Barriers to implementing Building Information Modelling (BIM) in the Malaysian construction industry

S Y Wong¹ and J Gray²

¹Department of Civil and Construction Engineering, Curtin Malaysia, CDT 250, 98009 Miri, Sarawak, Malaysia
²School of Civil Engineering and Built Environment, Queensland University of Technology, 2 George St, Brisbane 4000 QLD Australia

E-mail: shiyee.wong@curtin.edu.my

Abstract. Building Information Modelling (BIM), as the parametric modelling of building designs, can offer many benefits to the construction industry, but it is not commonly used in Malaysia. This paper aims to investigate the reasons on why BIM has not been widely adopted within the Malaysian construction industry and identify the barriers involved. A literature review identifies and frames the relationship between three main likely contributing factors of lack of education and training, legislative barriers and limitation of interoperability and fragmentation. The results of a questionnaire to collect primary data among Malaysian construction industry professions showed that the barriers are lack of education and training and lack of standards for the modelling projects largely due to funding shortages in education and industry, low incentives, issues of copyright and an unwillingness to accept changes in using new software within the Malaysian construction industry. The findings of the research will be vital for professions within the Malaysian construction industry who are considering adopting BIM and enable them to have a basic idea and develop strategies to overcome these barriers. This will help to increase the efficiency and productivity of the construction industry.

1. Introduction

Building Information Modelling (BIM) is an information exchange method by using information technology between various parties. It is the parametric modelling of the building and also digital representation of the functional and physical characteristics of the facility [1, 2]. Recent statistic showed that there is an increasing trend on BIM adoption as approximately more than 30% of their projects [3].

BIM has been demonstrated as an effective method for reducing the adverse impacts on data exchange within the construction industry. Clients and the built environment sector Disciplines select BIM for a number of reasons including reduced changes and conflict, providing a clear picture on the exact project before construction, concise cost estimates and ability for linking for the energy analysis tools [4, 5]. Malaysia has started to discover the benefits of implementing BIM within the construction industry [6]. Development Bureau (DevB) was introduced as an administrator of BIM-related regulations to ensure that the comprehensive framework for BIM implementation for design, construction and maintenance processes is being implemented [7].

Despite the benefits and the strong recommendations by some of the companies, there are currently perceived challenges on the BIM adoption in Malaysia. BIM is still relatively new and in its early implementation stage in Malaysia [1]. The literature reveals there are only a few universities and
organizations have commenced teaching and adopting BIM to some degree. There is a lack of recognition of the new role of BIM leadership which can help to implement this new technology into the construction sector. The business data involved in BIM adoption internally within organizations and externally for clients are not fully collaborative [8].

Through a comprehensive literature review and questionnaire, this paper aims to identify the main barriers and limitations which hindered BIM adoption. The main problem being investigated in this research relates to why BIM is not widely implemented within the Malaysian construction industry.

2. Literature review
In reviewing the literature concerning the barriers to the implementation of BIM in the Malaysian construction industry, three main issues were identified and investigated throughout this paper: (1) lack of education and training [9, 10]; (2) legislative barriers [11] and (3) limitation on interoperability and fragmentation [12, 13].

2.1. Lack of education and training
Lack of education and training is one of the most challenging barriers for BIM adoption in construction industry [9, 10]. The lack of education on BIM leads to inadequate skills, expertise and professionalism in the real work place [14].

There is a shortage of tertiary education that helps in delivering BIM knowledge through lecture or lab combination, introducing the skills to model for estimating and understanding drawings [15]. Limited education programs were introduced to tertiary education students on BIM technology and limited number of academic institutions introducing BIM into their curriculum [5].

Challenges exist when there are difficulties in training staff in area of data handling [9]. The employees of organizations may require completing certain certification to be able to engage in the new organizational process. Difficulties arise in training people in BIM and overcoming resistance to change and the obstacles relating to learning new software and reinventing workflow processes [4, 16].

Moreover, training in organizations require a large amount of financial support due to the high initial investment cost [17]. A huge amount of investment is needed in different areas, including software, hardware, training and network infrastructure in order to run BIM [15]. Smaller and medium firms which do not have enough financial support and human resources are facing difficulties in training staff. There is a reliance on outside experts in training staff on using BIM which leads to substantial expenses [18]. There are additional costs in reviewing and inputting BIM data [19].

