BIM technology implementation in Vietnam: an institutional perspective on a bridge project

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BIM technology implementation in Vietnam: an institutional perspective on a bridge project

Completed Research Paper

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Abstract

Many of today’s building designs are created based on three-dimensional modelling technology. Architects and engineers use so-called Building Information Modelling (BIM) systems for creating digital representation all physical assets of a building. Using these systems has proven effective for improving designs and the process of construction. Inspired by the improvements in building construction projects, a Vietnamese construction project team decided to use the system to model a large-scale bridge crossing the Saigon River in Ho Chi Minh City, Vietnam. This paper provides an understanding of what motivated the team to deploy BIM in this new industrial context which is very different from building construction. To explain this, the influence of institutional pressures was analyzed. The findings revealed how institutional pressures influence the project team to overcome BIM hurdles for successful implementation. Furthermore, this qualitative case study presents an example for other infrastructure projects which also target BIM as an objective.

Keywords: Building information modelling, institutional pressures, infrastructure, developing country

Introduction

Building Information Modelling (BIM) systems are viewed as technology capable of transforming design and construction processes, ultimately resulting in better quality of buildings (Azhar 2011; Bryde et al. 2013). A BIM system is a “shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from the inception onward” (National BIM standard - United States 2015). There is a large consensus that BIM will be an essential cornerstone for digitalizing and modernizing the architecture, engineering, and construction industry. However, there are also scholars challenging these great visions pointing out the challenges of implementation and limitations of the technology (Dainty et al. 2015; Vass and Gustavsson 2017).

It has been argued that BIM practices are so far limited to large and highly information technology (IT) - literate firms able to capitalize from using BIM technology (Hosseini et al. 2016). Others find that BIM is foremost used in building construction projects with other parts of the sector, like transportation being left behind (Dongmo-Engeland and Merschbrock 2016). In addition, developing countries are known to face large knowledge gaps and having only limited and occasional technological innovation which leaves their construction sectors to miss out on BIM (Bui et al. 2016). This resembles what has been reported for healthcare systems, the internet and e-procurement systems which all prove difficult to implement in developing economies (Adams 2004; Anaman and Osei-Amponsah 2007).

Considering that an effective construction industry is a key driver of economic growth in developing countries then studying how BIM can be implemented in this context is worthwhile (Giang and Pheng 2011). There are some encouraging recent developments in Asia where several developing countries like China, India, Malaysia have accumulated experience from working based on BIM (Bui et al. 2016;
Ismail et al. (2017). In addition to the inherent challenges of information and technology (ICT) implementations in a developing country context, BIM implementations are generally of a complex nature. BIM involves shared information space technology used for collaborative digital design work across several organizations. This paper sets out to explore challenges and opportunities of BIM implementation in a developing country construction context. Institutional theory was adopted to understand how BIM emerges, diffuses, and sometimes vanishes in the project (Colyvas and Jonsson 2011; Mignerat and Rivard 2009). The research focus is how institutional effects shape the organizational behavior in BIM implementation. The research question asked in this paper is: What are important factors explaining the emergence and institutionalization of BIM in a developing country construction context?

The research question is answered by conducting a case study of the Thu Thiem 2 Bridge project in Ho-Chi-Minh-City Vietnam. This project constitutes Vietnam’s first BIM implementation in a transportation project. The project can be viewed as successful since the design team was awarded an international prize for its BIM work (Tekla 2017). The practical contribution is providing an example for other project teams elsewhere wanting to implement BIM technology in their transportation projects. Beyond the aforementioned, this paper contributes to the information systems for development literature by studying how BIM can be institutionalized and thereby make construction firms in a development context more efficient. Further, BIM work was enabled by a collaboration of companies from both developed and developing countries where mutual learning enabled BIM work. Data were collected through semi-structured interviews with eleven BIM subject matter experts working in the project and by assessing project documentation.

The next section explains the IT artefact placed at the core of our study and the local Vietnamese context. Then it is explicated how institutional theory was used in this paper. This is followed by a presentation of the research method. The following sections include the findings and discussion which provide insights from the data through the institutional lens and relate the research outcomes to previous studies. Finally, the conclusion section summarizes key findings and the agenda for further research.

Industrial context

In Vietnam, several major consultant companies have begun using BIM systems (e.g. Hoa Binh Corporation, Contrexim, VNCC, Polysius Vietnam) (Tran et al. 2014). However, it appears as if modelling would be foremost used within the individual disciplines and there are few projects with significant model-based interchanges between the different firms and disciplines (ibid.). Thus, when viewed through the “BIM capability maturity index”, the Vietnamese industry would seem to have several firms operating at stage 1 maturity where only minor process changes have occurred and contractual relations, risk allocations and organizational behavior persist (Succar 2009). Tran et al. (2014) wrote their article about the state of BIM in Vietnam at same time when the case study of this paper started up, but there have surely been some recent developments and advancements in the country which are not accounted for in the article.

