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Developing an Organizational Readiness Framework for BIM Implementation in Large Design Companies

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Abstract: BIM is a set of interacting processes, human, information, and technology components. A successful BIM implementation in organizations requires not only the consideration of technical issues but also other organizational changes. However, existing standards, guidelines, and protocols mainly focus on guiding practitioners the right way to develop and implement BIM technology. Change management for BIM implementation in organizations has not had sufficient attention in practice to other components, which would result in ineffectiveness and inefficiency. In the process of organizational change, readiness is considered a first critical step to break the status quo before going to the adoption and institutionalization phase when the necessary changes are implemented, and the system is internalized. This study aims to develop a comprehensive organizational readiness framework for BIM implementation to help large design firms build up organizational capabilities in the BIM adoption phase. Twelve semi-interviews were conducted with the participation of BIM specialists working in design companies, BIM consultants, and Design-Build contractors in Vietnam. The framework consists of six key elements: strategy, organizational structure, process, people, technology, and information management. Each of these elements was developed with specific criteria to support design companies to assess and create organizational readiness for BIM implementation. The paper ends with a further discussion on influential factors in creating organizational readiness for BIM.

Keywords: BIM implementation, readiness, design companies, organizational change

1. Introduction

It is noted that BIM is not only software or a three-dimensional model, but also a set of interacting processes, human, information, and technology issues (Chen, Dib, & Robert, 2014). The full potential benefits of BIM can only be achieved when changes in organizational structure, work practices, and skills of project members are implemented (Froese, 2010). Arayici et al. (2011) supported the significant changes should be required at almost all levels in the building process, including changes in the way of modeling, training staff in new software applications and processes, and also the reinvention of the workflow. The higher maturity stages of BIM implementation require larger changes in intra-and inter-organizations (Succar, 2009). Therefore, organizations should pay much attention to managing changes in their organizations to gain successful BIM adoption.

At the organizational level, many researchers have attempted to propose models to measure BIM maturity. However, the purpose of BIM maturity models intends to measure BIM performance rather than provide a framework from management perspectives to implement BIM in organizations, especially from the early phase of BIM adoption. Besides, the standards, guidelines, and protocols tend to guide users the right way to develop and implement BIM technology rather than to manage the BIM performance in organizations (Tsai, Mom, & Hsieh, 2014). Especially, although the Vietnamese Government declared decision 2500/QD-TTg in 2016 about steps for application of BIM in the Vietnamese construction industry, there have been no official guidelines, national standards for BIM implementation.

In Vietnam, BIM is in the early phase of adoption and is mainly implemented in major projects. The successful BIM implementation in large design companies can make great contributions to BIM diffusion in the construction industry. The purpose of this paper is to develop an organizational readiness framework as a first step in the process of organizational change for successful BIM implementation in large design companies. Influential factors are also analyzed to provide better understanding of the complexity when implementing BIM.

1. Organizational Readiness for BIM Implementation

1.1 BIM Implementation

The term of BIM implementation has appeared in the literature with some variability regarding their use (Sinoh, Othman, & Ibrahim, 2020). Succar and Kassem (2015) clarified the concept of BIM implementation by comparison with BIM diffusion and adoption. While BIM implementation refers to the preparedness, deployment, and improvement of BIM deliveries and workflows in a single organization, BIM diffusion demonstrates the rate that BIM tools and workflows are adopted across markets. BIM adoption regards to both BIM implementation and BIM diffusion. The BIM implementation proceeds through three phases. First, BIM readiness is the pre-implementation status regarding the planning and preparation for implementation, the potential to participate, or the capacity to innovate. Second, BIM capability refers to the determined implementation of BIM tools, workflows, and protocols. Third, BIM maturity presents the performance improvement milestones of BIM implementation.

