Building Information Modeling (BIM) for Construction Project Schedule Management: A Review

Tuan Anh Nguyen
Ho Chi Minh City University of Transport, Vietnam
tuanna@ut.edu.vn (corresponding author)

Tu Anh Nguyen
Ho Chi Minh City University of Transport, Vietnam
nguyenanhtugts@gmail.com

The Van Tran
DEOCA Research and Training Institute, DEOCA Group, Vietnam | Ho Chi Minh City University of Transport, Vietnam
tran.van.the@deoca.vn

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ABSTRACT

Nowadays, the implementation and application of the BIM process in construction project management is a pressing need. This aligns with the global development trends in the construction sector and project information management in general. Numerous scholars and companies are actively engaged in learning, understanding, and investigating various aspects of BIM to stay up-to-date and meet the inevitable developmental requirements. This study focuses on the role and application of BIM, intending to identify limitations that hinder its fulfillment of expectations in project schedule management. In addition, it explores studies that show how other countries have effectively employed BIM in project management and progress tracking throughout the project lifecycle. The study aims to address three main objectives: (a) comprehensively examine and provide evidence related to the concept of BIM in project schedule management, (b) present the benefits of applying BIM in comparison to traditional methods in project management and operation, and (c) identify limitations stemming from various factors that may pose challenges in the application of BIM in project schedule management.

Keywords-BIM; schedule management; project; model; technology

I. INTRODUCTION

Building Information Modeling (BIM) is an information management process that encompasses the creation and administration of digital elements throughout various phases, including design, construction, and commissioning, as well as the operation of works that can encompass construction projects or industrial products. Information is categorized into two primary groups: geometric information, covering dimensions and positioning of building components, such as columns, beams, floors, pipes, bathtubs, light bulbs, cabinets, and tables, and non-geometric information (data), which provide additional details about components, such as manufacturer, maintenance time, cost, and supplier. BIM serves as a comprehensive model that contains project information and encourages collaborative utilization between departments and stakeholders from the conceptual design phase through the construction and operational stages.

Not only does BIM act as a repository for storing and delivering project information throughout the design, construction, and operation management phases, but also as a dynamic process for generating and utilizing information sources to construct a virtual model of the building. This approach aims to optimize the design, construction, operation, and overall management of the project [1-3]. BIM provides users with a comprehensive project overview, helping project stakeholders make informed decisions, mitigate risks, and improve work efficiency while minimizing design changes during construction. The BIM model's content encompasses parameter information that can be adjusted at the user's discretion. When a party requires a design revision, the model and related elements, like volume and drawings, are promptly updated. This feature is highly effective for designs that undergo substantial modifications during the approval process and the actual construction. BIM technology offers participants early exposure to the project, allowing users to easily identify inconsistent design points in different disciplines. This capability facilitates accurate design adjustments, minimizing conflicts and enhancing harmonization during project implementation.

Implementing BIM produces significant economic benefits for all stakeholders involved. The design team can reduce design and production costs, while contractors can coordinate more effectively, resulting in savings in estimating and supply management. Investors can reliably calculate project-related results, including costs, time, and operation and maintenance. Investors benefit from minimized management and supervision costs, optimized designs, reduced construction time, and minimized additional costs. The ability of BIM to enable accurate design and anticipate difficulties during construction without wasting time allows contractors and investors to reduce unnecessary costs.

BIM management technology significantly simplifies Design & Build work, with the incorporation of 4D BIM as a supplementary technique to enhance project management. The primary goal of 4D BIM is to ameliorate the visualization of the construction progress by linking the 3D model of the building with a pre-established schedule. This study outlines key aspects for visual comparison to underscore the effectiveness of using 4D BIM for project management in contrast to traditional methods: (a) Planning and scheduling, (b) Baseline vs actual progress comparison, (c) Construction progress control, (c) Lookahead plan, (d) Claim analysis and dispute resolution, (e) Construction methods presentation, (f) Work safety planning and management, (g) Tower crane location research and safety, (h) Total floor management, and (i) Construction drawings management. Embracing general project management with a unified BIM shared model represents a pivotal turning point in the era of applying new technologies to construction project management. Undoubtedly, it will soon see widespread use and become an indispensable tool for engineers, architects, and construction managers in Vietnam.

