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Benchmark Alberta’s Architectural, Engineering and Construction Industry Knowledge of Building Information Modelling (BIM)

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1. Abstract

Construction professionals agree that BIM will revolutionize the AEC industry and its impact will be felt by all project stakeholders including owners and facility managers. Statistics show that many owners and other stakeholders perceive BIM as a technology that can make project delivery more efficient because it allows project information to be fully integrated. In the future, owners are expected to demand the use of BIM to prevent over-budget and over-time project delivery. However, as we are preparing this contribution the level of implementation and use of BIM varies widely across the globe. This paper probes the state of BIM in Alberta from three points of view: (i) the current understanding and implementation, (ii) the motivations driving its use and (iii) the challenges hindering its implementation. The findings of this paper are extracted from individual responses to a web-based survey which was proposed to professionals in the Albertan AEC/FM industries.

Key Words: construction < type of paper to review, constr. management < Construction, buildings < Construction, engineering surveys < Computer Applications
2. Introduction

The efficiency of a construction project is determined in large part by the effectiveness of the specific model used to communicate information. Architects use 2D- or 3D-CAD models to develop a project design, while construction engineers use Project Management (PM) software to assist in project control and integration. These discipline-specific models contribute to misinterpretation and construction errors, leading to re-work, process and material waste, as well as loss of productivity and increase in costs. To circumvent these difficulties, it is paramount to interconnect all the relevant models in order to ensure consistent information project-wide. Building Information Modelling (BIM), has emerged as the solution of choice for the preparation of what is commonly referred to as smart designs, since they integrate all of the discipline-specific models (and information), hence making minute coordination practically possible among all participants, e.g., owners, architects, engineers, contractors, and facility managers, to name a few. A direct by-product of this coordination is the minimization (or possibly the elimination) of misinterpretation in the design and construction processes (Eastman et al. 2008). In the interest of completeness, it is worth reminding that although the definition of BIM may vary from one professional association to another, the common denominator to these definitions is the concept of information. In this respect, the most comprehensive definition of BIM has been provided by the National Institute of Building Sciences (NIBS) and describes BIM as: “A digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward. A basic premise of BIM is collaboration by different stakeholders at different phases of the lifecycle of a facility to insert, extract, update or modify information in the BIM process to support and reflect the roles of that stakeholder. The BIM is
shared digital representation founded on open standards for interoperability” (NIBS 2007). The need for BIM-specific standards has emerged due to the difference between the BIM-required delivery process and the traditional manual document-based process that has dominated the AEC industry for decades (Gu and London 2010). Internationally, many standards have been developed that allow definitions for entities, properties, and relationships to reflect the complex and detailed nature of the AEC industries (Clayton 2006; Eastman 2006; NIBS 2007). The National Building Information Modeling Standard™ (NBIMS), for instance, includes two reference standards: (i) the IAI Industry Foundation Classes (IFC), which consist of definitions and protocols that define datasets throughout a building’s lifecycle and (ii) the OmniClass™ which is a multifaceted classification system that includes some of the most commonly used classifications in the industry (Kiviniemi et al. 2008). Most CAD software vendors have developed IFC-certified applications that support BIM for the AEC industry (Eastman 2006; Fu et al. 2006; Khemlani 2007).