In terms of implementation maturity levels, Succar (2009) identified four stages of BIM maturity. Pre-BIM status describes traditional practices using the traditional 2D drawings and document-based workflows. BIM stage one refers to the migration from 2D to 3D object-based modeling. BIM stage two refers to the progress from modeling to collaboration. BIM stage three refers to the progress from collaboration to integration

1.2 Organizational Readiness Framework for BIM Implementation

In the process of organizational change, creating readiness is of fundamental support to the adoption and institutionalization phases when changes are implemented and internalized (Armenakis & Harris, 2002). However, the meaning of readiness for change is ambiguous (Weiner, Clary, Klaman, Turner, & Alishahi-Tabriz, 2020). On the one hand, organizational readiness is defined as a psychological construct involving organizational members' attitudes, beliefs, and intentions (Armenakis, Harris, & Mossholder, 1993). Whereas Holt, Helfrich, Hall, and Weiner (2010) contended that readiness for change is comprised of both psychological and structural factors. The meanings of readiness are different at different levels, including individual, group, and organizational readiness (Vakola, 2013). The study aims to assess and create readiness for change at the organizational level.

Regards to the organizational change for new technology adoption, Scott Morton (1991) developed the MIT90s Framework to help people understand the impact of adopting new technology in an organization. The model includes two groups of factors: internal components (structure, strategy, technology, management process, and individuals and roles) and external environment. Organizational culture as a part of an organization consists of organizational structure, management processes, and individuals and their roles. To develop the organizational readiness framework for BIM implementation in large design companies, five internal elements in the MIT90s framework are used as the baseline concept. However, the adoption of BIM is not only limited to the equipment of staff and technology infrastructure but also seen as a systematic approach to the lifecycle information related to a building. Information factors are also critical in BIM implementation (Chen et al., 2014). Therefore, six elements are studied to establish the organizational readiness framework for BIM implementation, including strategy, organizational structure, process, people, technology, and information.

To develop the readiness criteria of each element, available BIM maturity models and BIM guidelines are studied to clarify the necessary requirements of BIM performance. BIM maturity models with evaluation context in organizations include BIM Maturity Matrix (Succar, 2009), the BIM QuickScan (Sebastian & van Berlo, 2010), the BIM proficiency matrix (IU, 2009), and BIM maturity model for the Dutch construction industry (Siebelink, Voordijk, & Adriaanse, 2018). In addition, previous studies on factors of BIM implementation in different countries are analyzed, such as in Taiwan (Mom, Tsai, & Hsieh, 2014), Korea (Won, Lee, Dossick, & Messner, 2013), Hong Kong (Chan, Olawumi, & Ho, 2019), Unites State (Mutai, 2009), Singapore (Oo, 2014), and Malaysia (Sinoh et al., 2020).

- **Strategy**

Creation of a need and urgency for change is an important first step to gain success in organizational change (Kotter, 1995). When people are dissatisfied with the current state and perceive the need for change to achieve the desired state, motivation can be created to break the status quo as an important step towards organizational change (I. Smith, 2005). The driving forces for design firms to adopt BIM can come from the main external motivators such as pressure from the government, clients and their competitors (P. Smith, 2014) or the internal motivation such as BIM benefits for design firms (Eadie, Odeyinka, Browne, McKeown, & Yohanis, 2013). Besides, defining clear BIM vision and goals is seen as the most important readiness criterion for BIM adoption (Haron, 2013). This should be aligned with the organization strategy and vice versa to support the successful BIM implementation in the organization (Khosrowshahi & Arayici, 2012; Siebelink et al., 2018). The transformation from traditional working methods to BIM-based processes also requires management support to develop appropriate strategies and directions, ensure resources for investment, training and IT support, and promote employees (Mutai, 2009). Furthermore, management change strategies play a vital role in minimizing resistance and achieving successful implementation. In the early stage of adoption, the top-down approach is recommended to drive and manage the adoption, such as developing BIM goals and vision, appointing senior leaders to lead the change, setting up the BIM team, and monitoring the progress of implementation (Haron, 2013). On the other hand, Arayici et al. (2011) contended that the bottom-up approach is more effective to engage employees in the change, ensure their capabilities to implement BIM, and address resistance.

