# Analyzing the Impact of Government-driven BIM Adoption: Introducing the Case of South Korea

**Donghoon Ji[a] and Yelda Turkan[a]**

[a]School of Civil and Construction Engineering, Oregon State University, United States of America
E-mail: jid@oregonstate.edu, yelda.turkan@oregonstate.edu

**Abstract**

**Unlike what South Korea have accomplished in the Architecture, Engineering and Construction (AEC) industry, current situation of Building Information Modeling (BIM) adoption in South Korea is still challenging. To identify the impact of government-driven manners on BIM adoption, this study presented the status of BIM application in South Korea. First, BIM adoption plans from 2010 to 2020 is described in chronological order. Second, statistical data of public projects from 2010 to 2020 regarding BIM application is presented and analysis based on the relationship between BIM adoption plans and statistical data was carried out to identify drawbacks and required improvements of BIM adoption plans. Third, two cases of Incheon International Airport and Godeok Bridge were introduced to represent the actual level of BIM application in South Korea. It can be identified that 1) mandatory BIM adoption is not effective for the expansion of BIM implementation, 2) current adoption plans exclude private projects which have greater amount than public projects and 3) stakeholders in South Korea have competent capacities of BIM despite challenging circumstances. Lastly, implications to improve government-driven BIM adoption were addressed.**

**Keywords –**

**BIM, BIM Adoption/Implementation, South Korea**

## 1 Introduction

Architectural, Engineering and Construction (AEC) industry in South Korea has achieved a significant growth since the late 1960s, when South Korea's industrialization began. According to the 2020 Engineering News Record (ENR) report [1], there are 12 South Korean contractors ranked in the top 250 in global rankings and their total revenue is $24,595.5 million, which accounts for 5.2% of international revenue of the top 250 contractors (Table 1).

Table 1. Global Market Share of the Top International Contractors in 2019

| Contractor Nationality | No. of Firms | Int'l Revenue $ mil. | Int'l Revenue % |
|---|---|---|---|
| European | 45 | 236,218.9 | 49.9 |
| Chinese | 74 | 120,005.7 | 25.4 |
| American | 35 | 24,648.5 | 5.2 |
| South Korean | 12 | 24,595.5 | 5.2 |
| Turkish | 44 | 21,639.2 | 4.6 |
| Japanese | 13 | 19,433.6 | 4.1 |
| Australian | 5 | 8,703.4 | 1.8 |
| Indian | 5 | 6,786.0 | 1.4 |
| All Others | 17 | 11,037.4 | 2.4 |
| All 250 Firms | 250 | 473,068.1 | 100.0 |

However, when it comes to Building Information Modeling (BIM) adoption, South Korean AEC industry is behind despite the formal, government driven BIM adoption plan [2][3]. South Korean government has launched BIM adoption plans for the public sector AEC projects in 2010 and demanded full BIM implementation for all public projects by 2016 [4]-[6]. Unfortunately, this plan was not as successful due to a variety of reasons including the readiness of the AEC industry in South Korea. Accordingly, the government revised their BIM implementation plan in 2020, which will be discussed further in the next section.

This paper examines the current level of BIM adoption in South Korea as it has features of both government-driven efforts and challenges faced by the AEC industry and by analyzing this circumstance, it may be possible to better understand and possibly improve the success of government led BIM adoption programs. Accordingly, this study analyzes the current level of BIM adoption in South Korea to identify the impact of government-driven plans on implementing BIM. In sections 2 and 3, the BIM adoption plans in South Korea are described in chronological order and statistical data from South Korean BIM projects are

analyzed to identify the impact of government-driven BIM adoption plans. Section 4 describes two projects that implemented BIM, namely, Incheon International Airport and Godeok bridge projects, to showcase the level of BIM adoption for different types of projects in South Korea. Finally, the government-driven BIM adoption plans and possible ways to improve such plans are discussed and conclusions are drawn.

