Study on the Development of BIM/DPD Around the World and Relevant Application in Western Canada

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Abstract

BIM, DPD and VDC are common buzzwords in the construction industry around the globe. This below report provides an extensive and detailed review of BIM implementation in different places around the world including Europe, The United States, South-East Asia and Middle East & North Africa regions. This includes the adoption rates of BIM across these different jurisdictions, as well as the tactics adopted by government or private entities (construction associations and tendering/procurement platforms) to push forward and incentivize the usage of data rich modelling. The main purposes include: increasing efficiency, building higher quality structures, saving on construction costs, and maintaining a much lower cost over the life cycle of the building (the operations and maintenance phases).

The second part of the report focuses on Alberta, where past research papers are highlighted, and interviews are executed with local key-industry players, including engineers & architects, general contractors, owners and fabricators /manufacturers. These interviews present points of view that at times can seem opposing, however, all the interviewees emphasized the importance of a road-map that leads owners/clients (the main drivers of DPD/BIM due to their ultimate control over project requirements) to an understanding of how to employ DPD/BIM in their future projects. The outcome of this report, the process map, is designed to act as an igniter as it relates to Building Information Modeling within our local construction community, supported by the Edmonton Construction Association and BuildWorks Canada.
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Chapter 1: Introduction

1.1 Background

Building Information Modelling (BIM) is one of the most promising developments in the architecture, engineering and construction (AEC) industries. With BIM technology, an accurate virtual model of a building is constructed digitally. When completed, the computer-generated model contains precise geometry and relevant data needed to support the construction, fabrication, and procurement activities needed to realize the building. BIM also accommodates many of the functions needed to model the lifecycle of a building, providing the basis for new construction capabilities and changes in the roles and relationships among a project team. When implemented appropriately, BIM facilitates a more integrated design and construction process that results in better quality structures at lower cost and reduced project duration (1). BIM is developed as an alternative to the traditional work flow which suffers information losses due to interruptions in information flow as represented in figure 1.1.

![Figure 1.0.1- Traditional Work flow data loss in every stage (1)](image)

BIM workflow is represented appropriately in comparison to the traditional workflow using the MacLeamy curve in figure 1.2. This diagram appropriately displays how using BIM an earlier project integration and development is obtained in a way that reduces the margin of error in the future portions of the structure lifecycle.
1.2 Problem Statement

Usage of BIM is restricted by various aspects which include Lack of knowledge about BIM, clients do not request/enforce BIM, reluctance from clients, contractors or consultants to implement BIM, proprietary interests and mistrust (3). Although the technology is relatively new, some countries/regions did overcome these challenges successfully and implemented BIM, other countries are still struggling to develop the use of BIM by the construction players. Some regions did not develop interest in following the new technology and are resisting the change completely.

1.3 Aim

The aim of this study is to comprehend the global perspective about the application and use of BIM in different regions (Europe, The United States of America, South-East Asia and Middle East) and their current stage of BIM employment through construction associations and tendering platforms. The analysed patterns, regulations, hurdles in every region is used such that this data is employed towards developing BIM usage in western Canada (specifically through Edmonton Construction Association (ECA) and BuildWorks Canada).
1.4 Objectives

This paper highlights three main objectives which follows:

- Investigating the procedure of reinforcing BIM usage in the United Kingdom, Germany, United States of America, Malaysia, Singapore and United Arab Emirates, its implications and the obstacles in its application on differently sized projects.

- Understanding the roles played by the construction associations and tendering platforms to push and adapt to the new workflow in different regions.

- Analysing and interpreting the global usage of BIM and derive the potential usage guides (mainly for owners and general contractors) in western Canada through support by Edmonton Construction Association and BuildWorks Canada.
Chapter 2: The World of BIM

2.1 Introduction

The development of the proposed research requires proper understanding of the global perspective and approaches towards inducing BIM usage around the world. Therefore the BIM usage strategies, hurdles and opportunities in every region will be studied for the purpose of establishing the vision of the BIM development in western Canada and the role construction associations such as ECA and tendering platforms such as BuildWorks Canada can undertake to facilitate BIM usage and push it to greater number of construction stakeholders.

2.2 BIM in the European Region

As BIM is considered currently the most impactful technological development in the construction sector, in a market as large as the European construction sector, which is worth over 1.3 trillion euros (1.96 trillion Canadian Dollars) (4) a wider adoption of BIM is anticipated to unlock a saving of 15-25% by 2025. Anticipating this great potential, EU BIM task group collaborated with strategic construction players across 21 countries in Europe (public policy user, public clients and operator users) to establish “Handbook for the introduction of Building Information Modelling by the European Public Sector” where the purpose of this handbook is to reach for the 2025 savings goal by encouraging wider introduction of BIM by the European public sector as a strategic enabler; and to adopt an aligned framework for its introduction in built environment and construction sector (5). This handbook is seen as a tool which will accelerate growth and encourage competitiveness of the construction sector especially its micro, small and medium sized enterprises (SMEs) (5). For the purpose of encouragement, the European methodology starts with the benefits of using BIM approach which is summarized as shown in table 2.1

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accelerate National Efforts</td>
<td>Through collaborative opportunities, nations can acceleration their own BIM initiatives by learning from one another.</td>
</tr>
<tr>
<td>Minimise Costs</td>
<td>Waste reduced by reuse of existing developments and knowledge.</td>
</tr>
<tr>
<td>Impactful and Robust Programs</td>
<td>By developing existing knowledge, each nation can be informed to create and implement effective initiatives</td>
</tr>
<tr>
<td>International Critical Mass</td>
<td>Encouragement of BIM will increase the strength and effectiveness of each individual national program.</td>
</tr>
<tr>
<td>----------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Reducing trade barrier to growth</td>
<td>Alignment of a European approach will encourage trade and opportunity for growth across borders. Creating national specific approaches will likely confuse the construction sector, discourage cross border working and add a cost burden to the industry when complying with national different approaches.</td>
</tr>
<tr>
<td>Encouraging international standards development</td>
<td>Europe could collectively encourage the development of standards for use in international markets. This ensures open competition in the supply chain and the open sharing of information across software platforms.</td>
</tr>
</tbody>
</table>

### 2.2.1 Action and Strategic Recommendations

In (5) the authors provide a set of recommendations for the introduction of BIM as part of a national strategy or policy as a part of a public estate program. The targeted audience for the strategic recommendations would be:
- Strategic leaders and change managers of public client organisations
- Central government policy officers
Moving on the strategic recommendations lead to action recommendations (which we are more concerned with in the scope of this study). The principle audience for this implementation level definition includes:
- Public procurers and technical managers within the public client organisations
- Technical policy officers, public sector legal specialists
- Building and infrastructure regulatory officers
- Industry suppliers (e.g. manufacturers, architects, engineers and contractors)

This recommendations sections explains the actions to be taken by public stakeholders to introduce and enforce the usage of BIM.

### 2.2.1.1 Public Leadership Action 1: Define Compelling Drivers, A Vision and Goals

This action is necessary to establish basis for the concerted action of a BIM program for the purpose of:
- Defining what it is motivating the public organization to take public leadership for the encouragement of BIM to its public estate
- Describing what the future will look like by taking this action (or avoiding it)
- Specifying the measure and targets that will be improved through BIM usage
- Making a public statement of intent to provide leadership and encouragement to the industry
- Increasing the competences of the public owner, procurer or manager acting as the client

The combined effect of this action is important for:
- Building support within the public sector organization to allow funding and the necessary resources to be committed
- Building alignment for a common direction between stakeholders across the public and private sector
- Creating focus on the outcomes expected by taking action

2.2.1.2 Public Leadership Action 2: Document the Value Proposition and Strategy

In the beginning, define the expected benefits of BIM in relation to the organizations’ objectives and then document the proposed strategy to be implemented by organization to introduce BIM across the construction sector. A phased roadmap development for progressive introduction of BIM would be a recommended option.

