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Article

Enhancing BIM Diffusion through Pilot Projects in Vietnam

Quynh To Thi Huong[1,a,*], Eric C. W. Lou[2,b], and Nam Le Hoai[1,c]

1 National University of Civil Engineering, Hanoi, Vietnam
2 Department of Engineering, Manchester Metropolitan University, United Kingdom
E-mail: [a,*]quynhtth@nuce.edu.vn (Corresponding author), [b]e.lou@mmu.ac.uk, [c]namlh@nuce.edu.vn

Abstract. Significant BIM uptake barriers in Vietnam include the lack of awareness and knowledge on BIM, high investment costs, and shortage of regulations, standards or guidance related to the AEC industry. This research focuses on enhancing BIM diffusion through eight selected projects with diversity in the type, scale (grade), location and funding sources - representing the myriad of construction project classifications in Vietnam. Additional reporting and interview sessions were held with BIM professionals involved in the projects, with the notion of immersing into professional experience during the project. These experiences were extracted to provide implementation experience and lessons learnt for future projects in Vietnam. This research highlighted the key issues around BIM skills and competencies, BIM investment and BIM regulations, standards and guidance. The research findings will support stakeholders to adopt the solutions to meet BIM adoption challenges to enhance the effectiveness of BIM implementation in future construction projects.

Keywords: BIM, implementation, diffusion, Vietnam, pilot project.

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1. Introduction

The architecture, engineering, and construction (AEC) industry plays a vital role in the Vietnamese national economy. In 2018, the AEC industry's total output value reached VND 358,684 billion and contributed 5.94% of the GDP of the country [1]. However, this sector still faces several issues – most concerning being the low productivity and inefficient performance [2]. Many countries face a myriad of issues by leveraging advanced technologies to lift their AEC industry, such as Building Information Modelling (BIM) [3]. In Vietnam, the government introduced BIM as the key solution in solving Vietnam's challenging AEC issues, by mandating its BIM adoption plan to promote BIM implementation within project stakeholders [4, 5].

The diffusion of BIM in construction projects and firms worldwide is growing in recent years [6, 7]. In parallel with the maturity and spread of BIM technology, several research projects have been conducted to investigate the benefits, barriers, and challenges that BIM delivered through various life cycle phases of BIM-enabled projects [1-6]. These findings provided a significant scientific foundation to promote the practical application of BIM for construction projects. BIM has been applied more widely in the architecture, engineering, and construction (AEC) industry of Vietnam after the issuance of the National Decision No.2500/QD-TTg [12] in 2016 and National Decision No.1057/QD-BXD [13] in 2017. However, the number of BIM-enabled projects is still small compared to other countries [6, 7, 8]. Despite the government efforts on enhancing digitisation of the AEC industry by leveraging BIM, the implementation barriers and challenges have restrained construction projects' stakeholders (e.g. investors, consultants contractors, construction contractors, etc.) from applying BIM [10, 12]. Among BIM barriers and challenges include the lack of BIM awareness and knowledge, inadequate investment in IT, scarce human resource and incorrect processes, shortage of national and regional regulations, inadequate international, national standards or guidance on BIM were the most significant obstacles [8]. They require further research to seek viable solutions to address these difficulties, thus, enhancing BIM diffusion that expands BIM implementation within the AEC industry for Vietnam.

Emanating from the need above, the study will focus on investigating experiences of how overcoming these challenges of BIM adoption through data collection and interviewing BIM professionals whom have worked in eight BIM-enabled pilot projects in Vietnam. These selected projects represent all types of construction projects in terms of types, grade, location, and funding resources. The research findings will provide a reliable and persuasive foundation for construction project stakeholders to perceive solutions to uptake BIM. The study outcome can also enhance the effectiveness of BIM implementation within construction projects in the Vietnamese context, and encourage adopting BIM within the AEC industry and improve the diffusion of BIM in Vietnam for the future.

