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Final Report

Navigating the Digital Landscape: Exploring BIM/CIM Utilization in Private Companies

Zhihui Gao

Yishu Wang

Jiecan Wang

Vibhav Gangamwar

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Abstract

The report examines the implementation of Building Information Modeling (BIM) and Construction Information Modeling (CIM) in the private sector, assessing the role they play throughout a project from inception to completion and ongoing maintenance. This article will detail the challenges they pose and their impact on company operations, as well as how BIM/CIM can help improve construction management practices. The study used interviews and surveys with industry professionals and NYU faculty to collect detailed and reliable data, followed by meta-analysis and cost-benefit analysis. The data and results collected after analysis highlighted several key benefits of BIM/CIM, such as streamlining construction activities, improving project visualization, enhancing communication and collaboration among stakeholders, and enhancing long-term management of resources. Additionally, the report explores the economic aspects of BIM/CIM, noting the explicit costs associated with technology adoption, training and software licensing, as well as the hidden costs due to labor. This report focuses on the strategic advantages provided by BIM/CIM, allowing companies to manage large projects more effectively, reduce costs, and improve customer satisfaction. At the same time, looking to the future, the integration of artificial intelligence, machine learning, smart building technology and BIM/CIM will fundamentally change the design, management and operation of construction projects, guiding the industry to develop in a more adaptable, intelligent and intelligent direction.

Introduction

With the advent of information technology, all walks of life are undergoing tremendous changes, and the fields of architecture, engineering, and construction are undergoing major changes. After more than 20 years of evolution, architectural practices have transitioned from hand-drawn plans to computer-generated models. The adoption of Building Information Modeling (BIM) and Construction Information Modeling (CIM) is key to driving this change. This report will describe the importance of BIM throughout the entire project, from initial demolition through to project completion and subsequent maintenance, as highlighted by the interviewees. It will also explain why it is crucial for private companies to understand and adopt BIM in today's market. This report offers a unique perspective on how companies adopt technology, their approach to decision-making, and the resulting benefits and barriers encountered. Our analysis explores the complex dynamics of BIM/CIM deployment, taking a closer look at its wider impact on how projects are executed, financed, planned, and how it impacts asset management over time. We gathered a comprehensive set of empirical evidence using interviews and surveys as our primary tools, interacting with diverse stakeholders, including NYU faculty and industry professionals. The discussion centered around measurable and non-measurable costs, barriers encountered, and the far-reaching benefits that BIM/CIM integration can bring.

Literature Review

2.1 Adoption Of the BIM.

The existing research on BIM from Salman Azhar (2011) discussed that BIM is the most promising development in the architecture, engineering, and construction (ACE) industry, which improves the processes of the whole project lifecycle and is also able to eliminate or reduce the waste of material, resources, and cost. It also enables users to share information, virtual design, and manage conduction projects. According to Belay et al. (2021), there has been a rapid increase in the number of adoptions of BIM in private construction sectors in recent years. This illustrates the widespread acceptance of BIM globally due to its numerous benefits in the construction business environment. Based on McGRAW Hill Construction's report on The Business Value of BIM for Construction in Major Global Markets (2014), the United States leads with a high level of BIM adoption. In 2013, the adoption rate stood at 55%, and by 2015, it had increased to 79%.

2.2 Benefits and barriers of BIM in the implementation of project life cycle management.

Various research studies have suggested that adopting BIM in construction projects has several advantages over traditional construction practices. According to Ullah et al. (2019), research studies identified the benefits of BIM and categorized them according to the construction phases. During the pre-construction phase, BIM enhances visualization of projects, leading to better planning and feasibility studies, improved accuracy in cost estimation, and early detection of potential design clashes. In the construction phase, BIM facilitates the management of complex construction logistics and optimizes resource allocation, leading to enhanced communication between stakeholders and more efficient project management. Even in the post-construction phase, BIM is useful for building maintenance and management and provides detailed information that aids in decision-making for facility management. These benefits are drawn from comprehensive studies and reports that outline BIM's impact on reducing construction time and costs while enhancing overall project quality.

Although BIM is becoming increasingly popular within the construction industry, there still are some barriers in the private and public sectors to adopting it; according to the research of Belay et al. (2021), challenges may be due to a lack of awareness, cost of implementation, data management and standards. Additionally, the challenge for the private sector in low-income countries may be fragmentation and weak collaboration among stakeholders, which impact the overall project success.

The current research on BIM (Building Information Modeling) and CIM (Construction Information Modeling) often utilizes public projects as examples to showcase the advantages of BIM/CIM implementation. The public sector hires private companies, which may use BIM/CIM for their work on public projects. However, the public sector has not yet fully embraced BIM/CIM practices in their own operations, and they may or may not require their private sector contractors to use BIM on their projects. This study aims to enhance our knowledge of the uses, benefits, and challenges of actual BIM/CIM implementations through interviews with private sector professionals. The information gathered will assist in creating a tailored cost-benefit analysis model that is suitable for public sector contexts. By utilizing the practical experiences and lessons learned from private sector actors, this research will promote the adoption and expansion of BIM/CIM technologies within public sector construction projects. This will help to advance construction management practices and encourage more effective technology utilization in public sector settings.

Methodology Approach

3.1 Participant Selection

For this study, we selected seven participants to provide a diverse perspective on BIM/CIM adoption within the private sector. Among these, two are faculty members from NYU's Civil Engineering department, chosen for their academic and technical expertise. The remaining five are employees from various architecture firms that have adopted BIM technologies. This mix of participants ensures a comprehensive insight into both theoretical and practical applications of BIM/CIM.

3.2 Instrument Design

Prior to the interviews, we developed a semi-structured questionnaire aimed at exploring the specific themes of BIM/CIM application challenges, associated costs, and potential benefits. The questionnaire was designed to elicit detailed responses that would provide depth to our understanding of these areas. The initial part of the questionnaire gathered background information about each interviewee, which helped contextualize their subsequent responses and enabled a more tailored discussion around their specific experiences with BIM/CIM.

3.3 Interview Format

We employed a semi-structured interview format, which provided a flexible yet focused framework for dialogue. This approach allowed us to address our predefined questions while also giving interviewees the space to introduce and elaborate on topics that emerged during the conversation. This balance was crucial for capturing the nuanced perspectives necessary for a comprehensive analysis of BIM adoption.

3.4 Scheduling and Execution

Interviews were scheduled using an online sheet that both parties could access, ensuring that the interviews were conducted at times convenient for the interviewees. All interviews were conducted virtually via Zoom, leveraging the platform's capabilities for recording and transcribing the sessions. This method ensured that all information exchanged during the interviews was accurately captured and could be revisited in detail during the analysis phase.

3.5 Data Collection and Analysis

In addition to the qualitative data gathered through interviews, we also distributed a survey featuring 13 questions with multiple-choice answers to quantify the insights on BIM/CIM adoption. This survey was instrumental in validating the qualitative interview data and provided a statistical basis to support the findings, enabling a robust analysis of viewpoints and trends.

3.6 Rationale for Using Interviews

Interviews were chosen as the primary method for data collection due to their ability to yield detailed, context-rich information. This approach is particularly effective in exploratory studies like ours, where understanding the depth of personal experience and the subtleties of practice within firms is crucial. Interviews allow for a dynamic exchange of ideas and foster a deeper understanding of the respondents' attitudes, behaviors, and experiences with BIM/CIM. Moreover, the semi-structured nature of our interviews facilitated a comprehensive exploration of the complex landscape of BIM/CIM adoption, capturing the intricacies that might be overlooked in a strictly structured questionnaire.

Through this methodological approach, our project aims to provide actionable insights and foundational knowledge that can guide future capstone projects in addressing barriers to BIM/CIM adoption in the public sector. By integrating both qualitative and quantitative data, we enhance the reliability of our conclusions and offer a well-rounded perspective on the challenges and opportunities associated with BIM/CIM technologies.

Takeaways from Interviews and Survey

4.1 Adoption of BIM in the private sector.

Through interviews and surveys conducted, it has been revealed that most of the firms in the private sector have been utilizing BIM software in projects for over two decades. Autodesk Revit emerges as the predominant BIM software utilized in these projects. A noteworthy observation is that the majority of private construction companies opt for project-based licensing, procuring new BIM licenses for each new project. The selection of BIM software is guided by several key factors. According to our findings (Appendix B), 20% of interviewees prioritize Adoption and Staffing Availability, while another 40% emphasize interoperability. The remaining respondents perceive a combination of factors, ensuring the selection of the most efficient tool to accomplish project objectives. During construction projects, 60% of respondents affirm that BIM has substantially reduced errors and clashes, contributing to smoother project execution. Additionally, 40% believe BIM has moderately reduced errors and clashes, further underscoring its efficacy in enhancing project outcomes. Furthermore, survey respondents were asked to rate the interoperability of their primary BIM software with other systems on a scale ranging from 1 (very poor) to 5 (excellent). The average response was 4, indicating a high level of satisfaction with the interoperability capabilities of their chosen BIM software.

4.2 Impediment and Benefit of uses BIM

Based on the interviews we conducted, we have observed that implementing BIM in the private sector presents both benefits and challenges (Table 1). The key benefits of implementing BIM include streamlining the construction process and enhancing project outcomes. According to Chiarelli (Appendix A_6) mentioned in the interview, BIM is not just softwares, but a comprehensive process that covers various stages of a construction project, such as designing, 3D modeling, scheduling (4D), tracking cost budgets (5D), specifying materials, and more. The transition from traditional 2D drawings to 3D models enriched with comprehensive project information evolves from basic 3D geometry to an integrated model linking time (4D), cost (5D), and materials. BIM helps with enhanced visualization during the design phase and facilitates better communication between designers and owners, allowing for the early identification and resolution of potential construction issues. This visual clarity helps identify problems early and control clashes, thereby reducing errors, duplicate and costs while shortening project timelines.

BIM fosters enhanced internal collaboration by providing a centralized platform for communication and data sharing. The accuracy of BIM data enhances asset management capabilities throughout the project lifecycle, optimizing quality and efficiency. According to the digital delivery director at the interview, surprises and delays can be minimized by building digitally and integrating the right technologies, ensuring projects are executed correctly the first time. Through virtual construction, teams can coordinate effectively, plan logistics, schedule tasks, and detect collisions or issues well in advance. This approach streamlines the construction process and provides clients with a clear understanding of what they will receive. Traditional methods often lack this level of transparency, leading to misunderstandings or surprises during implementation. BIM fosters collaboration among team members, ensuring everyone is aligned on project goals, tasks, timelines, and execution methods. BIM improves decision-making by providing real-time insights and supports long-term project management by ensuring data accuracy and facilitating ongoing collaboration among project teams.

Implementing BIM in the private sector faces several challenges (Table 1 & 2). One of the major hurdles is the need for standardization across tools, processes, and practices to ensure consistency and interoperability within projects. Two of our interviewees, Ayse and the Digital Delivery Director mentioned that standardization would be one of the challenges that different offices may have using different tools or standards, especially if firms acquire other organizations with their own practices during the transition. This required extensive training, onboarding processes, and the establishment of consistent standards and templates across the organization. The choice of BIM software can often depend on what is commonly used in the industry or geographical area, which may limit the options available to a firm seeking to use the best tool for specific needs.

Resistance to change is also challenging due to the perceived costs, complexities, and training needs associated with BIM implementation. According to the interview that Andersson (Appendix A_7), Scozzari (Appendix A_2), and Polat (Appendix A_3) mentioned in the interview, the client may be more open to change since they have paid for the service. However, lack of familiarity with BIM, differing levels of technology adoption, and fear of reduced earnings can cause resistance to change. Additionally, the upfront and maintenance costs may be high, with the initial development costs and complexities in setting up a comprehensive BIM environment being the main reasons. This can be especially difficult when collaborating with other firms that are not able to work within the BIM framework.