Shabanefahani and Mohammad [20] stated that there is lack of knowledge on transferring the new technology in construction firms. The challenges in determining the appropriate technical and organizational approach contribute to the reluctance of construction sectors in using BIM. This uncertainty will increase the risk and cost on BIM implementation [21].

In Malaysia, as in many countries, there is a lack of tertiary education on BIM. The lack of teaching syllabus on BIM and other related subjects adds to the challenges in BIM implementation [22]. BIM-based software such as Navisworks, is being introduced for viewing, combining and examining clash detection, verifying models’ content and analyzing construction safety management issues. Despite the strength of this software of being able to combine different file formats there are still challenges for wide implementation in Malaysia including a lack of financial resources in many companies to purchase this software. The lack of the internal training also leads to the failure on delivering knowledge for using this software [23].

2.2. Legislative barriers
According to Royal Institution of Chartered Surveyor, 58% of the Quantity Surveyors felt that lack of standards is the barriers of BIM implementation in the construction industry. There are 51% of Quantity Surveyors surveyed believed that the uncertainty on the ownership of data and responsibilities leads to the challenges of construction industry in adopting BIM [11].
The primary reason for legislative barriers within the construction industry is the lack of standards for the modelling structures. This leads to low incentives to implement BIM [24, 25]. Kent and Becerik-Gerber [26] illustrated that there is a gap on the usage of BIM as a collaborative framework due to the absence of BIM contract issues and documents.

The lack of BIM contract documents leads to the unclear framework for practices and reduction in the effort to document the roles of the participants [27]. The ownership of the data and also information exchange process are not stated clearly in the contract [28]. There is no standard contract document which can help to establish the risk allocation consensus and integrated relationship between the dispute resolutions, risk compensation and insurance [24]. Ghosh [15] stated that the free flow of information without the formal contracts which can help to specify the ownership of data is the main concern in most of the parties within the construction industry.

The owners are concerned about the copyright of BIM and also security of their data [19]. The owners wanted to protect their proprietary information as there are uncertainties on the ownership of the model at different stages of the projects. Kent and Becerik-Gerber [26] mentioned that the primary legislative barriers is the lack of determination on the ownership of BIM data and the necessity to protect BIM through legal channels and copyright laws. In this stage, there is no clear copyright law on protecting the ownership of the data in BIM [19]. As the data used in BIM can be assessed by various parties, there is a concern on the security of the data, such as drawings and specifications. BIM data are not well managed and it is hard to identify and capture the input. The condition becomes worse when uncertainties exist in exchanging information through BIM [15]. Kuehmeier [29] reiterated this statement by enforcing that the contractor and developer are reluctant to provide electronic data to suppliers and subcontractors as the data can be modified. The protection on data and work for copyright and liability purposes are the major concern.

In Malaysia, BIM is used in waste management in the construction industry. According to Rajendran and Gomez [30], about 70% of waste in Malaysia are produced by five states in Malaysia, which are Pahang, Terengganu, Kuala Lumpur, Selangor and Kelantan. Malaysia government plans to implement BIM through design-out-west, to reduce waste in west Malaysia. However, due to the contract documentation and litigation issues, government is facing challenges in implementing BIM in the waste minimization activity [30].

2.3. Limitation on interoperability and fragmentation

BIM is difficult to be implemented as it requires the use of more complex and difficult systems for data exchange [12]. The fragmented nature of the construction industry leads to low data quality and more time and effort required for project control [13]. Although the construction industry had adopted supply chain management methods to ensure better control and better flow of data exchange, the fragmented nature of the construction industry is not fully resolved. The lack of innovation and individual dominants intensity within the construction industry becomes a limitation to supply chain management. The data qualities are still low and require more time and effort for completing project control [13]. Hence, there is a chance for errors to occur in exchanges between tools.

The lack of uniformity between each scheme adopted by BIM tools will increase the errors occurring in BIM adoption [31]. The variety of schemes and tools being adopted by different parties leads to the involvement of many different types of file formats, and hence inadequate to handle the collaboration of different firms at the early design stage. This creates limitation for BIM in terms of information collecting and exchanging processes [16].