2. Methodology

The Vietnam AEC industry has been slowly expanding towards the full adoption of BIM. It witnessed only a small number of BIM-enabled projects and only a few Vietnamese experts fully aware of BIM. This research will utilise quantitative research methodology (Fig 1): case study and triangular approaches (report, interview-in-person and phone interview) to investigate BIM implementation experiences [6, 7, 11, 12]. The case study method is used to select BIM-enabled construction pilot projects to explore BIM implementation. The selected projects represent the diversity of construction projects through funded capital, scale, use. One key personal (whom fully participated in the BIM implementation process) from each selected project will be required to complete a BIM implementation report and/or be interviewed (in person and on the phone). The triangular approach was chosen to provide an immersive data collection approach from further questioning or interviews after examining the submitted BIM implementation reports.

The selected research participants have high BIM knowledge and experience to provide workable solutions to face barriers and challenges of BIM adoption within construction projects in Vietnam. This is to ensure BIM implementation experiences are reliable and can be applied to any construction projects and stakeholders in the Vietnam AEC industry.

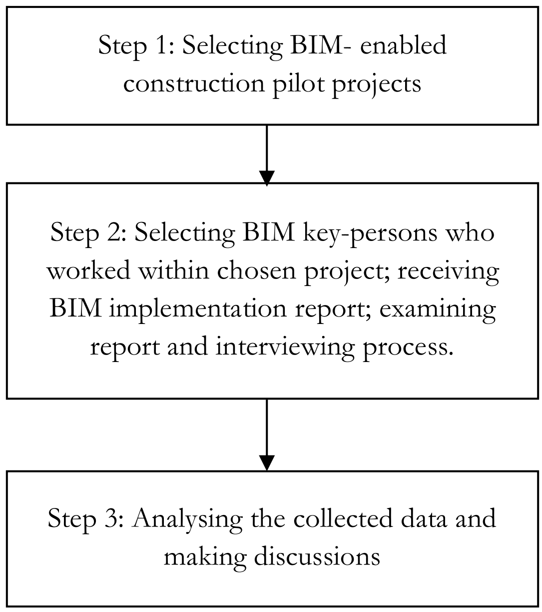

Fig. 1. Research methodology.

2.1. Selection of Pilot Projects

Eight recently completed BIM-enabled projects in Vietnam were selected for this research. Each project is encoded randomly as a number from 1 to 8 (see Table 1) to ensure the confidentiality of the projects and respondents' information.

Table 1. The selected BIM-enabled pilot projects' information.

Related information	Projects 1	2	3	4	5	6	7	8
Location (See Fig. 2)	Binh Phuoc province – ***Southern Vietnam***	Hanoi- ***Northern Vietnam***	Quang Nam province - ***Middle Vietnam***	Binh Duong province - ***Southern Vietnam***	Hoa Binh province - ***Northern Vietnam***	Hanoi - ***Northern Vietnam***	Quang Ngai province - ***Middle Vietnam***	Hanoi - ***Northern Vietnam***
Grade (according to [18])	I	III	I	II	I	I	I	II
Type (according to [18])	Industrial work	Infrastructure work	Complex work (Infrastructure, Residential buildings, Complex buildings)	Industrial work	Agricultural infrastructure work	Civil work (office)	Transportation work	Infrastructure work
Funded by	Foreign capital	State capital	Private capital and Foreign capital	State capital	State capital	State capital	State capital	State capital
Commenced	March 2019	January 2017	August 2019	April 2019	January 2018	Decembe r 2018	2017	2017
Status to September 2020	Finished in 2020	Finished in 2018	On-going	Finished in 2020	On-going	Finished in 2020	Finished in 2020	Finished in 2020

The projects are from different locations (in the Northern, the Middle and the Southern Vietnam), grades (I, II, III), types (Civil works, industrial works, infrastructure works, transportation works, agricultural works, and complex works), funding sources (State capital, Private capital, Foreign capital) and stakeholders (Different Investors, Consultant contractors, Construction contractors) (Table 1). Five in eight selected projects (Project 2, project 5, project 6, project 7 and project 8) were pilot projects mentioned in the decision no 362/QD-BXD issued by the Ministry of Construction [17]. These projects' delivery approach is Design-Bid-Build, which is the most widely used construction delivery method in Vietnam. In short, these eight selected projects represents the majority of BIM-enabled construction projects in the country.

