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A Review on Material Management Using BIM

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A B S T R A C T

Building information modelling is a revisionary technology that is used in different areas of building construction, such as estimation, scheduling, and sequence of construction works, light analysis, visualisation, and communication of works, etc. Now our topic is material management through building information modelling, which can be achieved by 3D BIM, 4D BIM, 5D BIM, and integration with inventory management techniques such as ABC analysis, RFID technology, construction logistics management (CLM), construction logistics plan (CLP), 3D laser screen display, etc. These all improve construction efficiency and reduce construction costs, clash detection, and environmental impact due to construction.

Keywords: Material management, Inventory management techniques, Construction logistics management.

1. INTRODUCTION

Building Information Modelling (BIM) is a method of using technology to manage information in the architecture, engineering, and construction industries. BIM offers numerous benefits to the construction industry. It improves efficiency by reducing errors and rework and facilitating cost estimation, visualization, light analysis, sustainability, material management, etc. In this, our aim is to investigate how BIM can be applied to construction material management and its benefits to the construction project. Material management can be possible through proper communication of works, visualization, appropriate scheduling and sequence of construction works, the right material quantity estimation, reducing construction material waste, the application of inventory management techniques in construction works, etc. The 2D drawings provide only a plan of the structure and different views of the structure plan, dimensions, etc. These are not fulfilling the material management requirements. Thus, BIM plays a huge role in the construction industry, which provides visualization by 3D BIM, scheduling and material quantity by 4D and 5D BIM dimensions, etc. This BIM can be applied from various perspectives, like inventory management techniques, designing waste in construction, etc. Eventually, by integrating BIM into material management processes, it will enhance material management efficiency.

2. Literature Review

- **Rajesh Gangani et al (2018)** [1]. "This paper suggests using BIM and its benefits BIM is a method of using technology to manage the information in the Architecture, Engineering, Construction Industry. BIM can apply into different number of dimensions such as 3D BIM, 4D BIM, 5D BIM etc. The project's BIM model can be utilized for structural, electrical, mechanical, plumbing, and other collision identification and it is saved up 10% of the contract value. These BIM models aid in precise quantity calculations, scheduling, planning, and visualization of building projects, as well as material tracking and storage. Construction inventory management systems results facilitate the tracking, organizing, ordering, and storage operations. Eventually BIM improves material management efficiency.
- **Qunzhou Yu et al (2016)** [2]. "This paper explains the application of 4D BIM and how it is beneficial to material management. 4D BIM plays a huge role in construction projects. It provides a schedule and order for the construction tasks. One can use Navisworks, Rivet, and Primavera to construct a 4D BIM. When the material quantity is taken off and the cost of materials is added to the 4D BIM, it becomes a 5D BIM, which aids in precise pre-cost estimation. In this journal, architects created a 3D model of the structure's curtain wall using Revit and incorporated schedule information to generate a 4D BIM. These models can be used to confirm material quantities and delivery times. The rate realignment is therefore reduced by 90%, and construction efficiency is increased by 20%. Finally, BIM helps to reduce the rework and errors of construction works.
- **Abid Nadeem et al (2017)** [3]. "The paper explains the advantages of the 3D BIM model when compared to 2D drawings. Throughout the construction process, site management and material management are critical. Material costs account for 50% to 60% of total project costs. The 2D drawings provide multiple perspectives of the construction, which takes high imagination skills as well as understanding of building designs, which is not easy for the clients. BIM is an innovative technology that benefits site management in terms of time and coordination, labour safety, capital investment reduction, flexible work space, and better communication throughout the entire project.

- **Punitha Rajendran et al (2012)** [4]. "This paper explains construction waste and its effects on the environment and economy. "Design out Waste in the Construction" is a method of decreasing waste in a construction project. Waste in the construction industry must be eliminated for both environmental and economic reasons. India generates around 150 million tons of construction and demolition garbage each year. In India, however, just about 1% of this material waste is recycled. Material procurement waste, design waste, and site operation waste are all examples of construction waste. Implementing BIM in construction operations can help decrease it. BIM shells reduce rework and, consequently, generate less waste during the preconstruction stage. Eventually, BIM helped reduce construction waste.

- **K. Whitlock et al (2018)** [5]. "The journal paper explains construction logistics material wastage. There are various strategies in construction logistics management (CLM), such as Demond smoothing, on-site marketing, off-site manufacturing, and so on. "CLM" (Construction Logistics Management) is a process of planning, transportation, storage and distribution of material and equipment needed for the construction project. Integration of BIM with construction logistics management allows complicated logistical strategies to be communicated quickly and clearly, improving safety and efficiency, and so forth.