II. OVERVIEW OF BIM APPLICATION IN CONSTRUCTION PROJECT SCHEDULE MANAGEMENT

The adoption of information and communication technology in the construction industry remains relatively low, contributing to the emergence of certain complications, such as low productivity, frequent time and cost overruns in projects, as well as challenges with incident management processes, communication, and process automation [4]. Manual creation and updates of project progress persist, leading to time-consuming and error-prone practices that negatively impact planning and scheduling, a significant factor in project delays [5]. Numerous known and unknown risks underlie schedule delays, prompting the development of various theories and models. However, addressing this aspect still requires considerable effort due to the ongoing time failures in projects [6]. In 2004, the National Institute of Standards and Technology (NIST) reported that interoperability issues and inadequate data management cost the construction industry an estimated $15.8 billion annually, equivalent to approximately 3-4% of total industry costs [7].

The advent of BIM technology has presented robust technical capabilities to achieve informatization and digitization of the engineering construction sector, significantly accelerating the transformation and improvement of management practices in engineering construction projects [8-10]. The development of information management aligned with BIM for construction data enhances BIM's capacity to integrate modeling, communication, collaboration, as well as harmonization of design and construction requirements throughout all phases of sustainable construction projects [11]. Consequently, BIM plays a pivotal role in advancing automation within the construction industry and its corresponding management systems. However, the successful implementation of such initiatives depends on the comprehensive skills, capacity, and enthusiasm of builders and contractors, recognizing them as critical factors for the future success of these endeavors [12].

BIM proves advantageous in the creation of schedules, estimation, change tracking, and on-site logistics management [13]. In recent years, there has been an increasing focus on the use of BIM for project and cost management, becoming a prominent area of interest for project owners [14]. Storing a facility management plan within a BIM model helps facility managers comprehend task schedules, durations, and maintenance personnel, thus improving efficiency and convenience in facility management. Not only does this BIM input method streamline facility management processes, but also mitigates scheduling issues arising from human factors [15]. Visual representations of project schedules, coupled with ongoing project visuals, can aid in tasks, such as retention, record management, and identification of effective construction strategies for project time management [16]. Throughout the planning, design, and implementation phases, various tasks heavily rely on diverse location data, including worker and equipment locations for safety planning and management, as well as material location data for progress tracking. Given that a significant proportion of construction activities occur indoors, indoor location data for workers, materials, and other construction resources significantly affect quality, project safety, and productivity [17].

The concept of BIM theoretically originated and evolved at the Georgia Institute of Technology in the late 1970s and rapidly developed thereafter. This growth was driven by increasing attention from construction teams and companies that recognized the value of integrating and managing construction project processes using BIM. The term "Building Information Modeling" was coined in 2002 to describe virtual design, construction, and facility management [18-21]. Since BIM is perceived as a management process rather than just a model, a term gaining broader usage in recent times is "Building Information Management" [22]. This includes 3D/4D/5D BIM tools as innovative approaches to constructing visual models, performing collision detection, volume dissection, simulating construction, and graphically scheduling to ensure timely project completion [23]. BIM has emerged as a prominent technological trend and a promising tool for various functions in planning, design, construction, and facility management [24]. In construction planning, BIM allows for the detection of conflicts during the design phase, enhancing project schedules [25]. Regulations should be flexible enough to allow the reorganization of project teams even during implementation, and a well-established BIM-enabled project structure should be transferable to other projects, ultimately reducing construction costs and improving communication among participants [26-27]. BIM offers the advantage of easily inserting, extracting, updating, or modifying digital data by various stakeholders, including owners, customers, engineers, architects, contractors, suppliers, and building owners [28].