An example of a more recent development is that the Vietnamese software vendor “Harmony Soft” started making add-on packages for mainstream BIM software to include local Vietnamese building components in the models reflecting the national building culture. Another recent development is that local researchers from the national University of Construction (An T. H. Le) and the Institute of Construction Economics (Hung V. Nguyen, Binh N. Binh, and Mai H. Tran) have begun focusing on BIM. These two institutions partnered up to organize several BIM seminars increasing BIM awareness in the country. Through these seminars, government agencies, research institutes, universities, and construction practitioners in Vietnam update themselves on ongoing trends and good practices in BIM (ibid.).

Tran et al. (2014) state that BIM implementation in Vietnam is in its infancy and there exist a range of challenges. The challenges include a lack of requirements from authorities, high investment costs, lack of skillful personnel, and a lack of BIM training. The fact that there are substantial challenges corroborates extant research and it would appear that these types of challenges do not really disappear even though a country has advanced it BIM work (Bosch-Sijtsema et al. 2017b). To address some of
the challenges and to strengthen BIM implementation the Institute for Construction Economics suggested a BIM roadmap from 2015 to 2020. The government actively uses this roadmap for promoting BIM use in their projects (ibid).

In December 2016 the Vietnamese government approved the BIM adoption plan (Vietnam BIM Steering Committee 2017). According to this plan, the government decided to undertake BIM pilot projects in the 2018-2020 timespan. The pilot period includes a minimum of 20 projects in design and construction phases, as well as 10 others in the operation phase (ibid.). The latest development in this area is that a national BIM steering committee was formed in March 2017 for putting in-place BIM implementation strategies and to advocate BIM use (ibid.). Activities for this committee include the introduction of an online information portal and to coordinate and guide government agencies in their BIM implementations. The Vietnamese government aims to apply BIM in all its public projects from 2021 (ibid.).

Theoretical lens

This paper aims to understand the institutional effects in making the Thu Thiem 2 Bridge project team succeed in their BIM implementation. In the IS literature, scholars have used institutional theory to examine innovation adoption phenomenon in organizations. In 2009, Mignerat and Rivard (2009) identified and reviewed 53 articles published in 20 IS outlets all using institutional theory. These articles focus on both institutional effects and institutionalization of innovations (Mignerat and Rivard 2009). While institutionalization mentions different formation stages of institutions, institutional effects refer to the influences from the external environment on a specific organization (ibid.). In a similar review, Weerakkody et al. (2009) examined 210 different peer-reviewed journals and found 511 articles from 1978 to 2008 with institutional theory use. Among those scholarly works, 28 articles used institutional effects as a central analytic tool in IS studies. These IS articles were classified into three general themes related to IT which are innovation (1), development and implementation (2), and adoption and use (3).

<table>
<thead>
<tr>
<th>Table 1. Three pillars of institutions (Scott 2014, p. 60)</th>
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<tbody>
<tr>
<td><strong>Basis of compliance</strong></td>
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<tr>
<td><strong>Mechanism</strong></td>
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<tr>
<td><strong>Logic</strong></td>
</tr>
<tr>
<td><strong>Indicators</strong></td>
</tr>
<tr>
<td><strong>Basis of legitimacy</strong></td>
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</tbody>
</table>

Institutional theory supports researchers to explain organizational change in the innovation adoption process (Colyvas and Jonsson 2011). Organizational change happens because organizations seek for appropriate acceptance within some socially constructed systems (Scott 2014). Institutionals study an organization in its environment which consists of the relationship between that organization and other related ones (ibid.). The analytic framework of institutional theory consists of three pillars as can be seen in Table 1 (ibid.). Regarding institutional effects, the three pillars present the mechanism forming institutions through institutional pressures which are coercive, normative, and mimetic pressures (ibid.). Coercive pressures relate to explicit regulatory processes which are mandatory to organizations (Dimaggio and Powell 1983). Normative pressures derive from professionalization such as inter-organization networks, similar educational background, and mimetic behaviors in a profession (ibid.). Mimetic pressures are about following practices of other organizations which are perceived more successful (ibid.). Construction project teams work in a network of related organizations such as clients, administrative agencies, other similar project teams, etc. These related organizations exert different types of influence on project teams. The construction project environment is similar to that described in institutional theory. Together with the explanatory power of the theory, this similarity
makes institutional theory an appropriate lens to understand a project team’s behavior. In brief, this paper uses institutional theory to analyze BIM implementation in the Thu Thiem 2 Bridge project case study. The three pillars of institutions in Table 1 are the framework for analysis.