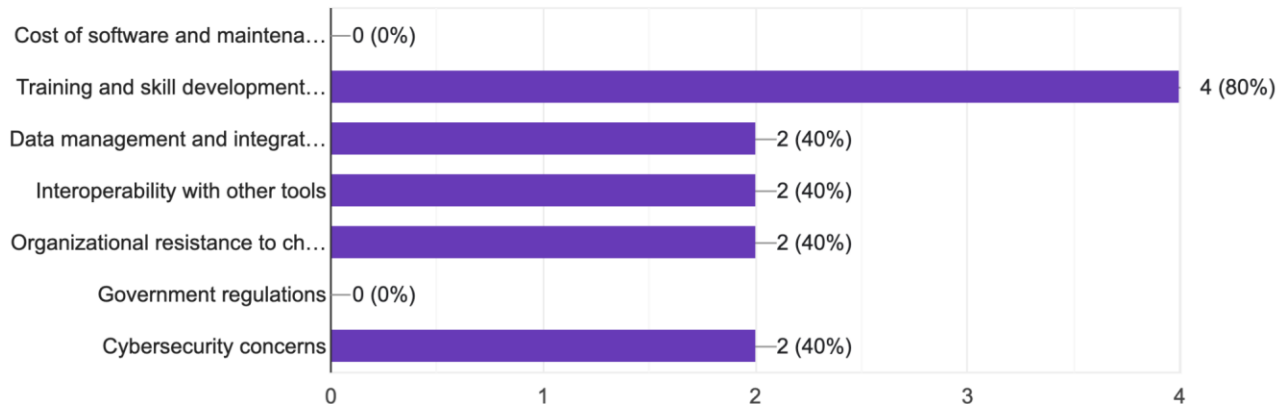
Table 1.

Interviewees	Benefits of BIM use	Challenge of BIM use
Digital Delivery Director @Large Engineering & Architecture Firm	1. Streamlines the construction process 2. Enhance visualization 3. Enhance internal collaboration	1. Standardization 2. Security concern
Sam Scozzari Practicing Engineer, @ Greenman-Pedersen, Inc.	1. Accuracy 2. Asset management capabilities throughout the project lifecycle 3. Clash control	1. Challenge of getting everyone on board with its usage 2. Need for understanding its value
Ayse Polat Regional VDC Manager @ Turner	1. Enhanced visualization 2. Clash control 3. Enhance internal collaboration 4. Reduce error, lower cost, shorter project time	1. Cost and complexity and training needs 2. Resistance to change 3. Technological Maturity 4. Standardization and security concern
Berkay Baykal Adjunct professor @ NYU Tandon Civil Engineering Department	1. Efficiency improvement 2. Quality optimization, reduce error & wastes 3. Accuracy and precision 4. Enhance visualization	1. Integration and collaboration 2. Cost (Various cost & intangible cost) 3. Security concern 4. Legal and compliance regulatory
David Green Principal @ Arup	1. Enhance internal collaboration 2. Enhance data accuracy 3. Improve long-term management of construction project	1. High upfront development costs 2. Complexity in setup comprehensive BIM environment 3. Training diverse professionals
Lawrence Chiarelli Industry Professor @ NYU Tandon Civil Engineering Department	1. Enhance Visualization 2. Early Problem Identification 3. Enhance internal collaboration	1. Cost evaluation (New technology) 2. Resistance to change
Lennart Andersson Director @ Enstoa	1. Accuracy, reduce errors and duplication 2. Enhance ability to manage and utilize spatial data effectively 3. Standardization and automation	1. Cost evaluation 2. Resistance to change 3. High upfront cost (High barrier to entry)

Table 2.

Which aspect of BIM do you find most challenging to implement in your projects?

5 responses



4.3 BIM softwares widely used in private sector

According to the survey and interviews we have conducted, we have observed and listed the BIM software and other software, systems, and equipment that are being used (Table 3). In terms of advantages, these software help in visualization, model building, and analysis, including sustainability analysis and clash detection. Autodesk Revit is widely used for design, Navisworks, clash detection, and project coordination. Rhino was highlighted for form modeling and visualization, while Tekla was used for structural engineering tasks. Bentley software like Bentley Open Roads was predominant in transportation projects, and Autodesk FormIt supported conceptual design. OpenSpace and Reconstruct were utilized for virtual site tours and progress tracking, enhancing project monitoring capabilities. Additionally, Arup (Appendix A_5) emphasized the integration of GIS and its proprietary system, Fuse, for simulation models and building modeling, integrating resilience and sustainability considerations. The use of Primavera P6 for scheduling and Synchro for 4D scheduling was also noted, illustrating the diverse and specialized software ecosystem crucial for efficient and collaborative project management in the construction industry.

Table 3.

Firm	BIM Software	Other System,Software & Equipment
Turner	Autodesk Revit, Rhino, Sketchup, Navisworks , Tekla, Synchro	
Arup	Autodesk Revit	GIS, Fuse, BIM Plugins
Greenman-Pedersen, Inc.	Autodesk Revit, Synchro	Primavera P6, 360-degree
Entsoa	Autodesk Revit	
Large Engineering & Architecture Firm	SketchUp, Autodesk Forma, Fuzor	laser scanning, 360-degree, Primavera P6

4.4 Concerns associated with BIM Software

BIM brings numerous advantages to the construction process. As we rely more on digital representations and data analysis, the need for robust cybersecurity measures becomes paramount. Ayse, Berkay, Sam, and the digital delivery director are all mentioned in the interview. There is a need to safeguard against unauthorized access and ensure data integrity throughout project lifecycles. This is particularly crucial because BIM platforms are now predominantly cloud-based, which introduces inherent security risks. For government projects like those with the General Services Administration (GSA) and federal projects, certain cloud services, such as Amazon's servers, are not permissible due to stringent security requirements. Similarly, projects under organizations like the Port Authority of New York & New Jersey involving infrastructure like bridges and tunnels necessitate adherence to strict security standards and non-disclosure agreements. Software used in such projects must comply with standards like FedRAMP, which can limit the available software options for government agencies or organizations. These considerations highlight the complex cybersecurity landscape associated with BIM adoption in critical infrastructure and government projects.

Conceptual Cost Benefit Analysis

According to interviews and surveys we collected, we have identified several potential costs associated with implementing BIM in the private sector. For a clear understanding of these expenses, we have categorized them into three groups: direct costs, indirect costs, and other costs.

The **direct costs** are the costs that are directly linked to BIM implementation within the firm, such as software licensing fees, hardware requirements fees, necessary hardware maintenance and upgrades to support BIM software, costs related to employee training on BIM systems, integration expenses to align BIM with existing software infrastructure, data management costs, and labor cost. Based on the survey we conducted (Appendix B & Table 6), it shows that out of five firms, three of them reported that their initial costs of implementing BIM, which include software, training, and hardware, were less than \$10,000. One firm reported a cost between \$50,000 to \$100,000, and another firm reported a cost of over \$500,000. For the annual maintenance cost of these firms, three of them reported a cost between \$10,000 to \$50,000, one firm reported less than \$10,000, and one firm reported more than \$500,000. From the survey, we understand that initial and maintenance costs can vary widely. It depends on the scale of the firm, the scope and complexity of BIM implementation, software dependency, and training requirements.

Table 6.

Firm	Initial cost of implementing BIM	BIM SW maintenance cost (per/year)
Large Engineering & Architecture Firm	Less than \$10,000	Less than \$10,000
Arup	More than \$500,000	More than \$500,000
Enstoa	Less than \$10,000	\$10,000 to \$50,000
Greenman-Pedersen, Inc.	\$50,000 to \$100,000	\$10,000 to \$50,000
Turner	Less than \$10,000	\$10,000 to \$50,000

Indirect costs are fixed overhead expenses associated with BIM implementation and ongoing operation. Indirect costs include utilities fees, office rent fees, licensing fees if the company opts for a comprehensive license plan, and wages of employees who support multiple departments or projects.

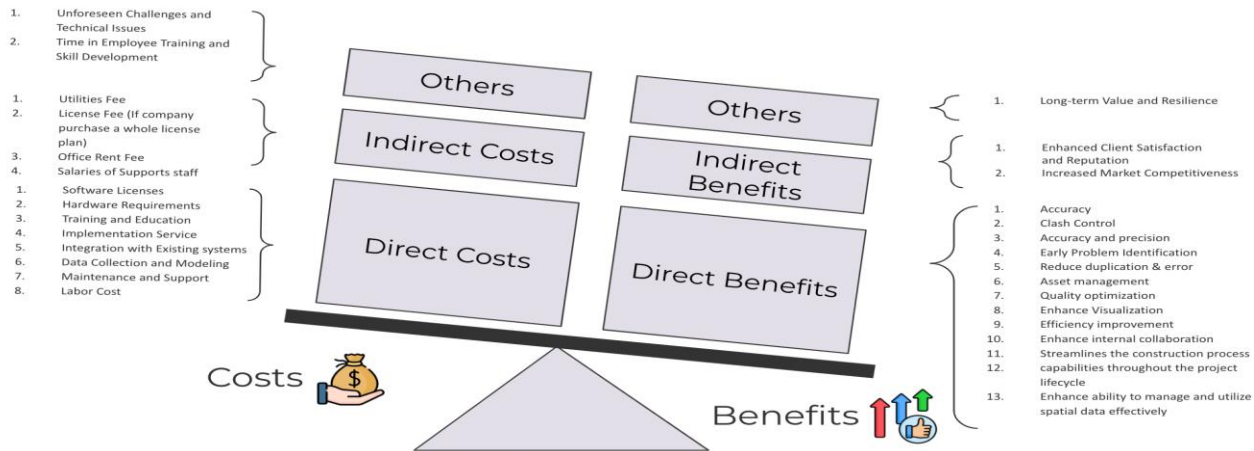
Other costs may include costs resulting from unforeseen circumstances or disruptions during implementation. Such as technical issues with software integration, project delays due to training or software compatibility issues, unexpected costs to address obstacles and the cost of investment of time required for employees to undergo training and become proficient in using BIM software, as well as the time spent on the initial setup and configuration of BIM systems. While time itself cannot be directly measured in monetary terms, the allocation of resources and personnel towards these activities represents a valuable investment for the organization. It's essential to account for these miscellaneous costs to develop a comprehensive budget and risk assessment plan for BIM implementation.

While the costs associated with implementing BIM in private companies may seem a lot, our interviews have revealed that the **long-term benefits** far outweigh these expenditures. Among the **direct benefits** highlighted by interviewees is the substantial increase in efficiency and productivity across the entire project lifecycle, leading to enhanced project quality and significant cost savings. According to our survey (Appendix B), 60% of responses say BIM reduced a project's overall life cycle sustainability costs. The collaborative nature of BIM facilitates improved communication and coordination among project stakeholders, fostering a more seamless workflow and reducing the likelihood of errors or delays.

Beyond these direct advantages, there are also several **indirect benefits** that contribute to overall business success. For instance, the utilization of BIM often results in higher client satisfaction due to improved project outcomes and better alignment with client requirements. This heightened client satisfaction not only strengthens existing relationships but also enhances the company's reputation within the industry, positioning it as a competitive player in the market. Based on our interviews, 3 of interviewees mentioned that using BIM/CIM enhances their firm market competitiveness.

The initial investment in BIM technologies and training may seem significant, but ongoing costs tend to decrease over time due to increased efficiencies and advancements in technology. The long-term benefits of BIM adoption are noteworthy as well. By streamlining processes and workflows, BIM ultimately saves both time and costs over the project lifecycle, making it an attractive option for private companies. While the initial investment may be substantial, the benefits of BIM adoption can position private companies for sustained success and growth in the highly competitive construction industry.

Table 5.



Future Trends

The UK Government's "BIM Mandate," in effect since 2016, requires all public sector construction projects to utilize at least Level 2 BIM, where collaborative 3D models are shared by all participants to enhance efficiency and reduce costs throughout a building's life cycle. This mandate, rooted in policy rather than legislation, is supported by resources such as the UK BIM Framework, which provides guidance and standards for BIM adoption. These initiatives reflect a broader trend towards increased digitalization in construction processes, aiming to bring about cost savings, efficiency improvements, and better asset management across the lifecycle of buildings.