Integrating project schedules with BIM elements can produce visual representations aligned with goals that involve the interpretation and production of construction drawings using computer-aided drafting, reasoning, and application of BIM software [29-30]. In the United States, integrated project delivery has become the preferred system for major BIM-related projects [31]. The government actively encourages and facilitates the application of BIM to increase productivity, conserve quality resources in construction activities, and improve project operation management [32]. A BIM model has significant potential to streamline the data collection and storage process for a project, serving as a comprehensive source for all project-related data. The overarching purpose of using BIM in facility management is to leverage facility data throughout the lifecycle, ensuring a safe, healthy, efficient, and productive work environment [33].

BIM revolutionizes how information is generated, managed, and communicated within project teams [34]. Scheduling is a crucial factor influencing the success of construction projects, guiding the when and where of tasks for all team members. Despite its importance, scheduling is often based on approximate timelines, leading to frequent delays and additional costs [35]. Many 4D models have been created by linking the 3D components of a BIM to project scheduling activities. However, traditional 4D models have limitations, as BIM primarily provides information about 3D components. In [36], an interface system was introduced to enhance the benefits of BIM in 4D applications, take advantage of its capabilities to reduce material requirements (e.g., steel, molds, concrete), and support site-level activity simulation, ultimately contributing to project scheduling. The proposed system facilitates information exchange among different software packages, allowing for improved operation simulations that consider uncertain task durations and competing resource needs. This enables the evaluation of various resource allocation strategies to create an optimal construction plan. The resulting project schedule is then linked to the 3D BIM components, creating an enhanced BIM-based 4D model [36].

To address safety concerns in construction schedules, the risk of accidental falls can be identified using automated safety checks in a 4D simulation application [37]. During BIM modeling, the tracking and management of various versions of the BIM model are crucial for all BIM engineers. Regular meetings are essential to discuss collaborative work, where BIM engineers submit progress and unfinished work to the BIM manager before each meeting. The BIM manager updates and communicates the latest integrated collaborative work, addressing issues, such as corrupted BIM model files on the server side. To mitigate this problem, BIM engineers should daily backup the BIM model on the client side and save new BIM model files exclusively on the server side [38].

Achieving active control and dynamic optimization of project objectives through integrated information management is a key benefit of BIM technology-based cost management. This approach enables professional coordination in design, pipeline collision testing, energy-saving calculations, sustainability analyses, program simulations, construction process simulations, scaffold support system testing, schedule control, cost control, and safety management. Such dynamic optimization upgrades the quality of engineering design, construction, and maintenance management, improving work efficiency and the scientific management level, reflecting the dynamic optimization of information for project services [39]. During design development, challenges related to data collection and management often arise along with multidisciplinary collaboration issues. Design team members, even from the same discipline, often use different software tools and work simultaneously [40]. Adopting BIM improves design reviews, accelerates processes, and enhances conflict detection and collaboration, leading to more efficient work. The application of BIM facilitates the early detection of potential conflicts during the design phase.

Effective communication of progress and schedule variations is deemed a project management strategy to enable timely corrective actions. The 4D model in construction control changes colors to represent progressing activities over time, aiding understanding [42]. Construction progress directly impacts speed, cost, and quality, and the construction schedule is determined based on the main circuit, considering factors, such as time, space, technology, management, and resources [43]. Semantic search, utilizing ontological mapping, automates conflict resolution by identifying and negotiating solutions, reducing delays. Mobile applications play a crucial role in providing instant feedback and accelerating decision-making processes [44]. To improve the quality, schedule, and cost performance of off-site construction projects, BIM incorporates as-built information, pairing it with design information for project control. As-built information studies focus on quality control and evaluation of structural members [45]. In [46], a BIM-based early warning model was proposed for construction project cost and risk management, while BIM functions, namely "construction process simulation" and "4D description of construction progress" are widely used in prefabricated construction project management for post-production planning, resource utilization planning, and workspace congestion analysis [47]. BIM's knowledge management and storage function effectively address discrete information challenges during green building construction, applying construction information modeling to manage quality, schedule, cost, and safety in project supervision [48]. The former strives to realize the partial application of the supervision audit system in actual engineering projects [49].