The traditional document-based (in digital and/or paper form) project delivery method is archaic, error-prone, litigation-prone, high-risk, and reliant upon inefficient, difficult to predict construction processes that result in owners receiving completed projects with little information on how to operate and maintain their buildings (Neeley 2010). A recent study (Becerik-Gerber and Rice 2010) has shown that although the traditional design-bid-build paradigm is currently the most widely used project delivery method in the AEC industry, Integrated Project Delivery (IPD), which integrates BIM in project construction, is identified as the most effective delivery method since it facilitates collaboration among all stakeholders. However, effective collaboration requires software interoperability which is one of the greatest challenges encountered by BIM practitioners (Amor et al. 2007; Holness 2008; Sullivan 2005; Tse et al. 2005)
Currently, and despite many documented case studies and a rich literature showing the practical benefits of BIM (Eastman et al. 2008; Furneaux and Kivits 2008; Kymnell 2008; Young et al. 2009), the industry is still lacking the motivation which will catalyze the wide adoption of this technology (Kiviniemi et al. 2008). In this respect, Kiviniemi et al. argue that this lack of motivation is due to the fact that the construction industry is currently trapped in a paradoxical loop which they have described as follows: “there is not enough market demand for integrated BIM, because there is not enough measured evidence of benefits of the integrated BIM, because there are no adequate software tools to use integrated BIM in real projects”. Interestingly, despite these challenges, AEC professionals and academics are actively working on extending the applications of BIM by integrating models to measure the impact of built infrastructure on the environment (and possibly on social behaviour) thus laying down the stepping stones towards a holistic paradigm for construction (Häkkinen 2007; Tucker et al. 2003). Aside from the obvious preoccupations of IT that primarily focus on developing standards to ensure software interoperability (Amor et al. 2007; Eastman 2006; Fu et al. 2006; Kiviniemi et al. 2008; NIBS 2007) and those of managers which mostly focus on delivering projects on time and on budget (Azhar 2011; Eastman et al. 2008; Kymnell 2008; Staub-French et al. 2011; Young et al. 2009), the quest for this holistic paradigm led researchers to investigate the possibility of using BIM outside these mainstream issues. For instance, because BIM allows practitioners to develop a broader yet more accurate view of any given project, this technology has been used to gain better insight into (i) the risks of accidents associated with on-site construction (Ganah and John 2015; Zhang et al. 2013), (ii) sustainable designs in construction (Azhar 2011; Bank et al. 2011; Bynum et al. 2013; Häkkinen 2007), (iii) building BIM models for existing buildings (Volk et al. 2014), (iv) optimal implementation of BIM within organizations with limited resources (Wong
et al. 2013), and, most importantly, (v) integrating BIM in post-secondary teaching curricula (BIM Academic forum 2013; Sacks and Pikas 2013).

In Alberta, the provincial government is a major owner of buildings and other infrastructure assets, which gives it considerable leverage with respect to influencing the implementation of specific standards and technologies in the construction industry. For instance, the generalization of the so-called Leadership in Energy and Environmental Design (LEED) certifications has, within a few years, been widely adopted by the majority of contractors in Alberta because the provincial government has requested all of its new buildings to be LEED certified. Extrapolating from this case, it may be conjectured that, given the proven benefits of BIM (Eastman et al. 2008), the provincial government is expected to amend its project delivery policy to be information-centered. This is the case not only in North America, but on a wider scale as witnessed by the increasing number of country-specific studies which have examined the current state of this technology among construction professionals (BCIS 2011; Egger et al. 2013; Latiffi et al. 2013; NATSPEC 2011; von Both and Kindsvater 2012). As a result, it is an urgent to probe the Alberta AEC/FM industry with respect to BIM technology in order 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. The findings reported in this 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 in order to gain insight into selected economic (or
social) indicators. In the context of BIM technology, many freely accessible (online) reports have probed the state of the construction industry either for specific jurisdictions, e.g., Europe (Buckley et al. 2010), UK (NBS National 2015 –and prior reports 2011-2014), North America (Buckley 2012; Young et al. 2009), or on a much global scale (Buckley et al. 2014). In the case of Canada, (Froese 2001) have conducted a survey in order to determine the trends of project management insofar as information technology (IT) is concerned. The vast majority of the respondents agreed that, by 2020, IT will make project management more efficient by improving the work conditions, increasing the quality of information, and reducing management teams. Although the authors do not specifically address BIM technology, which in another contribution Froese et al. (Froese et al. 2007) referred to as advanced technology, these findings are believed to be applicable. Stated differently, this research uses well established analytical statistical based methods to address the state of BIM within the construction industry of Alberta. 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.

3. Methodology

The results of this contribution are obtained from the answers to a web-based survey proposed to AEC/FM professional associations in Alberta. These associations invite their members to
participate to this study, leading to 144 professionals completing the questionnaire. However, to gain a better insight into the obstructions to the implementation of BIM in Alberta’s construction industry, the survey is supplemented by focus group discussions revolving around the question, “What are the obstructions preventing the Alberta construction industry from making a cultural change towards BIM?”. The survey consists of 23 questions arranged in four sections, a sample of which is given in Table 1.