The effect of this action is important for:
- Value proposition would clearly emphasize why the public sector should provide its resources to support adoption of BIM across private industry, therefore; providing the required support for an investment request.
- Document program strategies and methodologies to gain the general support and buy-in from key industry and public sector stakeholders to ensure people pull together in the same direction rather than taking different action that could weaken the overall program.

2.2.1.3 Public Leadership Action 3: Identify Sponsors, Funding and Stewardship Team

The last component to establish public leadership, a public sector representative to be a sponsor which will assist in necessary funding to drive the program forward. That have the appropriate level of seniority and responsibility to inform and influence others within the public sector organisation(s). For example, the sponsor might support the funding request decision-making process, or speak publicly at an industry conference about the program.

The effect of this action is important for:
- Gaining the support of a senior public sector advocate increases the visibility and authority of the program both within government and with industry stakeholders. It also unlocks access to funding and acquires resources that allow the program plans to be executed.
2.2.1.4 Communication and Communities Action 1: Engage Early with Industry

An essential component at the center of any change program is the need to communicate with people about the intended change. The communication is better if started early and reaches to targeted audience through implementation of road map of BIM.

- Why change is needed?
- What future will look like?
- How to get where we are going?
- What are expected barriers and how these will be addressed?

The effect of this action is important for:

- Foster buy-in for the BIM program and signal to the industry that change is anticipated, therefore; encouraging people to change.

2.2.1.5 Communication and Communities Action 2: Create Networks

Public sector BIM programs are encouraged to participate in and, if necessary, take action to promote the formation of groups of industry stakeholders to share best practices and lessons learned. It is recommended to collaborate with other countries and encourage alignment and accelerate learning. Similarly, it is highly recommended to join established international and national networks to facilitate the transfer of knowledge.

The effect of this action is important for:

- The use of networks to disseminate information and learning across the industry can accelerate the change process and remove barriers of adoption. Networks are especially useful to allow different organisations to interpret the BIM program to their specific context. For example, an architect’s network will discuss what the BIM program means to them; as well as a general contractor network consider the issues relevant to them. This is an especially useful tool to engage SMEs in the change program.

2.2.1.6 Communication and Communities Action 3: Using Mass Communication and Social Media

It is recommended to include the development and implementation of a mass communication plan. This action would utilise multiple communication channels such as media publications, websites, conferences and social media.

The effect of this action is important for:

- Clear messages to be understood by a wide and diverse audience.
- Clear milestones of the program.
- Sharing success to build and maintain the momentum of the program.

### 2.2.1.7 Collaborative Framework Action 1: Develop Legal and Regulatory Framework

It is highly recommended to assess and clarify the regulatory, procurement and legal contracting arrangements between clients and suppliers to facilitate the use of BIM and the exchange of digital information across the project and asset lifecycle. The legal aspects may include:

- Intellectual property ownership
- Obligations and liabilities of suppliers
- Purpose of information exchanges
- Roles and responsibilities for information management

The effect of this action is important for:

- Clarifying the procurement and contracting process and requirements can unlock new ways of working, stimulating innovation and encouraging the exchange of digital data.

### 2.2.1.8 Collaborative Framework Action 2: Develop Technical and Process Standards

The program should require the use of a standards based open data format for the exchange of information between the supply chain and the client. This format would be used in the tendering and contracting documentation to ensure a non-discriminatory definition for suppliers to comply to. This would also be consistent with European Union rules to ensure an open market to suppliers.

The effect of this action is important for:

- The technical framework for data and process standards provides a consistent language and common understanding of the required outputs from the BIM process.

### 2.2.1.9 Collaborative Framework Action 3: Build Skills, Tools and Guidance

Action should be taken to encourage industry skills development and learning relevant to the BIM program. A skills framework is a recommended development for describing the learning outcomes expected by the BIM program. It is encouraged that guidance material is developed by the program to explain the technical framework of the program; along with the necessary tools to support the project level implementation.

The effect of this action is important for:

- Training providers and academia need to be equipped with a common definition of the target behaviours expected by the BIM program. Without a consistent definition
of the required skills it is likely that training providers and academia will not be able to develop the sufficient capacity of capable skilled professionals.
- In most countries it would be inefficient and cost prohibitive for the central BIM group to develop BIM training courses and training materials. Therefore, the development of a skills framework defines the expected learning outcomes which industry and academia can then respond to by developing courses and materials which meet this requirement.

2.2.1.10 Industry Capacity Action 1: Promote Industry Pilot Projects

It is recommended that pilot projects are a useful way to test the collaborative framework (legal, data and process standards) and to provide a practical demonstration of how BIM is to be implemented under the BIM program.

The effect of this action is important for:
- Build industry’s confidence in the BIM program
- Learn from implementation so that the collaborative framework can be improved based on feedback
- Provide examples of best practices for industry to adopt

2.2.1.11 Industry Capacity Action 2: Increasing Usage of Strategic Lever to Grow Capacity

The public sector program should provide consistent and long-term encouragement or requirements to progressively grow industry wide capacity for digital methods. It is recommended, that public procurement be used to progressively introduce BIM to public project tenders and contracts.

The effect of this action is important for:
- The use of a public policy driver (such as public procurement or regulation) provides industry certainty and confidence to begin the transition towards digital construction; and provides the necessary motivation to invest in re-tooling and re-skilling its workforce.
- Without the drive to use the collaborative BIM framework it is unlikely that the whole sector would transition to digital. The leading organisations and early adopters would take the opportunity but given the large size and high fragmentation of the industry this approach could leave many organisations behind the digital transition.
2.2.12 Industry Capacity Action 3: Measure and Monitoring Progress and Embedding Change

The public sector program should provide consistent and long-term encouragement or requirements to progressively grow industry wide capacity for digital methods. It is recommended, that public procurement be used to progressively introduce BIM to public project tenders and contracts.

The effect of this action is important for:
- Measurements of projects and of the program are helpful to inspire and continue building the support of industry for its digital transition.
- Key performance indicators (KPIs) for the public sector are also useful to gain the support of public clients that are potentially introducing BIM to their public estate.

2.2.2 BIM in the United Kingdom

The Government has identified Construction as an enabling sector under industrial strategy. The sector is highly diverse with a range of discrete subsectors. It delivered around £69 billion GVA (£107bn output) to the UK economy in 2010 employing around 2.5 million workers and as such is a key contributor to UK growth. It is also critical to the achievement of UK climate change targets [9].

The United Kingdom’s 2011 construction strategy embraced the use of BIM and mandated its use at a maturity level 2 on all centrally procured government projects (usually over £5M) by April 2016. The strategy was introduced putting in mind the potential benefits which includes driving greater collaboration, efficiency, innovation and value across all elements of industry [6]. The UK BIM Task Group was set up to support and help to deliver the objectives of the Government Construction Strategy 2011 through the strategic and action recommendations which are explained in section in 2.2.1 earlier.