**Methodology**

*Case description*

![Figure 1. Thu Thiem Bridge, Ho-Chi Minh City, Vietnam [Courtesy TEDI South]](image)

The setting of our case study is a large infrastructure construction project in Vietnam. The 1473-metre-long bridge is one of five connections crossing the Saigon River in the center of Ho Chi Minh City. The cable-stayed bridge is set to become a landmark in the region with its pylon rising to 111-metres above water level. The bridge, linking the “Thu Thiem” district to the old city center, features six traffic lanes and two pedestrian walkways on either side of the bridge deck. In 2008, the Ho Chi Minh city council (HCMC) allocated €80 million for the project allowing it to go ahead. Once the land acquisition was enough to start the implementation in February 2015, the private corporation Dai Quang Minh (DQMC) was appointed to oversee the design and construction activities of the bridge. A part of the agreement was to deploy BIM technology throughout the design and execution (Tuoi Tre Newspaper 2015). DQMC has played the client role since the agreement signing. The city’s intention was to embrace BIM use following a wider national strategy seeking to increase digitalization in the Vietnamese construction industry. An example of the BIM models used in the project can be found in Figure 1. Besides the request from the city, DQMC has to comply with national construction regulations monitored by relevant authorities such as the city Department of Transportation, the Ministry of Construction, the Ministry of Transportation, the Institute of Construction Economics, etc.

A Finnish consultancy (WSP Finland Oy) was appointed to work alongside the local consultant (TEDI South) to deliver the engineering design of the bridge. The Finnish engineers had a track record of working with BIM software in their projects. Finland is renowned for its highly digitalized construction sector delivering its first BIM projects nearly twenty years ago (Kam et al. 2003). However, BIM use in infrastructure projects is only a recent development in Finland, too (Bradley et al. 2016; Kivimäki and Heikkilä 2015). Although TEDI South is a leading infrastructure consultancy in Vietnam, they had no prior experience from working based on the technology. Thus, the Finnish engineers supported their local counterpart in their BIM work. In turn, the Vietnamese consultant made sure local regulations were followed and that the project was delivered smoothly. The BIM vendors supplying the software and IT-support were from Finland, Viasys VDC and Tekla companies.

The Thu Thiem 2 Bridge project was selected for several reasons. First, this case constitutes Vietnam’s first BIM technology implementation in an infrastructure project. Following from this, the institutional context of BIM software implementations in Vietnam is little understood. Second, this project is also viewed as internationally leading, signified by the team winning the international Tekla BIM Awards.
2017. This indicates that studying this advanced practice may yield important insight for companies elsewhere, too. Moreover, the international collaboration in this project seems to have worked well, with the Finish consultants being named “creative company of the year” by the Embassy of Finland in Hanoi for their contribution to the Finnish Vietnamese relations. Last, the experiences made by the local engineers are likely to shape the development of Vietnam’s national BIM standard for infrastructure.

The interview guide was prepared based on institutional theory with a focus on the pillars of institutions similar to what has been suggested by Scott in his work on institutions and organizations (Scott 2014). The interviewees went through seventeen open-ended questions allowing them to share their experiences from the BIM-based work. The opening questions aimed at learning about their professional background and role in the project. The following three thematic areas were designed to capture the regulative, normative, and cognitive elements experienced in BIM work (ibid.). The questions captured how institutional pressures manifested in day-to-day project activities (experience sharing, training…), work-materials (certificates, standards, models, procedural guidance…), and in the actors’ information sources related to BIM. The interviews concluded by asking the engineers for what they would view as the principal elements inspiring them to work based on the BIM technology. In addition to the interviews, a range of BIM-related project documents informed this paper. This includes the written investment decision, BIM guidelines, training materials, meeting protocols, a simulation model of the project, and materials presented online.

Table 2. List of informants

<table>
<thead>
<tr>
<th>#</th>
<th>Position</th>
<th>Organization</th>
<th>Discipline</th>
<th>Experience (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Technical manager</td>
<td>Dai Quang Minh Corp.</td>
<td>Structure</td>
<td>10-15</td>
</tr>
<tr>
<td>2</td>
<td>Project Director</td>
<td>Dai Quang Minh Corp.</td>
<td>Management</td>
<td>15-20</td>
</tr>
<tr>
<td>3</td>
<td>Project manager 1*</td>
<td>TEDI South</td>
<td>Management</td>
<td>15-20</td>
</tr>
<tr>
<td>4</td>
<td>Bridge engineer 1</td>
<td>TEDI South</td>
<td>Structure</td>
<td>5-10</td>
</tr>
<tr>
<td>5</td>
<td>Bridge engineer 2</td>
<td>TEDI South</td>
<td>Structure</td>
<td>0-5</td>
</tr>
<tr>
<td>6</td>
<td>Survey Engineer 1</td>
<td>TEDI South</td>
<td>Geology</td>
<td>+20</td>
</tr>
<tr>
<td>7</td>
<td>Survey Engineer 2</td>
<td>TEDI South</td>
<td>Geology</td>
<td>+20</td>
</tr>
<tr>
<td>8</td>
<td>BIM coordinator 2</td>
<td>Viasys VDC</td>
<td>Structure</td>
<td>0-5</td>
</tr>
<tr>
<td>9</td>
<td>BIM coordinator 3f</td>
<td>WSP Finland</td>
<td>Management</td>
<td>10-15</td>
</tr>
<tr>
<td>10</td>
<td>Technical manager 2</td>
<td>WSP Finland</td>
<td>Structure</td>
<td>15-20</td>
</tr>
<tr>
<td>11</td>
<td>Project manager 2**</td>
<td>WSP Finland</td>
<td>Management</td>
<td>+20</td>
</tr>
</tbody>
</table>