Table 1, near here

The choice of questions is made based on previous studies and also using a focus group selected from local industrial partners in order to evaluate the questionnaire. Even though the results of the web-based surveys could be biased in the case where multiple answers are received from the same individual or from the same organization, this risk is, however, practically unlikely. Furthermore, a question regarding the precise affiliation of the respondents, that would have partially, solved this problem is deemed unacceptable by the professionals who reviewed the questionnaire since this could harm the image of the organization. Another issue specific to technical surveys is the possibility of having multiple descriptions and terminologies for the same concept, which could lead participants to misinterpret certain questions. This issue is generally circumvented by cross-validation. For instance, questions B\(_2\), (C\(_2/C_1\)), D\(_1\) (see Table 1) are used to cross-validate (to some extent) the direct question B\(_1\). At this juncture we note that, since one of the objectives of this contribution is to capture the state of BIM among practitioners of the AEC/FM industries in Alberta, the categories proposed in the questionnaire (cf. Table 1) are purposely chosen to be as broad as possible in order to encompass all AEC/FM actors.
4. The Survey Analysis

To provide an overview of the respondents, general statistics describing the participants, their organizations, disciplines, roles, and years of experience are computed and summarized in Table 2.

Table 2, near here

An interesting element worth noting is the experience of the respondents, which for the majority of the attendees exceeds 10 years (the estimated median is approximately 14 years). Another descriptor of interest is the size of the companies with which the respondents are affiliated. This indicator is thought to be influential since larger companies are likely to work on complex (and potentially geographically delocalized) projects requiring minute coordination. In this respect, it is important to note that only 14% of the respondents are affiliated with small companies (i.e., fewer than 10 employees), which makes it difficult to draw statistically significant conclusions that apply to small companies. As a result, we primarily limit the scope of the investigation to focus on overall trends.

4.1 Current state of BIM within Alberta’s AEC/FM industry

In what follows, we delve into the first objective of this contribution, which is directed toward understanding the current state of BIM, i.e., the level of use and understanding, within Alberta’s AEC/FM industry. This objective is examined at the individual and organizational levels, given that, although a particular respondent may not be directly involved in projects using BIM, the organization as a whole may have had experience in this technological paradigm. Currently, the majority of respondents report rarely using BIM within their respective organizations. According to Figure 1a the 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 (Young et al. 2009) 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 (Buckley 2012) 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, cf. Figure 1a, whereas the same 2012 SmartMarket study has reported that 71% of North American companies have embraced BIM technology. In essence, the data in Figure 1a is a clear statement regarding the level of effort that needs to be made in order 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. In this respect, the participants are asked to select one or more options from the set: {“BIM is a technology”, “BIM is a tool”, “BIM is a process”, “BIM is a philosophy”, “BIM is a piece of software”}. Although, there exist as many definitions of BIM as there are professional associations, none of these definitions reduces BIM to a mere software tool. In fact, since the participants’ answers are likely to be dependent on knowledge of and familiarity with BIM technology, it is necessary to include in the survey a categorization mechanism permitting segregation of the respondents. As a result, to gain a better insight into the respondents’ understanding of BIM, the variables “Are you a BIM user” and “How do you describe BIM” are cross-correlated. The results of this analysis, shown in Figure 1b, seem to
suggest that those who report not using BIM are inclined to select “BIM is a tool” as their primary description. However, for participants who consider themselves to be BIM users, their descriptions of BIM tend to be evenly distributed, including, in addition to “BIM is a tool”, definitions such as “BIM is process” and “BIM is a philosophy”. Surprisingly, 10% of those who claim to be BIM users have answered “BIM is a piece of software”.

**Figure 1, near here**

In fact, a $\chi^2$ test shows that the answers of the latter category of respondents is close to a uniform distribution in which the first 4 classes are expected to receive 25% of the respondents, whereas the class “BIM is a piece of software” receives 0%. Given that 51 respondents considered themselves to be BIM users, the P-value of the $\chi^2$ test is close to 47% which indicates that the distribution of the answers is not significantly different from the expected one. An important feature that needs to be pointed out is the higher percentages falling in the class “I am not a BIM user” who report “BIM is a piece of software”. Another question worth exploring is whether there exists a correlation between the number of years of experience of the respondent and their description of BIM. This particular investigation is motivated by the belief that younger generations tend to be comparably quicker to become familiar with new technologies. However, a $\chi^2$ analysis of the data in Table 3 leads to a P-value of 81.9% which indicates that at the 5% significance level the description of BIM is independent of the number of years of experience.

**Table 3, near here**

Perhaps the most striking feature is, once again, the emphasis on the definition “BIM is a tool”, which is particularly important among employees with moderate and intermediate experience. Interestingly, the percentage of respondents who answer “BIM is a piece of software” ranges
from 9% to 13% which, to within the errors inherent to the survey, can be considered similar for all experience classes.

At the organizational level, the results describing the current state of BIM are presented in Figure 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 (Buckley 2012) or compared to Europe (Kiviniemi et al. 2008; Staub-French et al. 2011).