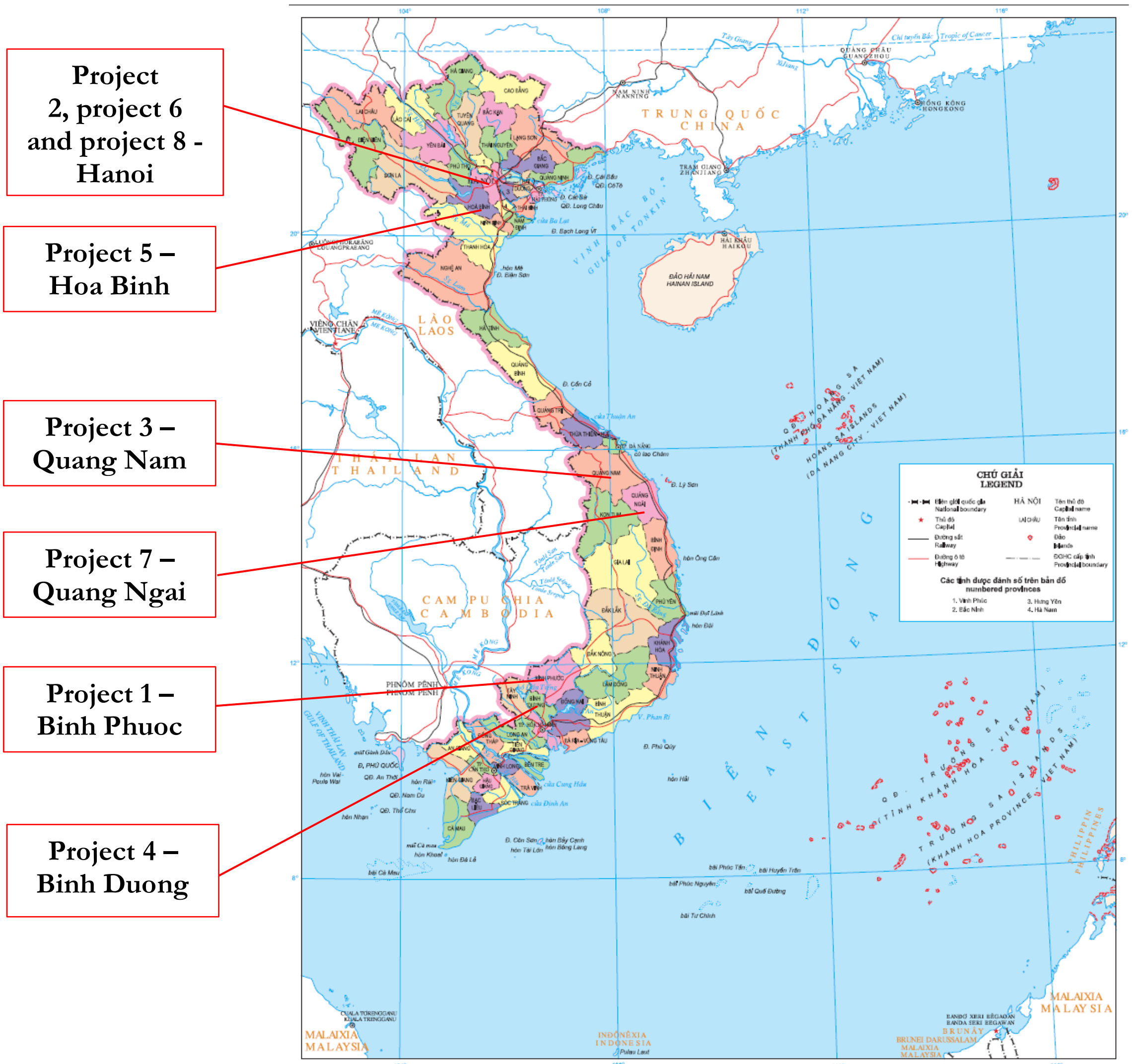

Fig. 2. The location of pilot projects.

2.2. Selection of Research Participants

Eight BIM experts were selected from key stakeholders of each BIM-enabled pilot project in this research. The experts have important roles in the BIM implementation process of each project, as shown in Table 2.