There is also a lack of standardised procedures for work collaboration with the external team members of the firm [32, 33]. The fragmented nature of the construction industry creates difficulties in sharing BIM with other external teams such as subcontractors [34]. This is because external parties would not share their model and would not utilise the contractor’s BIM model. A lack of innovation and individual dominants intensity within the construction industry can create errors in data exchange [35].
Interoperability problems not only occur within different professions within the construction industry, but also occur between the software used and data transferring from various parties. The current BIM tools are inadequate to handle the integration of different firms at early design stages [36]. As the software is developed by one particular single party, in some conditions, it might not be able to be fully understood by the whole project team members [37]. Shabanesfahani and Mohammad [20] also explained that fragmentations and lack of investments in research and developments on a common software added to the barriers of BIM innovation and implementation.

2.4. Critique of literature
The literature associated with the three main sub-factors has been critiqued and analysed based on a number of factors, including empirical work, assumptions, bias, data collection, extent of literature relating to the local problem and the information gap. These weaknesses within the literature will affect the reliability of the literature review. For example, a number of authors work either had a lack of empirical studies or had included assumptions in the literature. There is limited literature that can be adopted from Malaysia and therefore a proportion of the literature reviewed was from different countries on the same issues being investigated which may not relate directly to the Malaysian construction industry. Hence, the issues discussed in the literature can only be related to local problems to a certain extent as different countries may have differing approaches to construction design and delivery.

3. Research Method
To investigate the situation in Malaysia, a questionnaire was conducted to obtain the opinions of Malaysian construction industry professionals on the barriers of BIM implementation. The respondents were balanced as far as possible across the participants in contractors, developers, architects, engineers, quantity surveyors and consultants. Before the official data collection, a pilot study was conducted among three Malaysian construction experts to address the deficiencies of questions, assess the feasibility and gather information before the final questionnaire was conducted throughout within two months (August-September). The pilot study consisted of open ended questions, Likert scale questions and some multiple choice questions. Final surveys were distributed to 175 professionals among the Malaysian construction industry through email exchange.

4. Results
4.1. Profile of respondents
Among the 175 professionals, 43 of them completed the questionnaire (25% of response rate). The respondents represent a wide range of construction professionals in Malaysia, including developers, engineers, builders, architects and quantity surveyors.

Majority of the respondents (58%) were experienced with five years or more. This indicates that the respondents had a good knowledge and awareness in the construction industry and therefore in a position to provide a good perspective on BIM implementation within Malaysian construction industry. From the respondents that have less than five years of experience, 84% of them are unfamiliar with BIM. There were eight respondents (19%) having involvement in BIM. This shows that BIM perhaps currently has a low participation within the Malaysian construction industry and remains relatively innovative within the construction industry in Malaysia.

The respondents were asked to rate the three main issues from the literature review with rankings: 1-least important; 2-important; 3-most important (table 1). 40% of the respondents believe that lack of education and training is the most important barrier of BIM implementation in Malaysia. The feedback on this statement is slightly unjustified with Section 2.2 as legislative barrier is considered one of the most important factors especially in terms of copyright issue. However, the findings may affect by the culture of Malaysian construction industry which do not stress much on copyright issue.
| Barriers                                      | Percentage |
|----------------------------------------------|------------|
| Lack of education and training               | 40.5%      |
| Legislative barriers                         | 31.0%      |
| Limitation of interoperability and fragmentation | 28.5%     |

4.2. Lack of education and training

58% of respondents do not have BIM knowledge from either education or the firm. This suggests that BIM is not widely used in Malaysia. In addition, among the 43 respondents, only two respondents indicated that their firms provided training in BIM. This seems to support the issue that there is a serious lack of training from Malaysian construction firms. This may also contribute by the high training cost and challenging software changes [17].

Respondents rated the question “To what extent would you agree that the cost of BIM software put a large hurdle on BIM implementation?” on a scale of 1 (strongly disagree) to 5 (strongly agree). 56% of the respondents agreed that cost of BIM software put a large hurdle on BIM implementation and is a barrier towards BIM implementation. 62.5% of the BIM users’ participants agreed or strongly agreed that the cost of BIM software may contribute to the hindrance of BIM implementation. This indicates that the cost factor is most likely to be one of the main contributors for the lack of BIM implementation.

4.3. Legislative barriers

In response to the question “Has the Malaysian Government contributed in introducing BIM in construction industry?”, 90.6% of the respondents believed that Malaysian Government did not contribute on introducing BIM in the construction industry. The respondents also commented that cost is the factor which contributes to unwillingness of government on introducing BIM and the Malaysian Government had not at the time of the questionnaire at least mandated the use of BIM in the local construction industry. There was no apparent initiative put in by the government to encourage the use by the professionals at the time of the survey.