* project level BIM coordinator; ** project level BIM manager; f: foreign engineer

The data collection started in May 2017 by contacting the director of Viasys VDC Vietnam, the software vendor that provides programs for virtual design in the project. At this point in time, the design had been underway for two years. Following this initial contact, a letter of intent was sent to the project director who consented to the research being conducted. The first interview with WSP Finland’s project manager took place at the end of June 2017. WSP’s manager who oversaw the design work on the project pointed us to the key actors performing managerial, coordinating, and modelling tasks with BIM. From June to July 2017, a total of eleven interviews with the design team members responsible for implementing BIM were conducted and recorded. Then, the recorded interviews were transcribed and analyzed based on concepts important in institutional theory. An overview of the interviewees, their positions, professional discipline, and construction work experience can be found in Table 2.

As can be seen, most interviewees have extensive experience in bridge construction. Only one bridge engineer and one BIM coordinator had less than 5 years of experience. However, these two engineers possessed strong BIM modelling skills. Other Vietnamese or local engineers had just explored modelling programs in a few months before the project started. The interviewees consisted of two foreign and nine local engineers. While the foreign engineers only work for WSP Finland, the local or Vietnamese engineers are the voices of the client, the WSP Finland office in Ho Chi Minh City, TEDI.
South and Viasys VDC. The interviewees’ strong professional backgrounds allowed them to reflect both on traditional practices and emergent BIM use.

Findings

The framework used in the analysis follows Scott’s three pillars of institutions which allow classifying the data into mimetic, coercive and normative pressures. The analysis identified three main barriers to BIM implementation, exerting coercive power on the project team. Also, this section describes the effort of the project team to overcome these barriers.

Regulative pillar

BIM implementation happened only after the relevant authorities triggered the innovation. However, the project members commented that they had to deal with three main barriers during the process. These barriers were the paper-based tradition, cost estimate regulation, and the technology capacity.

First, construction authorities only accept paper-based drawings for approval. This requirement applies to all projects in Vietnam. The project director found no exception for approval of a 3D model. He agreed that the use of 3D models or electronic files was more convenient for construction processes, but the government had no guidance on e-materials. Thus, the authorities had to request hard copies for submission. “The Ministry of Transportation agencies always want to see physical signatures and stamps in all submissions”, survey engineer 1 added. The paper-based tradition also influenced the design sequence of TEDI South in the project. Instead of beginning with the 3D model, the local consultant prepared their design on paper first. Then, they produced the 3D model based on the 2D design to meet the requirements in the engineering contract with the client. In that way, TEDI South could satisfy the local requirements and the deadline. Since this project was the first BIM experience, the TEDI South project manager was afraid that the local consultant was unable to complete their assignment on time while learning the new technology. For WSP Finland, it was an unusual practice. After finished the 3D model successfully, WSP Finland team had to prepare 2D drawings for submission. It seemed they had to “go 100% back [to paper-based] to finalize the design”, stated by BIM coordinator 3. Since the drawings must comply with the construction regulations and the software was unable to export these accordingly, the WSP Finland team manually modified the drawings exported from the 3D model. This modification consumed a large amount of time. When the authorities requested for changes, the WSP Finland team updated the model first; then, the drawings’ modifications followed. The consultant team perceived the 3D model for TEDI South and 2D drawings for WSP Finland as the extra tasks they had to do for adopting BIM in the project.

Second, the regulations for cost estimate have no item for applying new technologies. It meant the state budget would refuse to pay for such items. Thus, clients focused on the total cost more than innovations. They only wanted the construction with the cost as low as possible. Since the Thu Thiem 2 Bridge belongs to Ho Chi Minh City, the bridge was a state project and the construction has to strictly follow the cost estimate regulations. According to the project director, it was difficult to register software licenses and computers as cost items in the project because the consultants could use those ICT tools in various projects. Thus, it was unreasonable to depreciate the whole investment amount in one project. On the other hand, the consultant could increase their fee a little if they use new technology, but no extra point for innovation was given in the bidding process. According to the Technical manager 2, consultants or contractors could use the project budget for software licenses and computers, but they must hand over such items to the client after the project completion. It was an asset management regulation. Unfortunately, some projects might last for several years. After the implementation duration, the software and computers might be outdated. Thus, the client would be unwilling to receive them. Even when BIM could show proven benefits, the project director insisted “the cost has to be approved”. A decision from a higher level of authority is necessary in this case.