In 2012, Lee et al. published the results of their survey presenting the status and future expectations of implementing BIM in South Korean AEC industry [7]. The research identified that South Korean AEC industry has high level of competency to utilize BIM and positive perception of BIM adoption. However, throughout the years between 2012 and 2020, BIM adoption in South Korea has failed to yield successful results, therefore follow-up research to analyse the overall BIM adoption in South Korea is needed. In addition, South Korean government conducted a study to review their previous BIM adoption plan while establishing a new BIM adoption plan [2]. However, the research mainly focused on the articles from the BIM adoption plan in terms of their weakness and areas for improvement, thus, it does not provide a comprehensive analysis such as the effectiveness of the BIM adoption plan. Therefore, by reviewing the government driven BIM adoption plans in South Korea and the associated statistical data published since 2011, this study provides not only the recent status of BIM adoption in South Korea but also a look into government-driven BIM adoption plans.

## 2 BIM Adoption Plan in South Korea

In South Korea, the Ministry of Land, Infrastructure and Transport oversees and regulates all construction and civil engineering projects and most of the public construction and civil engineering projects are controlled by the Public Procurement Service, a department in South Korean government. The Ministry of Land, Infrastructure and Transport establishes the masterplan for BIM adoption and the Public Procurement Service provides detailed plans and guidelines to accomplish the masterplan.

The first BIM implementation plan in South Korea was established in 2010 [5][6]. The Public Procurement Service published the BIM adoption plan and guidelines for public projects based on the Ministry of Land, Infrastructure and Transport's masterplan. Starting with public turn-key projects over 50 billion KRW (approximately 50 million USD), the Public Procurement Service had planned to mandate BIM for all public projects regardless of their cost. Also, this plan proposed the expansion of BIM adoption to all stages of a project including bidding, planning, design, construction, and management. Details regarding the 2010 BIM adoption plan are presented in Table 2.

Table 2. BIM Adoption Plan in 2010

| Year | 2011-2012 | 2013-2015 | 2016- |
|---|---|---|---|
| Target | Public turn-key | Public project | |
| Cost | Over 50 billion KRW | | All projects |
| Application stage | Design stage | | All stages |

Unfortunately, the 2010 BIM adoption plan was not as successful due to several reasons. First, the plan was set for 5 years, a relatively short time period, and the stakeholders in South Korean AEC industry was not ready to immediately start utilizing BIM [2][8]. As a result, the plans for updating and expanding the 2010 adoption plan in 2016 did not proceed. To overcome these shortcomings and improve the level of BIM adoption in South Korea, in 2018, both academic institutions and the South Korean AEC industry invested into research to supplement the plan. The government, both the Ministry of Land, Infrastructure and Transport and the Public Procurement Service, established a renewed, ten-year roadmap plan for BIM adoption in 2020 [2][9]. The main objective of the 2020 plan is to supplement the progress achieved with the previous plan to enable continuous expansion of BIM implementation throughout the whole lifecycle of infrastructure projects. A more gradual transition was pursued by adding additional details to the previous plan, which is expected to serve as a buffer prior to full BIM adoption. Under this new plan, public projects over 30 billion KRW are mandated to utilize BIM in the design stage and projects under 30 billion KRW are mandated to partially utilize BIM targeting architectural and structural design or during the schematic design phase. BIM adoption plans regarding public projects from the Korea Land & Housing Corporation (LH), a public enterprise for the development and management of public housing, were also established. Furthermore, BIM implementation plans for the private sector have been added to expand BIM utilization to private sector projects. The details of the 2020 BIM adoption plan are presented in Table 3.

Table 3. BIM Adoption Plan in 2020

| Year | 2021-2023 | 2024-2026 | 2027-2030 |
|---|---|---|---|
| Public project | 1) over 30 billion KRW Design stage / All construction works 2) 20 billion~30 billion KRW Design stage / Architecture and Structure 3) 10 billion~20 billion KRW Schematic design / Architecture | | |
| LH project | 50% of new projects (25% in 2021) | 100% of new projects | |
| *Private project | *No Plans* | **Total floor area over 10,000m$^2$ | ***Total floor area over 2,000m$^2$ (500m$^2$ in 2030) |

*Not mandatory
**Officially referred to as a project of cooperation with relevant specialized engineers
***Officially referred to as a project with resident supervisor

