

# *Analysis of national BIM implementation strategies, for the creation of a reference frame-work for the implementation of BIM in Mexico.*

## **Análisis de estrategias nacionales de implementación BIM, para la creación de un marco de referencia para la implementación de BIM en México.**

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### **Abstract**

*For some years now, the construction industry has been looking to improve productivity levels, reduce time and avoid cost overruns of the projects they perform; and has found a solution in BIM. In Mexico, the lack of national standards for the use of BIM makes it difficult to reach its potential. This research located different national strategies for BIM implementation world-wide; which were analyzed through a comparative analysis of qualitative content, in order to identify the various actions, and regulations that these countries have used to homogenize this implementation. The research concluded that the public and private sectors must create the conditions to promote implementing BIM, by creating criteria and standards related to the management and delivery of the information in the projects, to successfully take advantage of this approach. The results will serve as support for the creation of a reference framework to implement BIM in Mexico.*

**Keywords:** Building information modeling; BIM implementation strategy; National BIM standards; BIM framework; BIM regulations.

### **Resumen**

Desde hace algunos años, la industria de la construcción busca mejorar los niveles de productividad, reducir el tiempo, y evitar sobrecostos de los proyectos que realizan; y han encontrado en BIM una solución. En México, la falta de normas nacionales para el uso de BIM, dificulta se alcance su potencial. En esta investigación se localizaron diferentes estrategias nacionales de implementación BIM a nivel mundial; las cuales fueron sometidas a un análisis comparativo de contenido cualitativo para identificar las diversas acciones, y normatividad que estos países utilizaron para homogenizar esta implementación. Se concluyó que los sectores público y privado deben generar las condiciones para impulsar la implementación de BIM, mediante la creación de criterios y estándares relacionados con el manejo y entrega de información en los proyectos, y así aprovechar este enfoque. Los resultados obtenidos servirán para la creación de un marco de referencia para la implementación de BIM en México.

**Palabras clave:** Modelado de la información de la construcción; Estrategia de implementación BIM; Estándares BIM nacionales; Marco de referencia BIM; Regulaciones BIM.

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## 1. Introducción

In this article, several national strategies carried out by different countries to give way to the implementation of the BIM methodology in their territories are analyzed, in order to identify the various actions, plans and regulations that those countries have used to homogenize this implementation, as well as the challenges they have faced during this process. The results obtained will serve as support for the creation of a reference framework for the implementation of the BIM methodology in Mexico.

In 2015, the Embassy of the United Kingdom in Mexico City presented a report for the implementation of BIM in Mexico, where it is mentioned that BIM has the potential to offer considerable benefits to the country, through more efficient designs and constructions, as well as access to critical data to maintain and operate buildings (Embajada del Reino Unido en México, 2015).

A "National BIM Implementation Strategy" is the set of activities carried out by a government entity to prepare for the deployment or optimization of BIM workflows" (Padilla et al., 2019).

According to the Computer Integrated Construction Research Program, a BIM implementation strategy should include the following (Computer Integrated Construction Research Program, 2013):

- Strategic planning. To assess existing organizational conditions; align BIM goals and objectives with BIM uses and the desired level of maturity; and develop a transition plan for BIM implementation.
- Implementation planning. To develop the detailed implementation plan within the organization's operations.
- Procurement planning. To identify key issues to consider when creating BIM contracting requirements.

The objective of implementing BIM at a national level in a country is to increase the productivity of the construction industry of that country, reduce the execution time of projects, avoid cost overruns during their life cycle; including the operation and maintenance phases, guarantee the quality and safety of the buildings; as well as reap the many benefits associated with this methodology (Secretaría de Hacienda y Crédito Público, 2019).

In the SmartMarket Report published by Autodesk in 2019, some of the benefits of implementing BIM are pointed out (Autodesk, 2019):

- Reduce errors in projects.
- Reduce the time required for communication, workflow and decision making.
- Increase customer satisfaction.
- Delivery of projects with better quality and more creativity in design.

In Mexico, a lot of money is lost in the execution of works that are not completed. According to figures from the Center for Economic and Budgetary Research (CIEP), the investment spending in 2019 approved in the Federation Expenditure Budget (PEF) was 715 thousand 566 million pesos, of which 370 thousand 522 million correspond to infrastructure, equivalent to 51.8% of these. That same year, the Ministry of Communications and Transportation (SCT) and the health sector reported a large number of unfinished works; such as airports, train lines, medical units and hospitals (Centro de Investigación Económica y Presupuestaria, 2019).

Hence the importance of creating a reference framework for the use of BIM in Mexico, which will serve to enhance the benefits of BIM in the country, including better resource management.

The objectives of the study presented in this article are focused on a comparative analysis of qualitative content, of different national strategies published by various countries focused on the implementation of BIM, this in order to (I) identify which strategies have carried out in other countries to implement BIM in their territory; (II) identify what standards these countries have used to standardize implementation; (III) identify points to take into account for the creation of a reference framework for the implementation of BIM in Mexico. The results of this analysis will serve to lay the foundations for the content and focus that a reference framework for the implementation of BIM in Mexico should have.

## 2. Methodology

A bibliographic review was carried out to locate different national BIM implementation strategies worldwide. For the bibliographic search, the following descriptors were used: "National BIM implementation strategy", "National BIM standards", "National BIM implementation guide".

The method used to analyze the selected documents was a comparative analysis of qualitative content; Comparative analysis of qualitative content is a type of study that seeks to collect observations from different social entities, in order to study similarities, divergences, as well as detect their causes (Ariza and Gandini, 2012).

