Identification of Potential Uses of Building Information Modeling (BIM) for Construction Supply Chain Management: Preliminary Studies

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Abstract. The 4.0 industrial revolution in all fields encouraged the construction industry to make technological-based innovations. Building Information Modeling (BIM) is one of the tools in advancing construction technology today. On the other hand, supply chain construction continues to grow and becomes important in project management. This study aims to identify the potential use of BIM in construction supply chain management. Preliminary studies on several projects in Indonesia were carried out as identification methods. The Delphi process was used to obtain the data described in the Strength, Weakness, Opportunity, and Threat (SWOT) analysis. As a result, BIM has the potential to be applied to the construction SCM with several considerations. There are 5 trends in strength, 4 trends in weakness, 5 trends in opportunity, and 3 trends in threat. Trends in strength and opportunity are used as indicators in the analysis of impacts. BIM as advanced technology is the highest indicator and the lowest trust between stakeholders in the application of BIM in the construction supply chain. In addition, harmonization between BIM actors is needed: the Ministry of Public Works, contractors, suppliers and academics in the supply chain.

1. Introduction
In recent year, a lot of researches on Supply Chain Management (SCM) in the construction industry. Application of construction SCM is still focused on the internal level that is material and resource management [1]. Meanwhile, BIM as new technology has been applied to the construction industry. BIM facilitates designers to visualize structure planning in integrated automatic drawing, code, and sequencing so that it becomes a model of the building that truly provides information [2][3]. The SCM concept basically integrates stakeholders to work together from upstream to downstream. In one study said that the construction of SCM on recycled materials to support sustainable construction [4].

The problem that occurs in the construction project is how to establish good communication between stakeholders in the supply chain flow. There are still many missed communication and lack of information between contractor and supplier, contractor and sub-contractor, contractor and owner. These problems will affect the low quality of the project. BIM with integrated technology from design to construction and monitoring has the opportunity to bridge the communication [5]. By understanding the concepts of BIM and SCM together, there is an opportunity to be able to integrate SC actors better using technology. Research on BIM’s contribution to the construction supply chain in Canada states...
that out of 12 trends in the construction supply chain there are 2 key trends related to BIM and technology, namely (1) "BIM flexibility to meet the complicated needs of the construction supply chain" with 62% votes and (2) "process, information, IT infrastructure standardization and alignment between supply chain actors" with 30% votes [6]. In addition, it turns out that BIM has been used as a breakthrough solution in traditional construction contracts in Qatar [7].

At the moment, there are many people who understand BIM and are aware of the importance of SCM in construction projects but have not implemented it together [8][9]. Besides being a factor of human resource capacity, this big idea requires a significant budget. To fill this gap, then the purpose of this study is to identify opportunities for the implementation of BIM in construction supply chain management. Case studies will be explored in several construction projects in Indonesia. Indeed, BIM in Indonesia has not been widely used when compared to a neighboring country such as Malaysia, but BIM's promotion has now become stronger [10].

2. Material and Methods

2.1. Delphi method

Because the academic literature is still lacking in exploring the relationship between the use of BIM on construction supply chains, the choice in this study was to listen to experts and BIM-supply chain actors to build initial views in the field [11]. The research method begins by identifying opportunities for the implementation of BIM in construction supply chain management with literature studies. Literature was obtained from journals to be asked to respondents through a questionnaire.

The Delphi study requires at least 20 people to get unbiased results between individuals [12]. The chosen respondents were academics and practitioners who had experience in researching and using BIM. In addition, they were chosen because of their understanding of construction supply chain management. Academic participants involved two professors and five researchers/students from different universities. The practitioners involved contractors from the State-Owned Enterprises and employees of the Ministry of Public Works and Public Housing, nine and four people respectively. At the beginning, the Delphi request wanted to involve many more academics and practitioners, especially practitioners, but some of them refused for various reasons. The main reasons are their inexperience about BIM-supply chain and the inappropriate time for the Delphi process. More detailed participants are shown in Table 1.

| Table 1. Delphi participants background |
|----------------------------------------|
| **Position**                           | **Number of participants** | **Work experience (average year)** | **Field of competence** |
| Professors                             | 2                         | 25                                   | Construction management |
| Researchers/students                   | 5                         | 5                                    | BIM and construction SCM |
| Employees of the Ministry of           | 4                         | 10                                   | Construction innovation and BIM |
| Public Works and Public Housing        |                           |                                      |                           |
| Project managers                       | 1                         | 10                                   | Leading projects with BIM technology |
| Site engineers                         | 2                         | 5                                    | Site engineers of contractors using BIM |
| BIM engineers                          | 6                         | 3                                    | BIM |

Based on Table 1 above, if present, the academics 40% and practitioners 60%. At the beginning of this research idea, there were more practitioners taken because they were the actors in the field who used more BIM and were involved in the supply chain construction.
2.2. Delphi research design

The Delphi process begins with designing the objectives of the study. Each of the objectives was carried out Delphi both face to face directly in Focus Group Discussion (FGD) and online. Details of the research design are as follows:

**Table 2. The research design of goals and Delphi rounds**

| No | Goal | Delphi round |
|----|------|--------------|
| 1  | Identify supply chain trends in construction | Discuss with participants about the development of the supply chain in the construction industry. Participants explain the construction supply chain relationships with suppliers and how to use the technology, for example, BIM. |
| 2  | Identify BIM trends in construction | Discuss with participants about the use of BIM so far. Is there a connection with construction supply chain management or not and how is its potential. |
| 3  | Identify potential uses of BIM in the construction supply chain | Discussions with all participants about the potential of BIM in the construction supply chain by mapping SWOT analysis. |

The Delphi process that is rounded up aims to formulate research ideas in a structured way. So that the potential application of BIM in construction supply chain management, especially in Indonesia, can get good results.