The experts work for highly experienced companies with BIM implementation in Vietnam. The BIM consultant was responsible for assisting and consulting investors on all issues related to BIM implementation throughout the construction project. Their responsibilities include: (1) planning the BIM Execution Plan (BEP), establishing the Employer's Information Requirement (EIR), recommending the Level of development (LoD) that should be applied; (2) proposing BIM standards or guidelines in consideration of the project's characteristics and requirements. By collaborating with designers, the BIM consultant participates directly in developing BIM models to ensure their quality aligns with the project contract's requirements. Furthermore, the BIM consultant works in all stages of a project, from the early stages to the project handover.

Six of eight research participants work for BIM management organisations, as demonstrated in Table 2 - the division represents project investors, pointed at the first step of the BIM-enabled project implementation procedure. A BIM manager acts as the leader of the BIM implementation process and supports the project manager in all BIM-related works. More specifically, a BIM manager works directly with the project manager and as the BIM coordinator for the project (BIM consultants, designers and construction contractors). BIM coordinators work with BIM colleagues to collect data, including both geometric and non-geometric data to develop the project's BIM models and submit them back to the BIM manager after completion. Therefore, the research participants' experiences and report on BIM adoption within the pilot projects are reliable and workable in the Vietnam context.

Table 2. The role & responsibility of the research participants and projects had BIM consultant.

	Projects							
	1	2	3	4	5	6	7	8
Research 'participant's position in the project	Project manager	BIM manager	BIM general manager	BIM coordinator	BIM leaders	BIM manager	BIM leaders	BIM coordinator
Research 'participant's project party	BIM consultan t	Construction contractor	Construction contractor	BIM consultant	BIM consultant	BIM consultant	BIM consultant	Construction contractor
BIM manager pointed for	Design consultan t	Construction contractor	BIM consultant	BIM consultant	BIM consultant	BIM consultant	BIM consultant	Construction contractor
BIM consultant had been hired	✓		✓	✓	✓	✓	✓	

3. Findings

3.1. BIM Implementation Status Quo for the Pilot Projects

BIM has been adopted within the pilot projects with various approach levels, as shown in Table 3. Based on the needs of each project and the requirements of its investors, diverse BIM models have been delivered. Likened to the skeleton of BIM as the foundation for all BIM related activities during a BIM-enabled project's life cycle, the "BIM 3D model development" and "3D coordination" were required and established for all pilot projects. The project stakeholders coordinated the base on a CDE, BEP and strict coordination rules between BIM managers, BIM coordinators and BIM developers of the architecture, structure, MEP or other works. A data access decentralisation system integrated into a CDE enabled project participants to improve their working collaboration. Now, the project team can quickly and effectively address any issues arising during the implementation process, task completion assurance, and shortened project schedule.

Table 3. BIM adoption for the BIM-enabled pilot projects.

BIM adoption	Projects							
	1	2	3	4	5	6	7	8
1. Site existing condition modelling	✓			✓	✓	✓		
2. BIM 3D model development	✓	✓	✓	✓	✓	✓	✓	✓
3. Multidisciplinary Coordination	✓	✓	✓	✓	✓	✓	✓	✓
4. Construction process simulation (BIM 4D model)	✓		✓		✓	✓	✓	
5. Site utilisation planning	✓		✓		✓	✓	✓	
6. As-built model development	✓	✓	✓	✓	✓	✓	✓	
7. BIM model with asset data and maintenance plan (BIM 7D model)		✓	✓			✓	✓	

The BIM model for the as-built task was also implemented in almost all of the pilot projects to ensure a smooth handing-over process. Only project 8 (small scale) did not comply due to a lack of precise BIM model development requirements. Other BIM models such as "Construction process simulation", "Site existing condition modelling" and "Site utilisation planning" were presented (detailed in Table 3). Based on integrated information of the actual construction process and site and neighbourhood, these BIM models enabled construction contractors to control the project progress and construction quality proactively. However, the development cost and time were significant, and as major adoption barriers to small and medium projects and stakeholders. Only four of seven projects were interested in developing BIM as-built models for operating & maintaining the projects' assets.

3.2. Benefits and Challenges of BIM Implementation within the Pilot Projects

The BIM implementation state of the pilot project indicated has differences through various projects' stakeholders (Table 4). In which, "Improving design quality", "Enhancing transparency and performance of Project Management" and "Improving coordination between project stakeholders" were the most recognisable effectiveness of BIM implementation. The other benefits demonstrated less impact, especially "Optimising construction duration" and "Enhancing construction maintenance productivity and performance". This result is comparative when reflecting the state of BIM implementation mentioned above. Therefore, it can be concluded that BIM models created for the project will deliver gains – and ensure model accuracy.