Additionally, the development of BIM and CIM is increasingly intertwined with advances in artificial intelligence, machine learning, and IoT sensors. These integrations lay the foundation for a complete transformation in how we design, construct, and manage construction projects. AI-driven automation is transforming BIM and CIM by enhancing efficiency and reducing manual labor. Tools like Buildots utilize AI to analyze 360-degree camera data for precise construction tracking and report generation. This technology improves virtual site tours, making them more interactive and detailed, and enhances the accuracy of virtual representations. Future BIM/CIM trends will further integrate with digital twins and employ VR and AR technologies, elevating project visualization, increasing management efficiency, and facilitating early error detection.

Future BIM/CIM trends will involve greater integration with digital twins, which are real-time virtual replicas of physical structures, and cloud technology that improves collaboration and real-time updates. By using cloud-based BIM platforms, stakeholders can seamlessly work together, stay on top of project changes, and access the latest information, fostering greater collaboration and accessibility in the industry. Digital twins, enhanced by cloud technology, enable straightforward comparisons between planned and actual results. They are frequently updated with scheduling data, like that from Primavera's P6 software, to show real-world progress accurately. In asset management, adding data like product certifications, serial numbers, and Environmental Product Declarations (EPDs) enhances capabilities. EPDs offer clear, comparable information about the environmental impact of building materials, supporting better choices for sustainable construction. This level of detail enables owners to accurately track assets, maintenance needs, and wear trends, which is critical for efficient building management.

It also is pivotal in urban areas where economic efficiency and evolving infrastructure needs are critical, especially given climate change challenges. BIM/CIM is becoming integral to managing increasingly complex and dynamic infrastructures. While widespread adoption may take another decade, standardization and automation within BIM/CIM systems are expected to become more common, driven by potential government initiatives similar to the GPS rollout. This shift towards integrating BIM/CIM with AI and smart technologies promises to revolutionize project management, making systems more adaptive, efficient, and cost-effective, setting a new standard in the construction industry.

Conclusion

From above, this report delivers an in-depth analysis of the adoption and application of BIM within the private companies, emphasizing the considerable advantages and obstacles linked to these technologies. By thoroughly reviewing industry practices, conducting interviews with experts, and other methods, we have uncovered crucial insights into how BIM/CIM technologies can enhance the construction process, improve visualizations, and encourage improved collaboration among stakeholders. The findings indicate that BIM/CIM provides substantial benefits, such as better project management, reduced errors, and increased operational efficiency, which in turn lead to cost reductions and enhanced quality throughout the project's lifecycle. However, despite these advantages, the adoption of BIM/CIM encounters several challenges, including the necessity for substantial initial investments in training and technology, resistance to change from stakeholders, and the need for standardized practices across the industry. The further integration of BIM/CIM with cutting-edge technologies like artificial intelligence, machine learning, and digital twins is set to revolutionize the industry further. These enhancements are expected to improve the precision of construction models, better manage project data, and enable real-time updates and decision-making. The strategic implementation of BIM/CIM is poised to significantly propel the construction industry towards a more efficient, collaborative, and technologically integrated future. It is advised that companies continue investing in this technology to not only boost their operations but also to maintain competitiveness in a swiftly changing digital landscape.

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Appendix A

Interview questionnaire.

1. What sort of components does BIM include?
2. Could you explain how BIM was adopted at your firm?
3. Can you talk about the transition to BIM? How was that transition, and what were the challenges?
4. Discussing the challenges, how difficult was the transition in terms of cost, training, and resources?
5. Can you discuss the transition from traditional drawing methods to BIM?
6. When did your company start adopting BIM, and how long has this tool been used within your company?
7. What are some challenges faced when adopting these technologies, from both the client and firm perspectives?
8. Are there some resistance to change from clients or other individuals before adopting 3D modeling?
9. What are the main challenges in adopting BIM within your organization, especially regarding personnel and technology integration?
10. What are some advantages of using BIM?
11. Could you provide specific examples of advantages or operational improvements your firm has observed since adopting BIM/CIM?
12. How do your firm use the BIM/CIM software and what components are those software being used?
13. What challenges do you think private sector companies face during the adoption process? Can you name some of the software that is widely used at your firm?
14. How has your firm's use of BIM/CIM enhanced market competitiveness?
15. Speaking to the cost, can you provide a price range for the budget corporations allocate to develop BIM?
16. What's the cost of BIM, including software costs?
17. Are there ongoing costs or considerations with maintaining the software and training necessary for BIM?
18. Are BIM/CIM systems used throughout the whole firm or just in specific areas, and what are the reasons for this selective use?
19. What types of equipment does your company use? Are there any less physical equipment like VMs?
20. Can you elaborate on the stages involved in the BIM process, particularly focusing on 3D modeling, scheduling, and material aspects, including their 4D and 7D applications?
21. How does your company handle the maintenance or updates of the BIM/CIM system?

- 22. How do you ensure your employees stay updated with the latest trends and software?
- 23. How does your firm manage software concerns?
- 24. What feedback do you get from clients about these systems?
- 25. How do you see the future of BIM/CIM?

[Appendix A 1](#)

BIM/CIM Interview

March 12, 2024

Attendees

Digital Delivery Director

(Large Engineering & Architecture Firm)

NYU MOT Student

(BIM/CIM Group)

Interview Questions and Respondents Summary

Q1: Could you explain how BIM was adopted at your firm? We would like to better understand what software your firm uses for modeling, designing, scheduling, and material management and what tool your firm uses to integrate all of those different software.

A1: Our firm uses various software tools for modeling, designing, scheduling, and material management, depending on the purpose and market of the project.

Three main area of information modeling:

Vertical Information Modeling (VIM) for buildings (Traditional),

Linear Information Modeling (LIM) for Transportation projects (Roads, Highways, Rail etc.)

Plant Information Modeling (PIM) for water treatment and distribution projects.

For Vertical Information Modeling, the primary tool used is Autodesk Revit for design, while Linear Information Modeling predominantly employs Bentley software such as Bentley Open Roads for transportation projects. Water-related projects utilize a mix of Autodesk and Bentley software. SketchUp is also used for early-stage design exploration, and Autodesk Forma is utilized for conceptual design.

Additionally, reality capture techniques like laser scanning and 360-degree imagery are employed for progress tracking and documentation purposes. Our firm has its own capabilities for laser scanning, utilizing various tools from drone-mounted scanners to stationary laser scanners for different project needs. Software platforms like OpenSpace and Reconstruct are used for virtual site tours and progress tracking, often paired with 360-degree cameras mounted on hard hats for on-site documentation.

Overall, the choice of software tools depends on the specific requirements of each project and the area of information modeling it falls under, whether it's vertical, linear, or plant modeling.

Q2: Question about virtual site tour, this is periodically right? it just coordinates based on GPS location or maybe your spatial location?

A2: Site tours are indeed periodic and can be coordinated based on GPS or spatial location. Various platforms are used, some of which create virtual walks and understand the user's location relative to the site. These platforms may generate spot coordinates on PDF files or even provide basic 3D models. Additionally, AI-powered platforms like Buildots are being leveraged, especially in projects in the Middle East, to process captured information from 360-degree cameras. These platforms can automatically analyze the captured data, such as identifying different stages of construction like raw studs, drywall, or paint, providing detailed progress reports. The choice of tools and technologies for site tours depends on the project's requirements, with options ranging from affordable Matterport 360 cameras to high-precision scanners like RTC 360 for detailed as-built modeling. Coordination of content, including clash detection, is facilitated by platforms like Revizto, which allow for the integration of various file formats and enable collaboration on issue resolution throughout the project lifecycle.

Q3: Which tool does your firm use for timeline tracking and scheduling?

A3: Our project managers primarily use Primavera P6 for scheduling, which is not directly tied to the models. For visual scheduling and 4D sequencing, we employ various tools. Bentley Synchro is one such tool that allows integration between Primavera P6 and BIM models for visualization. Additionally, some teams utilize Fuzor, a visualization tool, for construction scheduling and logistics planning. We also have a dedicated visual media group that assists with custom visualization, often using Unreal Engine for simulations of the construction process. This can include superimposing footage from drones onto the simulation to provide a comprehensive visual representation. Ultimately, the choice of tool depends on the specific requirements of the project and the desired message for the client.

Q4: What are some challenges faced when adopting these technologies, from both the client and firm perspectives?

A4: The primary challenge lies in the vast array of available technologies and the difficulty of establishing a standard tool across a large organization. Keeping up with the right tools for specific purposes becomes challenging. Additionally, understanding client needs poses a significant challenge. Often, clients struggle to articulate their requirements or are swayed by appealing technologies without considering their practical value. It's crucial to engage in a discovery process to educate clients about available technologies and guide them toward solutions that provide real value. However, this can lead to conflicts when clients want to change course mid-project after discovering new possibilities. Thus, managing expectations and aligning workflows among

stakeholders becomes critical. Overall, while technology presents challenges, navigating people and processes proves to be the more significant hurdle.

Q5: What are some advantages of using BIM?

A5: BIM offers several advantages, foremost among them being speed to market and unparalleled accuracy. By building digitally and integrating the right technologies, surprises and delays can be minimized, ensuring projects are executed correctly the first time. Through virtual construction, teams can coordinate effectively, plan logistics, schedule tasks, and detect collisions or issues well in advance. This approach not only streamlines the construction process but also provides clients with a clear understanding of what they will receive. Traditional methods often lack this level of transparency, leading to misunderstandings or surprises during implementation. BIM fosters collaboration among team members, ensuring everyone is aligned on project goals, tasks, timelines, and execution methods.

Q6: What's the cost of BIM, including software costs?

A6: The cost of BIM software can vary depending on factors such as vendor pricing, licensing agreements, and specific project needs. Generally, standard software prices can often be found on the vendors' websites, although actual costs may vary based on negotiated agreements and enterprise-level pricing. At our firm, we have standard software that everyone has access to, and for specialized or project-specific needs, we procure software on a project-based licensing basis. Pricing may also differ between companies and depend on factors like enterprise agreements and overhead costs. Ultimately, the cost of BIM software is considered part of the overall cost of doing business in the industry.

Q7: How do you manage your software, including updates and renewals?

A7: At our firm, we have a dedicated team responsible for managing our software. We primarily handle software deployments and installations through a tool called Software Center, which utilizes SCCM (System Center Configuration Manager) packages. These packages are deployed by our IT team, who manage software procurement, updates, patches, and related tasks.

We also have Networks of Excellence (NOEs) for each software platform, comprising a group of experts who oversee the management of specific software tools across the organization. This centralized approach ensures efficient software management and deployment for all employees at our firm.

Additionally, for project-specific needs or smaller packages, project teams may manage software on a project-by-project basis. However, the majority of software management is handled by our IT team, which is well-equipped to address the diverse software needs of our organization.

In terms of our technology infrastructure, we also utilize hybrid environments, including Virtual Desktop Infrastructure (VDI). VDI allows users to access virtual machines remotely via Citrix, providing a standardized environment for all users regardless of their hardware specifications. This setup enables efficient use of computing resources and ensures consistent access to software tools across the organization.

Q8: Can you talk about the transition to BIM? How was that transition, and what were the challenges?

A8: Transitioning to BIM was a significant process for many organizations, including firms. I can speak to some common challenges and strategies for managing the transition. One of the main challenges during the transition was standardization. Different offices within the organization may not have used the same tools or standards, especially if firms acquired other organizations with their own practices. This required extensive training, onboarding processes, and the establishment of consistent standards and templates across the organization.

Having a dedicated team that understood the transition process was crucial. This team could provide support to projects and users, ensuring that everyone had the necessary resources and guidance to adopt BIM effectively. Centralizing support and ensuring ongoing communication and training were essential aspects of managing the transition smoothly. In the early stages, some companies may have charged extra for BIM services, such as Revit. However, this practice has become less common as the industry has recognized the importance of efficiency and quality in project delivery. Speed to market and maintaining high-quality standards have become top priorities, driving the adoption of BIM as a standard practice rather than an optional add-on.

Overall, the transition to BIM involved identifying technologies that enabled to achieve more work with better quality, using fewer resources and less time. Leveraging technology and automation has become the norm in the industry to enhance project outcomes and efficiency.

Q9: How does your firm manage software concerns?

A9: At our firm, managing software concerns involves addressing various factors such as data sovereignty, security, and client requirements, especially for projects with different levels of classification and confidentiality.