As of the mandate, the BIM will be a contractual condition of working with the UK’s largest client, central government. BIM will help the government meet its strategic aims, specifically:
- 33% reduction in the initial cost of construction and the whole life cost of built assets;
- 50% reduction in the overall time, from inception to completion, for new build and refurbished assets;
- 50% reduction in greenhouse gas emissions in the built environment; and
- 50% reduction in the trade gap between total exports and total imports for construction products and materials.

The BIM increases the efficiency and reduces the cost of construction for central government, so the government can build more for less. They also believe that successful government projects will set an example for the private sector, leading to more rapid adoption of BIM throughout the industry [8].

National Building Specifications (NBS) [8] in the United Kingdom releases a yearly report (National BIM Report) that provides updates on BIM adoption rates in the United Kingdom and it also works to assess the strength of government mandate reinforcement. In the NBS 2018 report, the BIM adoption rates over time by interviewing a number of construction players in the UK, is presented as shown in figure 2.1.

**BIM adoption over time**

![Figure 2.0.1- BIM adoption rates in the UK from 2011 to 2018 [8]](image)

By studying the patterns, the increase can be seen to be consistent regardless of the mandate introduced in April 2016. Therefore based on NBS, “If people felt that the mandate was not successful, this was almost always because the Government wasn’t seen to be doing enough to promote, enforce and embed BIM, and almost never because the aim of the mandate, to embed BIM in UK construction, was seen as a mistake”[8]. In the same
study, an analysis of construction stakeholders’ perception on the government mandate is seen in figure 2.2 and figure 2.3.

How successful do you think UK Government’s 2016 BIM Mandate has been?

![Success of UK Government’s 2016 BIM Mandate](image)

Perceptions of the Government's mandate (% agreement)

![Perceptions of the Government’s Mandate](image)

Whilst almost two thirds (63%) agree that the Government requires BIM on its projects, a very similar number (62%) feel that the Government is not enforcing this. For the first time, less than a majority (47%) feel that the Government is ‘on the right track’ with BIM. That is still a high percentage, but less than last year (51%). Just over two fifths are not clear on what they have to do to comply with the mandate. Less than one fifth agree that ‘the construction industry is now delivering on the Government’s 2016 BIM mandate’ [8].

This can clearly preview that although mandating BIM is a move which holds great potential, many construction stakeholders believe that it was not performed in a way that enforces the mandate. It is also seen that the government stepped back and lost momentum by not doing much to promote the initiative and its potential benefits.
2.2.2.1 Tendering Platforms

Various tendering platforms are used in the United Kingdom for public and private projects. Some of the tendering platforms is a subscription-based model, while others are free to use which are created by city councils or government initiatives. However, there is nothing that can be set as an equivalent for BuildWorks Canada. The United Kingdom tendering platforms feel more generic and not perfectly tailored for the use by the construction industry only (rather for any forms of contracts). An example here would be "Kent Business Portal", which registrations for the website is free and would allow access to different tendering opportunities (even outside construction industry). A screenshot of a tender opportunity in Kent Business Portal website is shown in figure 2.4.

![Kent Business Portal Tendering Opportunity](image)

Other similar platforms were also identified as a part of this research which include but not limited to:
- Competefor.com
- Ted.europa.eu
- Publiccontractsscotland.gov.uk
These platforms did not show any signs of BIM/DPD integration/motivation through their interface. The platforms look more outdated and does not support any form of collaboration and are not intended for the purpose in any way.

2.2.3 BIM in Germany

Germany was one of the countries closely following the lead in becoming a major European nation to mandate the implementation of BIM.

Recently, The Federal Ministry of Transport and Digital Infrastructure (BMVI) has also announced that it will be supporting SMEs in undergoing the BIM transition by providing financial support. The Government will also encourage pilot projects by helping companies achieve the optimal approaches to the BIM transition.

The Federal Ministry of Transport and digital Infrastructure already provides financial aid to four pilot BIM projects to BIM including within a research project in the area of road and rail construction, with a total of € 3.8 mill.

Supporting the implementation of BIM further, a group of industrial associations, major companies and non-governmental organizations came together to set up a German BIM Steering Group – “Planen Bauen 4.0”. Dr. Ilka May the group’s managing director and most prominent spokesperson shared that a main impediment to BIM adoption in Germany was not in the technology but rather in people’s knowledge of BIM. Actors did not know what was expected of them, who has to provide what data and who is responsible for what. That is why, “Planen Bauen 4.0” initiative aims at setting clear guidelines (not obligations) for the practical application of BIM methods by introducing the BIM Level Plan – STUFENPLAN FÜR BIM IN DEUTSCHLAND [10].

The aim of the Road Map is the gradual introduction of BIM in the area of responsibility of the Federal Ministry of Transport and Digital Infrastructure. It therefore applies primarily to infrastructure construction and infrastructure-related building construction but can also be used as a model in other areas. The Federal Ministry of Transport and Digital Infrastructure, which has the lead responsibility for digitalization in the Federal Government and is the Federal Government's main investor in the construction sector, will lead by example in the implementation of the Road Map [10].
From mid-2017 onwards, the BIM minimum requirements of Performance Level 1 has been applied in an increasing number of projects. From the end of 2020 onwards, Performance Level 1 is to be used, on a regular basis, in Federal Government transport infrastructure projects that are to be newly planned. The purpose of the first phase, which is currently underway, is to prepare for the application of BIM by creating the necessary conditions and providing targeted support to clients and members of the supply chain alike. The first phase also aims to help convince the market participants of the significant advantages BIM offers. At the same time, it is being examined for which types of projects BIM makes sense and in which way it should be applied. In addition, it is important that the market participants themselves gain concrete experience with BIM. For this purpose, simple projects are a good way to start. At the beginning, it may also make sense to plan and carry out projects in the traditional way and in BIM in parallel. This means additional effort but also reduces risks, especially in the initial period when BIM skills are still limited, and permits a direct comparison of alternative approaches [10].

2.2.3.1 Construction Associations in Europe

AEEBC (Association of European Experts in Building and Construction) is the only construction association which was found in Europe which holds resemblance and operate partially similarly to Edmonton Construction Association (ECA) or any construction association generally in Western Canada. The AEEBC defines itself as a member organization with various membership categories. Principal members, Honorary members and affiliate members from all over Europe. Comprising of professional organizations, academic bodies and individuals that share a common goal of sharing knowledge and expertise for the benefit of the construction industry. AEEBC operates various events around Europe where representatives of professional, academic bodies and interested members do attend [11].

The AEEBC is involved in projects covering all aspects relevant to the profession of building surveyors and construction experts. It is recognised within the AEEBC that each member country faces on going legislative changes related to their professions that is largely driven by EU legislation. The opportunity to disseminate and discuss each countries approach, understanding and implementation is key to the spirit of the AEEBC. The AEEBC is also involved in Leonardo De Vinci Programmes with member countries. These programmes link policy to practice in the field of vocational education and training (VET). Projects range from those giving individuals the chance to improve their competences, knowledge and skills through a period abroad, to Europe-wide co-operation between training organizations. The programme funds a wide range of actions, notably cross-
border mobility initiatives; co-operation projects to develop and spread innovation; and thematic networks. The AEEBC has sponsored a successful Leonardo da Vinci (LdV) bid for funding which focuses on the creation of manuals promoting common platforms of managerial qualifications in the field of construction [11].