## 3 Status of BIM Projects in South Korea

In this section, the status of BIM implementation in South Korea is analyzed using statistical data from 2011 to 2020. The data for this study is limited to the annual statistical source published by the Public Procurement Service [10]. During the period from 2011 to 2020, right after the 2010 BIM adoption plan was activated, the public projects which were mandated to use BIM is relatively scarce [9] except for the projects executed by the Public Procurement Service. The statistical data for this study present the total number of Public Procurement Service's projects and their net cost as well as the projects that applied BIM and their net cost. Following the 2010 BIM adoption plan, the projects that used BIM in 2011 and 2012 are public turn-key projects over 50 billion KRW. Likewise, the projects that used BIM from 2013 to 2020 are all public projects over 50 billion KRW as the target cost in the 2010 plan have remained the same after 2015. The statistical data are presented in Table 4.

Based on the data presented in Table 4, Figure 1 represents an aggregated timeline from 2011 to 2020, which includes both internal and external issues related to the BIM adoption plan and the AEC industry in South Korea. Figure 1 indicates that there has not been a significant change in net cost or the number of projects using BIM. For instance, focusing on the 2014 to 2020 period, net cost of the projects that used BIM has slightly decreased (from 5,192 billion KRW to 5,061 billion KRW) while the number of projects using BIM have also decreased from 53 to 40. This result aligns with the characteristics of government-driven public projects. In general, public projects based on government plans maintain a constant proportion each year without drastic changes. So, although BIM has been mandated and utilized in public projects, it is difficult to achieve gradual increase in BIM adoption since public projects hold their proportion each year.

Table 4. Cost and Numbers of BIM-applied Projects

| | Total Project | | BIM-applied Project | |
|---|---|---|---|---|
| Class | Net Cost (KRW bil.) | No. of Projects | Net Cost (KRW bil.) | No. of Projects |
| 2011 | 15,033 | 1,250 | 2,270 (15.10%) | 14 (1.12%) |
| 2012 | 14,009 | 1,151 | 308 (2.20%) | 5 (0.01%) |
| 2013 | 15,089 | 1,433 | 3,759 (24.91%) | 32 (2.23%) |
| 2014 | 10,579 | 1,255 | 5,192 (49.08%) | 53 (4.22%) |
| 2015 | 11,435 | 1,483 | 4,871 (42.60%) | 46 (3.10%) |
| 2016 | 10,428 | 1,651 | 4,307 (41.30%) | 40 (2.42%) |
| 2017 | 11,218 | 1,891 | 5,238 (46.69%) | 46 (2.43%) |
| 2018 | 10,736 | 1,801 | 4,746 (44.21%) | 38 (2.11%) |
| 2019 | 12,438 | 1,799 | 3,968 (31.90%) | 29 (1.61%) |
| 2020 | 12,686 | 1,593 | 5,061 (39.89%) | 40 (2.51%) |
| Average | 12,365 | 1,531 | 3,972 (32.12%) | 34 (2.22%) |

In addition, in the 2010 BIM adoption plan, the project cost, which was over 50 billion KRW, was overestimated. There are limited number of stakeholders who have the capacity to manage projects over 50 billion KRW and if this condition remained the same, only those stakeholders would have utilized BIM in their projects. Moreover, the target cost translates into a small number of target projects, 2.22% of all public projects. In the 2020 plan, the project cost target has been adjusted, increasing the percentage of target projects compared the total number of projects to 4.56% (for projects that are 30 billion KRW) and 12.64% (for project that are 10 billion KRW). Thus, the new 2020 BIM adoption plan is expected to provide improved results compared to the previous adoption plan.

| | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|
| Activation Stage | *Stage I:* Public turn-key project over 50 billion KRW | | *Stage II:* Public project over 50 billion KRW | | | *Stage III:* Public project over 50 billion KRW | | | | |
| Cost in KRW bil. | 2,270 (15.10%) | 308 (2.20%) | 3,759 (24.91%) | 5,192 (49.08%) | 4,871 (42.60%) | 4,307 (41.30%) | 5,238 (46.69%) | 4,746 (44.21%) | 3,968 (31.90%) | 5,061 (39.89%) |
| No. of BIM Pjct. | 14 (1.12%) | 5 (0.01%) | 32 (2.23%) | 53 (4.22%) | 46 (3.10%) | 40 (2.42%) | 46 (2.43%) | 38 (2.11%) | 29 (1.61%) | 40 (2.51%) |
| Trend | Decline | | | Steady with upward tendency | | | | Steady with downward tendency | | |
| Internal issue | *Decline due to pre-executed turn-key projects in 2011* | | | | | | | *Preparation for the new BIM adoption plan* | | |
| External issue | | *Presidential election* | **Policy revision* | | | *President impeachment* | *Presidential election* | **Policy revision* | | |