- Data Sovereignty: Many countries have data sovereignty laws that dictate where data can be stored and accessed.
- Client Requirements: Clients may have specific requirements regarding data management and security.

- Cybersecurity: Security is a top priority, especially for US federal projects. Our firm maintains a highly secure data center environment isolated from external networks.

Appendix A 2

BIM/CIM Interview

March 7, 2024

Attendees

Sam Scozzari

(Practicing Engineer, Greenman-Pedersen, Inc.)

NYU MOT Student

(BIM/CIM Group)

Transcript

<https://drive.google.com/file/d/1dfqvA2jZgUJBMeJOxoLl6U3Dn56XJX70/view?usp=sharing>

Note: This transcript is what we download from zoom, some of the words may have typos.

Interview Questions and Respondents Summary

Q1: How do your firm use the BIM/CIM software and what components are those software being used?

A1: We utilize the BIM/CIM software to develop a comprehensive 3D digital twin of the project, encompassing both horizontal and vertical aspects. Initially, due to the absence of drawings from the designer of record, we had to manually transfer 2D data to 3D. However, with the availability of CAD, the conversion process became more streamlined. Although I'm not directly involved in CAD or BIM operations, I oversee and comprehend the process.

Additionally, for our projects, the prime contractor is required to provide a CPM schedule using Primavera's P6 software, which breaks down construction activities into 15-day increments, including crew sizes and costs. We align our BIM model with these activities, ensuring accuracy. As a result, upon completion of the work, our BIM model when animated in chronological order reflects the actual construction process.

This digital twin enables us to visualize the project's construction through animation, facilitating the comparison of planned versus actual outcomes. It helps identify discrepancies and determine liability for any deviations from the plan, whether borne by the city or the contractor. We regularly update the digital twin with schedule data, allowing for real-time monitoring of progress.

During the development of the digital twin, we were able to identify clashes that went unnoticed in 2D drawings, adding significant value to the process. We also incorporate additional data layers

to track product certification, serial numbers, and lot numbers, enhancing asset management capabilities.

Beyond the immediate value to the project teams, the digital twin empowers owners to pinpoint necessary repairs and analyze trends with wear and tear of assets, such as recurring issues with specific components. We foresee leveraging AI to further optimize maintenance strategies.

Initially, we utilized Autodesk software, but encountered compatibility issues when integrating with Primavera. Consequently, we transitioned to Synchro and Revit, which currently constitute our primary software suite for BIM/CIM operations.

Q2: So far for 3D modeling, is your firm using Revit and Synchro, and for scheduling, is your firm using Primavera?

A2: Yes

Q3: Apart from scheduling, does the software handle other aspects like material details? Is there separate software for that or is it integrated into the same system?

A3: No, all aspects, including material details, are incorporated into the same software. It functions as another layer within the model, providing essential data although it may not have a visual representation. (Note: 'layer' within the model is referred to as 6D, which is dedicated for asset management)

Q4: How was the transition from 2D to 3D, and what were the challenges? Are 2D drawings still used, or is everything now digital?

A4: The transition from 2D to 3D was gradual, with contract documents remaining in 2D while a 3D model serves as a prototype for the project's agency, NYC DDC to explore its benefits. The 3D model is being considered for future use in construction inspection, potentially replacing the current manual inspection process. This transition involves utilizing augmented reality to compare actual work with the 3D model, ensuring spatial and dimensional accuracy.

Q5: Can you visualize 3D modeling in front of your eyes, like wearing augmented reality glasses?

A5: We don't use augmented reality glasses here, but I've seen demonstrations of them and they're impressive. In one demonstration, users could reach out and interact with the model, which is fascinating. However, the technology is costly and the average skill set of field workers isn't there yet. Interestingly, New York state has started contracting some projects in 3D, with only 2D drawings extracted manually from the 3D model. This prompted a study for the National Academy of Sciences on what inspectors need when a contract is let out for bid in 3D. There are two types

of inspectors: those who prefer traditional methods and those who are more technologically advanced and comfortable working directly from the model.

Q6: Discussing the challenges, how difficult was the transition in terms of cost, training, and resources?

A6: Transitioning to BIM/CIM wasn't too challenging in terms of training because we have skilled personnel in our company. The City of New York, through the DDC, requested our services and our firm provided a budget. One major difficulty was accurately depicting underground features like water mains, as their depths weren't always accurately shown in drawings. This data was crucial for efficiency and cost savings, especially in Manhattan where underground infrastructure is often unknown. We also encountered clashes in the model, but identifying them beforehand allowed us to solve issues proactively and before the clash is encountered during the construction activities. Additionally, for elements like subway lines and control buildings, placeholder models were initially used until specific details were provided by contractors.

Q7: Are there some resistance to change from clients or other individuals before adopting 3D modeling?

A7: Yeah, well, I'm going to say from individuals because the client is eager to have us provide the service and they're paying for it, so we have concluded that the client themselves are forward thinking, but you saw the human factor of people who have had different levels of experience, different levels of exposure to digital technology and devices and then there's broadband and you know, that's another issue when you get in these rural areas. Now we're in an urban area. but if you were to do this type of work in an urban area, you have to have connection to the cloud.

Q8: Can you summarize the advantages and disadvantages of BIM?

A8:

Advantages of BIM:

1. Accuracy
2. Asset management capabilities throughout the project lifecycle
3. Clash control

Disadvantages of BIM

1. Challenge of getting everyone on board with its usage
2. Need for understanding its value

Q9: Speaking to the cost, can you provide a price range for the budget corporations allocate to develop BIM?

A9: It is expensive in the early days, I'll need to follow up with precise figures, but historically, the cost has decreased as more people in the company use it. We typically pay for a general license

with additional user fees. I recall seeing figures around \$2,600 per user per quarter, but I'd need to confirm. For our project office, we opted for a shared user account to minimize costs. Additionally, hardware requirements are significant, necessitating higher RAM and powerful desktops to handle the software efficiently. I'll provide more detailed information via email once I gather precise figures.

Q10: What types of equipment does your company use? Are there any less physical equipment like VMs (virtual computer access through cloud)?

A10: We primarily use higher-end office PCs, all running on Windows operating systems. While we considered wireless setups, we opted for wired connections to minimize lag during meetings when viewing the model. These PCs are dedicated solely to running meetings and viewing the models, ensuring efficiency. Additionally, we're incorporating time-lapse 360 cameras on-site, allowing us to track project progression over time at specific locations. These camera files are synchronized with GPS systems, providing detailed insights into project developments.

Q11: Are these equipment running 24/7 (the 360 cameras on-site)?

A11: No, we mount them to a hardhat and walk the project site twice a week. They're synchronized with GPS, so while not capturing footage continuously, they provide sufficient coverage. The cameras cost about \$500 each, with software totaling around \$8,000 for four years.

Q12: What is the name of the software (360 cameras on-site)?

A12: The software we're using is called Cupix. We're still evaluating its effectiveness as it can be a bit clunky at times, but we're hopeful for improvements. Additionally, each BIM 360 license costs about \$4,000.

Q13: Is the \$4,000 fee for one license or for a group license?

A13: The \$4,000 fee is for one license, and it covers usage until 2027 when the licenses expire. Additionally, the laptop capable of handling this software costs about \$3,000, while the project office PCs are approximately \$6,000 each. High-resolution monitors, which are essential for viewing the models, cost around \$400 to \$500 apiece. We also use standard software like Microsoft Office and Adobe. Additionally, we plan to purchase a touchscreen for client interaction, which will be around \$1,200. These project offices cost a total around \$40,000 to \$50,000. However, for a larger corporation, costs may vary, and I can provide more accurate figures once I gather that information.

Q14: Is the \$40,000 cost for software and hardware per project or does it cover a certain period, like three years?

A14: The \$40,000 cost covers software and hardware per person. So if a person with a license were to work on another project, they would still have access to the software and hardware.

Q15: Could you provide a rough estimate of the cost difference between projects with and without BIM for small, medium, and large-scale projects?

A15:[For the BIM project, which has a construction budget of \$350 million, the fee for labor starts at about \$1.5 million, with an additional \$50,000 to \$200,000 allocated for equipment. For construction inspection and management services on any project without BIM, a general rule of thumb is between 8% and 10% of the project's bid price. So, for example, on a \$100 million project, the fee for inspection services would be around \$10 million, spread out over the project duration.]
ballpark figure, cost will differ depending on project and staff.

Regarding the decision to move to BIM or traditional methods, it's essential to consider factors like labor costs, equipment expenses, and the potential long-term benefits of BIM, such as improved asset management and streamlined project oversight. Smart cities initiatives, enabled by digital twins and BIM, offer opportunities to optimize asset maintenance and reduce long-term costs by identifying and addressing issues before they escalate. This holistic approach to infrastructure management can lead to more efficient resource allocation and minimize disruption to communities.

Q16:When did your company start adopting BIM, and how long has this tool been used within your company?

A16:A: Our company began adopting BIM approximately 10 to 12 years ago, about seven years before I joined. Initially, the use of BIM was limited to small assignments and was more cumbersome compared to its current capabilities. However, different agencies expressed interest in 3D models to track cost and schedule for their projects. For example, in New York State, some projects are paid by progress in contrast to unit-prices for individual work items, and the 3D model helps determine the actual progress made by contractors compared to the costs incurred. Over time, the utilization of BIM evolved to encompass 4D and 5D aspects, which involve integrating scheduling and cost data into the 3D model. Now, BIM is also leveraged for asset management (6D) and environmental considerations (7D), linking environmental commitments to project documents and monitoring factors like carbon footprint.

Q17: Are there any issues with the software?

A17: Not that I am aware of. However, I can mention one potential issue related to software compliance with security standards, particularly in the homeland security realm. Projects under organizations like the Port Authority of New York & New Jersey, bridges, and tunnels often require adherence to security standards and non-disclosure agreements. Certain software must

comply with standards such as FedRAMP, which can limit the software options available to agencies or groups. This compliance criteria, like FedRAMP, can significantly impact software choices and potentially affect pricing. It's essential to research and understand such security requirements when selecting software for specific projects or organizations.

Q18: How does your company handle the maintenance or updates of the BIM/CIM system?

A18: Maintenance and updates for our BIM or CIM system are primarily managed by our IT teams. Updates are typically performed overnight to minimize disruption, and they vary in duration from quick updates to longer, more time-consuming ones. Our IT teams handle maintenance branch by branch, as we don't have a centralized IT department across the entire company. We receive notifications about updates, usually occurring twice a month, during which the cloud service may be temporarily unavailable. These updates ensure that our systems remain secure, up-to-date, and efficient. Our servers are hosted in the cloud, so access to our company's cloud space is essential for working on these systems.

Q19: How do you ensure your employees stay updated with the latest trends and software?

A19: We have dedicated individuals who ensure that employees receive training as needed. Rather than formal training classes, updates are communicated as they arise. Employees are often directed to relevant resources or provided with links to stay informed about the latest trends and software updates. It's similar to staying updated with technology trends like using an iPhone, where you learn and adapt as you go along.

Q20: How has your firm's use of BIM/CIM enhanced market competitiveness?

A20: While it may not be fully realized yet, I believe that leveraging BIM/CIM technologies will eventually enhance market competitiveness. Currently, these technologies are seen as a niche, but I foresee them becoming commonplace in the industry. Being ahead of the curve in adopting these technologies is positive for our company. Additionally, integrating drone technology for base mapping and inspections further enhances our capabilities. However, it's crucial to have the resources to deliver on the demand generated by these technologies. Balancing innovation with operational capacity is key to maintaining the market.

Q21: How do you see the future of BIM/CIM?

A21: In summary, I believe BIM/CIM is becoming increasingly essential, especially in large urban areas, both for economic efficiency and to meet the demands of evolving infrastructure needs, particularly in the face of climate change. Infrastructure is becoming more complex and requires robust maintenance, often involving movable parts rather than static structures. While it may take some time for BIM/CIM to become commonplace, perhaps another decade, I envision it becoming a standard practice. Smaller organizations may still rely on CAD initially, but there could be

government initiatives to promote widespread adoption, similar to GPS systems, to enhance overall infrastructure efficiency.

Q22:What's the adoption rate of BIM/CIM right now? Do you think it has reached 60%?