Table 4. BIM adoption benefits were delivered to the eight BIM-enabled pilot projects.

BIM adoption benefits	**Projects**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Improving design quality	✓	✓	✓	✓	✓	✓	✓	✓
2. Optimising construction duration		✓	✓			✓		
3. Optimising construction cost		✓	✓		✓	✓	✓	
4. Optimising construction lifecycle cost	✓		✓	✓	✓	✓	✓	
5. Enhancing transparency and performance of Project Management	✓	✓	✓	✓	✓	✓	✓	✓
6. Improving coordination between project stakeholders	✓	✓	✓	✓	✓	✓	✓	✓
7. Enhancing construction maintenance productivity and performance		✓				✓	✓	

The research participants emphasised that all BIM-enabled projects did not record any tardiness in schedule or cost overrun compared to the initial plan. Project 2, project 3 and project 6 have shortened their construction duration and reduced construction costs by adopting BIM. This evidence demonstrated a great examplar of a BIM-enabled project, especially for mega projects. Notwithstanding, it has not been possible to conclude that the application of BIM helped the pilot projects to achieve their goals in terms of time and cost. Research participants indicate that BIM contributed to ensure the initial project schedule and cost were controlled through preventing conflicts or mistakes before construction. Thus, the construction processes were not interrupted by changes in design or works re-implementation; or un-controlled construction risks.

The research participants noted the significant barriers and challenges to BIM-enabled projects in Vietnam (Table 5). The lack of BIM awareness and knowledge of construction project stakeholders, shortage of BIM investment and the incompatibility of traditional project delivery approach were the three biggest obstacles. Furthermore, all BIM experts agreed that the broad application of the "Design–Bid–Build" method for delivering construction projects drove the "Project implementation approach" barrier as the biggest challenge for BIM implementation. This traditional approach affects the collaboration between designers and construction contractors especially in developing construction design as regulated in Vietnam. The "Shortage of Regulations, Standards or Guidance related to BIM in Vietnam context" was apparent in almost all pilot projects, excluded projects funded by foreign capital. Only two projects escaped this barrier as the investors decided to adopt international regulations, standards or guidance from the beginning.

Table 5. BIM adoption barriers and challenges to the eight BIM-enabled pilot projects.

BIM barriers and Challenges	Projects							
	1	2	3	4	5	6	7	8
1. Awareness and knowledge on BIM implementation	✓	✓	✓	✓	✓	✓	✓	✓
2.Investment on BIM	✓	✓	✓	✓	✓	✓	✓	✓
3. Shortage of Regulations, Standards or Guidance related to BIM in Vietnam context		✓		✓	✓	✓	✓	✓
4. Project implementation approach (Design – Bid – Build)	✓	✓	✓	✓	✓	✓	✓	✓

3.3. BIM Implementation Experiences and Lessons Learned for Construction Project Stakeholders

Emanating from this finding, the pilot projects' stakeholders synergised in confronting with BIM adoption barriers and challenges. They sought for appropriate solutions to deliver BIM-enabled projects successfully. The research participants elicited and recommended several BIM implementation experiences on addressing each barrier and challenge, as follows:

3.3.1. BIM awareness and knowledge

BIM implementation is still at its development stage in the Vietnam AEC industry. The number of studies on BIM adoption within construction projects in Vietnam is small compared to global projects [19]. The existence of BIM training courses have been designed and integrated into several short and long educational programmes of various Higher Education Institutions (HEIs) in Vietnam, but the awareness and knowledge of project stakeholders on BIM remain limited. A large number of practitioners maintained that the idea of BIM is just a designing tool, software or a digital model; while many acknowledged that BIM is not just a designing tool but a system to manage projects throughout their life cycle.

3.3.2. BIM investment

The high investment expenses required for BIM infrastructure (hardware and software), BIM skills (modelling and collaborating) but uncertain Return on investments (ROI) is a significant disadvantage of BIM implementation. In the private sector, progressive large construction and consultant companies adopted BIM widely due to the high demand for optimising the time and cost of delivering construction projects [15].