Design consulting for phased implementation necessitates progress tracking and output deliverables for deployment. In the realm of BIM implementation, the tangible success of the application is significantly influenced by the seamless coordination among organizations and departments engaged in construction projects. The Specialized Construction Investment Project Management Board within the Ministry of Construction organizes weekly meetings with stakeholders. These gatherings serve as a platform to share insights, foster coordination, and align on the implementation process, progress expectations, and overarching goals. In addition, regular online meetings are held to ensure timely updates and maintain alignment with the project's progress and objectives [50].

BIM applications are used for bridge projects, emphasizing their utility in cost and time analysis and management. The cost estimation application accommodates both approximate and detailed cost estimates, offering flexibility with default or user-defined values. Diverse impact metrics are used to monitor project costs and progress throughout the construction implementation phase [51]. Cost and schedule represent two crucial pivotal objectives for construction projects, with risk management serving as the linchpin for their realization. In [52], a novel risk early warning method was introduced based on emerging BIM technology. In the face of design changes, construction managers traditionally spend time reviewing updated drawings and revising schedules, a process highly dependent on the manager's interpretation of the drawings. The introduction of BIM aims to improve efficiency through shared databases and precision through 4D model visualization. A 4D model is generated, combining the BIM model and the construction schedule, using 4D tools, such as Autodesk NavisWorks, offering a 3D model integrated with time-based geometry [53]. This 4D BIM acts as a tool for safety management and monitoring, contributing to the reduction of safety-related hazards. Secure processes are implemented to address the limited automation in 4D modeling [54]. The construction process is simulated, followed by adjustments and optimizations of the construction sequence and method, refining the construction process to obtain an optimal plan. Construction simulation encompasses progress, program simulation, site layout, and more, ensuring not only control over construction progress but also quality assurance to prevent delays [55].

Project management plays a key role in minimizing or eliminating risks associated with a project. Risks can be due to human activities or natural causes, some being foreseeable, while others are unforeseen. Project risks can significantly impact the project if not competently managed. Collaborative risk reduction is crucial for project teams, and various approaches are employed. BIM has emerged as a vital approach to mitigate project risks, playing a critical role in the project lifecycle stages, including planning, design, and construction management. BIM ensures comprehensive project monitoring through information management, facilitating efficient execution and milestone achievement. Despite BIM's effectiveness in various projects, its specific application in the construction industry remains somewhat unclear. In [56], the significance of BIM as a highly suitable method to reduce project risk was investigated. The substantial potential of BIM for quality management in infrastructure projects has been recognized, showcasing successes in error detection and mitigation, obstacle anticipation and resolution, improved design solutions, improved communication with stakeholders, and optimized budget and schedule options [7, 57]. In the construction industry, the project management team's core responsibility is to complete projects within the specified budget, time, and quality identified in the contract documents [58]. The integration of BIM with advanced digital technologies offers the prospect of automating modern construction project management, improving productivity, and controlling waste and resource consumption [59]. In [60], the application of 4D visualization in construction was explored, bridging the gap between 4D research and BIM principles, particularly addressing the level of development [60].

Construction management leverages BIM for visual communication among key stakeholders, knowledge integration to enhance management expertise, and automation for improved efficiency. Despite these applications, BIM data in construction management are often utilized for simple and localized purposes. Traditional construction progress management is susceptible to disruptions from natural, objective, and subjective environments, leading to interruptions and blockages in the construction process. However, with the support of BIM models and BIM5D software, construction progress management anticipates future steps, tracks real-time progress, and provides insight into resource requirements, equipment needs, and capital utilization. It also facilitates the formation of comprehensive construction progress management modes, ensuring timely monitoring of quality and safety issues, defect recording, data integration, model linking, and prompt corrective actions [61]. Using the BIM model, defect managers examine information relevant to the management of reinforced concrete work defects, such as building geometry, materials, and project schedules. BIM technologies have revolutionized the construction industry by organizing relationships among stakeholders, offering benefits in design, procurement, construction, and maintenance processes, along with change control, repetition reduction, energy efficiency, health and safety, risk management, and quality [62]. BIM spans beyond 3D modeling, encompassing dimensions, such as 4D (time), 5D (cost), and even 6D (as-built activity). It integrates information and cost data and creates an as-built model for operational phases [63].