**Figure 2, near here**

Despite the limited use of BIM in Alberta AEC/FM industries, cf. Figure 1a and 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 is 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 Figure 3.

**Figure 3, near here**

According to Figure 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/drafting phases.

4.2 Motivation towards adopting BIM

To gauge the opinion regarding the motivation towards adopting BIM, respondents are asked to rate the effectiveness of BIM; the survey proposes several stages in a lifetime of a project for which participants are asked to select between the following options: “Ineffective”, “Moderately effective”, “Very effective”, “Not relevant to my experience”, and “Not applicable”. BIM experts typically see significant advantages of BIM’s interconnectedness, which allows both upstream and downstream data to be updated when any parameter is modified. For instance, an update to the design will trigger changes in cost estimation, scheduling, energy efficiency, and operating costs that will be experienced following completion of the project. In order to ease the visual assessment of the result, an overall score is calculated for each of the project stages satisfying Equation (1),

\[
S_{\text{overall}} = \frac{\left(\% \text{ ineffective}\right) \times 1 + \left(\% \text{ moderately effective}\right) \times 2 + \left(\% \text{ very effective}\right) \times 3}{\sum \text{percentages}}
\]  

(1)
Based on Equation (1), the scores associated with the effectiveness of BIM are represented in Figure 4a which shows that the overall opinions of the practitioners differ markedly. Only with regard to “design coordination” and “sharing data with others” does the score for all levels of experience exceed the 2.40 threshold that would indicate that most of the respondents consider BIM to be “very effective”. At present, there is still not a high level of appreciation of the potential value of BIM, in sharp contrast to the views of BIM reported in other studies (Buckley 2012; Eastman et al. 2008; Young et al. 2009). From these observations, we conclude that a great challenge lies before academic professionals, who must update their educational programs to provide learning opportunities related to BIM.

**Figure 4, near here**

Another analytical route which corroborates the results in Figure 4a uses the cross-correlation of the data on effectiveness with the answer to the question “Are you a BIM user?” The findings of this analysis summarized in Figure 4b appear to show that BIM users have a greater appreciation for its effectiveness\(^1\). Although BIM users are generally more appreciative of the positive impact on every stage of a project, *cf.* Figure 4b, they do, however, still have mitigated feelings in two main areas: (i) scheduling and (ii) energy simulation. This is likely due to the lack of software interoperability. 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 which they perceive will fuel the push towards adopting BIM as a standard for the industry. In line with a previous observation (Young et al.

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\(^1\) Although the small sample size does not allow us to reach this conclusion at the 95% confidence level, a larger sample would probably be able to provide statistical confirmation of the observation.
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 in order to simply maintain their current market share.

4.3 Challenges for adopting BIM

Although BIM is capable of playing a major role in the modern construction industry, its adoption requires overcoming several challenges (Staub-French et al. 2011). Perhaps the first challenge facing practitioners is the choice of appropriate software as a platform for handling the storage and treatment of project information. In this respect, one of the questions of the survey is aimed at probing the importance of factors such as cost and interoperability in the purchase of software supporting BIM. Table 4 provides the proportion of respondents who rate these factors as “somewhat” or “very important”.

Table 4, near here

According to Table 4, usefulness appears to be the driving force when buying software. Second to the usefulness factor, respondents report that their decisions are affected by “What others use”; this can easily be explained by the need to use a standard platform which will ease communication (efficiency) between partners. Interestingly, cost of software is not considered as a very influential element. To further our understanding of the cost factor, the data corresponding
to small companies (fewer than 10 employees who have answered the cost-related question) is analyzed separately. As for the overall picture summarized in Table 4, usefulness has the highest score at 81%, followed by interoperability at 75% of opinions in favor of “somewhat important” or “very important” and finally cost of software (63%), on par with cost of training (67%), and what others use (63%). As a result, we infer that, overall, practitioners value the usefulness of software (which is particularly important for small companies), followed by “cost of training”, and “interoperability”. Interestingly, while small companies have ranked “Interoperability” as the second buying factor, the overall picture (dominated by large companies) shows that “What others use” is the second-most important decision factor. Although many reasons may have impacted the answers of the participants, including specifics of their respective companies, we may venture to explain the importance of interoperability for small companies by the need to be efficient under limited personnel.