- **Organizational Structure**

Many studies in different countries stated that organizational structure to support the BIM system within a company is one of the most critical factors to achieve the successful BIM adoption, such as Hong Kong (Chan et al., 2019), Korea (Won et al., 2013), Malaysia (Sinoh et al., 2020), USA (Mutai, 2009), and Singapore (Oo, 2014). The senior leaders should be assigned to guide and sustain the organization towards the BIM adoption, and a BIM committee can be created to support the senior leaders to develop and carry out the BIM adoption program (BCA, 2013a). Organizations can consider establishing a BIM team and promoting its development. Since such a separative department allows BIM personnel not only to implement BIM to meet project requirements but also to actively update the current trend of BIM knowledge and applications (Chan et al., 2019). New job instructions are formulated to help employees clearly understand their new roles and then can build their confidence and commitment to the changes (I. Smith, 2005).

- **Process**

A BIM roadmap is a critical plan that managers need to consider in the development of the BIM adoption program. This supports managers to manage and control the implementation process. Furthermore, process flow redesign is necessary since BIM requires changes in the workflow from linear to more collaborative. BIM implementation should align with the work process and vice versa, which is more important than technology readiness (Taylor & Levitt, 2007). Contracts can help to build a collaborative environment among project parties for effective BIM implementation (Liao & Teo, 2018). Based on the contract, design organizations can outline the type of BIM deliverables to be produced at different stages of projects (BCA, 2013a). The project delivery method is another factor affecting the BIM process and collaboration among project members. For example, in a Design-Build (DB) contract, a single model is produced which allows the involvement of contractors from early design phases (BCA, 2013b). However, Haron (2013) argued that in both contracts and project delivery methods, design firms have little to no power in dictating BIM requirements. Thus, design companies should pay attention to the alignment between organizational BIM requirements and project delivery requirements.

- **People**

According to Arayici et al. (2011), although organizations can achieve BIM adoption by using a top-down approach, managers should pay attention to engaging employees into the change and ensuring their capabilities for BIM implementation to motivate their staff and eliminate resistance to change. *Communication for buy-in can promote employees to* commit and support the proposed change (Sinoh et al., 2020). By engaging in the change process, employees can understand the connections between their work and organizational performance, then have high personal responsibilities for change (I. Smith, 2005). Furthermore, employees can be motivated when they are provided clear BIM information and aware of BIM advantages for their work, their organization, and projects (Siebelink et al., 2018). Building BIM competency is an important step of the adoption plan, which involves skills and knowledge that each relevant position needs to complete their tasks and responsibilities in the BIM process (BCA, 2013a). *Training is compulsory to provide adequate knowledge and understanding to managers and employees to avoid mistakes during implementing BIM* (Ding, Zuo, Wu, & Wang, 2015), *including both technical and process aspects.* Another critical factor of the success of BIM implementation is internal and external collaborations (Azhar, 2011). People need to work in a collaborative and integrative manner, such as the willingness to share information and effective collaboration between disciplines and project participants (Liao & Teo, 2018).

- **Technology**

Successful BIM adoption requires the right selection of appropriate BIM tools and their applications (Tsai et al., 2014). Because of significant investment and difficulties to convert from one system to another, software should be selected based on its functionality, interoperability, potential benefits to the company, the ability to use for a long-term period (Won et al., 2013). Hardware should be a sizable model to run the selected software (BCA, 2013a). Financial resources for hardware tend not to be a significant problem in large companies since it is concluded in the BIM adoption. However, such an investment may be a major barrier in small and medium organizations. Another preparation is BIM facilities to support interactive coordination among disciplines and project partners, such as meeting rooms equipped with large screens to visualize the model. Additionally, the staff tends to have little to no knowledge and skills when implementing new technology, a competent technical support team within the company is needed to deal with any technical issues and provide a clear guideline on using BIM. This is fundamental to the successful BIM implementation (Chan et al., 2019).

- **Data Structure and Information Flow**

Organizations should define how to structure data to create an appropriate model in a specific project stage and quality assurance to ensure the quality of information (BCA, 2013a). Libraries can be utilized to facilitate the BIM model design processes (Siebelink et al., 2018).

