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Mixed approach to government BIM implementation policy: An empirical study of Taiwan

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ABSTRACT

Building Information Modeling (BIM) technology has been rapidly adopted in the global architecture, engineering, and construction (AEC) and facility management (FM) industries. Two major approaches, government- and industry-driven, are commonly identified for making BIM applications more widely available in different countries. However, those approaches are not suitable for all countries that plan to implement BIM. It is necessary to find other approaches to benchmarking. Based on two surveys, this paper discusses the status of BIM applications from government sectors in Taiwan to identify the drivers of BIM applications. The lessons learned from this study are also summarized for reference. The case of Taiwan represents a mixed approach that is suitable for most countries without strong government influence on BIM implementation.

1. Introduction

Building Information Modeling (BIM) technology has attracted a great deal of attention in the architecture, engineering and construction (AEC) and facility management (FM) industries. Over the past several years, there have been many quick and positive changes related to the use and implementation of BIM in practice [1]. Many counties have successful BIM implementation strategies and have received obvious benefits [2]. For a country, it is difficult but necessary to face the significant impact of BIM-related technologies. Clearly, implementing BIM technology to make advancements in the AEC/FM industries has been accepted by most countries in the world. According to a global review of BIM adoption and implementation, a previous study concluded that many approaches and technology adoptions have been proposed to support the implementation of BIM, but a practical mechanism for adopting and implementing BIM is still lacking [1]. Previous studies mainly discussed the actual implementation in different countries or areas, but rarely focused on exploring the rationale behind the implementation, which is fundamental for developing a new approach for adoption. There is a need to identify BIM implementation approaches for benchmarking. Therefore, this study targets the pattern of government BIM implementation policy by reviewing available implementation approaches and related measures and key features.

A client in a construction project is a major beneficiary of BIM implementation. The government is the largest client of BIM implementation and receives a majority of benefits from BIM implementation. This fact drives most countries to be actively involved in promoting BIM adoption. The national policy initiatives of BIM vary significantly in different countries, which results in a variation in BIM implementation [3] and consequential outcomes. Previously, there were two major approaches for promoting BIM applications in different countries: government-driven and industry-driven approaches. A government-driven approach means that the government issued a series of polices (for example, a BIM mandate) to lead the industry involved in BIM applications. Conversely, an industry-driven approach means that the government has taken limited actions in promoting BIM applications, but the BIM-related activities in the industry are active and BIM implementation is high. Clearly, the benchmarks for the government-driven and industry-driven approaches are Singapore and the United States, respectively. Aside from the government-driven and industry-driven approaches, BIM implementation in most countries belongs to a mixed approach that is somewhere between the two obvious approaches above. This study defines another new mixed approach. Furthermore, this study addresses real cases to form a new approach for BIM implementation and provides value for its followers. This study discusses the case of BIM implementation in Taiwan, which is a typical case of the mixed approach.

Based on previous studies [2–4], BIM implementation approaches employ many means, including mandates, implementation periods, expected objectives, contents, standards and related activities. An organization has to select or develop a suitable approach for its use. The BIM mandate is a clear policy made by a government to be followed by

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its affiliated agencies. It is usually used as a key element in a macro BIM adoption study [5,6]. This study selects the means of BIM mandates as the index to classify the approach in a country as belonging to the government-driven or the industry-driven approach. Furthermore, when the level of BIM implementation in a country is different, the approach and means of BIM implementation have to be different. This study uses the BIM adoption rate as a measure to represent the BIM implementation level, which is discussed later.

Benchmarking is the process of determining the better or best processes, strategies, and techniques for achieving the anticipated goals of the learner. To form an innovative government BIM implementation policy, this study adopts a case study approach to discuss the implementation approach, and its related outcomes, in Taiwan. Although an empirical study of BIM implementation might be limited to its environment, its outcomes (the experience and lesson learned) still provide value to following research.

The rest of this paper is organized as follows. In the next section, this study reviews the BIM application measure, BIM adoption rate, implementation level and the roles of government sectors. In Section 3, this study reports the status of BIM implementation in Taiwan. Section 4 illustrates the surveys and outcomes based on the government sectors in Taiwan. Section 5 discusses the key implementation policies and actions belonging to a mixed approach. The last section presents the conclusions of this study and provides further research suggestions.