A22: No, It hasn't reached 60% yet. While there is significant adoption within the private sector, particularly in vertical construction projects like buildings, the pace of adoption is faster in private sector applications compared to government-funded infrastructure projects. Vertical construction projects are generally more straightforward than infrastructure projects, which involve complexities like underground utilities and environmental considerations. Therefore, while the private sector is advancing rapidly in BIM/CIM adoption, the overall adoption rate may still be below 60%.

[Appendix A 3](#)

BIM/CIM Interview

March 8, 2024

Attendees

Ayse Polat

(Adjunct @ Columbia University, Regional VDC Manager @ Turner)

NYU MOT Student

(BIM/CIM Group)

Transcript

https://drive.google.com/file/d/1cDrcYhLKYPFH3z2B5c7THg2gzRCKKgq_m/view?usp=sharing

Note: This transcript is what we download from zoom, some of the words may have typos.

Interview Questions and Response Summary

Q1. Can you name some of those software that are widely used in the industry?

A1: Of course. In North America, widely used model authoring software includes Revit, which is highly adopted by design teams. We also use Rhino, which is more form-focused. Another model development software we use is Sketchup, though it is not as popular in construction-focused tasks as Revit and Rhino. In terms of advantages, these software help in visualization, model building, and analysis, including sustainability analysis and clash detection. The main disadvantage could be the steep learning curve and integration challenges across different platforms.

Q2. How do you want to approach the evaluation of these platforms?

A2: We look at it from a financial perspective to determine if it makes financial sense. We assess interoperability between platforms and their ability to support various BIM functions. It's crucial to choose software based on what is commonly used in the industry to ensure compatibility and support.

Q3. What about the challenges in technology management, especially concerning the timing of adopting new technologies?

A3: It's crucial to find the perfect moment to adopt new technology. If you're too early, the technology might not be mature enough to warrant investment. If you're too late, you risk falling behind in the industry. We try to make well-timed decisions to balance these factors.

Q4. How does Turner manage the selection of software for different projects?

A4: We often consult with our clients, like DDC or NYU, to understand if there are any specific BIM platforms they prefer using for a project. If the client has no preference, we use our expertise to select the most suitable platform that meets the project's needs and optimizes performance and cost.

Q5: Could you expand on how BIM integrates with different stages of construction and post-construction phases?

A5: BIM is crucial not just in the design and construction phases but also post-construction. It helps in managing the maintenance and operations of buildings, which constitutes a significant part of a building's life cycle costs. Effective BIM implementation can lead to better management and lower costs over the building's life.

Q6: Can you discuss the training and updating processes at Turner for keeping up with BIM advancements?

A6: The field of BIM is continuously evolving, necessitating ongoing training and updates. At Turner, we ensure that our teams are up-to-date with the latest software by engaging in continuous learning and training, provided both externally by software vendors and internally to spread high-level expertise across the team.

Q7: In regards to BIM implementation, what are the main financial considerations?

A7: Financially, the timing of technology adoption is crucial. We assess the maturity of the product, its prevalence in the industry, and interoperability with other platforms. These factors influence our investment decisions because premature or late adoption can significantly affect project costs and efficiency.

Q8: What software platforms does Turner commonly use for BIM tasks?

A8: We use a variety of software platforms depending on the task. Revit is widely used for model authoring, while Rhino is used for more form-focused modeling. For clash detection and project coordination, we utilize Navisworks. Additionally, we often use specialized software for specific tasks like Tekla for structural engineering or Synchro for 4D scheduling.

Q9: How does Turner handle the licensing and costs associated with BIM software?

A9: The cost of BIM software can be significant. We negotiate licensing directly with software providers like Autodesk to secure the best possible terms. For smaller projects, the cost is less, but for larger projects, the fees can be quite substantial. We aim to optimize our software use to ensure we are getting value for our expenditure.

Q10: Are there particular challenges you face when training new employees in BIM technologies?

A10: Yes, ongoing education and adaptation to new technologies are some of the biggest challenges. BIM technology evolves rapidly, and keeping the team updated requires continual training and learning. We leverage both internal and external training programs to ensure our staff are proficient and efficient in using BIM tools.

Q11: How does Turner decide which BIM software to use for a particular project?

A: The decision often depends on the project requirements and client preferences. We also consider the software's capability to handle the project's scope and complexity. If the client does not specify, we choose based on what will provide the best functionality and integration for the project's needs.

Q12: What are the main benefits of using BIM at Turner?

A12: BIM brings numerous benefits, including improved visualization, better clash detection, enhanced coordination among different teams, and more efficient project management. These advantages lead to reduced errors, lower costs, and shorter project timelines.

Q13: How do you see the future of BIM in construction?

A13: The future of BIM is very promising. It is becoming increasingly integrated with other technologies such as AI and machine learning, which can further enhance the planning, design, and construction processes. The ability to integrate BIM with digital twins and smart building technologies also presents opportunities for significant advancements in how we construct and manage buildings.

Q14. Advantages and Disadvantages of BIM:

A14: **Advantages of BIM:**

- **Interoperability and Integration:** BIM allows for better interoperability between different software platforms, which is crucial in managing large-scale projects where different teams may be using different tools.
- **Improved Visualization and Analysis:** BIM starts with model creation and moves to model analysis, allowing for tasks like sustainability analysis, clash detection, and other forms of detailed evaluation that are crucial in modern construction.
- **Educational and Training Opportunities:** Ayse notes that as a teacher at NYU and Columbia, she introduces many students to BIM, indicating its growing importance and utility in the educational field, preparing new generations for modern challenges in construction.
- **Industry Adoption and Knowledge Accumulation:** Tools like Revit have been widely adopted, leading to a significant accumulation of industry knowledge and best practices that enhance project execution.

- **Customization and Flexibility:** The ability to customize through open APIs and the development of specific tools by in-house engineers at Turner shows BIM's flexibility to meet specific project needs.
- **Operational Efficiency:** BIM technologies lead to better planning and execution of construction projects, improving overall operational efficiency.

Disadvantages of BIM:

- **Cost:** BIM software can be expensive, with costs associated with acquiring, training, and updating the necessary tools. This can be particularly challenging for smaller firms.
- **Complexity and Training Needs:** The complexity of BIM tools requires continuous training and updating of skills, which can be a significant overhead for firms. Ayse mentions that the learning never stops, as stopping means falling behind.
- **Resistance to Change:** Adopting BIM involves changing traditional processes, which can meet resistance within teams, especially from those accustomed to older systems. This resistance can slow down the integration and effective use of BIM technologies.
- **Implementation Challenges:** For smaller firms, the challenges are more pronounced due to the high cost and the need to choose versatile platforms that serve multiple functions to avoid the high cost of multiple subscriptions.
- **Technological Maturity:** Early adoption of new technologies can be risky if they are not mature enough, as there can be bugs and issues that have not yet been resolved.
- **Dependence on Industry Standards:** The choice of BIM software can often depend on what is commonly used in the industry or geographical area, which may limit the options available to a firm seeking to use the best tool for specific needs.

Q15: Cyber Security Challenges:

A15: Ayse Polat highlights serious security concerns associated with BIM, particularly because these platforms are now cloud-based, which brings inherent risks. She specifically mentions that for government projects like those with the General Services Administration (GSA) and federal projects, it is not permissible to use certain cloud services, such as Amazon's servers. This restriction is due to the stringent security requirements that these projects entail.

For projects involving the military or similar entities, there are additional specific requirements that might necessitate keeping data localized rather than on a public or shared cloud service. These protocols ensure that sensitive data related to building designs and other critical infrastructure elements are safeguarded against unauthorized access and potential cybersecurity threats.

Ayse's remarks reflect a cautious approach to BIM's cybersecurity aspects, emphasizing the need for strict compliance with security standards and regulations, particularly when dealing with projects that have national security implications. This underscores the broader challenges of managing BIM data securely in an environment where cyber threats are continuously evolving.

Q16: Cost related questions:

A16: **Licensing Models and Costs:**

- **Subscription Base:** Ayse notes that many BIM platforms operate on a subscription basis. This model can be particularly challenging for smaller firms due to the ongoing costs, which may be difficult to sustain.
- **User and Project Size-Based Pricing:** Some platforms adjust their pricing based on the number of users and the scale of the project. Larger projects and more users typically incur higher costs.

Cost Justification:

- **Interoperability and Customization:** While BIM software can be expensive, the costs are often justified by the capabilities these tools offer, such as interoperability between different software and the ability to customize tools through open APIs.
- **Operational Efficiency:** The use of BIM can lead to significant improvements in operational efficiency, which can help offset the initial and ongoing costs by reducing errors, rework, and improving project timelines.

Challenges for Small Firms:

- **High Cost of Multiple Platforms:** Smaller firms face significant challenges with BIM costs because purchasing multiple platforms to cover all needs can be prohibitively expensive. Instead, they might look for one platform that can perform multiple functions.
- **Annual or Monthly Costs:** The recurring costs can be a burden, especially if the benefits are not immediately apparent or if the project load doesn't justify the outlay.

Enterprise Agreements:

- **Bulk Purchasing and Enterprise Agreements:** Larger firms like Turner might negotiate enterprise agreements directly with software providers like Autodesk,

allowing them to secure better pricing or additional features due to the volume of their purchase.

- **Project-Specific Pricing:** For firms handling projects of varying sizes, the cost might also be aligned with the project budget, where smaller projects might pay less compared to larger ones.

Costs Beyond Licensing:

- **Training and Implementation:** There are additional costs associated with training staff and implementing the software into existing workflows, which can be substantial and require ongoing investment.
- **Updates and Upgrades:** The need to continuously update and possibly upgrade software to stay current with industry standards also incurs costs.

Q17: Licensing Related Response:

A17: User-Based and Project-Size Based Licensing:

- Some BIM platforms charge based on the number of users, while others adjust pricing according to the scale of the project. Larger projects typically incur higher costs due to their complexity and the greater number of users.

Subscription Models:

- BIM software often operates on a subscription basis, which can be annually or monthly. This recurring cost model requires careful financial planning, especially for smaller firms that might struggle with the ongoing expense.

Enterprise Agreements:

- For larger companies like Turner, enterprise agreements are common. These are negotiated directly with software providers like Autodesk and are tailored to the firm's specific usage patterns and needs. These agreements might offer more favorable terms and prices due to the volume of licenses purchased.

Bulk Purchasing:

- By negotiating the purchase of licenses in bulk, Turner can often secure better pricing or additional features. This bulk purchasing is particularly beneficial for large firms that need multiple licenses across various departments and projects.

Flexibility Based on Project Needs:

- The cost of BIM licenses can also vary depending on the project's requirements. Smaller projects might pay less compared to larger ones, reflecting the scale and resource usage.

Renewal and Price Agreements:

- Turner engages in periodic negotiations (typically every three years) with software providers to renew their licenses and agree on prices. This process considers the number of active users and the anticipated project pipeline to ensure that the licensing arrangement meets current and future needs efficiently.

Q18: BIM's influence on Building's lifecycle:

A18: Lifecycle Cost Awareness: Ayse emphasizes that the construction cost of a building is only about 20% of the total lifecycle costs, which include design, construction, maintenance, and operations. The remaining 80% of costs accrue through the operational phase, which can last many years or even decades.

Operational and Maintenance Efficiency: BIM helps in significantly reducing the operational and maintenance costs that dominate the lifecycle of a building. By using BIM, detailed models of the building are created that can be used for efficient management and planning of maintenance activities. This leads to better prediction of future costs and scheduling of maintenance tasks, reducing downtime and expensive emergency repairs.

Post-Construction Benefits: BIM models are valuable even after construction is completed. They provide a detailed representation of the building, which can be used for ongoing maintenance and operations. This is beneficial not only for current owners but also for future stakeholders who might take over the management of the building.

Appendix A 4

BIM/CIM Interview

March 11, 2024

Attendees

Berkay Baykal

(Adjunct professor, NYU Tandon Civil Engineering Department)

NYU MOT Student

(BIM/CIM Group)

Transcript

<https://drive.google.com/file/d/1vEayVo9u3Lgqp6EZb7jZ2y0oxi-Odphk/view?usp=sharing>

Note: This transcript is what we download from zoom, some of the words may have typos.