**Promotion for BIM utilization**

**Review of policies from previous government**

**Adjustment of projects before new adoption plan**

* In this figure, the word 'Policy' refers general policies related to the AEC industry

Figure 1. Timeline of BIM adoption in South Korea

## 4 Case Studies

This section introduces two BIM-applied projects in South Korea as case studies, Incheon International Airport project and Godeok Bridge prjoect [11]-[13]. These projects were the grand prize winners of Korea BIM Awards in 2019 and 2017, respectively, hosted by buildingSMART Korea. Through this section, details regarding the BIM application for each project are presented.

### 4.1 Incheon International Airport

Incheon International Airport project, which was planned in 5 stages, launched in 1996 and the first stage, construction of Terminal 1 and related facilities, was completed in 2001. After the first stage, Stage 2 proceeded from 2002 to 2008 and focused on the construction of the Concourse (Auxiliary Terminal) and related facilities to cope with the increased demand. During this stage, BIM was partially applied for the first time and mainly used for quality management and coordination of complex structures and Mechanical, Electrical and Plumbing (MEP) components. In terms of BIM application, Stage 2 was mainly planned as a testbed to evaluate the feasibility of using BIM, and based on this experience, BIM was actively applied starting in Stage 3.

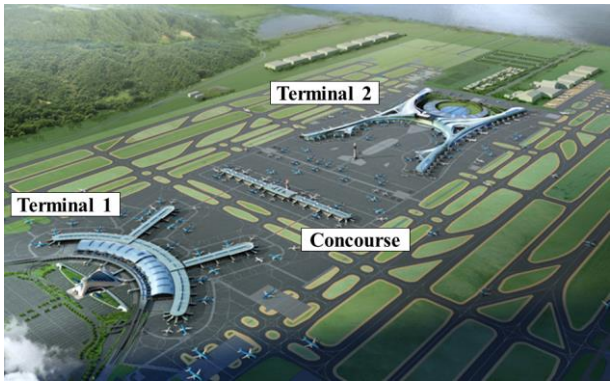


Figure 2. Incheon International Airport

Stage 3, construction of Terminal 2 and related facilities, was carried out from 2009 to 2017. The main objective regarding BIM application was to utilize BIM actively throughout the project. Accordingly, BIM was used for design and the scope of the design included not only the Terminal 2 but also every road, railway and other transportation facility on the site. As in Stage 2, overall management of design, construction and quality was achieved using BIM. Moreover, Stage 3 utilized as-built BIM in Level of Development (LOD) 300 and LOD 350 for managing construction procedure and schedule. Throughout Stages 2 and 3, BIM was utilized in 20 activities (17.86%) out of a total of 112 activities and it is estimated that it produced cost savings of 11.7 billion KRW, 0.15% of the total cost.

Stage 4, the expansion of Terminal 2, is scheduled to proceed from 2018 to 2024 and this stage has been planned to utilize BIM only during design by excluding all traditional 2D documents. Stage 4 also utilizes as-built BIM in LOD 300 and LOD 350 for overall management. Furthermore, Stage 4 has its objective for being a testbed for the-state-of-the-art technologies for BIM such as using Virtual Reality (VR) and Augmented Reality (AR), and mobile data management systems that are accessible via smartphones and tablets. During Stage 4, the goal is to utilize BIM in 62 activities (57.94%) out of total 107 activities and it is expected to result in 48.4 billion KRW in cost savings, 1% of the total project cost. The details regarding Stages 2, 3, and 4 are provided in Table 5.