As a part of AEEBC projects, the current project is called BIM4PLACEMENT. Countries involved: Italy, Finland, Norway + one partner (AEEBC) active all over Europe. The project general aim is to deepen knowledge about Building Information Modelling (BIM) as a skills' development training subject for employability goals, upgrading existing training tools and professional qualifications and creating a network to promote work-based learning with special attention to apprenticeship. BIM project is a capacity building project in the area of VET education, promoting cooperation and partnerships among 6 organizations (VET provider, Regional Authority, 2 universities, private company, European Association) and providing new methods for delivering training addressed to a variety of target groups [11][12].

Considering the lack of homogeneous tools validated at European level for training in BIM, this project has the aim of building a bridge between Northern Europe and Southern Europe: Italy will have the opportunity to learn from the European best experiences and consequently update the professional qualification related to building and construction design, while Finland and Norway will have the opportunity to enlarge their international BIM-related network of institution and companies and update their knowledge from mutual exchange of best practices. All together partners will create an innovative tool for training beginners in BIM in a wide range of training environments: high school, VET centre, university and companies [11][12].

2.3 BIM in The United States of America

2.3.1 The American Approach

Government mandated BIM is one example of how other countries are surpassing the United States. The United Kingdom’s standard now requires a Level 2 BIM deliverable for all public work. Holding all projects to a national standard is something lacking with BIM in the United States. Without this standard, the deliverable is determined on a client-to-client basis or even a project-to-project basis [13].

Many government departments have created their own standards and published them to forums such as the National Institute of Building Sciences, but
these standards are created independently with no relationship to one another. For example, a project for the Department of Veterans Affairs will have a different deliverable than a project for the GSA. While both departments reside under the same government, they act independently on projects. Some see this non-uniformed deliverable with BIM in the United States as a good thing, citing that it allows innovation in problem-solving as compared to areas of the world where government standards limit new ideas, such as Steve Jones, Senior Director of Dodge Data & Analytics who states:

"The innovation you are seeing is happening in the larger firms that work in multiple offices. They are now getting smart about picking up on what the other offices are doing, and you are seeing these ideas go viral. These ideas will get implemented on projects in those offices, which in turn helps them go viral in those markets. When the project finishes, others begin to copy it. That’s kind of the viral method that happens here as opposed to the UK, where basically a program gets laid out per the standard and people primarily learn how to do it that way [13].” - Steve Jones

Currently, the United States doesn’t have requirements for BIM on a national level. We have seen steps at the local level to increase BIM use, though. In 2010, for example, Wisconsin became the first state to require BIM on publicly-funded projects with a budget over $5 million. Even more locally, the Los Angeles Community College District (LACCD) has required BIM be used on a sustainable building project that is funded through a taxpayer-approved bond. The project includes $6 billion worth of construction on nine of the district’s campuses, and thus far, BIM has saved LACCD $12 million in construction costs.

The U.S. National Institute of Building Sciences has developed a consensus standard known as National BIM Standard – United States (NBIMS-US) to facilitate adoption, but will a BIM mandate come to place anytime soon? Some experts say it’s not likely, since unlike in the U.K., public construction projects in the United States aren’t handled by one agency. That makes implementing a mandate much more challenging.

The primary aim of the NBIMS-US is to provide standards to facilitate the efficient life-cycle management of the built environment supported by digital technology. This is accomplished through prescribing effective, repeatable elements and mechanisms in the creation, exchange, and management of building information modeling (BIM) data. These elements and mechanisms include reference standards of technology, classification
systems, and conformance specifications; information exchange standards describing processes and exchange requirements for specific tasks during different parts of the building life-cycle; and practice standards that outline processes and workflows for data modeling, management, communication, project execution, and delivery, and even contract specifications [15].

The National BIM Standard-United States is designed for two specific audiences:
- Software developers and vendors;
- Practice documents for implementers who design, engineer, construct, own, and operate the built environment.

For software developers, interoperability of data and information is an absolute requirement for designing and managing the lifecycle of the built environment. Software developers and vendors must develop and support programs to achieve the seamless exchange of data and information between users. The design and coding of software standards will allow developers to efficiently accomplish this task. NBIMS-US has delineated the appropriate standards to cover all aspects of software development [15].

Two sections within the standard provide the developer with the necessary information:
- Reference standards: This set of standards provides a data dictionary, data model, web-based exchange, and structures and identifiers for building data and information.
- Exchange information standards: This section sets standards for data management, assurance, and validation, as well as exchange concepts; defines the design of exchanges for specific types of data related to building analysis; and includes Construction Operations Building information exchange (COBie).

On the other side for implementers and users, this section of NBIMS-US focuses on BIM implementation within the building industry. This section describes the necessary professional knowledge, practice and judgment for all industry disciplines and professionals as well as critical management systems and tools for the building lifecycle. Thus far in the NBIMS-US development process, the Practice Document section has been the least developed and documented. As BIM becomes more developed as a tool and implemented within the industry, practice procedures and standards will be developed, documented and standardized. As these practices become documented, NBIMS-US™ will become the depository for such practices.
As we’ve seen in the local examples of BIM use above, though, this doesn’t mean BIM doesn’t have a future in the United States. The exact opposite is true. BIM provides many benefits to contractors, including reduced errors and rework, better logistics, more easily accessible documents, increased bid accuracy and more efficient change order management, all of which mean contractors may choose to adopt BIM in the future [15].

In addition to benefiting contractors, BIM also benefits the end users of construction projects. In the case of LACCD, BIM construction was partially implemented to enable future cost savings for maintenance and operations. BIM documents all necessary information about a project in one place, and owners can access that information down the line [15].

Recent public construction projects using BIM have demonstrated that it can help keep projects on track and reduce construction costs. At the end of the day, that saves taxpayer dollars. So, while we may not see a BIM mandate in the United States anytime soon, we’re likely to see continued BIM growth as local governments look to BIM and owners/contractors continue to see the benefits [15].

2.3.2 BIM Adoption in the US

McGraw-Hill Construction performed an extensive survey/research on the BIM adoption rates in North America (NA). This survey was carried in 2007, 2009 and 2012. The level of BIM adoption in NA is shown in figure 2.5.

![Levels of BIM Adoption in North America](image)

Despite the severe economic downturn between 2009 and 2012, the number of BIM reporting usage of BIM grew by 45%. This trend demonstrates the powerful value
proposition of BIM to a broad range of companies across the construction industry. Counteracting the instinct to cut back during a recession, the industry invested in a more efficient and productive future by embracing the technologies and processes of BIM [14].

In the US differences in BIM adoption between major regions were noticeable in the past. However, based on the latest data in the report (2012), differences are now much less as shown in figure 2.6.

![BIM Use in North America](image)

**Figure 2.0.6- BIM usage in different regions of NA [14]**

The west leads all regions with an overall BIM adoption rate of 77%, up from 56% in 2009 and well above the national average. In 2009, Northeast regional adoption was 38% which was significantly lower than the national average of 49%. Although, still behind in 2012, this region grew the most between 2009 and 2012. The Midwest and South are still slightly above and slightly below average respectively, and Canada remains essentially at average [14]. Canada is studied here as one region and it is not distributed and cut down into smaller portions (west, east, etc...) which I believe is not a very accurate representation of the actual BIM adoption patterns at that time.
2.3.3 Construction (Trade) Associations in the US

Based on this research around 12 different construction associations are identified in The United States of America, the different noticeable and important ones will be discussed in detail in this section:

**Associated Builders and Contractors Inc. (ABC),** is a national association with 69 chapters representing 21,000 merit shop construction and construction-related firms with nearly two million employees. ABC’s membership represents all specialties within the U.S. construction industry and is comprised primarily of firms that perform work in the industrial and commercial sectors of the industry. ABC adapts a membership-based business model similarly to ECA. ABC focuses on education and training similarly to ECA, however; it is more concerned construction site related trainings (rather than softwares or technical knowledge) and that perfectly aligns with its role as an association for builders and contractors. Not any initiative shown to support/use BIM by the relevant construction members [16].