Berkay's Background and Experience with BIM

Q1: Could you discuss your experience with BIM, the software you use, the implementation process, and any challenges or advantages you've noted?

A1: Of course. Let me give you a bit of my background first. I currently run a development advisory firm, and in the past, I've worked with construction managers and spent 7 years at Target Construction, where we used BIM extensively for construction. Following that, I spent 10 years with a large developer in New York City, called Group Field Properties, where I was deeply involved in development and focused primarily on construction. Over these 17 years, I've observed significant progression in how BIM is used, though my expertise lies in construction. I've also been teaching building information modeling at NYU, covering the full development lifecycle, including pre-planning, design, construction, and operations.

Operations management is a significant part of our BIM usage, incorporating concepts like digital twins and building management systems, terms commonly used in the HVAC world but now becoming integrated with digital models for comprehensive facility management. My personal experience has mostly revolved around 3D visualization, utilizing point clouds, and doing a lot of GIS work with civil projects for geographically locating aspects and integrating various data layers for coordination and scheduling.

Detailed Use and Transition to BIM Tools

Q2: We're interested in how you integrate BIM tools into your daily operations. Could you share details about your approach and any transition processes?

A2: Of course. While I'm equipped to use BIM software, my actual day-to-day involves guiding its strategic use. My interaction with the tools is through the lens of overseeing consultants and contractors. I direct what BIM tools are adopted, gauge the extent of their integration, and

determine the allocation of our resources to these technologies. The selection process is critical; it's about aligning the capabilities of BIM software with the specific demands of our projects and ensuring these tools are leveraged effectively to improve our construction processes.

Challenges and Advantages of BIM, Including Cost Aspects

Q3: In this process, have you encountered any specific challenges or noted particular advantages, especially regarding costs?

A3: Absolutely, the challenges are there. Smooth integration of BIM with existing workflows and systems is a delicate balancing act. It requires change management to accommodate new technological inputs and to modify team habits and processes. Then there's the cost—BIM isn't just about upfront expenses like software licensing and training. There are hidden costs, such as the potential disruption during implementation, that need to be accounted for.

However, the advantages often eclipse these challenges. BIM's precision and depth bring about substantial savings by preempting construction issues during the design phase, leading to a much smoother execution phase. So, while there are costs involved, the return on investment through increased efficiency, risk management, and enhanced project quality can be significant. It's this potential for return that underpins our investment in BIM and my role in overseeing its application.

Compliance, Security, and Other Challenges

Q4: With the advancements in technology, particularly in places like New York City, do you foresee a shift in the integration of BIM for compliance or city approval processes anytime soon?

A4: I'm quite optimistic about it, indeed. Yes, certainly within our lifetime. There's a momentum building, and I can confidently say that it's not just speculative; it's grounded in the active push from industry leaders. They are advocating strongly for the adoption of BIM, not just superficially, but in a manner that deeply integrates with the core processes of our industry, like city approvals and contract compliance.

Artificial Intelligence (AI) is becoming a significant force driving this change. Alongside AI, various agencies are taking a proactive stance, recognizing the potential BIM has to streamline and revolutionize compliance processes. It's this dual thrust from technology and regulatory bodies that I believe will propel the integration of BIM into these critical areas.

The potential for BIM to facilitate compliance, especially with the complex regulatory landscape of a city like New York, is immense. By adopting BIM, we can make the approval processes more efficient, transparent, and accurate. As for contract compliance, BIM's ability to provide detailed and accurate representations of buildings could help ensure that contractual obligations are met with a higher degree of precision.

In terms of security, while BIM brings numerous advantages to the construction process, it also introduces new challenges, particularly in securing the sensitive data within BIM models. As we

rely more on digital representations and data analysis, the need for robust cybersecurity measures becomes paramount. This includes safeguarding against unauthorized access and ensuring that the integrity of the data is preserved throughout the lifecycle of a project. It's a complex challenge, but one that we are increasingly equipped to handle through advances in IT security.

Overall, while there are challenges to face, the potential benefits that BIM offers make it a compelling choice for the future of urban development and construction. With the right mix of technology, regulatory support, and industry-wide collaboration, I'm confident we'll see significant strides in BIM's role in compliance and beyond.

On the Cost Justification and ROI

Q5: Could we get more insight into the costs related to BIM, specifically how they vary with the project size? What about the costs for software licenses and hardware?

A5: Sure, discussing costs is key. BIM software expenses vary greatly with the project's scope—smaller projects might incur lower costs due to less complexity, while larger ones will likely require more investment due to greater sophistication in BIM needs.

The costs associated with BIM go beyond the initial purchase; they include integration into project workflows and the ongoing investment in hardware and software maintenance. Soft costs, such as staff training and updating IT infrastructure, also contribute to the total expenditure.

Construction managers and design teams often anticipate these costs, factoring them into their budgets. The return on investment with BIM comes from the precise design that reduces errors, the improved collaboration that saves time, and the efficiencies in project management.

Software licensing is typically subscription-based, which covers continual updates and support—vital for security and functionality. Hardware investments might include advanced workstations and servers to support the BIM software's demands.

In essence, while the upfront costs for BIM may be substantial, the long-term value it provides—from construction through to maintenance—significantly outweighs the initial investment, proving BIM to be a valuable asset over the life of a building.

Future and Additional costs

Q6: Given your experience, do you think the investment in BIM technology is justified by the operational efficiencies it provides, like saving on printing and needing fewer people for tasks that used to require more?

A6: Yes, without a doubt. The value of BIM extends beyond immediate cost savings from reduced manual tasks, such as printing. It revolutionizes design and planning, making the construction process significantly more efficient. For example, where small-scale projects once needed a team of five for design and planning, BIM now enables a single person to manage these tasks effectively.

This efficiency is due to BIM's comprehensive toolset, which handles complex processes more seamlessly than traditional methods.

While quantifying these benefits can be challenging without extensive empirical data, our experience strongly supports BIM's effectiveness. 3D coordination, for instance, showcases BIM's strength. It allows for early identification of potential issues, reducing costly errors found only during construction.

BIM also improves resource allocation and project timelines, cutting labor costs and shortening schedules. This high level of management and efficiency was unattainable with older methods, marking a significant advancement in construction management.

Therefore, the costs associated with implementing BIM are balanced by its many efficiencies. As BIM technology evolves, I expect its ROI to increase further, making it an indispensable tool for the future of construction.

[Appendix A 5](#)

BIM/CIM Interview

March 12, 2024

Attendees

David Green

(Principal @ Arup)

NYU MOT Student

(BIM/CIM Group)

Transcript

https://drive.google.com/file/d/1pzQ_7Z_-adzeYqe5JFMdLv2gaN933OiY/view?usp=drive_link

Note: This transcript is what we download from zoom, some of the words may have typos.

Interview Questions and Response Summary

Q1: What sort of components does BIM include?

A1: BIM encompasses various elements, including modeling, scheduling, and managing material aspects. Additionally, it incorporates dimensions such as the 4D—time, and 7D—environmental standards, among other features.

Q2: Can you name some of the software that is widely used at your firm?

A2: We employ a variety of specialized software for our projects. At the urban level, we adapt GIS into simulation models, whereas for mechanical engineering aspects, we integrate Revit as a crucial element of our building modeling process. This method extends to incorporating resilience, sustainability, and material considerations by leveraging data from various external sources, which we then systematically organize within our internal modeling framework. Our overarching project system, known as Fuse, amalgamates these components, ensuring seamless coordination and integration across diverse disciplines, enabling us to compile a comprehensive dataset. Unlike some architects who might use software like Revit directly as provided, our approach involves custom plugins to cater to the wide range of disciplines we cover, including energy and water management, among other critical building resources. These efforts contribute to the creation of a digital twin of the construction project, facilitating ongoing evaluation and management throughout the building's lifecycle. Our use of proprietary plugins is essential for optimizing these processes.

Q3: How do these tools compare to industry standards like Revit?

A3: We primarily utilize Revit as our foundational tool, but our approach involves enhancing its capabilities. Specifically, we develop Grasshopper plugins to facilitate complex tasks like time sequencing and analyzing various data scenarios. This customization is applied directly within the Revit environment for building projects. For more intricate simulation modeling that exceeds Revit's capabilities, we transition to using GIS. It's important to clarify that our aim isn't to rival Bentley's offerings but rather to extend the functionality of the Revit platform. This strategy is crucial for enabling effective communication and collaboration with other consultants and designers involved in our projects.

Q4: Is Fuse widely used outside Arup?

A4: No, Fuse is proprietary and internal to Arup. It's not used by other firms.

Q5: How do you handle the costs associated with these technologies?

A: We spend about millions on platforms and development, with in-house teams for software development and an in-house research program.

Q6: Can you discuss the transition from traditional drawing methods to BIM?

A6: From my personal journey, we initially relied on manual hand drawings, a method that was not only time-consuming but also posed significant challenges in making modifications, visualizing projects, and coordinating with various disciplines. Imagine, 35 years ago, distributing physical drawings among mechanical, structural, and civil consultants. Any alterations required re-drawing, reprinting, and redistributing, a process that spanned weeks, underscoring the inefficiency of past practices compared to today's standards.

The transition to CAD marked a substantial shift, providing a unified platform despite the absence of the Internet, which meant sharing files via disks and couriers. This change facilitated a more collaborative and additive process among different consultants. My experience deepened as I spent two decades at Georgia Tech, where I worked alongside Chuck Eastman, the pioneer of BIM. Watching the evolution of BIM from its nascent stages in the 1970s was enlightening, especially as the advent of the internet and email revolutionized the way CAD drawings were shared, paving the way for an integrated model system, albeit still two-dimensional.

The emergence of Revit and the expansion of BIM leveraged other programs compatible with the Revit platform, moving towards the concept of a digital twin. This not only facilitated spatial and temporal planning but also shifted time sequencing into the realm of contractors, thus becoming the blueprint for project execution. This evolution brought to light several critical considerations, including ownership, liability, insurance, responsibility, and risk, necessitating a legal and operational framework overhaul to accommodate these changes.

Q7: What about the legal and contractual changes during this transition?

A7: The transition brought up issues with liability and insurance because BIM models are created in real-time and do not have a static documentation that could be held accountable, leading to more fluid contractual arrangements and project-specific insurance policies.

Q8: How many licenses does your company have for BIM software?

A8: We have thousands of licenses, with at least a thousand for Revit alone.

Q9: What are the top advantages or challenges you observe in your company from using BIM?

A9: The main advantages include improved coordination, data accuracy, and long-term management of construction projects. The challenges are the complexity and high cost of setting up BIM, especially when collaborating with other firms not capable of working within the BIM framework.

Q10: How do technology updates affect your BIM and CIM systems?

A10: We have regular updates and a policy to not adopt untested updates to ensure compatibility across systems. Our IT team manages these updates through subscription services to maintain system integrity.

Q11: Has the adoption of BIM and CIM enhanced your firm's market competitiveness?

A11: Absolutely, our robust BIM and CIM systems have been crucial in securing large, complex projects like the California High Speed Rail and master planning for Kuwait, providing a significant competitive advantage.

Q12: What feedback do you get from clients about these systems?

A12: Clients are generally very satisfied as these systems allow for cost savings and enhanced project tracking and scenario evaluation, which improves overall project management and outcomes.

Appendix A 6

BIM/CIM Interview

March 5, 2024

Attendees

Lawrence Chiarelli

(Industry Professor, NYU Tandon Civil Engineering Department)

NYU MOT Student

(BIM/CIM Group)

Transcript

<https://drive.google.com/file/d/1KljK5xyFop-sU9iKfsTIAJCuSUGMIImiZ/view?usp=sharing>

Note: This transcript is what we download from zoom, some of the words may have typos.

Interview Questions and Respondents Summary

Q1: What exactly is BIM/CIM?

A1: Building Information Modeling (BIM) represents a historical transition from two-dimensional paper to three-dimensional models. In the early days of computer modeling, tools like AutoCAD emerged in the 1970s and 1980s, initially focusing on 2D representations. As computers advanced, the industry moved toward 3D modeling. BIM, however, goes beyond mere 3D geometry; the "I" in BIM stands for information.