The role of the government in the advocacy and adoption of innovative technology is significant in the integration to BIM's successful implementation in the AEC industry [21]. The aid from the Vietnam government on BIM investment to pilot projects of the decision no 362/QD-BXD is an example of how the government could assist in this process. However, this solution will take time to spread throughout the industry. Hiring a BIM consultant to perform BIM activities is also an acceptable solution, but only in the short-term for large stakeholders or long-term for small-sized and medium-sized ones - as many could not afford high BIM investment expenses. Looking ahead, the BIM ROI for the large AEC firms will be endorsed and be persuasive if the demand for BIM services increases. Consequently, these firms should have a BIM investment schema to take the initiative and security for their activities.

3.3.3. BIM regulations, standards and guidance

Decision No. 1057/QD-BXD is the only legal BIM implementation guidance document was published in Vietnam and was followed by all pilot projects (Table 6). This document provided initial guidance for establishing contracts' agreements related to BIM, estimating expenses for developing BIM models, benchmarking the LoD of BIM implementation and developing the BEP. An introduction and overview of the CDE and EIR are contributions to decision No. 1057/QD-BXD. It also provided legal references for naming documents in the CDE of all construction projects. The decision only introduced preliminary characteristics and general structures of CDE, but ignored the detailed information exchange process within CDE, methods of responsibility decentralisation and coding of work, etc. The guideline of the decision on the EIR development is not proportional to the document's significant role. Despite these limitations, it cannot be denied that this decision provided essential concepts and instructions relevant to BIM in the local language and provided vital supports to projects with Vietnamese as the only language.

Table 6. References and standards adopted in the BIM-enabled pilot projects.

References and standards	Projects 1	2	3	4	5	6	7	8
Decision no 1057/QD-BXD – Vietnam	✓	✓	✓	✓	✓	✓	✓	✓
Singapore BIM guide	✓							
BIM Standards - the United Kingdom			✓	✓	✓	✓		
Infra-BIM – BIM standards of Finland							✓	
BrIM- BIM standards of The United States							✓	

4. Discussion

The barriers and challenges to BIM implementation within pilot construction projects demonstrated similar underlying issues that need to be addressed by the industry in Vietnam by both the government and private sector. More specifically, the lack of awareness (of the added value from applying BIM achieved by the project and construction firms) and knowledge on BIM technology of the project's parties (Investors, designers or construction contractors and governance officers) will restrain the amount of BIM investment into the industry. As a consequence of the delay in BIM investment, the non-fully compliant BIM infrastructure and non-up-skilling BIM human resources were the two main reasons for lowering the competitiveness of construction projects' parties. The stakeholders' dependence on Vietnamese BIM regulations and guidance to perform BIM-enabled projects is also an indirect consequence of incomplete BIM knowledge. The insufficiency of BIM regulations, guidelines, and standards in the Vietnam context significantly affects BIM's knowledge and awareness of all parties in the AEC industry.

Other difficulties in integrating and controlling input and output construction data due to incomplete the EIR, defining roles and responsibilities of the BIM model development task. Nevertheless, these were considered minor issues that could be quickly addressed if the aforementioned significant challenges were resolved.

The issues of BIM awareness and knowledge have been addressed through various BIM human resource development projects funded by both domestic grants and foreign aid grants [20]. The stakeholders of the BIM-enabled pilot projects, especially those mentioned in the decision no 362/QD-BXD, had improved BIM awareness and knowledge in these projects. The BIM consultant was hired in selected pilot projects, though some of the project stakeholders already existing BIM experiments. This decision is one way of enhancing BIM knowledge for all project stakeholders by leveraging BIM consultant BIM experts. Thus, it is visible that enhancing BIM awareness and knowledge of construction project parties is not an impossible mission. Project parties have to be active in searching for suitable training courses available online and offline, sometimes free of charge, and organise their work routine to fit with the training timetable.