2. Literature review

2.1. Global BIM application

2.1.1. Measure for BIM application

The serial smart market reports for BIM by Dodge Data and Analytics (formerly McGraw Hill Construction) clearly indicate that the adoption of BIM in construction projects helps to enhance collaboration among the project stakeholders, and it also leads to positive returns on the investments in BIM by reducing errors, omissions and project duration [7–16]. In these reports, the measures for representing BIM applications consist of the rate of use (adoption rate), top business benefits, and perceived return on investment, and others of interest in the study country/area are investigated. These are discussed and then used to reflect the BIM implementation status in each country or area.

The latest report describes the engineers and contractors who are currently working with BIM. The respondents were (2015), are (2017), and expect to be (2019) using BIM on 50% or more of their transportation infrastructure projects [14]. Notably, the percentage of BIM use in building-related projects is higher. The information on the BIM adoption rate is a good indicator for reflecting the degree of BIM implementation. As with the rate, the growth of BIM implementation (the percentage of projects on which a user deploys BIM) is another key indicator of the dynamics of BIM usage in a country. However, the time and target project type of the survey in each report are different. To use the BIM adoption rate, one must refer to the percentage of projects with BIM by a specific stakeholder, which is the BIM implementation level [10].

2.1.2. BIM adoption rate and BIM implementation level

The BIM adoption rate is a simple indicator to show the status of BIM implementation in a study country/area. Even if the maturities of the study targets are different, it is a good enough index for understanding the overview of BIM implementation. This study summarizes the BIM adoption rate worldwide from different data sources. In Table 1, the value of the general adoption rate is the reported adoption rate in the study country/area based on all surveyed stakeholders. Furthermore, the value of the advanced adoption rate represents the replies of a specific role based on the respondents with a BIM implementation rate at the level of high (51–75% of their projects involve BIM) and very high (more than 75% of their projects involve BIM). The values with a superscript star symbol indicate a forecasted value.

Overall, this study concludes that the order of BIM adoption rates in the same study year from high to low are the countries in western Europe, North America, Asia and others. Furthermore, based on the information in Table 1, this study summarizes some interesting findings as follows.

- In any country/area, the BIM adoption rate has increased with time.
- The BIM adoption rates for different stakeholders are different.
- BIM adoption rates by contractors are lower than the overall BIM adoption rate.

  For those countries with low BIM adoption rates, there is a clear requirement for a government approach to implement BIM more widely and efficiently. This study tries to discuss the approach used in Taiwan as a reference. For better usage while a country improves its BIM adoption rate, this study classifies all countries into three levels, and the representative countries are summarized as follows.
- Low BIM adoption rate: less than 30%; the Czech Republic and countries in the Middle East
- Middle BIM adoption rate: between 30% and 70%; China, Japan, New Zealand and South Korea
- High BIM adoption rate: more than 70%; Denmark, the United Kingdom and the United States

2.2. Roles of the government sectors in BIM application

2.2.1. General efforts by the public sector

The government is the major beneficial entity of BIM implementation. Therefore, the government usually plays a key role in supporting and encouraging BIM adoption. A previous study reviewed and discussed the efforts of the public sector in BIM adoption worldwide [20] and identified the major efforts, including the establishment of BIM programs and committees, the organization of BIM activities and seminars, the establishment of different BIM goals and promises, and the preparation of BIM guidelines and standards. The previous studies also identified six roles of the public sector in BIM adoption, namely, (1) initiators and drivers, (2) regulators, (3) educators, (4) funding agencies, (5) demonstrators, and (6) researchers [20]. According to the perspective of the governmental role in BIM application, Singapore is a typical successful country [2].

Although the identified roles have different effects on BIM implementation, this study focuses on the role of initiators and drivers by virtue of goals and promises, BIM committees and BIM activities by government sectors. This role is irreplaceable and makes the public sector vital for initiating BIM adoption in the industry. In this role, the government usually institutes a mandate for BIM implementation to be followed by its affiliated agencies.