**American Institute of Constructors (AIC),** is the constructor's counterpart of professional organizations found in architecture, engineering, law and other fields. As such, the institute serves as the national qualifying body of professional constructor. AIC adapts a membership-based business model similarly to ECA. The main focus of AIC is to accredit and certify the members through AIC Certification Examination for those involved in the management of construction process, other professional development activities are present with the aim of educating its members to boost their career opportunities. Not any initiative shown to support/use BIM by the relevant construction members [17].

**Associated General Contractors of America (AGC),** is the leading association for the construction industry in the US with over than 26,000 members. Operating in partnership with its nationwide network of Chapters, AGC provides a full range of services satisfying the needs and concerns of its members, thereby improving the quality of construction and protecting the public interest. AGC adapts a membership-based business model similarly to ECA. AGC similarly to ECA is taking the initiative to encourage BIM usage in the construction industry in the Metropolitan Washington DC area. Its approach toward encouraging BIM usage is offering a full BIM course and then apply for CM-BIM exam. Other learning options include lean construction, safety trainings etc… No solid approach is taken to support/encourage BIM usage other than relevant training, classes and examinations [18].
Construction Management Association of America (CMAA), is North America’s only organization dedicated exclusively to the interests of professional Construction and Program Management. CMAA provides a “go-to” resource for technical and leadership training, networking, and professional development which in turn, will ensure that you are staying current on industry best practices to complete projects on-time and on-budget. Members have access to benefits both at the national and the chapter level. CMAA provides certifications/accreditations such as CCM and CMIT. Not any initiative shown to support/use BIM by the relevant construction members [19].


2.3.4 Tendering Platforms (Builders Exchange) in the US

Based on research, dozens of different Builders Exchange platform which have different area coverages were identified, example: Sioux Falls Builders Exchange which operate in Sioux Falls, South Dakota area [20] and others. For the sake of this research only noticeable and important builders exchange platforms will be identified with relevant comparison relative to Buildworks Canada. Most of the Builders Exchange platforms identified are privately owned and operate as for-profit businesses.

Virtual Builders Exchange (VBE) (affiliated with ABC and ASA) is one of the most established builders exchange platforms in the US. VBE is considered as the number one source for commercial construction leads in Texas. This information is amalgamated and made available to construction professionals via membership that provides access to a suite of services customized to individual needs. One of the main selling points of VBE currently is the virtual plan room, which shows bidding opportunities state-wide with unlimited access to all plans, specs and addenda and daily email updates about projects (and project changes). This includes access to projects in the Pre-Bid/Design Phase, including project name, location, scope of work, Owner, Design Team (if applicable) and design status. Although the platform was not used (for the purpose of not going through the registration procedures), there is no any sign of BIM use, promotion or integration [21].
2.4 BIM in South-East Asia

Governments worldwide, including Denmark, Finland, Norway, South Korea, UK, and USA play an important role in leading the construction industry in BIM adoption. Singapore is one of a few countries in Asia which have implemented BIM. Others are Hong Kong, PRC and South Korea.

Building Information Modelling (BIM) is growing in South-East Asia (SEA), in this part of the study, Singapore is going to be undertaken as the main country to assess BIM development. Singapore is the most developed country in SEA; therefore, the best BIM adoption rates in the region and capabilities is expected.

2.4.1 BIM in Singapore

2.4.1.1 Government and Public Initiatives

In Singapore, the Building and Construction Authority (BCA) and buildingSMART Singapore have been promoting the use of BIM in the construction industry because BIM is identified as a key technology that will enhance productivity and integration across diverse disciplines in the construction value chain.

In 2010, BCA initiates the BIM Roadmap with the ambitious target that at least 80% of the construction industry uses BIM by 2015. A National BIM Steering Committee, comprising representatives of professional institutions, trade associations, major government procurement entities and regulatory agencies, was set up in 2011 to provide a governing framework to steer the implementation of the BIM Roadmap [28]. The committee led the development of the “Singapore BIM Guide” and “BIM Particular Conditions”. Platforms such as BIM Manager Forums have been organised to discuss and address technical issues faced by the industry. This is part of the government’s plan to improve the construction industry’s productivity by up to 25 percent over the next decade [24].

To encourage the BIM adoption in Singaporean AEC industry, BCA [25] has provided a series of initiatives. For example, BCA and buildingSMART Singapore developed BIM submission templates, a library of design objects and project collaboration guidelines. In 2011, pilot projects with BIM were performed with the public sector clients. Subsequently, BCA issued regulations to make it compulsory for practitioners to submit architectural, structural as well as mechanical and electrical plans for building works for approval in the
BIM format [26]. Specifically, after 1 July 2013, all architectural plans of new building projects with gross floor area of more than 20,000 m² must be submitted in the BIM format; after 1 July 2014, all the engineering plans of new building projects with gross floor area above 20,000 m² must be submitted in the BIM format; and after 1 July 2015, all plans of new building projects with gross floor area above 5,000 m² must be submitted in BIM format.

BCA also set up the BIM Fund, which is aimed to help firms establish BIM collaboration capability by covering the costs for training, consultancy services and purchase of hardware and BIM software [27]. Since 2013, mandatory BIM electronic submission has been introduced in phases. Thus, it is compulsory for practitioners to submit architectural or engineering plans in the BIM format for regulatory approval [22].

2.4.1.2 BIM Adoption Challenges

Despite governmental and industrial efforts, the BIM adoption rates in Singapore still faces some hindrances/stumbling blocks and challenges which are of interest to our study at the current stage. Based on an extensive study performed by [23] in Singapore through questionnaires “Lack of subcontractors who can use BIM technology” received the top rank as the main challenge to BIM adoption in Singapore, indicating that it was not sufficient to promote BIM adoption in only main contractors.

Subcontractors, which were also important participants in construction projects, also must be involved in the trend of BIM adoption. However, the subcontractors were likely to undertake small projects that did not face mandatory requirements for BIM submission, and thus do not have incentives to adopt BIM.

“Cost of investment” was ranked second in [23] suggesting the costs associated with BIM were still a great concern of the AEC industry practitioners in Singapore. Although BCA has set up the BIM Fund that may be used to cover the costs for training, consultancy services and purchase of hardware and BIM software [27], there were also specific requirements for the applicants. Thus, some firms may not be eligible for the BIM Fund and have to bear the costs on their own.

2.4.1.3 Alternative Routes for Adoption

In 2014, the second BIM Roadmap was launched after the International Panel of Experts in BIM proposed a number of key recommendations, which included the public-sector taking the lead, BIM for facility and asset management, accelerating process
transformation, building BIM capability and capacity and BIM R&D [29]. The report presented a review of the current state of BIM adoption. The developers are detached from the BIM process and lack the know-how to drive the process. The consultants focus too much on e-submission and lack the time to undertake design co-ordination. Main contractors commented on the lack of quality models from consultants. The main contractors are currently not taking advantage of the full potential of BIM to resolve issues with consultants and subcontractors. The specialist subcontractors lack BIM skills. There is a lack of BIM usage for facilities management. It was also highlighted that there is a lack of BIM collaboration among project participants.