Responses to the question “What is the main reason for BIM being hard to adopt in terms of legislative barriers?” are shown in figure 1. Majority of the respondents identified that copyright issues as the main legislative barriers of BIM adoption. This is unjustified with the literature review as previous research stated that uncertainties over ownership is the main barriers [26].

The respondents were asked about their opinion on the existence of BIM formal contact documentations. 72.1% of the respondents reckoned there is a lack of formal contract and documentation regarding BIM projects. Due to the fragmented nature of the construction industry, the professions are not willing to invest in BIM. The lack of formal documents also created difficulties on determining the ownership of the data entered into BIM [11, 27].
4.4. Limitation on interoperability and fragmentation

The nature of construction industry creates difficulties on BIM implementation. 65.10% of respondents believed that there is a lack of multi-discipline team working culture in BIM implementation within the construction industry. The working culture in most of the Malaysian construction industry is highly competitive and they are not willing to share information between different professions.

The respondents were asked to rank their opinions regarding the importance of guidelines and procedures on a 1 (Least Important) - 5 (Very Important) scale. 53.5% of the respondents ranked this statement with quite important or very important. It seems that the respondents preferred that a proper guideline will reduce the barriers on BIM adoption in the Malaysian construction industry.

Respondents were invited to choose which factor contributes more significantly to the fragmentation issue in Malaysian construction industry (see figure 2). There are 55.80% of respondents believed that technical issues contributed more towards BIM barriers compared to unwillingness to share information. This finding was in contrast with the literature review as previous findings indicated that the fragmentation issue arose mainly based on unwillingness to share information between different companies or professions [34].

![Fragmentation factors](image)

**Figure 2.** Fragmentation factors

4.5. Other barriers

The open ended question “Do you think there are other barriers to BIM implementation within the Malaysian construction industry?” provided several themes within the responses:

- The culture of the Malaysian Construction industry is unwilling to change and a lack of information about BIM exists at present.
- Lack of resources and expertise in Malaysian construction industry.
- Time barrier as it is time consuming to invest and setup new software.
- Unwillingness of private companies to initiate the investment into BIM.
- Lack of response from local architects and engineers as the majority of them are still using AutoCAD in their design and services.

4.6. Future of BIM application

Majority of the respondents believed BIM has a great potential to be adopted in Malaysian construction industry in the long term. The full adoption of BIM in Malaysia may not occur in the short to medium term, unless there is an utter change of perceptions by the key players of BIM. Most of them agreed that the adoption of BIM is fairly low, but there is potential as BIM is new. BIM maybe introduced as a necessity tool in the construction industry as it has many potential benefits.

A few respondents believed the chance of Malaysia to adopt BIM is currently difficult as much of the Malaysian construction industry is still using 2D drawing software (AutoCAD) and there are only a few companies venturing into 3D modelling such as Revit. This does however contradict the
literature which indicates that there is great potential on introducing BIM within the Malaysian construction industry despite the barriers indicated.

5. Discussion
The results confirmed that BIM has not yet been widely implemented within the Malaysian construction industry. The questionnaire revealed that the lack of education and training is the main barrier to BIM implementation in the Malaysian construction industry. It also showed that there is insufficient tertiary education and training being provided in Malaysia. It is costly to implement BIM and hence there is not enough training being provided by companies. The findings are supported by the literature in terms of the cost of BIM software being expensive and the high initial capital costs needing to be invested initially.

The current lack of standards for the modelling structures creates low incentives to implement BIM and there seems to be a gap on the usage of BIM as a collaborative framework due to the absence of BIM contract documents. The copyright of the model and also the confidentiality exposure creates challenges on BIM adoption. Therefore, the lack of formal contract documentations and copyright issues remain a significant concern within the construction industry.

Limitation on interoperability and fragmentation is another factor which contributes to the barrier of BIM implementation. The culture within design teams, culture of companies and interaction between construction teams are also highlighted throughout the literature review. It is noted that the fragmented nature of construction industry does impact on the implementation of BIM. This might be due to the highly competitive working culture and an unwillingness to share information between different professions. The incompatibility between software utilised by different firms becomes a significant barrier on BIM implementation compared to cultural behaviour. 56% of respondents believed incompatibility between software contributes more towards BIM barriers. The barriers highlighted are not fully supported by the literature review and an information gap exists.