Addressing limiting factors in management involves adapting working processes to new technologies, exploring BIM's applications in cost, schedule, and safety management, developing guidelines and standards, and adopting integrated project delivery. Integrated project delivery reduces fragmentation and is more effective when combined with BIM than traditional methods [64]. Owner motivation remains a crucial factor in BIM application, emphasizing the importance of aligning with owner requirements [65]. BIM's applications in building design and construction planning are evolving rapidly, enabling the storage of physical and functional data in multiple dimensions for in-depth analysis and prediction [66-68]. Basic construction management practices use advanced computer tools for budgeting, scheduling, risk analysis, and buildability studies, providing accurate and high-speed solutions [69]. The theoretical framework for BIM data in facility management assumes a seamless data exchange between BIM and facility management software [70]. Case studies are essential to understand the adoption of BIM and its impact on remote construction projects [71]. Testing and inspection schedules benefit from detailed planning using stored database information [72].

BIM enhances engineering work during the design stage by creating 3D models that integrate all building features. These models can be further ameliorated by linking to schedules (4D) and costs (5D), allowing better planning during the design phase and improved time and cost control, which is crucial for any construction organization [73]. Integrating quality information into BIM facilitates the creation of a shared quality model among stakeholders. Augmented Reality (AR) technology supports on-site inspections based on this quality model, providing a simplified integration with 4D BIM [74]. Construction schedules undergo modifications, and BIM provides a valuable tool for managing changes efficiently [75]. Visualizing risk management information improves the efficiency of dynamic risk management practitioners in terms of schedule, cost, and safety in challenging construction projects [76]. Traditional site inspection methods and manual progress tracking are being transformed, with quality management focusing on ensuring that construction specifications align with the design [77].

A. *Quality Assurance*

BIM serves as a repository for quality-related design and construction information within its models. Integration of mobile computing with BIM offers practical solutions for field workers to address real-time construction workmanship quality issues. This includes supervising on-site activities, tracking work progress, and checking project milestones. BIM models also facilitate the capture and management of quality checklists for each task [78]. Ongoing research aims to improve process efficiency in BIM-based quality control and inspection for safety management, focusing on areas, likee data interoperability and decision-making [79].

B. *Definition and Applications*

BIM is defined as a set of construction project management tools enabled by new technology. It encompasses the entire construction process, providing a 3D simulation of the project components linked to relevant information for planning, construction, operation, and decommissioning [80]. BIM acts as a complementary model to a project's technical information database, storing architectural designs, geometry, and engineering information. Infrastructure-integrated applications include earthworks simulation, schedule management, construction equipment management, walkability assessment, and facility management [81]. Quality control is a crucial element in project management, with various countries incorporating quality control requirements into BIM guidelines [82].

C. *Schedule Management*

Effective platforms for visually enhancing completion schedules during the construction phase are essential for general contractors. As the adoption of BIM becomes more widespread, integrated schedule management with BIM becomes necessary for visual construction management. A BIM information model for project cost management, based on BIM platform communication, enables real-time information sharing through parameterized material and component information. The use of BIM from pre-construction to post-construction stages in building construction processes has been discussed, emphasizing its potential benefits in improving project quality, lifecycle data management, collaboration optimization, and progress management [49, 83-86].

D. *Construction Progress Management*

Traditional construction schedule management faces challenges due to computational demands and a lack of an intuitive platform, leading to inefficiencies in progress control. BIM-4D technology, coupled with the key chain method, is proposed to build an informative, intuitive, and dynamic construction progress control system. This system includes modules for 4D realistic model management, key chain monitoring of buffer zones, and early warning of progress. BIM aims to address the weaknesses in the overall schedule management process, providing a solid foundation for construction progress management and control [47].

E. *Life Cycle Representation*

4D BIM extends beyond geometry and material information, incorporating progress and cost-related data for construction projects. The building information model encapsulates geometries, geospatial relationships, quantities, characteristics of building elements, material inventory, cost estimates, and implementation schedules. This comprehensive model represents the entire life cycle of a building, ensuring consistency and facilitating easy data updates [87-89].