In addition to the above analysis, which explores the factors impacting the choice of software, the survey also explores the views of the respondents with respect to sharing data, which is at the very foundation of BIM. Survey participants indicate that they are generally inclined to share project-related information with the exception of financial data and contractual information. Although the data shows a trend towards sharing the information, a significant number of participants are still unwilling to share particularly: (i) financial data and (ii) contractual information.

4.3 Obstacles for BIM adoption

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”). 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 (Young et al. 2009). 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.

4. Summary of the results of the Analysis

Although many Albertan companies recognize the importance of BIM technology in maintaining their competitive edge, the survey shows that practitioners are dramatically lagging behind with regard to use of this technology. The vast majority (close to 75%) of respondents report moderate use (at best) of BIM, whereas the overall trend in Northern America is that 49% of construction practitioners have used BIM or BIM-related tools. Furthermore, the survey shows that even among the respondents who have reported using BIM, 10% of the respondents have incorrectly reduced BIM to a piece of software. Understanding the nature of BIM is paramount since this will change the attitude of AEC/FM professionals towards this technology and will encourage its application outside the traditional fields of project development, instead touching every phase of a project’s lifecycle, cf. NIBS definition (NIBS 2007). In this respect, the data shows that, outside the areas of design/drafting and project management, respondents believe that BIM may have limited use. At the organizational level, Alberta’s construction industry appears to be lacking experience in BIM; close to 50% of the surveyed companies report only moderate
experience in BIM. This number is to be contrasted with the overall trend in North America, which as of 2012 showed that 71% of companies report having embraced BIM technology. On a positive note, the data shows that Alberta’s construction industry is motivated to implement BIM. In line with previous studies (Buckley 2012; Latiffi et al. 2013; Young et al. 2009) about BIM, a company strategy towards BIM adoption – or adoption of any new technology – is usually driven by the benefits and the expected return. Table 5 summarizes the expected benefits of BIM technology adoption.

Table 5, near here

The adoption of BIM is generally motivated by the quality of the end result, which can be achieved at similar (if not lower) costs to those incurred in traditional project delivery methods.

Implementation of BIM technology is usually a complex process since, in addition to practical difficulties such as software availability and lack of appropriate education, it also requires a cultural change among all stakeholders. In order 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?” (see section 3). 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, e.g., work procedures are still mimicking manual project delivery and information sharing, which Ashcraft Jr. described as the need to “unlearn” (Ashcraft Jr. 2009); (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.

5. Recommendations

Although companies are generally in favour of implementing BIM, construction professionals are still hesitant as to its full potential, (see Figure 4), 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 and co-workers (Kiviniemi et al. 2008) in which the lack of demand for BIM-based projects delays the implementation of the technology. In other words, not only do construction professionals need to be educated in BIM (technical side), but, more importantly, owners must also understand the advantages of utilizing BIM models for their projects. In fact, according to previous reports and studies a committed owner is the most important factor in the success of any given technology involving BIM (Young et al. 2009). In this regard, in what follows we provide a set of recommendations which can help construction industries entrapped in Kiviniemi’s paradoxical loop, 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 can 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 in order 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) An well thought education which 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 by-product 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 which 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.

6. Conclusion

Public and private owners and stakeholders believe that the future of the construction industry will be shaped around BIM technology for two main reasons: (i) BIM implementation entails proven benefits including increased efficiency, a platform to deliver projects on time and on budget, and sustainability; (ii) The use of BIM is rising to higher levels in competitive markets, especially in the US and Europe. Canadian jurisdictions such as Alberta must make up ground since only a small percentage of companies have adopted BIM; furthermore, there is not enough BIM-based project demand, as owners at this point do not require BIM in their projects. The survey conducted shows that the combined effect of the low level of BIM-based projects, an
imprecise understanding of BIM, and a lack of adequate education are the main restrictive forces acting against widespread use of BIM. However, given that the North American trend is showing an increase in BIM adoption, Alberta’s construction industry needs to engage aggressively in BIM technology in order to position itself to compete in a global market. In order for the Albertan AEC/FM industries to narrow the gap separating them from their American counterparts in terms of using BIM, two major strategies need to be implemented in the short term. Firstly, an educational paradigm adapted to construction professionals which implements a holistic view of project management. This will bring forward the practical benefits of BIM technology and thus help change mentalities with respect to this technology. Secondly, since provincial governments are generally the largest facility owners, public facility institutions need to play a leading role in spreading the use BIM by requesting BIM models from all the contractors engaged in public projects. In this respect, interesting lessons could be learned from the generalization (among contractors) of LEED certifications which could not have happened (as rapidly) without the appropriate policy at the government level.

7. References