2.2.2. BIM mandate

As illustrated by Tuckwood [21], it is very difficult and time-consuming to develop formal legislation, and it is not always necessary to do so. Therefore, a BIM mandate is an alternative that establishes the role of encouraging people and organizations to accept the major requirements that involve significant change without the need for formal legislation [21]. In 2007, the US General Services Administration (GSA) set a goal of requiring BIM on FY07 projects in order to improve design quality and construction delivery. This was the first time that an organization with this scale of projects, building assets and influence on the construction economy had made such a public and forward-thinking statement [22]. After that, several government sectors and countries set different mandates for promoting BIM applications. For example, in July 2009, the Wisconsin Department of Administration required that all state building projects with a total budget of $5 million or more, and all new construction projects with a budget of $2.5 million or more, use BIM throughout the construction process [23].

Based on a review conducted by Cheng and Lu [20], some

Table 1
Global BIM adoption rates.

Country/ Area	General adoption rate (Time, Project Type)	Advanced adoption rate (Time, Project Type, Role)	Data Source
Australia		33% (2013, NA, Contractor), 71% (2015, NA, Contractor)*	Jones and Bernstein [10]
Brazil		24% (2013, NA, Contractor), 73% (2015, NA, Contractor)*	Jones and Bernstein [10]
China	15% (2012, NA), 67% (2014, NA)		Jin, Tang [17]
Canada	49% (2009, NA), 72% (2012, NA), 71% (2016, NA)	29% (2013, NA, Contractor), 54% (2015, NA, Contractor)*	Young, Jones [16], Jones and Bernstein [10], Malleson [18]
Czech Republic	30% (2016, NA)		Malleson [18]
Denmark	81% (2016, NA)		Malleson [18]
France	38% (2010, NA), 81% (2017, Transportation)	39% (2013, NA, Contractor), 71% (2015, NA, Contractor)*	Bernstein, Jones [7], Jones and Bernstein [10], Jones and Laquidara-Carr [14]
Germany	36% (2010, NA), 74% (2017, Transportation)	37% (2013, NA, Contractor), 72% (2015, NA, Contractor)*	Bernstein, Jones [7], Jones and Bernstein [10], Jones and Laquidara-Carr [14]
Japan	49% (2016, NA)	27% (2013, NA, Contractor), 43% (2015, NA, Contractor)*	Jones and Bernstein [10], Malleson [18]
New Zealand	34% (2012, NA), 57% (2013, NA)	23% (2013, NA, Contractor), 50% (2015, NA, Contractor)*	Construction Information Limited [19], Jones and Bernstein [10]
South Korea	58% (2012, NA)	23% (2013, NA, Contractor), 52% (2015, NA, Contractor)*	Lee, Lee [15], Jones and Bernstein [10]
United Kingdom	35% (2010, NA), 50% (2016, NA), 76% (2017, Transportation)	28% (2013, NA, Contractor), 66% (2015, NA, Contractor)*	Bernstein, Jones [7], Jones and Bernstein [10], Malleson [18], Jones and Laquidara-Carr [14]
United States	56% in west region, 52% in midwest region, 38% in northeast, 45% in south region (2009, NA), 71% in west region, 73% in midwest region, 66% in northeast, 68% in south region (2012, NA), 46% (2012, Infrastructure), 76% (2017, Transportation)	55% (2013, NA, Contractor), 79% (2015, NA, Contractor)*	Young, Jones [16], Jones and Bernstein [8], Jones and Bernstein [9], Jones and Bernstein [10], Jones and Laquidara-Carr [14]
West Europe	36% (2010, NA)		Bernstein, Jones [7]
Middle East	20% (2017, NA)		Gerges, Austin [1]
North America	28% (2007, NA), 49% (2009, NA), 71% (2012, NA),		Young, Jones [16], Jones and Bernstein [9]

countries/institutions have set mandates on BIM applications, including the UK, the US, the Netherlands, China, South Korea, Japan, and Singapore. For example, to allow the public sector to take the lead on BIM implementation, the BCA (Building and Construction Authority) in Singapore collaborated with government procurement entities to request the use of BIM for their projects starting in 2012. This is a remarkable policy to lead the industry [24]. Similarly, the UK government showed its ambition by establishing a BIM mandate in its Government Construction Strategy (GSC) reports that were published by the Cabinet Office on May 31, 2011 [25]. This study determined that the policy of a BIM mandate is a government-driven approach to BIM implementation.