To address the lack of BIM regulations, standards, and guidance, BIM consultants proposed using international standards or guidelines, such as the Singapore BIM guide, Finnish Infra-BIM, United Kingdom BIM Standards, and United States BIM standards (Table 6). Their adoption has filled the gap of the decision No.1057/QD-BXD in terms of a) specific BIM standards for each type of construction works; b) the coding system for each work item to create an input database for BIM models. Despite applying several foreign BIM standards and guidelines, there were some difficulties for BIM developers especially in the classification system for construction work items or the lack of localisation of item names or codes to assign information into BIM models. There is a local context to be adhered to – as international documents were not suitable for the Vietnamese context. Therefore, the local authorities still need to consider enacting national BIM regulations, standards, and guidance in the future.

5. Conclusion

This paper focused on investigating BIM implementation experiences through report submissions and interviewing BIM experts within the eight BIM-enabled pilot projects across the North, the Middle, and the South of Vietnam. These projects were diverse in grades (from grade 1 to grade 3), and types (such as civil works, infrastructure works, agriculture construction works and complex works). They were invested by various capital sources (State capital, private capital and foreign capital). Most of the selected projects have completed their construction process and been under the operation phase.

This paper specified and indicated various significant BIM benefits, barriers and challenges for adopting BIM, according to implementation status within BIM-enabled pilot projects in Vietnam. The valuable solutions and recommendations for promoting the uptake of BIM in Vietnam were novel contributions of the research. The study result is expected to contribute towards solutions on how to implement BIM within construction projects successfully within the Vietnam context for policy-makers, local authorities, design consultants and construction firms, and other key stakeholders. Leveraging BIM implementation experiences, the improvement of BIM diffusion in the Vietnam AEC industry might be within touching distance in the foreseeable future.

This research highlighted the lessons learnt in BIM diffusion around BIM awareness and knowledge, BIM investment and BIM regulations, standards and guidance – some limitations remain. Only eight pilot projects were investigated among several BIM-enabled projects, and this research only concentrated on significant barriers and challenges of BIM implementation but not yet studied thoroughly on solutions for all the obstacles.

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Quynh To Thi Huong was born in Thai Binh province, Vietnam in 1986. She received the B.Sc. in 2009 and M.Sc. degrees in 2011 in construction economics from the National University of Civil Engineering (NUCE), Hanoi, Vietnam and the Ph.D. degree in civil engineering from Lille University, Lille, France, in 2019.

From 2010 to 2015, she was a lecturer at the Faculty of Construction Economics and Management, NUCE. From 2015 to 2019, she was a PhD student and a member of Sunrise smart city research team in the Civil and geo-Environmental Laboratory, Lille University, France. She is the co-author of one book and 4 articles. Since 2019, she has been a lecturer at the Faculty of Construction Economics and Management, NUCE Her research interests include Building Information Modelling and smart asset management in the building's operation and maintenance phases.

Eric C.W. Lou obtained his degree in Computer Science (Universiti Teknologi Malaysia), and MSc in IT Management in Construction with Distinction (University of Salford, UK). After spending time in practice, he then completed his PhD part-time in E-Readiness in Construction at the University of Salford, UK. Dr Lou's research interest encompasses the trichotomy of people-process-technology in the areas of project management, sustainability and environmental planning, corporate responsibility, BIM and IT management within the built environment industry.

He spent a decade in construction, higher education, information technology and environmental industries; and completed over £60 million in building refurbishment and new build projects before joining academia. He was previously the School Director of Internationalisation and Lecturer in Project Management at the University of Manchester. He joined Manchester Metropolitan University in March 2018 as a Reader in Project Management and Department International Lead.

Dr Lou is a passionate academic and researcher with enthusiasm towards internationalisation of his work and service. Dr Lou's research is internationally recognised through his success in Newton Fund, British Council and Royal Academy of Engineering grants and journal publications with partners globally.

Nam Le Hoai was born in Nam Dinh city, Hanoi, Vietnam in 1990. He received the B.Sc. degree in construction economics from the National University of Civil Engineering, Hanoi, Vietnam, in 2013 and the M.Sc. degree in construction management from National Taiwan University, Taipei, Taiwan, in 2015.

Since 2013, he has been a lecturer with the Faculty of Construction Economics and Management, National University of Civil Engineering, Hanoi, Vietnam. He is the co-author of a book and 10 articles. His research interests include Building Information Modelling and facility management in the building's operation and maintenance phases.