F. *Demand Forecasting*

BIM modules are used to calculate order due dates and forecast demand based on construction schedules. However, uncertainties in activity dates and times require advanced information and communication technologies to support cost management and the overall management of construction projects [90].

G. *Challenges and Opportunities*

A detailed analysis of current scheduling practices reveals weaknesses and unmet information needs. Integration of construction schedule planning within a coordinated BIM-based design process is proposed to address these challenges, eliminating redundancies and improving change management. However, existing software packages require adaptation to the collaborative, model-based scheduling approach, lacking adequate access to underlying data and efficient link mechanisms between product and process models [91].

Project time control involves monitoring the status of project activities, updating progress, and managing changes to the baseline schedule to ensure adherence to the plan. This process is essential to recognize deviations from the actual plan, allowing corrective and preventive measures to mitigate risks. The timely execution of the project is crucial for stakeholders, but project delays are prevalent worldwide, particularly in developing and underdeveloped countries [92].

The application of BIM extends to cost, quality, safety, engineering, and field management, significantly enhancing communication efficiency among project participants and allowing more effective cost and schedule control [93]. In [94], a BIM application was proposed for the cost and time management of bridge infrastructure using a 5D approach. The building information model encompasses geometry, spatial relationships, geographic information, quantity, characterization of building elements, cost estimates, material inventory, and project schedule. This model represents the entire life cycle of a building [95].

Succar's definition of BIM underscores its comprehensive complexity, including a software that goes beyond numerical modeling and data input to include tools and processes related to project management. BIM, viewed in its entirety, aligns with the field of structural project management, offering potential benefits to structural project operators by reducing documentation time and delivering favorable project outcomes. Specific documentation of BIM use in notable project scenarios, such as Heathrow Terminal 5 and the Walt Disney Concert Hall, is an aspect of BIM documentation [96]. Challenges in design management practices, coupled with the introduction of BIM, require new solutions. BIM technology addresses these challenges by creating component libraries to improve modeling efficiency, simulating the 4D process to improve site construction accuracy, and implementing quality management systems for analyzing problematic components [97-98]. The BIM model enables construction managers to promptly identify and address issues by marking their location within the model. Tracking verification and statistical analysis play a crucial role in effective control [99]. The introduction of BIM-based project management tools improves the development of realistic project-based classroom assignments for educators. BIM allows the design of class projects that simulate real-world project conditions, helping students learn various project management methods and optimize project plans [100]. BIM's data-rich nature facilitates model-based quantity reduction, cost estimation, scheduling simulation, and design coordination. Therefore, beyond teaching BIM in design education, it is crucial to educate students on applying BIM throughout the project life cycle and how to effectively manipulate and manage the model [101].

The Construction BIM-enabled Schedule Management (ConBIM-SM) system improves the visibility of updated 'Built' schedules in real-time for prefabricated construction, improving on-site efficiency [102]. Facility maintenance-related information can be updated in the facility model post-maintenance, preventing management errors related to staff verification [15]. The negative impacts of BIM integration are often attributed to project teams that do not optimize BIM usage, resistance from stakeholders, and frustrations with underutilizing the potential of BIM [103]. A continuously updated 4D building information model helps logistics coordinators determine the exact material requirements in each project stage, supporting efficient project planning [104]. These advances suggest a shift from the document model to the project-integrated database model, combining 3D CAD models with construction operations to visualize construction progress over time [105]. The use of 4D models, linking components with activities, allows stakeholders to review the construction plan and the 3D CAD model for any day, week, or month of the project, providing visual intelligence for construction management [106].

