice the government's BIM policy, there should be a selected government association/department/ministry to take up the foremost duties for BIM execution originally through some steer projects. It could be an existing government subdivision or society which can be assigned with the task of administration of BIM dynamism in the province.

Espousal by other divisions:

All sectors which can gain from BIM should be persuaded to take up BIM in deliberation with the central department accountable for regulating BIM discharge in the region.

Endorsement and cooperation:

The administration's BIM programme, once time-honored, should be frequently promulgated conciliatory at diverse engineering conferences and magazines whose subject can incorporate BIM. Cooperation with internationally specialized consultancies for intelligence data swap and incessant enhancements would be highly advantageous [18].

8. Managerial Issues in BIM

Problem of Teamwork and Model Ownership

All over the construction diligence, association and data transfer still is primarily document-based. Conventionally, dearth of edification/guidance resulted in a pretty

incompetent teamwork. Depending on the project, teamwork during BIM over the entire building lifecycle can perk up data and practice management in an essential information depository and smooth the progress of role and accountability management through close group or network services [10].

In new-fangled buildings, teamwork through BIM is escalating, particularly due to enhancing capacities of communication medium, BIM network, cloud computing, telecommunication servers and amplified veracity approaches. But also the scattering of collaboration principles and improved training of workforce helps to conquer the execution problems and secluded use of BIM. Moreover, requirements of project owners and political demands in some countries like Russia or America gradually more promote BIM collaboration in new-fangled construction [18].

Existing BIM teamwork systems center on functionalities of contented management, screening and coverage rather than on model conception or system management yet, but they are more burgeoning. However, there are still rampant communal and managerial difficulties retarding BIM performance in the construction sector. Frequently mentioned obstacles are a disjointed Architecture, Construction, Engineering, Facility Management and Deconstruction Industry (ACEFD), and confrontation to changes in service patterns and processes, leisurely adapting preparation of personnel, deficient tailored collaboration systems, in addition to customary problems of legal responsibility, data sanctuary and compatibility [14].

For safeguarding and demolition purposes in extant structures, stakeholders and their roles are clearly defined and can be coupled with BIM matter for which they are answerable. While the mainstream of present buildings are not maintained or deconstructed with BIM yet, stakeholder's group effort might remain unproductive. Many accessible and moderately BIM-incorporated facility management software solutions will improve facility management functionality and relationship [14]. But on the topic of deconstruction, actions and function-definite process or communication maps of BIM are not formulated or implemented yet. Due to governing time and cost limitations in deconstruction, the concentration is given on time and budget optimizations rather than on virtually supported collaboration through BIM [17, 21].

As described before, teamwork systems have four most important spheres: content management, model conception, coverage and system management. Particularly the second province raises a good number of discussed topics of level of concern, contractual fortification of model possession and intellectual assets, as well as of official uses and receptive information in joint project delivery (JPD). Indemnity matters like allocation of risk as well as recompense of liability are also significant issues.

For BIM use in new buildings, the ASCE and many other societies of prime importance are working on individual contractual guiding principle and are releasing contract samples. But legal suspicions in BIM implementation and in ACE, facility management or design sectors of other countries often stay behind [14, 18].

As many processes in facility management and deconstruction are not governed on BIM yet, specific contracts have not yet been developed and are consistent for these operations. Though tasks for perilous materials onsite are predetermined in new construction, contracts need alteration for existing buildings due to owner's liability for inheritance. Moreover, accountability of model and content management during RMO (repair, maintenance, operations) process seems not to be accounted in this study yet, though restructured BIM content is essential for any RMO, retrofitting or deconstruction scheduling [9, 12, 19].

9. Conclusions and Recommendations

The Building Information Modeling is an intensifying field of study assimilating many information spheres within the Architecture, Construction, Engineering, Production and Manufacturing commerce. Following are the conclusions:

- Construction business is keeping pace with expertise and modernization. Particularly, BIM and its paraphernalia are fetching widely adoption [4].
- BIM has tainted the means the buildings are planned, constructed and operated [5]. The exercise of BIM has led to enhanced productivity, abridged overhead costs, healthier time management and superior customer-client affairs.
- The construction trade uses competent modeling to plan, design, organize and manufacture modules of buildings. The planning and coordination using BIM curtail flaws before execution.
- Building Information Modeling is advantageous to construction diligence [15, 16]. BIM masterpiece such as synchronization, construction planning, facility management and modular construction make building projects more proficient.
- In other lexis, BIM contributes time and expenditure savings and hand over superior quality construction services. Assorted BIM tools can be used to put into practice the BIM in construction projects [12].
- This paper has acknowledged a research outline personalized to scrutinize the BIM domain and provides applicability of BIM in various construction or project management related activities.
- Managerial issues for convenient BIM performance were focused right through this paper.
- The paper premeditated the diverse uses, advantages of BIM. The research centered on the use of BIM primarily for a construction manager for research facility, cost estimation, modular construction and various other constructions facility services in a built environment.
- The paper proposes that the use of BIM will be a profitable course of action to the construction managers. However, the exploitation of BIM tools can be exigent and demanding.

Following are the recommendations:

- The discrepancy of study topics concerning to BIM, accentuate the inevitability and call for a research structure to permit its methodical analysis [6].
- Auxiliary research is requisite for the management of scheduling and other BIM tools [3, 6].
- The utilization of BIM based scheduling is suggested for only meticulous construction scheduling and monitoring for tasks such as QA/QC programs that demands more exertion to craft and revise activities.
- Furthermore, the industry will have to build up adequate processes and policies that sponsor BIM use and administrate nowadays issues of possession and jeopardy management [18].
- To perk up the performance of BIM, design cooperation and information swap with consultants should be enhanced well.
- Researchers and professionals have to build up apposite solutions to surmount these challenges and other allied risks.

As a number of analysts, specialists, software hawker and licensed organizations are functioning robust for the resolution of these challenges, the outlook of BIM is exhilarating and propitious [2, 7, 8].

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