- **A Montaser et al (2020)** [6]. "The paper discusses the importance of proper representation of real-world variables in simulation models for achieving more realistic responses and simplification of construction simulation. The use of computer-based representations is effective in uncertain, complex, and repetitive situations. A review paper on BIM technology and inventory management techniques identifies research gaps. The shortcomings of 4D modeling are also discussed. Various inventory management techniques, such as ABC analysis, Minimum Maximum, and Two Bim Techniques, are also mentioned. The critical literature review focuses on the application of BIM in various areas such as existing condition modeling, cost estimation, design authoring, and structural analysis.

- **Rajesh gangni et al (2020)** [7]. "The paper focuses on the application of 5D BIM for cost control in construction projects. It emphasizes the importance of accurate and detailed information at every stage of a construction project and highlights the common issues faced by the industry, such as time delays and cost overruns. BIM is seen as a tool that can help overcome these challenges by facilitating activities like scheduling and monitoring costs.

- **S. Sakule et al (2019)** [8]. "To develop a model that integrates quantity estimation and cost control with data visualization to improve decision-making in construction projects. It proposes a research agenda for utilizing BIM in quality, cost, and material management in infrastructure construction projects. The paper also discusses the challenges and potential of BIM adoption in the industry, emphasizing the importance of belief in the concept and investment in software, hardware, workflow development, and education.

- **Wangchoshen et al (2019)** [9]. "It discusses the integration of BIM/4D-BIM in construction projects. The study identifies the advantages, risks, and challenges of using BIM/4D-BIM in construction projects. The research concludes that the adoption of 4D-BIM in the construction industry is highly beneficial. The study also suggests that using BIM-4D contributes a lot in clash detection for early rectifications, optimizes the program of the project from design to construction stages, and clarifies construction sequence for engineers, coordinators, managers, and labours to streamline the construction process and reduce the associated risks and challenges.

- **Danigel reborj et al (2021)** [10]. "The provided knowledge discusses the importance of quality and budget in planning and controlling materials for construction projects. The focus is on space constraints due to logistics and the use of manual methods for materials management, which can lead to human errors. The implementation of RFID technology can optimize planning, provide accurate material status and inventories, and eliminate paperwork. However, current practices in tracking materials are manual and paper-based, and emerging technologies such as RFID not being adequately used. The study aims to identify the potential employment of RFID technology for materials management in construction projects.

- **Thu Anh Nguyen et al (2020)** [11]. "This paper explains the integration of Building Information Modelling (BIM) and 3D laser scanning in construction material management, focusing on a sports stadium project in Go Vap, Vietnam. They use Leica Cyclone 360 software to convert millions of data points from 3D laser scanning into a point cloud, to obtain 3d drawings. Application to the sports stadium project reveals a 7.16% higher accuracy for masonry wall volume using BIM-3D laser scanning compared to conventional methods. The BIM model achieves nearly 99% precision. Cost analysis indicates a 7.16% cost increase for wall construction using conventional methods, but the high implementation cost of BIM and 3D laser scanning is deemed more reasonable over the project's duration, reducing time and manpower requirements. Overall, this integration resolves limitations of traditional methods.

- **Qian Chen et al (2020)** [12]. "The paper suggests using BIM and RFID technologies together for better construction materials management. RFID uses radio waves to identify materials, and the method follows lean theory for a new workflow. It focuses on improved supply chain visibility. The BIM-RFID workflow aims to manage materials better and speed up construction. According to the paper's findings, implementing this workflow resulted in a significant 16.1% reduction in construction time. This can reduce overall project time, reducing time and manpower requirements.

- **Qunzhou Yu et al (2016)** [13]. "The study explains a material requirement dynamic model and employs 4D modelling, combining 3D BIM models with time related information. This 4D BIM process, 3D models + time information =4D, is applied in the Wuhan International Conference Centre project. The BIM-based dynamic model reduces material supply, reducing time wastage and significantly enhancing construction efficiency by 20%. Emphasizing the practicality of 4D BIM, the methodology improves planning and coordination in design and construction phases. The focus on material supply optimization suggests potential waste reduction and overall project performance

enhancement. The Wuhan International Conference Centre project serves as a practical case study, showcasing the real-world impact of implementing 4D BIM-based dynamic models for construction site management.

- **Xinhua Wu et al (2021)** [14]. "This paper explains the application of BIM in managing prefabricated construction materials, using a sampling survey method. It highlights the importance of collaboration and coordination for successful BIM implementation. The analysis emphasizes the benefits of BIM, specifically in improving material management, reducing turnover times to three times compared to the conventional two times. The article suggests that combining BIM with wireless communication can enhance efficiency and communication in prefabricated construction projects. In summary, BIM-integrated management processes significantly reduce turnover times for prefabricated materials, and the potential for further improvement exists.