Hence, the main focus of the second BIM Roadmap is to drive BIM collaboration throughout the value chain. The funding level from the BCA BIM Fund had been increased from 50 percent to 70 percent for Project Collaboration Scheme. The “Singapore BIM Guide” and “Public Sector BIM Requirement” would be reviewed to include BIM coordination and model handover. Procurement methods and contract conditions would be developed based on BIM.

2.4.1.4 Construction (Trade) Associations in Singapore

The only trade association with realised notable influence in Singapore is The Singapore Contractors Association LTD (SCAL). SCAL operates with the mission of being an effective voice of the construction industry advocating business-friendly practices, promoting industry development, and fostering a safe and productive work environment. Using a membership-based business-model with the aim of targeting individuals, associate and trade members. SCAL runs different set of events for different types of audience, educational events and social events (they have their own golf tournaments like ECA!). SCAL only shares BCA BIM documents and does not perform any extra steps/initiatives to motivate/induce the usage of BIM in the Singaporean AEC industry [30].

2.4.1.5 Tendering Platforms in Singapore

Government Electronic Business (GeBIZ) portal is the reference to the public for all tendering opportunities set and updated by Singapore Government; however, the website is very basic with only fundamental opportunities to search for bidding opportunities and bidding for it. No membership is needed to use the website for different construction projects (unless certain categories/packages are used). No BIM integration or signs of potential integration is shown in this website [31]. Other platforms are available but basically GeBIZ is the main tendering platform in Singapore.
2.4.2 BIM in Malaysia

Although Malaysia and Singapore are neighbouring countries; However, the situation in Malaysia is the contrary of that in Singapore. In Malaysia, regardless the efforts in transforming the nation to become a high-income and developed nation by the year 2020 through the ICT-driven or ICT-enabled strategic programmes, adoption of BIM in Malaysia is mostly driven by property developers and contractors as most of the work is controlled by private companies rather than public entities as shown in figure 2.7, while the government mainly supports the training for BIM adoption [35].

![Figure 2.0.7- Projects Classifications in Malaysia](image)

In Malaysia, the idea to implement BIM was introduced by the Director of Public Works Department (PWD) in 2007 [32]. This step was a result of the government’s awareness of the potential of BIM to reduce construction cost and avoid design problems in planning phase. On 27 August 2007, PWD committee was established by the government to choose the right BIM platform to ensure interoperability [32]. The purpose of establishing the committee was to identify construction project processes that involved BIM implementation. Moreover, the committee also prepared a BIM standard manual documentation for PWD as a guideline for construction players’ reference. The committee also provides BIM training and advisory assistance to project teams in using BIM tools [32].

Pilot projects are part of Malaysian government’s initiative in exposing government officers to BIM [32]. Only in 2010 it first took place, where the National Cancer Institute construction project was to be built [36]. To overcome issues associated with unawareness of relevant BIM softwares usage, Malaysian government has allocated a grant to undergraduate students and any organizations or individuals to receive training on BIM provided by Multimedia Super Corridor (MSC) Malaysia [34].
2.4.2.1 Malaysia Compared to The World

In worldwide, the adoption rate of BIM has been increasing over the past years especially by commercial contractors [37]. The level of adoption rate in North America has increased from 28% (2007) to 71% (2012) where contractors gave the highest adoption rate (74%) as compared to the architects (70%) and the engineers (64%) [14]. In 2016, in the United Kingdom, the government mandated the application of BIM. Therefore, the adoption rate is has increased from 60% to 95% for last three years [8]. In Malaysia, even though the adoption rate of BIM among construction organisations (or known as contractors), is only 5.2% increase from 2007 to 2013 [38], the number will increase as Construction Industry Development Board (CIDB) has enhanced a lot of seminar, talks and conferences regarding BIM adoption.

2.4.2.2 Future Plans to Facilitate Adoption

In 2014, CIDB developed BIM roadmap which focused into seven pillars: Standard and Accreditation (P1), Collaboration and Incentives (P2), Education and Awareness (P3), National BIM Library (P4), BIM Guidelines and Legal Issues (P5), Special Interest Group (P6) and Research and Development (P7). The Seven pillars were constructed by CIDB in order to facilitate many organisations in adopting and implementing BIM. In 2016, CIDB announced that Construction industry players will be required to use the Building Information Modelling (BIM) system on government projects worth over RM100mil by 2020; however, it is important to think whether this will be effective as only a small portion of the projects are worth this number as shown in figure 2.8 [39].

![Figure 2.0.8- Value of Active Projects in Malaysian Market [39]](image-url)
2.4.2.3 Construction Associations in Malaysia

The only construction association with realised notable influence in Malaysia is **Master Builders Association Malaysia (MBAM)**. MBAM operates with the vision of being the prime mover and recognized voice of the Malaysian construction industry. Using a membership-based business model with the aim of targeting construction firms. MBAM runs events for different types of audience, including educational events and social events. MBAM only provides BIM educational classes to motivate and induce the usage of BIM in the Malaysian AEC industry [40].

2.5 BIM in The Middle East and North African Region

The Middle East region consists of Gulf Cooperation Council (GCC), North Africa and some countries in Asia. In this section of the study we are more concerned with GCC and North Africa countries. According to [41] there are currently 117 major projects that are ongoing in the region and to be completed by 2030 with a total cost of US$1 trillion dollar. The UK BIM mandate has resulted in the wide spread of the adoption of BIM in the Middle East, with the close economic relationship between the UK and the Middle East, which is reflected in the local dominance of British architects, project managers, engineers and contractors [42]. In addition, there are many multi-national firms who have multiple offices across the Middle East region, which impose a wider adoption of BIM in construction processes across the Middle East. This is motivated due to the rapid growth of mega and complex projects in the UAE, Qatar, Bahrain, Kuwait and Saudi Arabia [42].

2.5.1 BIM Adoption and Implementation in The Middle East

Building Smart reported on the adaptation of BIM in the entire Middle East region [43]. The report concluded that the use of BIM in Middle East region is not mandatory. The report surveyed the usage of BIM across the Gulf Cooperation Council (GCC) and Jordan and recommended how the use of BIM can be increased in the future. Although the survey showed that only 25% of people are using BIM; in addition, the report stated that the lack of BIM specialists was a concern since 64% of people who received training are self-taught. Followed by there were 43% who did not know how to use BIM, and 41% were interested in using BIM but do not know how to start, and finally 19% of respondents stated that BIM is too expensive to be implemented [43].
It is explained in [44] that the Middle East has the lowest take up of BIM, with the public sector not taking any steps to implement it. Professionals in the Middle East look at BIM as just a tool that presents a 3D model of the building [44]. A recent research in [45] showed that non-existence of standards along with related implementation costs and uncertain profitability are the main challenges when investigating the use of BIM in the UAE. Although other countries (apart from the Middle East) have highlighted similar reasons for lack of adopting and implementing of BIM to those mentioned by current research in the Middle East, there are factors that motivate considering the Middle East as a whole entity when comparing it to the rest of the world. The first factor is the unified language (Arabic), which is used by all the Arab countries. The second factor is the similarity of Arab cultures whereas most of countries around the world have differentiated and distinguished cultures. The final factor is that most (if not all) construction practices within the Middle East use similar standards (mostly American or British) and protocols, which motivate the need for a holistic investigation of current BIM practices from different Middle Eastern countries [46].