Before the term BIM was coined, there were initiatives like FIAPP (Fully Integrated and Automated Project Processes), which involved tying project schedules to models. In the early 2000s, before Autodesk became prominent, Bentley MicroStation was used for 3D modeling. The integration of CPM (Critical Path Method) scheduling and 3D modeling led to the creation of 4D animations, adding the dimension of time to the model.

The next step involved linking the model to budget or cost, introducing the concept of 5D. This allowed for real-time cost accumulation associated with each scheduled activity. BIM continued evolving by incorporating additional information related to modeled elements, such as material type and specifications. Users could link the model to documents like specifications, providing a comprehensive view of the project.

Modern BIM applications offer diverse capabilities, allowing users to attach various forms of information to the model. This includes links to specification documents, manufacturers' data, and

other relevant details. The process has become more sophisticated, with numerous software applications and add-ons available for specific tasks.

One significant shift over time was the change in how designs were shared between designers and builders. Initially, designers would create models and hand over 2D drawings to builders, who then recreated their own 3D models. However, the electronic exchange of BIM models raised concerns about liability and responsibility for any issues arising during construction. Designers provide design intent in their models, and builders, being qualified professionals, are expected to interpret and implement these designs accurately.

The electronic exchange of models introduced challenges in communication and potential errors that could be harder to rectify. Designers lost direct control over the construction model, which led to discussions about liability and the responsibility for errors. Despite these challenges, BIM has become a crucial tool in the construction industry, offering an integrated approach to design, scheduling, cost estimation, and project documentation.

Q2: What are the advantages of using BIM(design phrase)?

A2: In the current landscape, one of the most significant advantages of the modeling process, particularly for the entire project team, is the ability to create a design that resembles a photograph during the design phase. This visual representation helps bridge the understanding gap between the design team and the owner, especially when the owner may not have a background in construction. The model allows owners to gain a much better sense of what the final project will look like compared to traditional 2D drawings.

Another crucial advantage of creating a model during the design phase is the ability to foresee and address potential construction problems early on. Depending on the level of detail in the model, designers can identify issues that might arise in construction before the project transitions to the construction phase. For example, in mechanical and other engineering drawings, the model enables engineers to visualize and resolve potential conflicts, such as clashes between ductwork, electrical conduit, and piping.

Currently, many projects involve collaborative modeling during the design phase, fostering a more integrated approach to construction. Some projects have even gone completely paperless, with the model serving as the primary tool for collaboration. While some jurisdictions may still require traditional drawings for permitting, the trend is moving towards a more digital and collaborative environment.

A recent advancement in the industry is the concept of a "digital twin." This refers to a living model that evolves with the actual construction progress. Digital twins are electronic replicas of the built environment, often enriched with more detailed information than the initial design team's input. Institutional owners are increasingly embracing digital twins for building operations. This means that beyond the construction phase, the model continues to be updated with real-world data, serving as a tool for ongoing building management.

Digital twins can be equipped with additional features, such as tying HVAC systems into the model. This integration allows owners to monitor the performance of building systems in real-time, measuring temperatures, and even creating heat maps to identify areas with varying temperatures. The evolving use of digital twins suggests a future where these models play a central role not only in construction and design but also in the ongoing operation and management of buildings.

Q3: How private sector using digital twins

A3: In the private sector, the utilization of digital twins has evolved into a dynamic and living model. Essentially, as construction progresses and adjustments are made, the model is continuously updated to reflect the actual built environment. A digital twin is an electronic replica of the physical structure, and it often contains more detailed information than what was initially prepared by the design team.

Owners, whether they engage a builder, a consultant, or manage the process themselves, play a pivotal role in enhancing the digital twin. They contribute additional information to the model, enriching it with real-world data and specifics that may not have been part of the original design. This collaborative approach ensures that the digital twin remains a comprehensive and accurate representation of the built environment.

One notable feature of digital twins is the integration of building systems, such as HVAC (Heating, Ventilation, and Air Conditioning). This integration allows stakeholders to monitor the operational performance of these systems in real-time. Users can observe how HVAC units are running, measure temperatures, and even generate heat maps to visualize temperature variations in different areas of the building.

The trajectory of digital twins in the private sector is dynamic and promising. The ability to incorporate real-time data and ongoing adjustments to the model opens up new possibilities for building management and optimization. The trend suggests that digital twins will continue to play a crucial role not only in construction and design but also in the long-term operation and

maintenance of buildings, providing valuable insights for efficient and sustainable building management practices.

Q4: What BIM is in summary?

A4: In summary, Building Information Modeling (BIM) is not just a software but a comprehensive process that encompasses various stages of a construction project. BIM involves designing, 3D modeling, tracking cost budgets, specifying materials, and more. It serves as a collaborative and integrated approach to construction project management.

The tools for BIM are diverse, with major players like Autodesk and Bentley dominating the building industry. However, BIM is not confined to construction alone, as demonstrated by its historical use in aircraft design. Unlike the expensive and limited technologies of the past, today's BIM tools are accessible on personal computers and the cloud, providing unlimited capabilities.

BIM is adaptable to projects of varying complexity. For simpler, low-tech projects, less detailed information may be needed, such as sketching a wood-frame house. On the other hand, sophisticated projects like a full-authority top park, a multi-story pencil building, demand a higher level of detail. The complexity of a BIM project depends on factors like the scale and nature of the construction.

Furthermore, the sophistication of a BIM project is influenced by the type of construction involved. Renovation projects, for example, may not necessitate modeling existing structures to the same extent as new constructions. BIM offers flexibility, allowing it to cater to a wide range of projects, from straightforward designs to intricate and large-scale constructions. The key is to tailor the level of detail to the specific requirements of each project.

Q5: What challenges do you think private sector companies face during the adoption process?

A5: The adoption of technologies like Building Information Modeling (BIM) in the private sector comes with its set of challenges. One primary challenge is the cost associated with implementing new technologies. Private sector companies need to evaluate whether the investment in BIM tools, software, and training can yield a viable economic return. The significant costs may include hiring skilled personnel and investing time and resources in deploying the technology. The question arises: What is the payback on this substantial investment, and can the company recover the costs through the services it provides.

The return on investment becomes a critical factor for companies considering the adoption of BIM. If the costs cannot be recovered or if there is no clear economic return, companies may hesitate to

make such substantial investments. This challenge is particularly pertinent for smaller projects where the financial feasibility of investing in advanced technologies may be limited.

Moreover, the willingness of owners to finance these technological advancements plays a crucial role. Some sophisticated construction management tools have been developed because owners had specific requirements and were willing to finance the associated costs. However, on smaller projects, the financial resources may not be sufficient to support significant investments in technology.

In some cases, there is a cultural or mindset challenge where companies may be resistant to change, especially if they have been operating successfully with traditional methods. Convincing stakeholders of the benefits and demonstrating the long-term value of BIM can be a hurdle in the adoption process.

However, companies that aspire to be industry leaders and understand the shifting expectations of clients are more likely to embrace these changes. As with the transition from slide rules to calculators and then to personal computers, incorporating advanced technologies into the business model becomes a crucial aspect of staying competitive. The companies that recognize technology as an integral part of their core business and include it in their services without separate charges are likely to be at the forefront of innovation in the industry. Ultimately, overcoming these challenges requires a strategic mindset, a focus on long-term benefits, and an understanding of how technology can enhance and become an inherent part of the company's business model.

Q6: Can you name some prominent software applications are widely used for Building Information Modeling (BIM)

A6: Design & Modeling : [ArchiCAD](#), [VectorWorks](#)

Q7: In your opinion, what is the primary reason or motivation for the private sector to adopt BIM or CIM?

A7: Cost saving, and Efficiency Improvement.

[Appendix A 7](#)

BIM/CIM Interview

March 11, 2024

Attendees

Lennart Andersson
(Director @ Entsoa, Adjunct @ Pratt Institute)
NYU MOT Student
(BIM/CIM Group)

Transcript

<https://drive.google.com/file/d/1MxguKVwGe4ckUUkwZsht9WJBavZo1p02/view?usp=sharing>

Note: This transcript is what we download from zoom, some of the words may have typos.

Interview Questions and Response Summary

Q1: What has been your company's experience with adopting BIM and SIM technologies, including the timeline of adoption?

A1: Lennart Andersson explained that he joined the LEVER GROUP in 2010 specifically to start up their digital practice with BIM and SIM technologies. He detailed his role in incorporating these tools into major projects, such as the East Side Access project under Grand Central Terminal, highlighting a budget of \$12 billion.

Q2: Are BIM and SIM systems used throughout the whole firm or just in specific areas, and what are the reasons for this selective use?

A2: He mentioned that the adoption of BIM and SIM is not uniform across the company, largely due to varying levels of skill and the strategic decision to focus initially on "low hanging fruit" to showcase value before broader implementation. He emphasized the need for greater integration across all departments and projects.

Q3: Can you elaborate on the stages involved in the BIM process, particularly focusing on 3D modeling, scheduling, and material aspects, including their 4D and 7D applications?

A3: Lennart outlined the three main aspects of BIM as utilized in his projects: 3D modeling for structural designs, 4D for scheduling (time management), and the incorporation of environmental considerations into designs, which he referred to as a part of "7D" considerations. He discussed how these elements improve project management by enhancing precision in cost, time, and quality.

Q4: What are the main challenges in adopting BIM within your organization, especially regarding personnel and technology integration?

A4: He shared insights into the resistance within the company due to a lack of familiarity with BIM and CAD among schedulers and other staff. He also touched on the broader organizational

resistance stemming from a fear of reduced earnings because faster work processes could lead to decreased billable hours.

Q5: Considering the financial aspect, what are the typical costs associated with implementing BIM, and how do these compare to the savings?

A5: Lennart discussed the substantial initial investment required for BIM software and training but argued that these costs are offset by the significant long-term savings through enhanced efficiency and reduced need for rework. He specifically noted the use of BIM in preventing and resolving disputes and in optimizing project management to avoid unnecessary expenses.

Q6: Could you provide specific examples of advantages or operational improvements your firm has observed since adopting BIM and CIM?

A6: He highlighted three major benefits:

Single source of truth: BIM provides a consistent and accurate database that reduces errors and duplication of effort.

Spatial data management: Enhances the ability to manage and utilize spatial data effectively.

Standardization and automation: BIM facilitates the standardization of processes and automates tasks, which significantly speeds up operations and reduces labor costs.

Q7: Are there ongoing costs or considerations with maintaining the software and training necessary for BIM?

A7: Lennart noted the ongoing costs related to software subscriptions, updates, and the training required to keep staff skilled in the latest functionalities of BIM software. He emphasized the importance of continual investment in both technology and personnel to fully leverage the benefits of BIM.

[Appendix B](#)

BIM/CIM Interview

April-May 9th, 2024

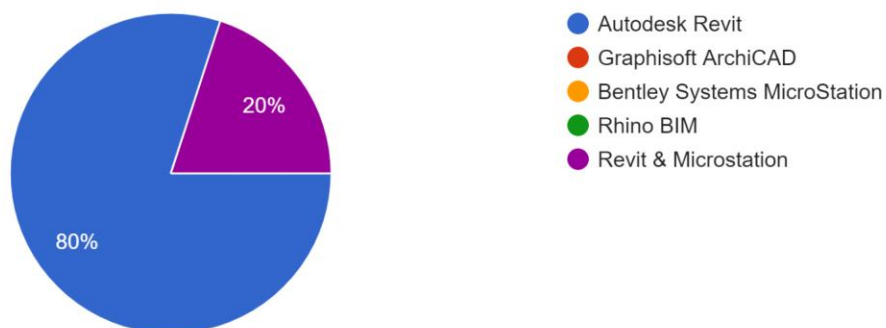
For how long have you been using BIM software in your projects? (Enter in years)

5 responses

20
20+
24
4
2

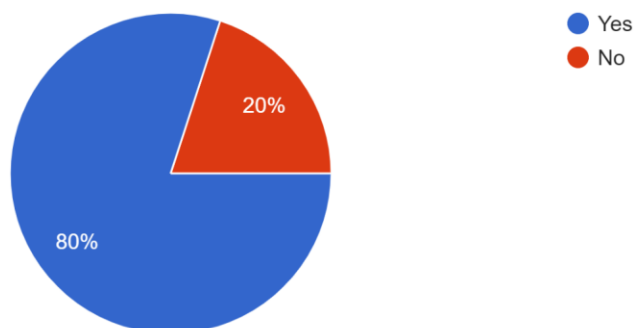
Which BIM software do you currently use for your projects?