Table 5. BIM Implementation for Incheon International Airport (Incheon International Airport Corporation 2019)

| Stage | Stage 2 (2002-2008) | Stage 3 (2009-2017) | Stage 4 (2018-2024) |
|---|---|---|---|
| Target | Concourse | Terminal 2 | Terminal 2 Expansion |
| Objective | Testbed of BIM | Active BIM | Full BIM design Testbed of add-ons |
| Content | - Partially applied BIM<br>- Quality management of complex structure, MEP | - BIM-based design<br>- Quality management of complex structure, MEP<br>- As-built BIM for process and schedule management | - Full BIM design<br>- As-built BIM for process and schedule management<br>- VR/AR for virtual completion<br>- Mobile management |
| BIM Activity | 20 activities (17.86%) *achieved* | | 62 activities (57.94%) *expected* |
| Cost Saving | 11.7 billion KRW (0.15%) *achieved* | | 48.4 bil. KRW (1.00%) *expected* |

The case of Incheon International Airport indicates that the level of BIM implementation in South Korea is advanced for larger projects. Contents of the case study, from traditional BIM applications (e.g., quality management of complex features and schedule management using as-built BIM) to adoption of new technologies (e.g., virtual completion with VR/AR and mobile management with portable devices) give a hint about the level of BIM adoption in South Korea. However, since this project is regarded as the flagship BIM project in South Korea, another project which represents an average case is discussed next.

## 4.2 Godeok Bridge (Tentative Title)

Godeok Bridge is a reinforced concrete, cable-stayed bridge and planned to cross the east of the Han River, Seoul. This six-lanes bridge has the maximum width of 30.6 meters and the total length of 1,725 meters, with 1,000 meters of the main bridge, 725 meters of two connection bridges and additional 1,645 meters of two interchanges. Godeok Bridge project, which is the fourteenth sector of the Sejong-Pocheon Highway, started in December 2016 and is estimated to finish in December 2022.

Figure 3. Godeok Bridge

Godeok Bridge project utilized BIM in the design stage. The original design of two pylons of the bridge became an issue in terms of the constructability. The lower part of the pylon had a multi curved surface, which could cause poor quality at intersections between the deck and the pylon. Therefore, BIM was used to review the alternative designs of pylons considering structure stability, economic feasibility, and design aesthetics. Also, reinforcing bars on these intersections were coordinated using Nemetschek's Allplan Engineering 2017, a class coordination software.

In addition, a 4D as-planned BIM was applied to perform the construction simulation of this project. The simulation focused not only on the overall process but

also the connection between the main bridge, two connection bridges and two interchanges. The result from this simulation provided the base line for developing the actual construction schedule.

Lastly, with Bentley's LumenRT 2017, Godeok Bridge project established the BIM-based VR environment for the design review and evaluation. This approach enabled every stakeholder to have access the as-planned bridge design easily enabling them to have a better understanding on this project. Moreover, the VR environment was utilized for safety briefings and education for the workers enabling them to experience their workplace and activities virtually.

Although the case of Godeok Bridge is a good example for BIM-applied civil infrastructure projects, it represents an average BIM adoption level in South Korea. Like most other projects implementing BIM, BIM use is limited to the design stage and the most common BIM applications such as constructability review and clash detection are utilized.

## 5 Implications

This study identified the impact of government-driven BIM adoption in South Korea. Although mandatory BIM adoption plans for public projects may accelerate BIM adoption, it is not effective in terms of the expansion of BIM use across the AEC industry since the portion of public projects is not expected to increase. In addition, the target project cost in BIM adoption plans have a huge impact on the results as a high ceiling would result in a smaller number of target projects and stakeholders as there are limited stakeholders with adequate capacities for utilizing BIM. Furthermore, since there is a close relationship between public projects and government policies, the continuity or success of BIM implementation based on public projects is not guaranteed due to frequent changes in government.

Second, current BIM adoption plans exclude private projects which make up a significant portion of all construction projects. In South Korea, net cost of private projects is 200% to 300% greater than that of public projects. Private projects are more flexible than public projects regarding progress during the project and clients often ask for more benefits (e.g., cost saving, schedule reduction, quality increase). Consequently, private projects have great potential for BIM application, and excluding private projects in the BIM adoption plan would negatively impact the widespread adoption of BIM across the AEC industry.