Based on study performed in [46] through questionnaires for consulting firms (architects, engineers, project managers, BIM managers, BIM coordinators, planners, and draftsmen), contractors, manufactures, construction managers, and site engineers. The authors made sure that the invitations were send to both the public and the private sector for a more accurate result. The reasons identified as barriers and obstacles to implementing BIM in The Middle East was different compared to different regions in the world, the main ones are, people comparing BIM to CAD (construction professionals still look at BIM as an advanced AutoCAD tool that gives a 3D model of the structure), resistance to change and contractors looks at BIM as an additional cost.

For the purpose of this study, The United Arab Emirates (UAE) and The Kingdom of Saudi Arabia (KSA) is to be studied in the next section to assess the performance of BIM in the region.

2.5.2 BIM in The United Arab Emirates

Rate of development of the United Arab Emirates (UAE) economy has increased remarkably during the last 25 years with a marked boom in the construction industry. BIM was mandated just in Dubai (one of the 7 states) by Dubai Municipality (DM) [Side Fact: Dubai alone contributes about 47% of the projects (properties) in all GCC countries]. DM mandate in May 2014 that BIM be used in buildings over 40 stories or more than 300,000 sqft. (private or government projects) and it is also mandatory on complex, specialized
buildings such as hospitals and universities [47]. According to Koseogle (2013), the main problem in implementing BIM in UAE was that there are no published and accepted BIM standards and protocols. While most clients want to have BIM used in their projects while they do not have a clear understanding of its meaning and practical implication. No more than 10% of the UAE construction industry know or is aware of the full scope of BIM [47]. Based on a research paper [49] survey, the surveys showed startling results concerning the academic sector in the UAE where almost 70% of respondents were not aware of the BIM mandate.

Non-existence of standards and not having comprehensive BIM stated advantages and related costs and profitability are of the main challenges in BIM implementation in UAE construction industry. Professionals, educational institutions and organizations have started to adopt BIM software tools and adapt their own project delivery systems to satisfy market requirements. The literature review shows that BIM is already mandated in Dubai but for specific type of projects. BIM is not yet mandatory in all the UAE construction projects, nor is it mandated in all of the emirates. Furthermore, there is a need to develop BIM standard and BIM protocols for the UAE construction industry [46].

However, BIM awareness is not the only concern, equally important is to prepare the legal system to be ready for it. The traditional lines of liability are blurring because of BIM shifting responsibilities, i.e. no single person could be responsible for all of its accuracy. In fact, only few court cases provide insight into the future of BIM law, risk and liability [50]. An important question arise, is the legal system in the UAE ready to handle disputes based on a BIM model? What are the legal implications arising from using BIM? There any many other questions surround Dubai mandate realization and efficient utilization [49].

2.5.2.1 Construction Associations and Tendering Platforms in UAE

It is redundant to discuss construction associations and tendering platforms in the UAE as obviously it is lagging in BIM adoption. Just for the sake of information, in terms of tendering platforms each state in the UAE has its respective tendering platform which is operated and maintained by the state government. These platforms satisfy basic intentions with obviously no BIM integration or signs of any tech advancement. One main construction association is UAE Contractors’ Association is a non-profit organization (with around 50 members of contracting companies) which mainly has the task of providing members with bilingual tender circular and opening results. UAE Contractors’ Association organizes very small number of events and is not demonstrating any educational events in the area of BIM [48].
2.5.3 BIM in The Kingdom of Saudi Arabia

The Kingdom of Saudi Arabia has one of the largest and rapidly growing construction sectors in the Middle East region. The revenues from oil has brought remarkable financial support to the Saudi Construction Industry [51], hence the financial flow and the size of the projects are comparable to the currently prevailing situation [52]. With over $629 hundred billion already invested in energy, infrastructure, transportation, education, healthcare, and other very important economic sectors still remain, making the Kingdom a leading investment destination for construction work [53]. Even though BIM promise to generate benefits and overcome problems in the design, construction, and management of buildings, the barriers to its adoption specific to Saudi Arabia cannot be neglected. These can be typified in four categories [54]:

- **Legal problems** include the undefined responsibilities of data content in the models and the legal status of these models compared to other documents [55], [56],
- **Business problems** concerned with the allocations of roles, responsibilities, and rewards, cost of implementation (software and training) lack of senior management support,
- **Human problems** (related to fear of changes to working culture and resistance to alterations in roles, ICT literacy), and
- **Technical problems** (related to the lack of training and project planning, the immaturity of software, particularly in terms of data exchange and interoperability) [55], [56].

Based on a very detailed set of surveys in the Saudi construction industry, AlHumayn et al., 2017 concludes that Saudi Arabia needs a top-down strategy that facilitates the smooth flow of information. As lack of BIM training and lack of governmental legislation are the main stumbling blocks to the growth and adaption of BIM in KSA [57].

2.5.3.1 Construction Associations and Tendering Platforms in KSA

KSA mandated that all construction companies should be part of a construction association known as **Saudi Contractors Authority (SCA)** under KSA Vision 2030 [58]. SCA aims at organizing and developing contracting sector, building distinctive productive competencies and creating a safe environment of international quality. The membership has added benefits, including medical insurance plans, sports and fitness clubs’ memberships and Hotel/restaurants discounts. SCA has an integrated tendering platform (**Muqawil**) which a user is redirected from (the way ECA and Buildworks Canada work together). Being an SCA member grants automatic membership in Muqawil platform (Although users can obtain membership/subscription in the tendering platform alone) [59].
Chapter 3: BIM In Western Canada

3.1 Introduction

After studying the BIM adoption in different regions of the world on a macroscale. It is essential to move in and narrow down the study towards BIM in Western Canada (and in Alberta specifically). Due to limited publications and available resources, this section would first study the available literature on BIM adoption and usage in Western Canada and then interviews with various industry players from different construction stakeholders perspectives (owners, designers, engineers, etc...) would be used to identify the possible areas of growth and valid approaches to develop BIM in Western Canada through our very own Edmonton Construction Association (ECA) and Buildworks Canada. As a result, it is urgent to probe the Alberta AEC/FM industry with respect to BIM technology to motivate the adoption of this technology in the perspective of what is currently happening in the rest of North America and the world. In addition, this work seeks understanding of the challenges that play against the implementation of BIM in the Albertan construction industry thus hindering the leap from the traditional dislocated approach towards an information centered paradigm.

3.2 Current State of BIM within Alberta’s AEC/FM Industry

Based on research paper [60] published in 2017 (relatively new), the findings reported in their paper are obtained from a web-based survey made available to AEC/FM professionals located primarily in Alberta. To put this work in the perspective of similar investigations, it is important to remind the reader that surveys (as a data collection tool) are today routinely used by market researchers and government agencies to gain insight into selected economic (or social) indicators. To gain a detailed insight into this aspect of IT within the construction industry of Alberta, a survey targeting the following three objectives is conducted:

(i) Understanding the current state of BIM among Albertan AEC/FM practitioners,

(ii) Investigating the motivations driving the adoption of BIM, and

(iii) Shedding light on some of the challenges hindering implementation of BIM.