The findings seem to draw to the point that there is a great potential for BIM to be implemented in Malaysian construction industry in the long term. Market forces, government initiatives and construction industry willingness are needed in order to drive the Malaysian construction industry in adopting BIM.

6. Conclusion
This paper has shown that the lack of education and training is the main barrier of BIM implementation, more efforts should be made to increase the knowledge on BIM and associated training. Furthermore, foreign professions involved with the implementation of BIM within their countries could assist in providing the overview and knowledge on BIM adoption in Malaysia.

The findings of the study are important to the construction industry professions in Malaysia who are considering adopting BIM, as it provides an overview of BIM barriers and recommendations to the industry. This research, highlights the three main barriers which hinder BIM implementation in the Malaysian construction industry, hence providing a basis to plan strategies to overcome these barriers. It also helps to raise the awareness on the behaviours of contractors, investors, building owners and developers in using BIM. The policy makers could look into these barriers and provides guidelines or incentives to support BIM implementation.

While the small sample size and extent of the study is a limitation, this study does provide a detailed overview and platform to conduct further research. As the Malaysian construction industry is lacking in BIM usage and this research only focused on three main barriers, further research is recommended to be undertaken to examine other barriers for creating more opportunity for BIM implementation.

References
[1] Ghaffarianhoseini A, Tookey J, Ghaffarianhoseini A, Naismith N, Azhar S, Efimova O, Raahemifar K 2017 Building Information Modelling (BIM) uptake: Clear benefits,
understanding its implementation, risks and challenges. *Renewable and Sustainable Energy Reviews* **75** 1046-53.

[2] Li M, Yang J 2014 Analysis of interrelationships between critical waste factors in office building retrofit projects using interpretive structural modelling. *International Journal of Construction Management* **14(1)** 15-27.

[3] Steel J, Drogemuller R, Toth B 2012 Model interoperability in building information modelling. *Software & Systems Modeling* **11(1)** 99-109.

[4] Sahil A 2016 *Adoption of building information modeling in developing countries: A phenomenological perspective*. In: Glick S, Folkestad J, Vasquez R. ProQuest Dissertations Publishing.

[5] Doherty G 2009 *How BIM and integrated practice may change architectural, engineering, and construction education*. In: Denzer A, Barker M, Puckett J, Robinson T. ProQuest Dissertations Publishing.

[6] Latifii AA, Mohd S, Kasim N, Fathi MS 2013 Building Information Modeling (BIM) application in Malaysian construction industry. *International Journal of Construction Engineering and Management* **2(A)** 1-6.

[7] Wong FKW, Wong AKD, Nadeem A 2011 Government roles in implementing building information modelling systems: Comparison between Hong Kong and the United States. *Construction Innovation* **11(1)** 61-76.

[8] Zahrizan Z, Ali NM, Haron AT, Marshall-Ponting A, Hamid ZA 2013 Exploring the adoption of Building Information Modelling (BIM) in the Malaysian construction industry: A qualitative approach. *International Journal of Research in Engineering and Technology* **2(8)** 384-95.

[9] Khosrowshahi F, Arayici Y 2012 Roadmap for implementation of BIM in the UK construction industry. *Engineering, Construction and Architectural Management* **19(6)** 610-35.

[10] Kim J-L 2012 Use of BIM for Effective Visualization Teaching Approach in Construction Education. *Journal of Professional Issues in Engineering Education and Practice* **138(3)** 214-23.

[11] BCIS 2011 RICS 2011 *Building Information Modelling survey report*. London: Royal Institution of Chartered Surveyors.

[12] Hjelseth E 2010 Exchange of Relevant Information in BIM Objects Defined by the Role- and Life-Cycle Information Model. *Architectural Engineering and Design Management* **6(4)** 279-87.

[13] Rebolj D, Babič NC, Magdič A, Podbreznik P, Pšunder M 2008 Automated construction activity monitoring system. *Advanced Engineering Informatics* **22(4)** 493-503.

[14] Rigby ET, McCoy AP, Garvin MJ 2012 Toward Aligning Academic and Industry Understanding of Innovation in the Construction Industry. *International Journal of Construction Education and Research* **8(4)** 243-59.