3. BIM implementation in Taiwan

3.1. Initiatives of BIM applications

Although a previous study reported that there was no government commitment to BIM until 2015 [20], the real situation is different. In Taiwan, the universities started researching BIM and then the R&D departments engaged in government-initiated activities and implementations related to BIM. Since 2011, the Architecture and Building Research Institute (ABRI) in the Ministry of the Interior has launched a series of research projects to investigate and promote BIM applications in the construction industry of Taiwan. The ABRI published a reference guide to encourage building sectors to implement BIM in their building projects [26]. It also hosted several conferences for sharing R&D outcomes annually, which is an important driver to get more stakeholders involved in BIM applications.

The Public Construction Commission Executive Yuan (PCC) in Taiwan established a platform for promoting BIM implementation in public construction works in May 2014 under a clear strategy of “case-by-case” and “step-by-step.” The PCC takes responsibility for planning, reviewing, coordinating, and supervising public construction projects in Taiwan. Therefore, its policies and related actions play a key role in the construction industry. In 2016, the PCC conducted a research project to develop a reference guide for owners to implement BIM in public construction works. A report titled “Implementing BIM techniques in public construction works” was published for reference [27]. Excluding the reference guide, the PCC allows public entities to allocate their project budgets to BIM-related works. This absolutely influences BIM implementation positively.

3.2. Previous BIM surveys and outcomes

Some previous studies have been conducted using different surveys to identify the status of BIM implementation in Taiwan. A study with 399 survey responses in the private sector construction industry [28] shows that there were BIM adoption rates of 40.5% and 46.6% in its two independent surveys. Based on the existing survey outcomes, another study compared the results from Taiwan and other countries and proposed some suggestions and recommendations for further BIM promotion and research [29].

To develop a reference guide to help owners implement BIM in public construction works, the PCC conducted a survey of the top-50 ranked companies in design, construction and project management according to the number of executed projects in 2015–2016. The survey reported a 64% BIM adoption rate based on a response rate of 54% [27]. The above information implies that large companies usually adopt BIM implementation more so than medium and small companies.

Through reviewing the literature, this study identifies the following features of BIM application in Taiwan: being in the start-up phase, concentrating on building-related projects, and focusing mainly on the design and construction stages. In addition, BIM implementation in Taiwan is at the level of middle BIM adoption rate.

4. BIM application survey on government sectors in Taiwan

4.1. Survey design and execution

In Taiwan, the government sector should announce tendering information on a Government e-Procurement System [30]. Since April 24,

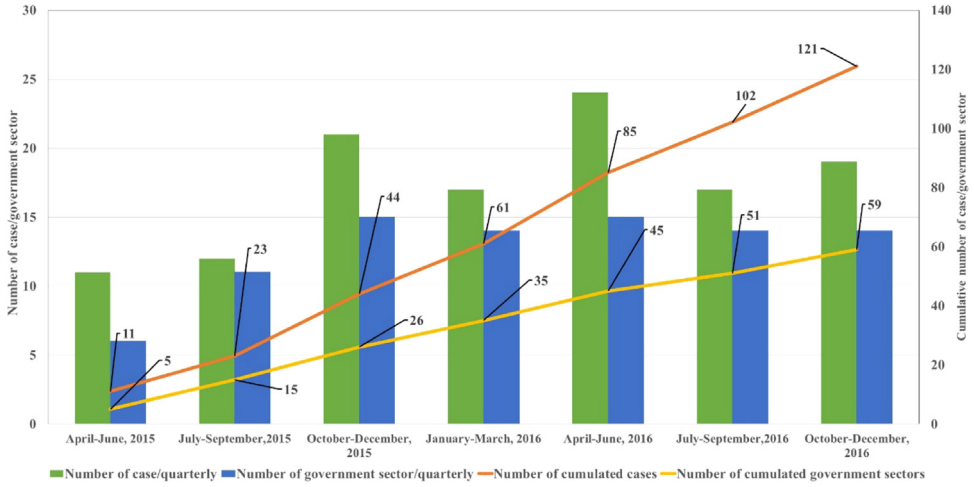

Fig. 1. Number of projects and government sectors with BIM application.