Even though the results of this research are specific to the province of Alberta, there is reason to believe that some of the issues reported in this work are context-independent and will serve to confirm previous findings [60]. Surveying 144 professionals, through a set of 23 questions arranged in 4 sections that give a through insight of the BIM adoption in the Albertan industry.
Based on the research results, the BIM technology is underutilized, since more than half of the respondents (51.47%) admit at best a rare use of BIM. If, to these individuals, one adds those who consider themselves as moderate BIM users, the fraction of participants who can be considered as under-using BIM increases to 75%. This result is to be contrasted with the findings of a 2009 SmartMarket report [7] devoted to BIM in North America in which 49% of the respondents have reported using BIM or BIM-related tools. Furthermore, a similar report going back to 2012 [14] has indicated that 55% of BIM users had an advanced or expert knowledge of this technology.

Clearly, Alberta’s construction industry is dramatically lagging behind this trend. An even more alarming statistic is the very limited number of companies who use BIM at the organizational level, as shown in figure 3.1, whereas the same 2012 SmartMarket study has reported that 71% of North American companies have embraced BIM technology. In essence, the data in Fig 3.1 is a clear statement regarding the level of effort that needs to be made to bring the Albertan AEC/FM industries from their traditional and disconnected state to a collaborative- and information-centered paradigm. Understanding the perceptions of construction professionals with regard to what BIM is, is essential for making recommendations, especially in connection to education planning.

At the organizational level, the results describing the current state of BIM are presented in Fig. 3.2, from which it appears that approximately 50% of the participants report having no or a limited amount of experience. This number, in keeping with the limited use of BIM by the vast majority of the respondents, indicates that Alberta’s construction industry has not fully embraced BIM, be it with respect to the overall North American trend illustrated in the Smart Market Report [14].
Despite the limited use of BIM in Alberta AEC/FM industries, refer to Figs. 3.1 and 3.2, a few companies are experimenting with this technology in a variety of engineering and (or) management areas. However, because the breadth of BIM usage is expected to be affected by the organizational experience in this technology, the data are partitioned into three blocks according to the answer to the question "Rate the level of use of BIM for your organization’s projects". The results of this analysis are summarized in Fig. 3.3.

According to Fig. 3.3, the industry seems to have a certain preference as to the areas in which to use BIM. For instance, construction professionals are likely to use it in the design process. Surprisingly, among those who have reported an extensive
organizational experience in BIM, only 25% (approximately) report that they have used it in the design stage; other areas of project delivery barely exceed 6%. Although impossible to prove from the available data, this situation may (tentatively) be explained by two considerations:

(i) lack of software interoperability, which makes it difficult to integrate within a single platform models and data for the entire project’s lifecycle and
(ii) there likely exists a more important inertia in certain areas of the projects’ lifecycle which is more difficult to overcome when compared to design and drafting, where practitioners are more willing to adapt to new technologies (often offered in new releases of software).

This, of course, can be remedied by a combined effort from

(i) software companies, which need to develop tools that can easily be integrated into BIM-supporting platforms and
(ii) by appropriate (holistic) training, which needs to showcase project activities outside the traditional design and drafting phases.

However, despite the potential challenges that could be encountered during its implementation, some construction practitioners are prepared to adopt BIM, anticipating the benefits their organizations will accrue. In this respect, the survey provides opportunities for probing the participants as to the motivations that they perceive will fuel the push towards adopting BIM as a standard for the industry. In line with a previous observation [7], the most important driver of BIM adoption is the expectation of an increase in process efficiency and project delivery, which close to 70% of the respondents’ rate as very important. The second-most important factor which will catalyze the adoption of BIM is the attitude of owners towards BIM. Interestingly, the expectation of an increased market share seems to have a lesser impact on the adoption of BIM than some of the other factors explored in the survey. In noting the reduced emphasis on market share, one may conjecture that respondents are accepting the fact that, in the coming few years, BIM will be the standard in the AEC/FM industries, hence making it imperative to adopt BIM to simply maintain their current market share.

3.3 Challenges for Adopting BIM in Western Canada

To gain insight into the current obstacles encountered by the Albertan construction industry as far as BIM adoption is concerned, the respondents are asked to indicate the degree to which each of the following factors is a potential obstacle: "BIM is not required
by clients for their projects”, “High cost for required training”, “High cost of acquiring software that supports BIM”, “High cost of maintaining software that supports BIM”, “High cost of hardware upgrade”, “Low return-on-investment”, “Legal issues”, “Do not see a value for BIM use”, “Other”} [60].

It is found that the most important factor presently hindering the large-scale adoption of BIM is the lack of client requirements (25% of the opinions) in line with a previously documented conclusion [7]. Software difficulties can be viewed as short-term challenges since computer technology is rapidly advancing. Interestingly, legal problems are not viewed as a particularly daunting obstacle [60].

To build a broader picture of the obstructions hindering or delaying the adoption of BIM in Alberta, we supplement the survey used for this contribution with a focus group discussion centered on the question: “What are the obstructions preventing the Alberta construction industry from making a cultural change towards BIM?” . Seven elements acting against the implementation of BIM are identified:

(i) lack of organizational training strategy;
(ii) lack of software interoperability;
(iii) lack of practical standards and guidelines;
(iv) low demand of BIM-based projects by clients, which translates into a low potential for return on investment;
(v) difficulty in navigating the required mentality change among professionals,
(vi) lack of regulations and legal definitions that can be incorporated into contractual documents in relation to BIM and sharing data; and
(vii) for many Albertan construction professionals, a lack of maturation of BIM technology to merit its being sought in the market.

Although companies are generally in favour of implementing BIM, construction professionals are still hesitant as to its full potential and are lacking appropriate training. However, it is important to mention that the Albertan construction industry is currently trapped in the paradoxical loop described by Kiviniemi et al. (2008) in [62] as shown in figure 3.4.
3.3.1 Recommendations to overcome challenges in BIM Adoption

In this regard, in what follows a set of recommendations is provided that can help construction industries entrapped in Kiviniemi’s paradoxical loop [62], to move towards an information-centered paradigm:

(i) eradicate obstructions to allow for difficulty-free implementation of BIM technology;
(ii) provide appropriate BIM-related education and training through collaborative effort between educational institutions on one side and public and private owners on the other;
(iii) establish national and local guidelines for the implementation of BIM that are compatible with international guidelines;
(iv) re-think the project delivery process so as to reflect the IPD paradigm rather of digitalizing the manual process; and
(v) provide incentives to allow the market for BIM to grow, which will justify the initial cost of training and acquiring software.

To complete these recommendations, it is of interest to mention a few important elements that can follow from the above recommendations:

(i) Overcoming obstruction in the implementation of BIM will generalize its use among the Albertan AEC/FM industries which not only will allow these to provide an important service to their local clients but more importantly open possibilities to nation-wide collaborations;
(ii) A well thought education that integrates a BIM dimension would broaden the views of future professionals and will ease their adaptation to an evolving market that is shifting towards an information-centric paradigm; A
byproduct of instilling this paradigm in the mind of future engineers and
managers will seamlessly reduce the inertia towards integrated project
delivery;

(iii) Given that owners are likely to be asking for BIM-based projects, Canadian
companies that are competing in an increasingly global market will need to
adopt international guidelines to BIM implementation as a proactive step
towards increasing their likelihood of attracting projects; Simultaneously,
local and national guidelines adhering to their international counterparts can
be even more helpful since this will ease the transition from national to
international markets.

3.4 BIM in Alberta through Interviews

The BIM interviews, outcomes, roadmaps and summaries are all produced in
different documents which are available in separate package for a concise by construction
stakeholders.
References


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