BIM provides a collaborative solution to facilitate communication and interdependence among parties (Chen et al., 2014). The successful BIM implementation significantly depends on the willingness of sharing information (Won et al., 2013). In both internal and external information flow, types of exchange data in each project phase need to be clearly defined with the right quality information (Sebastian & van Berlo, 2010). Information-sharing protocols and BEP should be drawn up for each project as a guideline on information delivery and assurance.

2. Methodology

A qualitative approach is employed in this study. A snowball sampling technique is used to identify respondents, which is based on initial interviewees to introduce additional samples. Interviewees are chosen from leading companies in the field of BIM, including large design companies, BIM consultants, and design-build (DB) contractors. One respondent is a member of the Vietnam BIM Steering Committee. Twelve semi-structured interviews were conducted to collect data. Respondents need to have knowledge and experience in the process of BIM implementation in large design firms. Respondents' profiles were coded to protect their anonymity (see Table 1).

Table 1 - Respondents' profiles

No.	Company	Respondent	Position	Years of BIM experience
1	Design	D1	BIM Team Leader	3
2	Design	D2	Architecture	3
3	Design	D3	BIM Team Leader	6
4	Design	D4	BIM Manager	8
5	Design	D5	BIM Team Leader	7
6	Design	D6	BIM Team Leader	9
7	BIM Consultant	BC1	BIM Specialist	9
8	BIM Consultant	BC2	Director	12
9	DB Contractor	DB1	Deputy head of BIM Department	4
10	DB Contractor	DB2	BIM Manager	3
11	DB Contractor	DB3	BIM Team Leader	7
12	Vietnam BIM Steering Committee	SC1	BIM Specialist	10

In terms of data analysis, the pattern matching technique (Trochim, 1989) is employed to compare a predicted pattern or a proposition with an observed empirical pattern, and the thematic analysis approach is chosen to analyze the complexity of creating organizational readiness.

3. Results Analyses and Discussions on the Readiness Framework

Based on the analyses and comparison between empirically found patterns and theoretical patterns. Twenty-six readiness criteria for BIM implementation in large design companies were identified with explanations for additional and alternative criteria. They were classified into six main elements: strategy, organizational structure, process, people, technology, and information management (Figure 1).
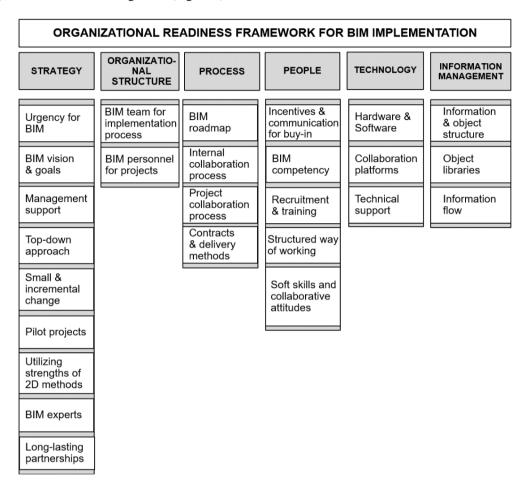

Fig. 1 - An organizational readiness framework for BIM implementation in large design companies

3.1 Strategy

A need for change is a critical success factor not only to create readiness for change as stated by Kotter (I. Smith, 2005) but also to sustain the change. When the traditional way of working still enables design companies to meet clients 'requirements, there is no motivation to break the current state (I. Smith, 2005). All interviews stated that BIM deployment is a global trend in the ACE industry. Especially, the Decision 2500/QD-TTg of the Vietnamese Government in 2016 and 1057/QĐ-BXD of the Ministry of Government in 2017 were the triggers for BIM implementation in design companies. Besides, clients of large and complex projects have started to require BIM due to awareness of the BIM benefits. Large design firms are motivated to adopt BIM to improve their competitive ability and quality of design, especially in large and complex projects.

All of the interviewees agreed that clear BIM vision and goals are important and should be aligned with the organization strategy as proven in previous studies (Haron, 2013; Siebelink et al., 2018). It is added that BIM goals need to be feasible, based on the company's capability, current and future market demand. This also helps to promote employees' buy-in. An excess expectation can cause the failure of the BIM implementation. Furthermore, BIM vision and goals should be revised periodically based on market demand, practical experiences from projects, the capability of the company, and what the organization wants to achieve from BIM.