2015, the PCC in Taiwan stipulated that all government sectors must answer the two questions of "does the tender ask the bidder to provide BIM applications?" and "does the bidder actively provide a BIM application in its submittal?" when they upload bid award announcements to the system. This is a mandate to push all government sectors to incorporate BIM-related activities. This study uses the criterion of having the answer of "yes" to one of the above two questions to determine a survey population. The time for selecting projects is from April 24, 2015, to December 31, 2016. Due to a time lag for uploading bid award announcements, this study does not use the case of 2017.

Originally, there were 921 projects with BIM applications in the uploaded announcements. This study selects 262 projects for further analysis. The criteria used for filtering include low project budgets, inappropriate project types, and incorrect replies based on a confirmation by telephone. Fig. 1 shows the profiles of the government sectors and projects with BIM applications during the study period. Among 59 government sectors, 121 projects had BIM applications. It is clear that the accumulated BIM cases and government sectors with BIM applications have increased with time. Although the number is still small compared to the number of tendered projects and tendered entities during the same period, it provides a signal that the government sector is paying increasing attention to BIM applications.

Based on 121 projects with BIM applications, this study sent questionnaires to ask the officer/staff in the government sector to reply with detailed information related to BIM applications. The surveys were conducted during two periods, from July to December 2016 and from February to June 2017. To control the quality of responses, this study sent questionnaires with a formal government letter. The officer/staff in the government sector should reply officially. After receiving the questionnaire responses, the research team examined the content to confirm that all required questions been replied to properly. Therefore, the quality of received responses is accepted for further analysis. Table 2 summarizes the response profiles of two surveys.

Fig. 2 shows the BIM adoption rate based on the survey responses in different stages of the lifecycle of a project. In each stage, the rate represents the responses with BIM applications versus the total valid responses. Although some stages show a decreasing trend from 2015 to 2106, the participants in the two surveys might be different. It is inappropriate to address the meanings behind the trend. However, the result definitely shows that BIM applications are focused on the design (preliminary and detailed designs) and construction stages in the study period. This information shows that the government sectors in Taiwan emphasize BIM in design and construction, but overlook the BIM applications in facility management, which is a BIM dimension used during the operational phase of construction projects and heavily required by many public and private owners in other countries [11].

Table 2
Response rate of two surveys.

Feature	First survey	Second survey
Number of sent invitations	54	67
Number of valid questionnaire	37	54
Response rate	68.52%	80.60%

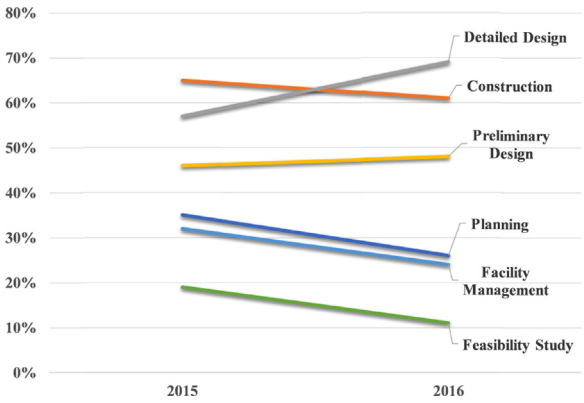

Fig. 2. BIM adoption rate in different stages of the project lifecycle.

Fig. 3 shows the anticipated benefits of BIM implementation. In the two surveys, the orders of the recognized benefits are similar. The key

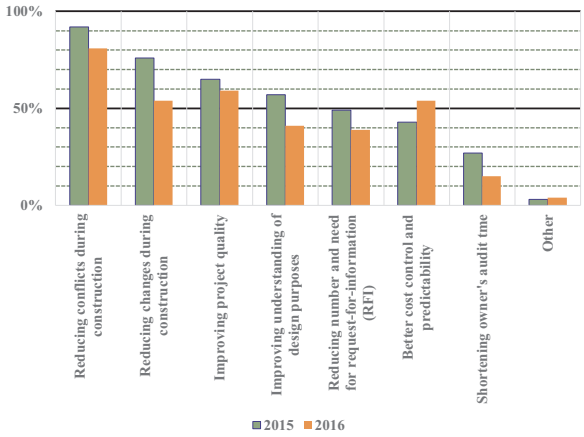

Fig. 3. Anticipated BIM implementation benefits.