Third, the technology capacity of the Vietnamese construction companies is another barrier. The local consultant team recognized that their company had to invest in staff training, software licenses, computer system upgrading and preparing a new working process to implement BIM. This could be a long process with a lot of efforts. Thus, the management board seemed reluctant to BIM adoption and
just encouraged staff to upgrade knowledge themselves. After the engineering contract was signed, TEDI South had more motivation, also had to deliver a 3D model. They used a part of the contract money to buy software licenses, request staff to join training days with external lecturers, and allowed to try different BIM programs in the working hours. Before the contract signing, interviewees from TEDI South commented that they were busy with other projects and had little time to learn about BIM. From the client side, the project director noted that other parties such as the contractors, government agencies, etc., should also implement BIM. In that way, the project could have most benefits from BIM.

In addition, BIM implementation happened only after the HCMC stated officially in the build-transfer agreement with DQMC. However, the decision to apply BIM seemed influenced by the Institute of Construction Economics’ consent. In the beginning, not all authorities agreed with the proposal, but consent from the higher authority level was more important. In this case, the Department of Transportation, the HCMC agency for infrastructure refused the proposed estimate for BIM but the Institute of Construction Economics agreed. This consent was given in approximately two years before the Vietnamese government officially approved the national BIM adoption plan in December 2016. It meant the Institute of Construction Economics perceived no coercive pressure for BIM at that time. HCMC decided based on the Institute of Construction Economics’ comment. The reason for why the Institute of Construction Economics recommended BIM use will be further discussed in the mimetic pillar section.

Regarding the BIM expectation from the client side, the project members had different opinions. The WSP Finland team were surprised because the client showed no demand for BIM. The project manager 2 understood that “the client didn’t know what to do [with BIM] so they often agreed with what we [the consultant] proposed”. The project director explained that he considered cost as the most important criterion. In addition, the technical manager admitted that his team had no experience with BIM. Thus, the client team was unable to prepare requirements and monitor BIM implementation. Regarding BIM implementation, the consultant team felt the large part of coercive pressures from the Institute of Construction Economics to showcase innovation benefits in the Vietnam context.

At the company level, the demand for BIM expertise was low. The members could join the project team without any advanced knowledge of BIM. No partners set formal recruitment requests such as BIM certificates or experience. Indeed, DQMC, WSP Finland, and TEDI South only encouraged their employees to explore software and BIM on a self-study basis. BIM implementation relied solely on the Finish team. From TEDI South’s side, the survey engineer 1 noted that “the management board only requested us to master the program for which the company has licenses and the board preferred more projects to adopting new technologies”. With DQMC, the project had a temporary basis. Members and technologies might be different from project to project. Moreover, HCMC would receive the bridge after the implementation in about three years. Thus, DQMC were unable to have the benefits from BIM in the long term. It led to low motivation for BIM adoption from the client. In this context, the local project members obtained BIM knowledge from seminars, conferences, and online channels. This environment which provided trends and status on BIM applications exposed them to normative pressures. The following part uncovers the effects of mimetic pressures in the Thu Thiem 2 Bridge project.

**Normative pillar**

The local project members from TEDI South and the WSP office in Ho Chi Minh City had the desire to follow modern trends in construction, resulting from normative pressures from the information sources and the competitive environment. This desire became another motivation to implement BIM at work without the management board’s request. Thus, BIM implementation could remain in their companies in the long run. “Eventually, BIM, building information modelling, is a piece of digitalization progress in building industry” (project manager 2).

In fact, the local project members knew about BIM through short courses, formal education, seminars, conferences, and online channels. The local modelling team prepared themselves in advance by attending short courses on modelling programs. After the project started, TEDI South also organized similar courses for their employees, including the Thu Thiem 2 Bridge project team. The courses
demonstrated new capacities of modelling programs and introduced new trends in BIM technology. However, bridge engineer 1 commented that those courses were ineffective because most of the tutors were from academic institutions and had little practical bridge modelling experience. The knowledge from these courses was unable to solve modelling issues in the Thu Thiem 2 Bridge project. Thus, they had to search for solutions in online channels such as Youtube and Autodesk Community. Furthermore, conferences and seminars on BIM application outside of the project were another information source. In addition, The WSP Finland project manager had completed his master thesis on BIM in 2014. The fresh knowledge he got provided the latest trends to the local engineers through internal project training. The WSP Finland project manager also led the expectations for BIM use in the project. Referring to the BIM levels in the United Kingdom (British Standards Institute 2013) as a measurement, he directed the Thu Thiem 2 Bridge project from zero to level 3. In the later phases, he expected to combine all digitized project information in the model. The short courses and these information sources provided new capacities of software and new trends in construction. The more the local project members knew about BIM, the more they wanted to update their knowledge. They wanted to match with the level of BIM practitioners in other developed countries such as the United Kingdom, the United States, Singapore, and Finland. This motivation encouraged them to implement BIM. “If you are a consultant, you must lead the market in terms of technology” (survey engineer 1).