- **Faris Elghaish et al (2018)** [15]. "The paper introduces a framework integrating material planning methods, specifically the ABC analysis theory or Pareto Principle, to categorize project materials. The Pareto principle, or the 80/20 rule, is applied to classify inventory materials into three categories based on their cost significance. The first category comprises 20% of materials, representing 80% of material costs; the second category includes 30% of materials, contributing to 15% of material costs; and the third category involves 50% of materials, but only accounts for 5% of material costs. The article addresses challenges in material management within the construction industry and proposes a complementary framework equipped with tools to tackle these challenges. The proposed framework considers dependent supply to optimize total material costs, effectively reducing every obstacle. The 3D laser scanning technology works on LiDAR technology (Light Detection and Ranging), hence it is also referred to as LiDAR scanning. The high-definition LiDAR scanner, targeted to a point, throws out laser rays in order to capture the structure's geometry. The rays emitted from the 3D scanner reflects back to the scanner after a collision with the surface. The laser scanning experts carry a Leica laser scanner, a tripod, backup batteries, an instruction manual and an iPad. Efficiently scan each site with Leica laser scanners, capturing millions of data points. Software called Leica cyclone 360 software used to convert the captured data. The virtual captured files converted into point cloud format. Then they take over the point cloud file to generate 2D and 3D deliverables.

- **Mohamed Saeed et al (2023)** [16]. "The journal titled "Building Information Modelling (BIM) and knowledge management in implementation for construction projects" provides a comprehensive overview of the implementation of BIM and knowledge management in the construction industry. It emphasizes the importance of BIM in streamlining project planning, budgeting, and execution, and discusses its various applications such as digital development, waste management, 3D coordination, and design review. The journal also addresses the benefits and challenges of BIM adoption, including cost reduction, hazard mitigation, and improved project sustainability and quality. It includes a literature review on the development and use of BIM globally, as well as its benefits in securing project requirements, assessing building performance, saving costs, and improving communication among stakeholders. The document also highlights the risks and challenges associated with BIM adoption and provides insights into the gaps in current research in this field. Overall, the journal provides a comprehensive understanding of BIM and its significance in the construction industry.

- **Yi Jiang et al (2021)** [17]. "The paper related to Intelligent Building Construction Management, founded on the synergy between Building Information Modeling (BIM) and Digital Twin technologies, represents a cutting-edge approach to modern construction practices. BIM serves as the cornerstone, enabling the creation of a detailed digital representation encompassing every fact of a building's life cycle, from initial design to ongoing operation. The integration of Digital Twin technology takes this a step further, offering real-time monitoring and analyses ca analysis capabilities for optimized performance. Through BIM's 3D modeling and simulation features, construction managers can refine resource allocation and scheduling, enhancing overall project efficient.

- **O. Moselh et al (2013)** [18]. "The paper suggests impact of Building Information Modeling (BIM) on Just- in-Time (JIT) material delivery is significant in optimizing construction processes. BIM facilitates precise planning and coordination, reducing the need for excess materials and storage. With real-time data from BIM, JIT material delivery becomes more accurate, minimizing delays and improving project timelines. The integration enhances communication between stakeholders, ensuring seamless coordination for timely material arrivals. BIM's 3D models aid in visualizing construction phases, allowing for better sequencing and scheduling of materials as per JIT principles. This approach reduces on-site inventory, lowering holding costs and minimizing waste.

- **Mogalli et al (2023)** [19]. "The paper explains the Integrating Building Information Modeling (BIM) with materials management in construction projects means combining digital design and planning with efficient handling of construction materials. This integration streamlines communication and coordination between project teams, reducing errors and enhancing collaboration. BIM allows for a detailed 3D representation of the project, helping in accurate material quantity assessments. By linking BIM with materials management, construction teams can better track and manage the flow of materials throughout the project lifecycle. This integration enhances decision-making by providing real-time information on material availability and usage. It also improves cost.

- **Amal Salman Jawad et al (2023)** [20]. "The paper related to Intelligent Building Construction Management, founded on the synergy between Building Information Modeling (BIM) and Digital Twin technologies, represents a cutting-edge approach to modern construction practices. BIM serves as the cornerstone, enabling the creation of a detailed digital representation encompassing every fact of a building's life cycle, from initial design to ongoing operation. The integration of Digital Twin technology takes this a step further, offering real-time monitoring and analyses ca analysis capabilities for optimized performance. Through BIM's 3D modeling and simulation features, construction managers can refine resource allocation and scheduling, enhancing overall project.