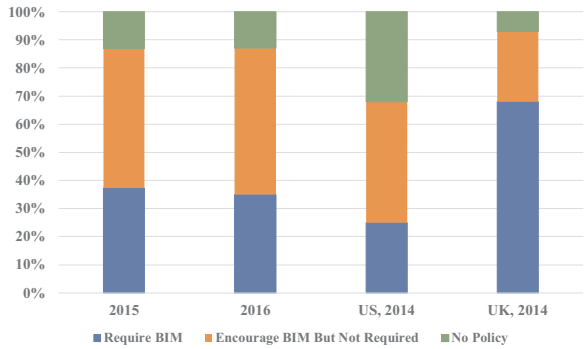

Fig. 4. BIM requirement by owners.

benefits (rate of selection greater than 50%) are "reducing conflicts during construction," "reducing changes during construction" and "improving project quality." Compared with emphasizing the design and construction stages, the BIM applications in Taiwan placed higher value on the implementation itself and not on the supply chain. This was proven by another study [29]. This situation would occur in other counties or areas with BIM application features similar to Taiwan's.

4.2. Survey results

4.2.1. BIM requirement by owners

Fig. 4 shows the survey results related to BIM requirements by owners, and they are compared to similar surveys with owners in the US and UK [11]. The government sectors in Taiwan mainly "encourage" BIM implementation. Most of the owners in the UK have BIM implementation requirements. However, the owners in the US without BIM implementation policies have the highest rates among all surveys. In general, a BIM mandate is a means to require government sectors to implement BIM. The BIM mandate by the UK consequently achieves this result.

Furthermore, according to the figure, the order of owners having positive BIM implementation policies (to require and encourage BIM) is the UK, Taiwan and the US. This finding is a reason for determining that the BIM implementation approach in Taiwan is a mixed approach, as the UK is government-driven and the US is industry-driven.

4.2.2. Ratings of BIM benefits by owners

Fig. 5 shows the results of the ratings of BIM benefit statements by owners among all surveys. In the figure, the data in Taiwan contains all responses, but the data in the US and the UK contains only the responses with a high or very high level of agreement [11].

The surveys in Taiwan did not cover the benefit of "BIM analysis and simulation capabilities can produce a more well-reasoned design."

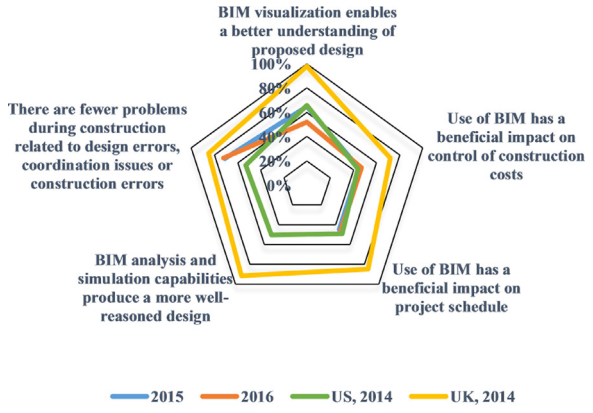

Fig. 5. BIM benefit ratings by owners.

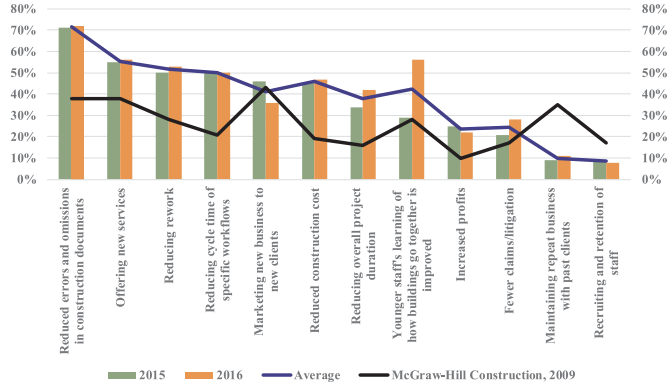

Fig. 6. Important internal BIM benefits.