III. DISCUSSION

Drawing on the synthesis of research findings presented in the overview of BIM applications in construction project progress management, it becomes evident that the utilization of BIM in managing project schedules offers numerous advantages. Insights from various studies underscore the significant potential of BIM evaluation, highlighting its widespread adoption in the application process. In Vietnam, BIM is gradually finding applications in project progress management, particularly in items associated with foreign-invested projects. Multinational companies and their branches, as well as various agencies and organizations, have demonstrated commendable proficiency in using BIM for project information management. The integration of the BIM process into project scheduling proves instrumental in mitigating the shortcomings associated with traditional manual scheduling methods. The time-consuming nature of manual creation and updating, error-prone tendencies, and resultant sub-optimal planning and progress, which are major contributors to project delays, can be resolved through BIM application. The pervasive issue of schedule delays, fraught with known and unknown risks, has prompted the development of multiple theories and models. However, addressing this persistent challenge demands continued efforts in the face of ongoing project time failures.

Beyond the rudimentary role of BIM in information modeling, its significance extends to considerable dimensions, including 4D (time), 5D (cost), and even 6D (as-built operations). In 4D, BIM establishes links between information and data in 3D object models, facilitating simulation analyses of construction operations. In 5D, BIM integrates this information with cost data, encompassing quantity, schedule, and price. In 6D, BIM represents an as-built model applicable in the operational phases of a facility. BIM's application enables the seamless update of information, ensuring consistency with all alterations. Enhanced interaction among project management stakeholders, coupled with regular conflict checks, guarantees continuous monitoring and updates from project initiation. This streamlined process aids in error reporting and progress tracking while it ensures project transparency during evaluations.

Despite the commendable aspects of BIM, certain limitations and risks persist due to various factors. A crucial factor is the national context, where each country's trends, policies, and regulatory frameworks impact the management landscape, including the construction sector. Implementing the BIM model requires extensive updates, exchanges, and changes in the approval and implementation processes. On the business front, adopting the BIM process incurs operating costs, equipment expenses, training fees, and adjustments in work procedures and organizational structures. The high costs associated with BIM software and skills training pose risks to businesses, particularly concerning mass adoption, where experienced individuals in this field are scarce. The human factor emerges as a fundamental prerequisite, demanding continuous learning and knowledge exchange between workers. With technology advancing each year, there is an increasing challenge in meeting the demand for work experience. New graduates may struggle to keep up with evolving technologies, while established employees may resist embracing change and updating their skills. This human factor poses a significant consideration when contemplating the application of the BIM process in construction project schedule management.

IV. CONCLUSIONS AND RECOMMENDATIONS

The delineation of advantages and drawbacks underscores the global proliferation of BIM as a ubiquitous language in construction management. However, certain factors, such as the country's level of development, applicable standards, operational methodologies, and technological considerations, continue to pose challenges and elicit dissatisfaction. To effectively address these issues, greater support is imperative from entities, namely the state, government, and businesses. Simultaneously, facing these challenges requires concerted efforts from both emerging talents and seasoned professionals well-versed in traditional management and application methods. Currently, enhancing the efficiency of BIM in construction management is highly dependent on the proactive involvement of government and state regulatory bodies. Their crucial role involves vigilant monitoring and the formulation of guidelines tailored to the specific prerequisites in Vietnam. These standardized processes are subsequently introduced and disseminated to authorities, serving as a foundational database for the broader implementation of the BIM process model, encompassing project progress management.

Integration of BIM software application training programs into university and college curricula is essential, offering advanced guidance on analytical thinking and the perspective required for handling digital data and project information at the graduate level. To optimize the effectiveness of BIM in managing the progress of construction projects, it is imperative to expand the dissemination of shared resources. These resources include standard documents, books, newspapers, and other guidelines on the BIM application process. Ensuring accessibility to high-quality and reputable resources for students, businesses, and implementation agencies is crucial. In addition to the common applications mentioned above, investors and design units should gradually promote the adoption of project information modeling. This involves adjusting and upgrading the equipment to ensure full integration and storage of the updated BIM application processes and project information management. Enterprises are encouraged to conduct proactive training sessions, widely disseminating guidance on the application of the BIM process to all personnel at various levels. Accessing insights from standard sources and journal articles or organizing seminars with the participation of esteemed domestic and foreign experts in BIM project management contributes to the comprehensive understanding and implementation of BIM processes.

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