Both the interview data and literature (Mutai, 2009) indicated that management support plays the most important role in BIM implementation. Top managers develop plans and directions to ensure financial and human resources, provide projects to implement BIM, and promote the implementation process. BIM implementation can fail if top managers do not have adequate understanding of BIM; thus, they are not able to develop appropriate strategies and directions.

In terms of management change strategies, all respondents agreed with Haron (2013) that the top-down approach is indispensable to implement BIM in large design companies. Top managers not only force the staff into the change but also support resources for change. Interviewees stated if large design companies decide to deploy BIM immediately in all teams, this will significantly impact their business. In the early implementation phase, those companies choose the small and incremental changes, beginning with a small team that is responsible for designing or only converting 2D drawings to 3D models in pilot projects. Experiences from pilot projects are used to establish processes and should be documented to convey the knowledge to other employees. After pilot projects, BIM is replicated to other teams of the company. However, due to limited BIM contracts and time pressure, design companies opt to implement BIM and CAD parallelly. According to interviews, 2D design methods can be utilized to minimize cost and human resources. Traditional design methods can have more effective outcomes when it comes to simple tasks.

According to interviewees, BIM experts/consultants can be used to assist companies in implementation strategies in the early stage if companies have little to no knowledge of BIM. External experts should acquire sufficient understanding of the company to develop a feasible implementation strategy. Another solution is that companies can consult the expertise from BIM experts to gain general knowledge of BIM, and then the BIM implementation plan is built by employees who both acquire BIM knowledge and understand the company's culture and business work.

Respondents added that regarding external coordination, establishing long-lasting partnerships can resolve the differences in culture and competence among parties, commonly with subcontractors.

3.2 Organizational Structure

It is highlighted in the interview data that managers and seniors in design companies often do not have the awareness of BIM at the beginning. Appointing a senior leader and BIM committee as suggested by BCA (2013a) tends to be not practical. Large design companies tend to start with a small BIM team and several pilot projects. The BIM team takes main responsibilities for guiding and sustaining the change in the whole process, as well as assisting top managers in BIM development strategies. According to Chan et al. (2019), the BIM team has responsibilities for meeting project requirements and in-depth research on BIM. This can be rational for contractors and clients, as the BIM consultant BC2 stated. However, in design companies, the BIM team is not modelers, members of design teams should enhance their BIM competence to create models. If design teams are unable to create 3D models, this will cause additional time for BIM teams to convert 2D drawings to 3D models and negatively impacts the project progress. In the early phase, the role of the BIM team is to support design teams, such as creating 3D models based on 2D drawings from design teams and coordinating for better design quality. When disciplines acquire sufficient BIM competence, the role of the BIM team should focus more on in-depth research on BIM tools, handling technical issues, developing training programs, controlling and supporting the implementation process.

At the project level, BIM implementation arises new roles, including modelers, BIM coordinators and BIM managers. Based on project requirements and the role of the company in projects, different positions are assigned from disciplines or the BIM team, depending on the BIM capability of design teams.

3.3 Process

As agreed by respondents, BIM implementation is a long-term strategy, and companies may not reach their goals if they do not have a BIM roadmap. It presents the plan of financial and human resources, investment progress, achievements and milestones, which should be reassessed periodically like the BIM vision and goals. The understanding of the company and BIM knowledge are necessary to develop a feasible BIM road map.

The interview data is in agreement with Chen et al. (2014) that beginners often consider BIM software and training as the highest priority investment, while experienced users tend to pay more attention to collaboration processes. It is noted that BIM creates a more collaborative working environment than the traditional working method. Collaboration processes are essential to clearly define the role of each party and how to coordinate with others. Large design companies with a considerable number of employees and multiple disciplines highly require an internal collaboration process as a foundation for exchanging information and coordinating in design more systematically. The process is unique to each company, that should be built in-house and based on project experiences as agreed by BIM team leaders. Besides, external collaboration processes largely depend on project requirements, this should be agreed by all project parties at the beginning.