3. CONCLUSION

Construction is the second-largest industry in India after agriculture. We need proper technology to enhance the development activities in the construction industry because BIM's major role in recent developments in the architectural and engineering construction industry (ACE) Implementation of BIM will increase day by day in the construction sector for clash detection, material quantity estimation, scheduling and sequence of construction works, sustainability, material management, designing of construction waste, etc. It savings of up to 10% of the contract value through clash detections & cost estimation accuracy within 3%. It reveals that the implementation of the model can reduce the rate repositioning by 90% and increase construction efficiency by 20%. It reduces wastage emissions during the construction. BIM is clearly becoming an essential component of any AEC project, and it may eventually be regarded as a fundamental tool for all such projects. BIM acts as an environmental friend to reduce building demolition and excavation waste arising in construction works. Eventually, in the material management aspect, BIM provides the right material, in the right quantity, in the right place, and at the right time, reducing losses.

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References

[1] Mahajan, G., & Narkhede, P. Analyzing BIM use and application in the building industry from 2008 to 2023.

[2] Yu, Q., Li, K., & Luo, H. (2016). A BIM-based dynamic model for site material supply. Procedia Engineering, 164, 526-533.

[3] Nadeem, A., Wong, A. K. D., Akhanova, G., Azhar, S., & Wong, S. N. (2018). Application of building information modeling (BIM) in site management—material and progress control. In Proceedings of the 21st International Symposium on Advancement of Construction Management and Real Estate (pp. 289-297). Springer Singapore.

[4] Rajendran, P., & Gomez, C. P. (2012, June). Implementing BIM for waste minimization in the construction industry: A literature review. In 2nd international conference on Management, Malaysia (pp. 557-570).

[5] Whitlock, K., Abanda, F. H., Manjia, M. B., Pettang, C., & Nkeng, G. E. (2018). BIM for construction site logistics management. Journal of Engineering, Project, and Production Management, 8(1), 47.

[6] Achkar, E., 2016. A BIM-interated approach to Construction Quality Management. Thesis, Construction Management Engineering, Eindhoven University of Technology, Netherlands.

[7] Afsari, K., Eastman C. M., Shelden, D. R., 2016. Cloudbased BIM Data Transmission: Current Status and Challenges. 33rd International Symposium on Automation and Robotics in Construction (ISARC), Auburn, Alabama, USA. Chen, L., Luo, H., 2014. A BIM-based construction quality management model and its applications. Automation in Construction, Vol.46, pp.64-73.

[8] Harmel, G., Bonjour, E., & Dulmet, M. (2006). "Product, process, and organization architectures modeling: from strategic.

[9] Cheng, Y.M., 2013. Application of BIM on Quantity Estimate for Reinforced Concrete. 3rd Int. Conf. on Civil Engineering, Architecture and Building Materials, Jinan, China.

[10] Cheng, Y.M., 2017. Application of BIM on Documenting Construction Defects. International Journal of Engineering and Technology, Vol. 9, No. 5, pp.393- 397.

[11] Fayed Mogalli, A. H. (2017). Integration of building information modelling (BIM) with materials management in construction project (Doctoral dissertation, Universiti Tun Hussein Onn Malaysia).

[12] Saeed, M., & Yas, H. (2023). Building information modelling (BIM) and knowledge management in implementation for con-struction projects. Management Science Letters, 13(4), 277-286.

[13] Jawad, A. S. (2023). Controlling quality costs in Iraqi construction projects using BIM (Master's thesis, Altınbaş Üniversitesi/Lisansüstü Eğitim Enstitüsü).

[14] Jiang, Y. (2021). Intelligent building construction management based on BIM digital twin. Computational Intelligence and Neuroscience, 2021.

[15] Ocheoha, I. A., & Moselhi, O. (2013). Impact of building information modeling on just-in-time material delivery. In ISARC. Proceedings of the International Symposium on Automation and Robotics in Construction (Vol. 30, p. 1). IAARC Publications.

[16] T.A. Nguyen, P.T.Nguyen and S.S.D. , Application of BIM and 3d scanning for material management in construction process , Advances in civil engineering ,2020.

[17] Qian Chen Yufei Hufang , and Guomin Zhang , department of civil , environmental, geomatic engineering at ETH Zurich Campus in switzerland. journal Automation in Construction in 2020.

[18] Qunzhou Yu , Kaiman Li , and Hanbin Luo , published in Procedia Engineering journal in 2016.The article is available at www.siencedirect.com.

[19] Xinhua, Wireless management system of pre-fabricated construction materials based on BIM technology, published in 2021, https://doi.org/10.1186/s13638-021-01955-x.

[20] Farris Elghaish, Sepehr Abrisham, Mark Gaterell, Richard Wise, Material management process in construction industry using BIM, journal of structural and construction engineering in 2018.