The competition in the Vietnamese construction market was another pressure to apply BIM. The WSP Finland project manager noted that his company wanted BIM experience in Vietnam to compete with other international consultants in the future. Regarding the local companies, the TEDI South team knew that other companies were trying to adopt BIM. They mentioned Hung Nghiep, VTCO, and TEDI Hanoi as the companies which were applying BIM. However, they had no discussion and information about the status of BIM implementation in these companies. On a personal view, the survey engineer 1 insisted that “an engineer needs both engineering and modelling skills”. With only the engineering skill, an engineer needs other people to prepare the model. With only the modelling skill, he might not be confident of his work. Thus, if they had no BIM skill, they might be outdated soon. Besides, the local team understood that the Ministry of Construction would prepare regulations for BIM implementation based on pilot projects including the Thu Thiem 2 Bridge. These regulations could be mandatory for the whole industry in a few years. They supposed that other companies were preparing well for this future and were afraid of losing their competitive advantage. Although all local members believed that Vietnam would adopt BIM, most of them presumed that the adoption would take five to ten years. This guess was much longer than that of the government plan which set 2021 as the milestone to apply BIM countrywide.

Cultural – cognitive pillar

Sharing of good practices was the proof of mimetic pressures in the project. Since mimetic pressures influenced related parties and project members, those pressures assisted the project team to overcome the strict regulations on construction cost and gradually change from paper-based to model-based design process.

Figure 2. A seminar on BIM use in the Thu Thiem 2 Bridge project
Regarding the cost regulation, the project director mentioned that the authorities had to approve the cost, but no one in Vietnam had experience with BIM in a bridge project before. Thus, it was difficult to prepare and approve the estimated expense. In the Thu Thiem 2 Bridge project, WSP Finland was the only partner who had competence and experience in BIM implementation. Since 2012, the Finish Company started to approach the Ministry of Construction, the Ministry of Transportation, the Institute of Construction Economics, the Department of Transportation, and other relevant authorities by organizing BIM seminars. In these seminars, the WSP Finland project manager presented case studies in the United States and Finland to introduce the benefits of BIM. The authorities saw the potentials and wanted to achieve such advances. Thus, the Ministry of Construction prepared a program for pilot BIM projects in Vietnam. In 2014, WSP Finland prepared the estimated cost for BIM as a design task in the Thu Thiem 2 Bridge project. The BIM implementation cost increased the total design fee with 10%. HCMC was about to decline the proposal. Fortunately, the Institute of Construction Economics, the Ministry of Construction’s agency in charge of construction economics, agreed with the proposal because it supported the Ministry of Construction’s pilot program. The Institute of Construction Economics expected evidence of BIM benefits in Vietnam from the Thu Thiem 2 Bridge project. With the Institute of Construction Economics consent, HCMC formally requested to apply BIM in the project. Thus, the project team could implement BIM in the project from the beginning of 2015. It is noticed that the government approved the pilot program in the BIM adoption plan in 2016 (The Prime Minister Office 2016). There was no coercive pressure when the Institute of Construction Economics regarding BIM implementation in the Thu Thiem 2 Bridge project. In this process, WSP Finland placed mimetic pressures on the relevant authorities to remove the traditional barrier of the cost estimate. In particular, WSP Finland had the approval for BIM implementation from presenting benefits of BIM to the relevant authorities. This indicated that the mimetic pressures turned into coercive ones. During the design phase, the project team has showcased the BIM use in the Thu Thiem 2 Bridge project through seminars. In these seminars, the project team invited representative from the Institute of Construction Economics, the Department of Transportation, and other relevant authorities. This communication channel maintained mimetic pressures on the authorities which held coercive powers in the project. Figure 2 illustrates one of these seminars.