3. Results and discussion

3.1. Identify potential uses of BIM in the construction supply chain

Research design and Delphi rounds have used a reference in getting data. The results of filling out questionnaires and discussions with practitioners and academics stated that there were several opportunities and challenges in utilizing Building Information Modeling (BIM) for Construction Supply Chain Management (SCM). These opportunities and challenges are seen from the internal and external perspectives of BIM-SCM implementers. The results of the SWOT analysis are detailed in the following table.

**Table 3. The potential use of BIM in SCM construction with SWOT analysis**

| Strength | Code | Ref | Weakness |
|----------|------|-----|----------|
| BIM is an advanced technology | S1 | [6][13] | The low ability of workers at BIM |
| BIM makes flexibility in design and construction | S2 | [5][14] | The low understanding of workers about construction SCM |
| BIM facilitates supply chain integration between stakeholders | S3 | [5][14] | The lack of work culture and organizational support |
| BIM facilitates supply chain integration between project phases | S4 | [5][14] | Big investment |
| Flexible work | S5 | [7][16] | |

| Opportunity | Code | Ref | Threat |
|-------------|------|-----|--------|
| Better risk-sharing between stakeholders | O1 | [17][18] | The lack of standardization |
| Better trust between stakeholders | O2 | [17][18] | Not easy relationship contractors and suppliers |
| Supply chain driver control | O3 | [16] | Lack of client demand |
| Government alignments | O4 | [19] | |

| Code | Ref |
|------|-----|
| W1   | [2]  |
| W2   | [2]  |
| W3   | [2]  |
| W4   | [2][15] |
| T1   | [6]  |
| T2   | [17][18] |
| T3   | [6]  |
Project tender requirements

Each indicator of BIM application in the construction supply chain above is validated to the participants. Strength (S) and Opportunity (O) are used as a basis for potential implementation because they will become supporters of issues and added value. Each of them has 4 indicators that have been coded S1-S4 and O1-O4. Weakness (W) and Threat (T) are not used as indicators in the opportunity to implement BIM in the supply chain of construction but rather as a warning and a sign that this idea still has obstacles. The opportunity mapping for BIM implementation is illustrated in the following opportunity and impact table.

|          | S1 | S2 | S3 | S4 | S5 | O1 | O2 | O3 | O4 | O5 |
|----------|----|----|----|----|----|----|----|----|----|----|
| Opportunity | 4.55 | 4.05 | 4.20 | 3.75 | 3.60 | 3.70 | 2.85 | 3.50 | 4.35 | 3.55 |
| Impact    | 4.47 | 3.55 | 4.30 | 3.25 | 3.45 | 3.80 | 2.95 | 3.70 | 4.50 | 3.25 |

Figure 1. BIM opportunity and impact on construction

The table and figure above map the opportunity and impact values to become more visual to be understood. The most likely trend or indicator to be applied and the impact on construction is BIM is an advanced technology (S1). While the lowest is better trust between stakeholders (O2). BIM as advanced technology is expected to assist the progress and effectiveness of construction work greatly. BIM is a new approach involving the process of designing and building assets using 3D representations. BIM is useful in the process of creating digital data sets that form 3D models and inherent information or Common Data Environment (CDE). In addition, the BIM principle lies in the process of making models and data simultaneously and is collaborated between actors from the planning, design, fabrication to construction and maintenance processes. Then why is trust between the lowest stakeholders? This is because the parties that use BIM are still partial. For example, the contractor uses the BIM and the planning consultant also uses the BIM, so the potential for mutual claims which is the most appropriate will be a source of conflict, especially if there are planning and implementation errors.

3.2. Harmonization of BIM actors in the construction

The idea to harmonize construction supply chain actors with BIM starts with the lowest (O2) trend compared to the others. The Ministry of Public Works as a government has become a central figure in
this harmonization. This harmonious relationship must be maintained between the government, contractors, BIM software companies, universities, and suppliers. The contractor, as the actor in the project, must be able to master BIM. BIM software companies should continue to open up and share knowledge with others. Universities as educational institutions must be able to access BIM to become part of courses in collaboration with BIM companies and contractors. In addition, universities which prepare human resources must be in harmony with technological advancements in educating their students.

4. Conclusion
The biggest challenge in the utilization of BIM in construction SCM is that currently there is still no familiar use of BIM on a mandatory basis in construction companies. Especially if it is applied to the SCM construction, of course, there are still not many. However, based on the discussion and analysis of most of agree and strongly encourage the adoption of BIM in an effort to improve the construction of SCM more effective and efficient. Therefore, it is necessary to encourage binding on the government to regulate the use of BIM comprehensively in project management, including the construction of SCM.

This research is still early identification in the application of BIM in the construction supply chain, so it needs to be developed in the actual application of BIM in supply chain management. The results of the identification of this good application become a good provision in further research. This application could invite the contractor to conduct an experiment in a material procurement simulation. A more detailed monitoring process in the procurement of material from the BIM design can be assisted with other software such as Google Maps or similar applications.

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