Except for that, it is clear that the UK has high ratings on all benefits. The benefits in Taiwan and the US do not have a strong variation except for the benefit of "there are fewer problems during construction related to design errors, coordination issues or construction errors." In Taiwan, the quality of design outcomes is a critical issue. BIM will provide a good solution to this problem.

4.2.3. Important internal benefits

Fig. 6 shows the results of the most important internal benefits selected by respondents, and the data for 2015, 2016 and the average of the two surveys are provided. This study compared the results with those of a 2009 survey by McGraw Hill Construction [16] because the questions for surveys are similar. The percentages of the most recognized benefits in this study are larger than the values in 2009, except for "marketing new business to new clients," "maintaining repeat business with past clients" and "recruiting and retention of staff." Based on the information in Fig. 6, this study highlights some key findings with similar outcomes by others.

- The top recognized benefit is "reduced errors and omissions in construction documents." This benefit is the same as the top one by BIM users in the transportation sector experience surveyed in the report 2017 [14], and has been identified in many previous surveys [10,11,16]. The finding points to the problem of design quality in Taiwan. This study concludes that the most obvious benefit of BIM implementation is to improve the design quality of construction projects.
- The benefits with lower percentages in Fig. 6 are "maintaining repeat business with past clients" and "recruiting and retention of staff." This implies that BIM implementation in Taiwan focuses on project-level benefits only. The organization-level benefits have not been recognized yet. However, for wider implementation of BIM, identifying and assessing critical BIM capabilities at an organizational level is necessary [31]. This study concludes that emphasizing on organization-level applications and measuring their benefits would attract considerable attention when project-level benefits are achieved.
- "Marketing new business to new clients" is the top recognized benefit in 2009 survey by McGraw Hill Construction [16]. BIM technology brings innovative solutions to both existed and new problems in AEC/FM industry. In Taiwan, most of the designers/contractors/design-builders adopt BIM to demonstrate their capability of completing construction projects during public tendering procedure. Because this study focused on the government sectors, the ranking of this benefit among all benefits is reasonable. This study considers the ranking of all benefits reflecting a typical case of a mixed approach to government BIM implementation.

5. Discussion

5.1. BIM mandate

BIM adoption and implementation has attracted many studies globally. To classify all countries that have BIM implementations, it is appropriate to develop a clear mandate to push the stakeholders of construction projects to incorporate BIM applications, because this is a good and proven BIM implementation driver [2]. Based on that, the degree of BIM implementation of a country can be divided into two types: developed countries (where BIM is mandated or nearly mandated) and developing countries (where BIM is still in its early stages) [1]. This study uses the above classifications to discuss the condition in Taiwan and its consequences.

Although the PCC did not have a clear BIM mandate for BIM implementation, on March 17, 2016, the Ministry of Transportation and Communications (MOTC) in Taiwan promulgated the "principles for the promotion of operation of the BIM to all affiliated agencies." This is a mandate demanding that all affiliated agencies consider BIM technology when processing construction-related procurements in order to improve project efficiency and quality and to strengthen the effectiveness of operational management and maintenance. In principle, construction projects with budgets over roughly $35 million (one billion New Taiwan dollars) should consider implementing BIM technology. Because the MOTC is a major sector for executing construction projects in Taiwan, it is clear that BIM implementation will be popular in the near future. This has been proven by reviewing the disclosed number of BIM projects and government sectors in bid award announcements in 2017.

Unlike the situation in the UK, the central government in Taiwan, which is in charge of public construction projects, does not have a BIM mandate. This study determines that the approach to BIM implementation in Taiwan is mixed. According to the mandated rules for BIM implementation, the BIM implementation status in Taiwan makes it a developed country in terms of BIM implementation. Furthermore, the BIM adoption rate in Taiwan is located at the level of a middle BIM adoption rate based on the predefined levels. It is anticipated that the BIM adoption rate in Taiwan will increase to a higher level quickly. This study believes that the BIM mandate is a good driver for BIM implementation. However, the threshold for the mandate must be determined carefully because BIM implementation requires professional capabilities and huge initial costs.