Mimetic pressures also encouraged the local team to gradually change the design process of the local consultant. Through the partnership with WSP Finland, TEDI South has received on-the-job training and seminars from their partner. This cooperation helped to increase BIM knowledge and skills for Vietnamese engineers. In this project, the experts from WSP Finland guided TEDI South’s engineers to follow the BIM execution plan as well as to prepare the model. WSP Finland also introduced typical BIM projects to the local consultant team. Since the project had a tight deadline, TEDI South decided to prepare the traditional 2D drawings for submission. Then, they created the 3D model from the 2D design and used it for reference. They felt that they were not ready for BIM in the Thu Thiem 2 Bridge project. Their purpose in the project was studying how to use BIM rather than making the best use of the new technology. However, as far as TEDI South knew how to use BIM, they utilized the 3D model to identify clashes in the paper drawings. When the 3D modelling team found clashes, they checked and modified the drawings. “The 3D model helped us to identify so many mistakes and clashes in the drawings, especially complicated structures”, bridge engineer 2 said. As can be seen in Figure 3, the steel bar placement, the pipes, the anchors, and other structure component were merged into the 3D model. The design team used this simulation to detect clashes among the components and adjusted the design accordingly. In the traditional procedure, a senior engineer would review all papers based on his experience. However, many clashes remained until the implementation. Bridge engineer 1 added that “sometimes we don’t know how the contractor can build from the paper drawings, some parts are almost impossible to imagine”. With the 3D model, the local design team seemed more confident with their product. The TEDI South project manager informed that the management board planned to change from 2D to 3D design with future projects of the company. The experience of the local design team in the Thu Thiem 2 Bridge project was important in this process. It implies the mimetic effects which made TEDI South modify their design process.
Moreover, the data reveals the influence of members who had better modelling skills and BIM knowledge. In the Thu Thiem 2 Bridge project, the design team relied on BIM coordinators from WSP Finland and the software vendor to solve modelling issues. These coordinators mastered the modelling programs and had engineering backgrounds. Since this was the first bridge project with BIM in Vietnam, the project members found many required components, for example, the handrail, to be difficult to model. In this case, the BIM coordinators checked the available solutions and solved the issues with them. This support was useful for the local consultant since they worked with the modelling programs for the first time. When the local consultant had gained more experience with the software, they began to write some add-ins that were tailored to their work. An add-in is a piece of code or mini-program that can be used as a function in a specific software to give extra features. Most of the add-ins were to input data or to visualize the components. For example, survey engineer 1 wrote a Revit add-in to input the displayed values for the bore holes in the model. This add-in could enter the data from the geological survey to the model. It saved much time compared to enter the data manually. Survey engineer 1 commented that “It took much time to familiarize with the software in this project, but we could do it faster in future projects when we have libraries and tailored add-ins”. In this learning process, the local consultant not only familiarized themselves with the modelling programs but also customized these for their own sake. The customization supported the design team to deal with local requirements. Although the customized add-ins only supported the survey information in the Thu Thiem 2 Bridge project, these mini-programs might be the key to solve the traditional barriers and local requirements for other BIM projects in Vietnam.

Discussion

This paper has described the effects of institutional pressures on the adoption of BIM in the Thu Thiem 2 Bridge project. The project team faced with three main barriers that hindered the innovation. These barriers derived from mandatory construction regulations in paper-based submission (1) and cost estimate (2), as well as the technology capacity of the companies (3). However, the project team managed to implement BIM successfully. Through the institutional lens, this effort represented a mutual effect of institutional pressures. In the case study, the mimetic pressures turned into coercive ones. After the relevant authorities acknowledged BIM benefits from presentations in workshops and seminars, they recommended the project owner to formally request for BIM. Since the local members had to apply BIM, they had stronger motivation to seek for related knowledge. They collected knowledge not only from other project members but also from outside sources such as short courses, workshops, seminars, conferences, and online channels. This environment provided them an overview of BIM implementation status worldwide. During this information seeking process, they exposed themselves to normative pressures. Thus, they felt it necessary to obtain new BIM skills. Otherwise, they could be outdated soon. The case study also explains how companies gradually change their working processes during the
innovation adoption, with the local consultant team shifting from paper-based to 3D modelling design. The mutual influence of institutional pressures is summarized in Table 3.

**Table 3. Overview of the findings classified based on the three pillars of institutions**

<table>
<thead>
<tr>
<th>Regulative pillar</th>
<th>Normative pillar</th>
<th>Cultural-cognitive pillar</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Project owner demand</td>
<td>• Participation in seminars, workshops, conferences and short courses</td>
<td>• Mimicking others’ processes at work</td>
</tr>
<tr>
<td>• Relevant authorities’ consent/decision</td>
<td>• Online channels</td>
<td>• Receiving training from others</td>
</tr>
<tr>
<td>• Construction regulations</td>
<td>• Competitive construction market</td>
<td>• Mimicking examples from online communities</td>
</tr>
<tr>
<td>• National BIM pilot plan</td>
<td>• Government initiatives</td>
<td></td>
</tr>
<tr>
<td>• BIM execution plan</td>
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Furthermore, the interviewees referred to the existing paper-based tradition as the most time-consuming issue in implementing BIM. Since the software was unable to export drawings with the required detail from the model, the project team had to modify them manually. This indicates a gap between the local requirements and the software capacity. In the Thu Thiem 2 Bridge project, project members used add-ins to reduce manual tasks. These customized mini-programs might decrease the gap. However, it seems difficult to solve this issue without the involvement from authorities and software vendors. These agencies define the local requirements and develop the software. How to harmonize the local requirements with software capacity might be an interesting research topic.

In the case study, the coercive pressures from the government authorities, the project owner, and the client were low. They requested BIM in the project only because of being presented with good practices in the consultant seminars and had no specific expectations for BIM. In contrast, coercive pressures from clients and government authorities have been reported as the major reasons for BIM in Hong Kong (Chan 2014) and China (Cao et al. 2014). However, none of these studies reveals why government authorities and clients request for BIM. Since these organizations have decision-making power in construction projects, what influences BIM adoption decision of government authorities and clients require further studies.