[15] Ghosh A, Root S 2013 *Industry and academia: A partnership to VDC curriculum*. 49th ASC Annual International Conference Proceedings. California

[16] Arayici Y, Coates P, Koskela L, Kagioglou M, Usher C, O'Reilly K 2011 BIM adoption and implementation for architectural practices. *Structural Survey* **29(1)** 7-25.

[17] Zainon N, Rahim FA, Salleh H 2011 The information technology application change trend: Its implications for the construction industry. *Journal of Surveying, Construction and Property* **2(2)**.

[18] Erika E 2012 *Implementing successful Building Information Modelling*. Boston, London: Artech House.

[19] Salman A, Malik K, Tayyab M 2012 Building information modelling (BIM): now and beyond. *Australasian Journal of Construction Economics and Building* **12(4)** 15-28.

[20] Shabanesfahani A, Tabrizi MRF 2012 Barriers of systemic innovation to increase productivity of engineering and construction industries of the world. *IOSR J Mech Civ Eng* **4(1)** 43-50.

[21] Sebastian R, Van Berlo L 2010 Tool for Benchmarking BIM Performance of Design, Engineering
and Construction Firms in The Netherlands. *Architectural Engineering and Design Management* 6(4) 254-63.

[22] Badrinath AC, Chang YT, Hsieh SH 2016 A review of tertiary BIM education for advanced engineering communication with visualization. *Visualization in Engineering* 4(1) 9.

[23] Khoshnava S, Ahankoob A, Preece C, Rostami R 2012 *Application of BIM in construction safety*. Management in Construction Research Association (MiCRA), Postgraduate Conference, University Teknologi Malaysia, Malaysia.

[24] Eadie R, Browne M, Odeyinka H, McKeown C, McNiff S 2013 BIM implementation throughout the UK construction project lifecycle: An analysis. *Automation in Construction* 36 145-51.

[25] Arensman DB, Ozbek ME 2012 Building Information Modeling and Potential Legal Issues. *International Journal of Construction Education and Research* 8(2) 146-56.

[26] Kent DC, Becerik - Gerber B 2010 Understanding construction industry experience and attitudes toward integrated project delivery. *Journal of Construction Engineering and Management* 136(8) 815-25.

[27] Foster L 2008 *Legal issues and risks associated with Building Information Modeling technology*. In: Glavinich T, Bai Y, Chong O. ProQuest Dissertations Publishing.

[28] Redmond A, Hore A, Alshawi M, West R 2012 Exploring how information exchanges can be enhanced through Cloud BIM. *Automation in Construction* 24 175-83.

[29] Kuehmeier JC 2008 *Building information modeling and its impact on design and construction firms*: University of Florida.

[30] Rajendran P, Gomez CP 2012 *Implementing BIM for waste minimization in the construction industry: a literature review*. 2nd international conference on Management, Malaysia.

[31] Cheung FKT, Rihan J, Tah J, Duce D, Kurul E 2012 Early stage multi-level cost estimation for schematic BIM models. *Automation in Construction* 27 67-77.

[32] Shen W, Hao Q, Mak H, Neelamkavil J, Xie H, Dickinson J, Thomas R, Pardasani A, Xue H 2010 Systems integration and collaboration in architecture, engineering, construction, and facilities management: A review. *Advanced Engineering Informatics* 24(2) 196-207.

[33] Liu M 2013 *The application of BIM and IPD in public design and construction*. In: Griffis FH, Bates A, Chiarelli L, Fayard A-L, Maloof R. ProQuest Dissertations Publishing.

[34] Ku K, Taiebat M 2011 BIM Experiences and Expectations: The Constructors' Perspective. *International Journal of Construction Education and Research* 7(3) 175-97.

[35] Porwal A, Hewage KN 2013 Building Information Modeling (BIM) partnering framework for public construction projects. *Automation in Construction* 31 204-14.

[36] Forgues D, Iordanova I, Valdiviesio F, Staub-French S 2012 *Rethinking the cost estimating process through 5D BIM: A case study*. Construction Research Congress 2012: Construction Challenges in a Flat World.

[37] Anker Jensen P, Ingi Jóhannesson E 2013 Building information modelling in Denmark and Iceland. Engineering, *Construction and Architectural Management* 20(1) 99-110.