Lastly, it can be concluded that South Korean AEC industry has sufficient capacity to utilize BIM despite the challenging circumstances. From both cases in Section 4, successful adoptions of traditional BIM applications in the design stage can be identified. Furthermore, there are possibilities for the advanced BIM adoption such as BIM application in the construction stage and adoption of BIM-based advanced technologies. To sum up, current insufficiency of BIM adoption in South Korean AEC industry results from inappropriate BIM adoption plans from the government as AEC stakeholders in South Korea have competent abilities to implement BIM. So, efforts to utilize the capacities of BIM stakeholders in effective ways are needed to improve existing government-driven BIM adoption.

In order to overcome the drawbacks summarized above and improve the current government-driven BIM adoption plans, a robust, long-term masterplan which is authorized by the government could be a potential solution. This masterplan would need to be consistently operated without being affected by changes in the government or other policies. Also, continuous expansion of the scope of BIM applications and motivation for active stakeholder engagement should be considered.

One example that can be added to the BIM adoption masterplan is a method of reward based on the performance of BIM applications for both public and private projects, such as direct rewards of subsidy or indirect incentives of tax benefits or bidding advantages. Especially, direct/indirect financial assistance for stakeholders could help avoid poor profitability of BIM application for them especially for the first few projects, which is one of the main obstacles for implementing BIM. In the meantime, to leverage rewarding contents properly, a reasonable amount of subsidy and incentive has to be set [14]. Also, equitable evaluation criteria under precise analysis to distribute rewards effectively are needed. These criteria have to consider both quantitative features such as cost savings, coverage ratio and qualitative features such as performance against capacity and client satisfaction.

## 6 Conclusions

The AEC industry in South Korea has made remarkable achievements as 5.2% of the total revenue of the global construction industry belong to South Korean contractors. However, compared to those achievements, the current level of BIM adoption is behind. BIM adoption in South Korea is relatively new, and the first government led BIM adoption plan put in place in 2010. Accordingly, this study analyzed the current status of BIM adoption in South Korea to identify the impact of government-driven plans on implementing BIM.

The BIM adoption plans in South Korea from 2011 to 2020 were presented and compared. The first BIM

adoption plan in 2010 set out for the full BIM adoption starting in 2016, by expanding on the types of target projects and project cost. However, from 2010 to 2015, the first plan failed to provide the expected results due to its short period and low BIM capacities of the South Korean AEC market at that time. The 2020 BIM adoption plan was established to improve the previous plan by gradually expanding the types and sizes of projects over the years. Next, the status of BIM projects in South Korea was analyzed using the statistical data from 2011 to 2020. The data pointed out that the BIM adoption plan did not have much effect as there has not been significant changes in net cost or the number of BIM-applied projects. Reasons for this result are related to the characteristics of public projects. The government controls the number of public projects. It is impossible to expand BIM adoption if only public projects are mandated to use BIM. Additionally, mandating only the very high-cost projects use BIM have resulted in limited number of target projects and stakeholders to participate in. Finally, Incheon International Airport was presented as a case study as it represents the best BIM application case in South Korea. The case study implies that BIM capacities of South Korean AEC industry are sufficient despite the challenging circumstances and methods to leverage their competent BIM abilities in effective ways, which could help improve government-driven BIM adoption.

This study suggests a robust, long-term masterplan, which covers both public and private projects, to overcome the shortcomings from government-driven BIM adoption. This masterplan needs to guarantee a consistent operation without being affected by internal/external issues. Also, continuous expansion of BIM adoption and motivating stakeholders with various incentives should be considered. Specifically, direct/indirect financial assistance based on the BIM application performance, such as direct rewards of subsidy or indirect incentives of tax benefits or bidding advantages, can be added. To leverage the contents of rewarding, details such as the amount of subsidy and incentive, evaluation criteria to distribute rewards have to be considered.

This study analyzed the impact of government-driven BIM adoption. In addition, implications to improve BIM adoption can be specified further by future studies. Meanwhile, this study has insufficient considerations of qualitative features of BIM application among BIM-applied projects, such as level and performance of application, in order to supplement qualitative considerations, surveys on the details of BIM-applied projects should be conducted.

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