The Thu Thiem 2 Bridge project confirms the importance of a BIM champion, who has the technical skills and leads the implementation of the organization (Messner and Anumba 2013). In this case study, the BIM champion was the WSP Finland project manager. He acted as the major change agent to implement the innovation in the project. The importance of a BIM champion has also been documented in other studies in Norway (Bui et al. 2018) and Sweden (Lindblad 2016). In a similar vein, Bosch-Sijtsema et al. (2017a) found that clients need solid knowledge to enforce BIM implementation in their projects. Different from these studies, the BIM champion in the Thu Thiem 2 Bridge project belongs to the consultant team. This position provides the Finish manager with less coercive power than BIM champions in the client team. Thus, coercive pressures might be important, but not necessarily the root of the innovation adoption initiative. Moreover, the client teams of public projects in Vietnam have low salaries compared to the consultant or contractor team because these salaries have to follow the national scale for state officers. Thus, it might be difficult to recruit competent BIM champions for the client team. This context raises the question of how BIM champions from the consultant team influence BIM implementation in public projects. The answer to this question might reveal practical contributions to public projects not only in Vietnam but also other developing countries which have a similar situation. Furthermore, studies addressing this question could contribute to better understanding of institutional effects on BIM implementation in construction projects which have a low level of coercive pressures.

In the BIM implementation study in China, Cao et al. (2014) found normative pressures had no influence on BIM implementation. However, the interviewees in the case study provided a different perspective. Through seminars, workshops, conferences and online channels, project members perceived the innovation trends in the construction industry. The trends made the project members want to learn new BIM skills for their own sake; otherwise, they could risk becoming outdated. This presents the normative pressure effects on the project team. Most of the project members knew about BIM trends...
through discussions in professional communities. Thus, how construction communities support BIM implementation in infrastructure projects deserves further studies.

This paper provides practical contributions to BIM implementation in infrastructure projects where BIM applications are still in the early stage. By describing the responses of different partners under institutional pressures in the Thu Thiem 2 Bridge project, the paper explains how the project partners overcame various barriers to make BIM implementation possible. The practical contributions can be useful for innovation adoption in infrastructure projects for government agencies, project owners, design consultants, and contractors. (1) Government agencies and project owners can create discussion channels for innovations in construction, coordinate inter-project experience sharing, prepare frameworks for testing new technologies, and may want to consider changing building regulations for BIM. (2) Project design teams can staff their projects with BIM experts in key roles, create environments where novice BIM users learn from experts, employ recent university graduates with strong IT/BIM skills. (3) Contractors can participate in professional forums and seminars to keep abreast of the latest technology and can collaborate with partners having better technological capacity.

Regarding institutional effects, the consultant team exerted mimetic pressures by presenting BIM benefits to the relevant authorities. Since the authorities acknowledged the benefits, they decided to allow BIM use in the case study. Furthermore, the project team not only adopted BIM but also customized modelling programs to make these programs fit with local regulations better. The findings might also be valuable to other projects which have similar contexts. Regarding the IS discipline, IS scholars have studied response strategies to institutional pressures for many years (Mignerat and Rivard 2009). Thus, strategic responses of construction organizations to institutional pressures on BIM implementation is a relevant topic for IS scholars. Furthermore, the paper also makes a theoretical contribution by providing an understanding of institutional pressures on BIM implementation in an infrastructure project within the context of a developing country. The findings illustrate how different institutional pressures combined to ensure innovation implementation in the case study.

The major limitations of this work lie in the context of the case study. The Thu Thiem 2 Bridge project is the first BIM pilot project in an infrastructure context in Vietnam. In this context, the influence of similar projects or companies were limited. Furthermore, the interviewees included the managers, coordinators, and 3D modelers. This combination helped to provide the data on the managerial and collaboration processes which are the key focus of this paper. However, the data does not include the local 2D bridge designers’ opinions.

Thus, a part of the BIM implementation in the Thu Thiem 2 Bridge project might remain uncovered. Furthermore, the case study identified the influence of the consultant team on the decision of the project owner, but the data includes no interviews with the project owner or the relevant authorities. Therefore, the data might reflect the opinions from the consultant only. Despite these possible limitations, this paper documents relevant findings on the BIM implementation in the Thu Thiem 2 Bridge project.

**Conclusion**

In summary, this paper presents a case study of the first BIM pilot project in the Vietnamese infrastructure domain. Analyzed through the institutional theory lens, the collected data reveals how institutional pressures influenced the project members to adopt BIM technology. Although the project team faced barriers from the local traditional working process and context, the experienced partner from Finland supported the team to implement BIM successfully. The description of institutional effects in this paper contributes to the understanding of BIM implementation in the IS discipline. The experience of the project team reported in this study might be transferable to other projects with similar contexts. Also, this paper suggests some topics for further study such as the gap between the local requirements and the software capacity, the influence on relevant authorities, the role of BIM champion in the consultant team, and, last but not least, the support of construction communities to BIM implementation.
References


A BIM pilot project in infrastructure

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