Contracts should be a legal basis to define collaborative rules among different project parties (Liao & Teo, 2018). At present, the two-party contractual relationship does not allow coordination among multiple project parties. Design Bid Build (DBB) is a common delivery method, and design firms carry out design consultant contracts separately, excepting design-build contractors. Respondents stated that the BIM contract is still based on the current regulations of general consulting contracts. A significant difference in BIM contracts is the rules on delivered models. A major issue highlighted in interviews is that there are no official guidelines or regulations on the expense of BIM implementation, which is based on negotiations with clients and tends to be low.

3.4 People

The interview results and literature agreed that communication for buy-in for change has significant impacts on the change process (Sinoh et al., 2020). Obtaining an entire employee consensus within a company can be impossible and waste resources. All interviewees stated that gaining buy-in should be prioritized from people who have decision power in the company. However, resistance to change often occurs from middle management because the traditional working method still enables them to meet projects' requirements. According to all respondents, top managers play the most vital role in forcing team leaders into the change process. Other solutions are to improve their knowledge of BIM, provide them opportunities to participate in projects with BIM (I. Smith, 2005), share experiences (BCA, 2013a), show them the benefits which BIM can bring to their team (Siebelink et al., 2018). Furthermore, offering a higher salary and free training programs is common incentives that companies often employ to motivate not only team leaders but also employees to learn and use BIM.

To achieve the success of a BIM roadmap, companies should define targeted BIM competence. While modelers are responsible for creating or converting 2D drawings to 3D models, the role of coordinators becomes critical at the high level of coordination. Moreover, narrowing the competence gaps among disciplines also contributes to the efficiency of design coordination. Based on the expected BIM competence, companies develop recruitment and training plans. According to respondents, young candidates who can use BIM tools and make 3D models are available; however, they lack the experience and knowledge of construction. Recruiting qualified people who acquire the knowledge of both construction and BIM is still difficult. An alternative solution is to improve employees' competence. This is often achieved by internal communication and training programs, related to both collaborative processes and BIM tools.

General BIM knowledge is introduced to all managers and employees while in-depth training programs are provided to people who implement BIM. The findings are in agreement with Liao and Teo (2018) that employees should learn from their colleagues and real projects since short-term training programs cannot cover every issue. Furthermore, interviewees stressed that individuals' attitudes play the most important role in the success of BIM implementation. This requires a significant change from document-based methods to a more structured way of working. Besides, to promote the collaborative working environment, soft skills and collaborative attitudes of employees are critical in BIM implementation.

3.5 Technology

In addition to hardware and software, all interviewees agreed that a network server is commonly used as a coordination platform to provide a collaborative environment. Those investments are quite large for design companies; hence it is necessary to have a specific investment plan based on assessment criteria, including financial resources, current and future project scales, number of personnel, requirements for each position, and chosen software. The initial investment in hardware and software has critical impacts on the decision of BIM implementation. In the later phase, the investments in the salary of the BIM team and additional software due to clients' requirements become major barriers. Since the selection of BIM tools makes great contributions to the success of BIM (Mom et al., 2014), Won et al. (2013) recommended seven critical success factors of selecting BIM software. However, only several BIM tools are commonly used in the Vietnamese construction industry, and software is selected mainly based on its popularity, prices and project requirements. BIM team is responsible for researching different BIM tools and applications to have optimal choices for their organization. Technical support is considered a fundamental factor to successful BIM implementation (Chan et al., 2019); however, respondents contended that technical problems are not serious and they can find solutions on the internet or ask for support from IT technicians and BIM teams. This is because design companies only use several common BIM software, and the BIM uses are mainly limited to 3D coordination and clash detection.

3.6 Data Structure and Information Flow

An important aspect highlighted during interviews is that people need to change their perception, and implementing BIM is to build information models, not limited to create 3D models. Respondents agreed that an appropriate model element breakdown and data structure can minimize time and resources. Information and object structures are mainly based on practical experiences and clients' requirements. To maintain and convey the practical knowledge, companies should establish standards and provide training programs to improve employees' skills. When it comes to large and complex projects, the way to divide model elements becomes vital to fit computer configuration, enable parties to manage information and coordinate more easily. Interviewees agreed that an object library is important to speed up model creation (Siebelink et al., 2018). Different company has its way to develop a library, such as using sources on the Internet, purchasing or creating by themselves. This is the company's property and should be secure.