5.2. Obstacles and responses to BIM implementation in Taiwan

The two surveys in this study asked respondents to state the major obstacles to BIM implementation. Fig. 7 shows the results of the two surveys. It is interesting that the responses to all obstacles decreased from 2015 to 2016. This information shows that the obstacles are gradually being removed.

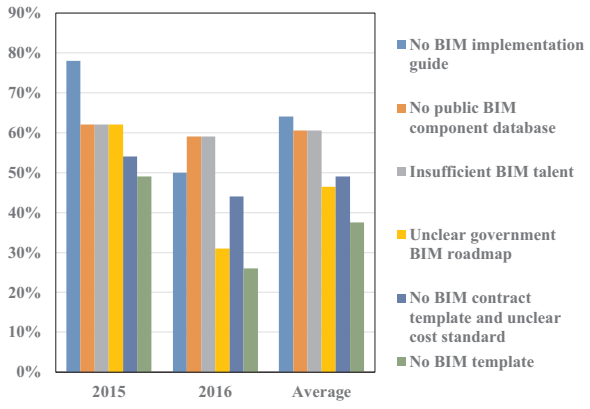

Fig. 7. Obstacles to BIM implementation.

To overcome the three major obstacles, the government sectors have provided positive responses. This study summarizes the responses as follows.

- No BIM implementation guide: The ABRI publishes a reference guide to help building sectors implement BIM in 2016 [26], and the PCC publishes a guide for implementing BIM techniques in public construction works in 2017 [27].
- No public BIM component database: The ABRI supports serial projects for the establishment of a Building Information Modeling Platform [32] for sharing BIM models. It is a website for BIM component exchange.
- Insufficient BIM talent: Many universities and institutions establish BIM courses and programs to provide trained human resources.

5.3. Roles of government sectors in BIM implementation in Taiwan

Unlike other countries or areas, the construction market in Taiwan is small. The government policies and actions for the construction industry are usually different from those in other countries. Based on the mixed approach for BIM implementation in Taiwan, this study summarizes the roles of government sectors and their corresponding actions, which are essential for wider BIM implementation. This information can be regarded as the lessons learned from Taiwan. The lessons are as follows.

- Initiators and drivers: to mandate BIM implementation.
- Regulators: to publish BIM implementation guides for use.
- Educators: to support universities and institutions in providing BIM training courses and programs.
- Demonstrators: to host BIM conferences to share their experiences.
- Researchers: to conduct research projects to identify obstacles and solutions.

6. Conclusions

BIM technology has attracted considerable attention in the AEC and FM industries worldwide. Considering the tangible benefits of BIM to the industry and all stakeholders, many countries have actively promoted BIM through diversified strategies. However, a practical mechanism for adopting and implementing BIM is still necessary. This study divides government BIM implementation policies into three types: government-driven, industry-driven and mixed approaches, and discusses the mixed approach in Taiwan for benchmarking.

Since the growth of BIM applications in the world is rapid, the government in Taiwan, with the help of academics and practitioners in the construction industry, has recognized the importance of adopting BIM technology and developing different approaches to conducting applications. This study contributes to the countries and organizations that have elected to promote BIM applications, which could use the lessons learned from this study to adopt more effective or appropriate strategies to achieve better application performance.

This study discusses the case of Taiwan, in which a typical case of the mixed approach to BIM implementation is adopted. The mixed approach is suitable for most of the countries without strong government powers for policy implementation. To successfully implement BIM, it is necessary to consider the situations in the localized construction industries and integrate with all capable stakeholders. Following research can learn from the outcomes in this study and then make necessary adaptations based on their own conditions.

BIM is still new, and most government sectors, which are always the biggest beneficiaries, lack experience with it. This study only discusses the case in Taiwan. Conducting additional empirical studies on other countries is necessary.

Declarations of interest

None.

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