5 responses



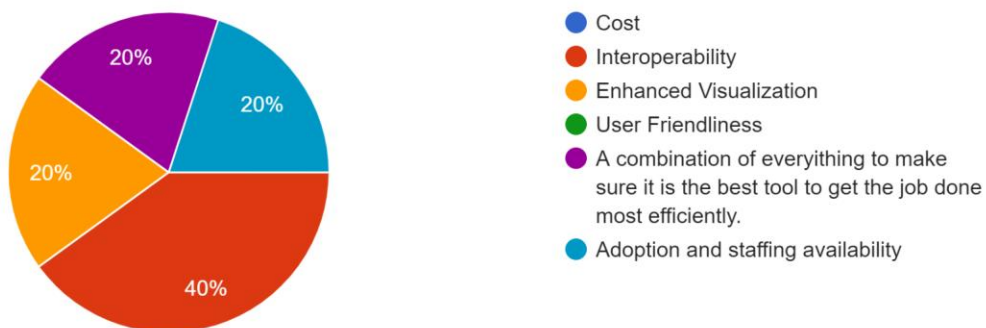
Does your firm purchase new BIM/CIM licenses for the new project? Applied BIM/CIM project by project or firm-wide?

5 responses



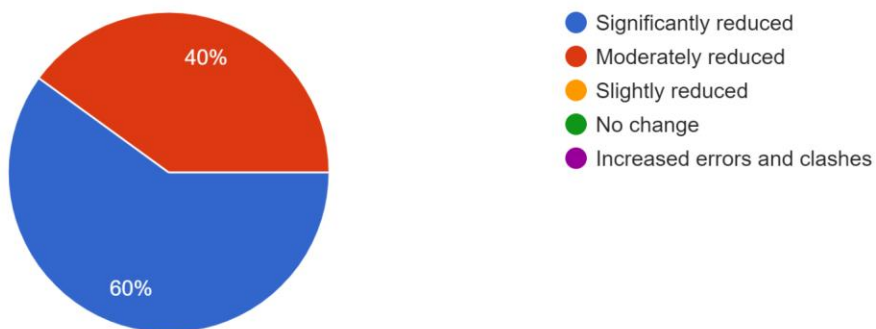
What are your key factors in choosing a particular BIM SW solution?

5 responses



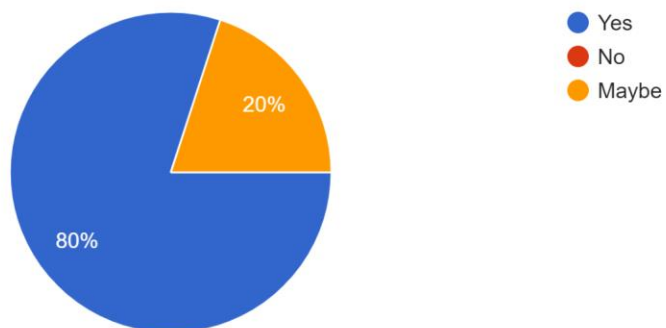
To what extent has BIM reduced errors and clashes in your construction projects?

5 responses



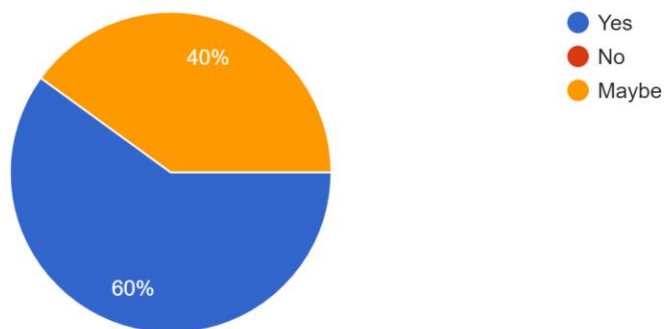
Has BIM improved your cost estimates (actual construction costs closer to estimate)?

5 responses



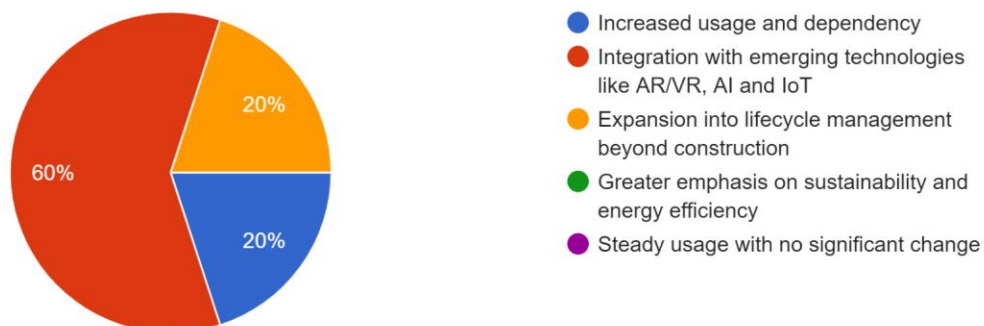
Has BIM reduced overall Lifecycle/Sustainability costs of a project as seen by your customer?

5 responses



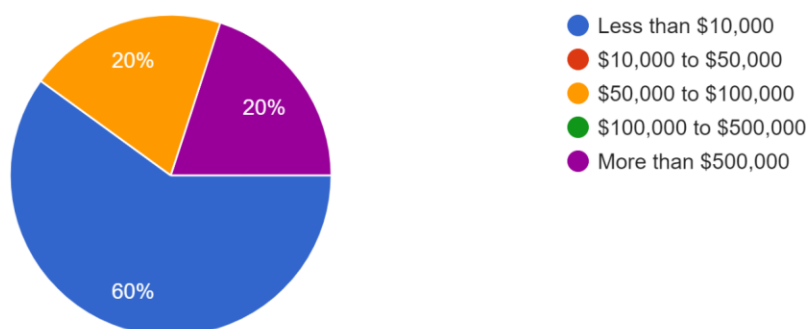
Looking ahead, how do you foresee the role of BIM evolving in your projects?

5 responses



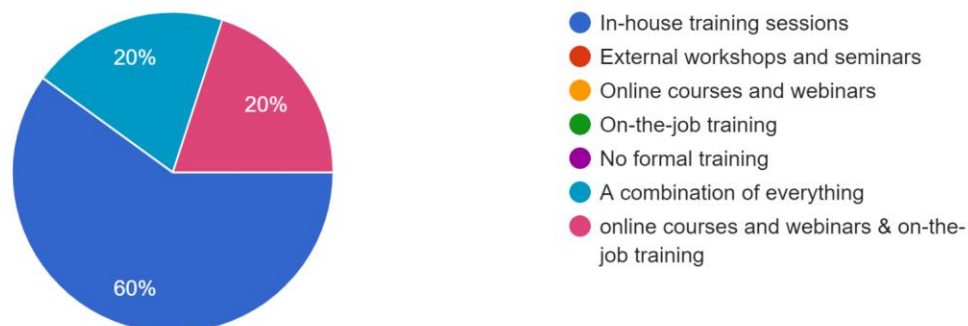
What was the initial cost of implementing BIM in your organization (including software, training, and hardware)?

5 responses



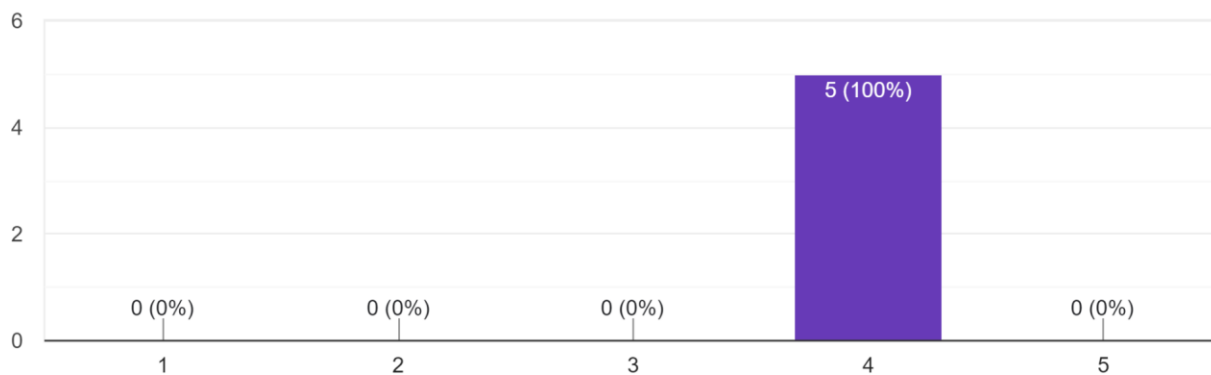
What type of training did your team undergo for effective BIM implementation?

5 responses



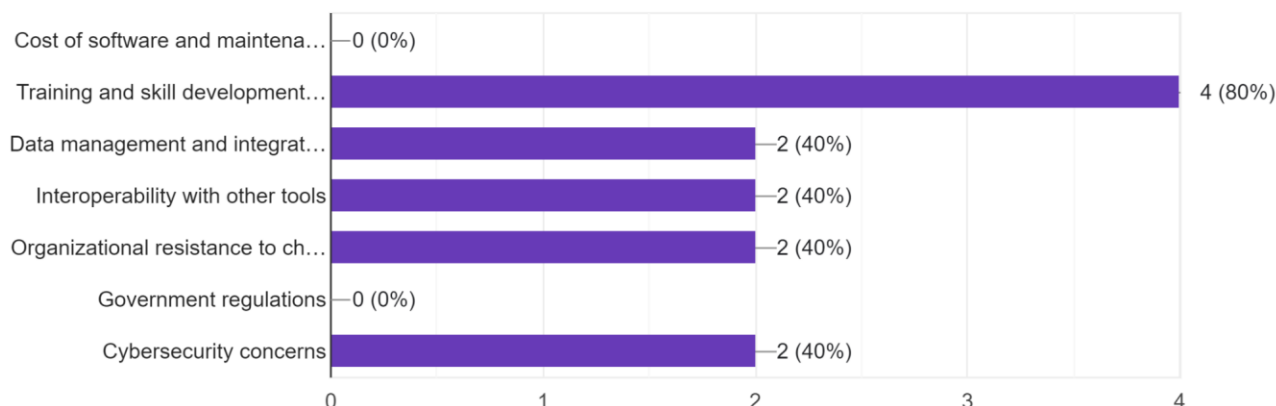
How do you rate the interoperability of your primary BIM software with other systems?

5 responses



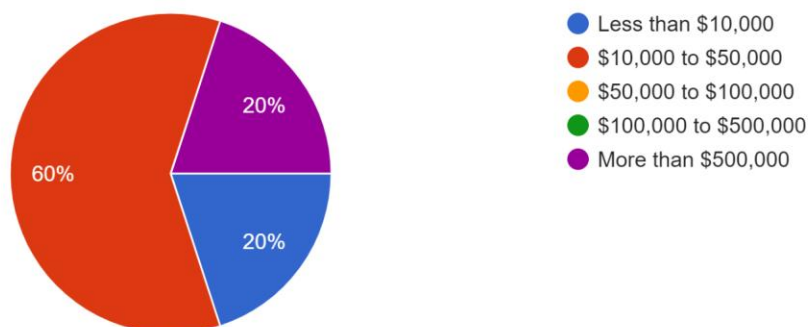
Which aspect of BIM do you find most challenging to implement in your projects?

5 responses



What's the BIM/CIM software maintenance cost per year of your company?

5 responses



Any additional comments/remarks?

5 responses

Nothing to add.

I would like to see the final product of your findings!

Lean effective data driven standards are key that utilizes the common denominators between all stakeholders for effective project execution.

Not sure about how much it costs us financially, but BIM has been a very useful tool for our company.

NA