In terms of information flow, common problems mentioned in the interviews are related to improper and late information exchange. Information is not updated and sent to the right person at the right time, this causes misunderstandings among parties and project delays. A common data environment (CDE) is an optimal solution that allows parties to access the same source of information and reach the latest information. Managing the access permission on CDE is crucial to ensure the accuracy and security of the information. Besides, collaboration processes are of

importance to information exchange. Based on project requirements, this should be clearly defined and agreed upon by all project participants. However, employees' competence and their willingness of sharing information are critical factors in the information flow (Won et al., 2013). According to interviewees, people and collaborative culture are critical success factors. The efficiency of information exchange largely depends on the way people use technology and processes as well as coordinate with others.

4. The Influential Factors to Organizational Readiness for BIM Implementation

The organizational readiness framework (Figure 1) is a guideline for large design companies to create their readiness for a BIM implementation. However, according to the interview data, the creation of organizational readiness is complexed in different companies due to multiple influential factors.

4.1 Government Policies and Clients

Government policies and clients' demand have significant impacts on the roadmap and strategy of BIM implementation in design companies. Respondents stated that special attention was paid to BIM deployment in their companies after the Decision 2500/QD-TTg of the Vietnamese Government in 2016 and 1057/QĐ-BXD of the Ministry of Government in 2017. However, the current market becomes quite on limited demands. Public clients tend to not request BIM and be unwilling to pay any additional cost for using BIM since no government mandates, no regulations on BIM expenditure have been enacted. The domestic demand is limited to a small number of big private clients and the expenditure of using BIM is mainly based on negotiation, but the supplementation tends to be low and unable to cover the investment and salary for BIM personnel. Design companies opt for implementing BIM and 2D parallelly, and others failed in BIM adoption. The decision on BIM adoption should be based on the assessment of the targeted market and long-term financial plan. Besides, rational preparations for BIM implementation should be considered to meet government mandates that are expected to be imposed soon.

The BIM maturity of clients has dominant influences on BIM performance and implementation of design companies. If companies implement BIM without clients' requirements, this will create additional work, time pressure, and financial burdens to maintain BIM personnel. BIM development should match clients' expectations. However, due to limited awareness of BIM, clients tend to only require 3D models or even not request BIM. Furthermore, requirements on BIM are often unclear and lack BIM coordination on projects. Design consultants can convince clients by showing the benefits of using BIM to clients and clarify their requirements at the beginning to avoid any misunderstandings and ambiguities.

4.2 The Characteristic of Large Design Companies and Top Management Support

Compared to small and medium firms, large design companies have a higher competitive capability to carries complex and major projects. Those companies also face challenges in deploying the use of BIM to the whole companies because of a large number of employees, multiple departments, such as resistance to change, and inequal competence among disciplines. The way to implement BIM is diverse because the specific business work of a company is unique and types of construction projects are varied, including buildings, infrastructure and industrial. The pace of adoption is slow in design companies with multiple disciplines but a limited number of BIM projects in different types of construction. It is highlighted in the interviews that architecture teams tend to have wide-spread acceptance of BIM adoption, while structure and MEP disciplines are at the lower speed of BIM adoption. Especially, MEP teams consist of different subdisciplines that are assigned to different people; thus, it takes more time to build BIM competency for all subdisciplines. In large-scale companies, immediate changes in the business strategy to adopt BIM in the whole organization can cause adverse effects on business activities. BIM implementation is a long-term strategy that requires top managers to continuously assess short-term improvements and provide clear directions on each step of the BIM roadmap.

The BIM perception of top managers can be varied based on the level of understanding in BIM maturity stages, from object-based modeling, model-based collaboration to integrated practice (Khosrowshahi & Arayici, 2012; Succar, 2009). This will affect their goals and strategy of BIM implementation in the organization. When top managers consider BIM as software to create 3D models, they will invest in software and BIM tool courses. By contrast, when they aware of the important role of BIM in design coordination, process development will be paid more attention. Furthermore, BIM implementation is a long-term process, and the outcomes are vague and difficult to measure. Therefore, it is difficult to maintain the commitment of top managers.

4.3 The Competence and Attitudes of People Using BIM

Developing the BIM competence of a design company involves the BIM maturity stage (Khosrowshahi & Arayici, 2012) that the company expects to achieve. In stage 1, companies focus on software training and hiring modelers. In higher BIM maturity levels, qualified people play a vital role as coordinators in design. Inequal and inadequate

competencies among different disciplines have negative influences on design collaboration. Besides, training programs provide the knowledge of new working processes rather than only focus on BIM tools.

BIM implementation requires additional responsibilities for design coordination and structuring documents. Insufficient BIM competence of employees can make projects behind schedule. However, due to the time pressure of projects, employees do not have time to learn and enhance their skills and knowledge of BIM. Design companies tend to choose traditional working practices to ensure project progress and avoid the risks of change.

Furthermore, BIM acceptance is different between the young and older generations. Juniors often have higher motivation for digital transformation, while seniors tend to resist change. Seniors often have authority but do not consider digital transformation as being crucial.

Individuals' attitudes play the most important role in the success of BIM implementation. People need to change their way of working from document-based to more structured and collaborative. Collaborative attitudes and the willingness of sharing information are the critical success factors of design coordination.

4.4 Standards and Guidelines

According to the result of interviews, no BIM standards and guidelines have been imposed in the Vietnamese construction industry. In large design companies, the development of new working processes and the rules of information structure are mainly based on experiences in real projects. Standardization of processes and information structure are essential to maintain and convey practical knowledge among employees, but this is time-consuming and different among companies. Furthermore, the regulations on models and collaborative processes are varied according to clients' requirements. Government open standards and guidelines are essential to improve the pace of BIM implementation in design companies and promote supply chain collaboration.

5. Conclusion and Recommendations

The organizational readiness framework for BIM implementation in this study can be seen as a guideline for large design companies to have a broader view of BIM adoption. The creation of readiness for BIM implementation is not limited to technical aspects but also requires management involvement. In the framework, readiness criteria are divided into six main elements: strategy, organizational structure, process, people, technology, and information management. To avoid risks for change, large design companies often start with a small BIM team converting 2D drawings into 3D models. In the long-term strategy, all disciplines should acquire adequate BIM competence to avoid additional time on converting and promote real-time collaboration.

This study found multiple influential factors in the creation of organizational readiness that help large design companies understand the complexity of BIM adoption and develop a feasible strategy for change. All found-influential factors are related to non-technology aspects and more difficult to deal with than technical issues. The key success factor is people who need to change their perception and the way of working and communication.

Government mandates are expected to boost the market demand for using BIM. Industrial standards and guidelines will support the process of BIM adoption. Furthermore, stage two and three BIM maturity levels require not only the capability of design companies but also higher BIM maturity of clients and supply chain partners, including contractors, subcontractors and suppliers. Collaborative contractual agreements and open standards will contribute to promoting design integration. Due to current regulations, Design Bid Build procurement method is widely used instead of collaborative delivery methods, especially in the public sector.

National regulations on expenditure for using BIM should be enacted. Design companies must make great investments in hardware, software, training their employees, and significant changes in their workflows and design process. The economic benefits of using BIM are less manifest for design firms, while clients, project managers and contractors can gain more benefits during construction and facility management phases. To create more incentives for BIM adoption in design companies, the project cost should be redistributed more for design work. Besides, the principle of sharing financial pains and gains can promote contributions from parties and reduce designers' potential liability due to providing inaccurate information.

It is difficult for design companies to measure the return of investment (ROI) of adopting BIM. This is a significant disincentive to gain the commitment of top management. Reports on BIM pilot projects of the Vietnamese government are expected to provide clear outcomes and practical experience of using BIM in the Vietnamese construction industry. The scope of the study only concentrates on large design companies. For further study, it is suggested to research small and medium design companies and other organizations, such as clients and contractors, contributing to BIM diffusion in the Vietnamese construction industry.

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