The steps for the selection and analysis of the different national strategies were the following:

1. Of the records obtained, those that meet the following criteria were selected:

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- o Being a national implementation strategy, endorsed by the government of a country, with a view to formulating mandates for the mandatory application of BIM in the construction industry of a given territory.*
- o. Be structured in detail, with specific objectives, strategies and regulations for the fulfillment of those objectives, as well as established times for their achievement.*
- o. Be available in English or Spanish.*

*The different selected national strategies are presented below, carried out by governments of different countries to support the implementation of BIM in the construction industry of those countries:*

- o. PlanBIM Chile. Published by the government of CHILE.*
- o. BIM BR “Build intelligently”. Published by the government of BRAZIL.*
- o. Strategy for Digital Construction. Published by the government of DENMARK.*
- o. Government Construction Strategy. Published by the UK government.*
- o. Road Map for Digital Design and Construction. Published by the government of GERMANY.*
- o. Strategy for the implementation of construction information modeling (MIC). Published by the government of MÉXICO.*

*There are several proposals made by other countries with the aim of promoting BIM, which were left out of this study since they did not meet the requirements previously established in the selection criteria:*

- o. The United States of America is one of the pioneering countries in the application of BIM, there are guides and standards, but no laws or regulations that companies have to follow.*
- o. The government of the People's Republic of China has issued different formal and informal policy documents to regulate and promote the application of BIM in its territory. Despite this, its application environment is not mature enough at the national level.*
- o. In Australia, the role of the public sector in BIM development has been crucial. The government has promoted a large number of national initiatives to drive the construction industry towards BIM through the development of standards and protocols. A national BIM guide has been published. However, it was impossible to access this guide through the web portal of the government of that country.*
- o. In 1995, Singapore launched a strategic initiative: The Construction and Real Estate Network (CORENET), spearheaded by the Ministry of National Development. The goal was to boost the construction industry through BIM. However, this initiative was never followed up.*
- o. The South Korean government has published basic guidelines for the application of BIM in construction projects in that country, but does not present as such a mandate or an implementation strategy at the national level.*

*2. Each document was read and the specific objectives were identified, the lines of action for the achievement of said objectives, the norms used to standardize or homogenize the implementation, as well as the challenges and expected benefits.*

*3. The content of the objectives and lines of action were compared to identify instances where different names were applied to the same topic.*

*Each of the different national strategies published by the aforementioned countries cover a large number of issues relevant to each specific country. Each government considers its own unique needs and contexts, so while the main issues covered are similar across all strategies, some have unique themes. The topics also vary in content and level of detail, since, sometimes, the same topic may not be deepened within one strategy, while, in another, it is deepened; There are also different terms used to refer to the same topics.*

*4. A comparative table of the analyzed national BIM implementation strategies was made, in which the common and discrepancy points that each of them have are observed.*

*“Understanding the current levels of BIM implementation in each country is important to determine directions for future development. This has become important due to the proactive moves by many governments around the world to facilitate the implementation of BIM in the construction industry of their countries” (Jung and Lee, 2016).*

### **3. Results**

*From the analysis of the selected national strategies, the following was obtained:*

*National Strategy for BIM implementation in Chile.*

*According to the Digital Transformation Committee, the "PlanBIM Chile" is an implementation strategy, in order to improve the productivity of the construction industry, using the BIM methodology for the development and operation of building projects and public structure.*

*The plan focuses on five lines of action (Gobierno de Chile, 2016).*

- *Institutionality and Strategy. Guarantee the continuity of the plan, based on alliances and agreements.*
- *Standardization. Define a BIM standard for the development of public projects.*
- *Human capital. Promote training of public and private personnel in BIM matters.*
- *Enabling technologies. Promote the use of technology, which allows the development and management of public projects.*
- *Communication and dissemination. Carry out a communication plan that serves the entire construction industry.*

*National Strategy for BIM implementation in Brazil.*

*In June 2017, the Strategic Committee for BIM implementation undertook the task of creating the bases to carry out a correct implementation in the construction industry of that country.*

*According to the Ministry of Industry, Foreign Trade and Services, the strategy contemplates nine specific objectives (Gobierno de Brasil, 2017):*

- *Disseminate BIM and all its benefits.*
- *Coordinate a training for the public sector to prepare it for BIM adoption.*
- *Create favorable conditions for investment in BIM for the public and private sectors.*
- *Promote training regarding BIM processes and methods.*
- *Standards on public contracts based on the adoption of BIM.*
- *Develop specific technical standards, guidelines and protocols for the adoption of BIM.*
- *Develop a platform and a national BIM file.*
- *Encourage the use of BIM-based tools and their development.*
- *Intensify the development and application of new technologies related to BIM.*

*The adoption of BIM in Brazil will take place in three stages:*

*Stage 1 – It is scheduled to start in 2021 and focuses on carrying out architectural and engineering projects for the construction of new buildings.*

*Stage 2 – It is scheduled to start in 2024, it will implement the use of digital models to carry out the planning of the execution of the works in case of a new work or expansion.*

*Stage 3 – Scheduled to start in 2028, it will involve the creation of digital models in all aspects related to the life cycle of the building, including the management and maintenance of existing assets.*

*National Strategy for BIM implementation in Denmark.*

*The strategy for digital construction is a document published by the Danish government in order to combat the lag in terms of productivity growth in the construction sector of that country, compared to other sectors. Such as agriculture and industry.*

*The Ministry of Transport, Building and Housing summarizes Denmark's Digital Building strategy into five focus areas (Gobierno de Dinamarca, 2019).*

- *Better use of digital tools.*
- *Open formats and common standards.*
- *Better use of data.*
- *Digital skills for business activities.*
- *More sustainable construction through digitization.*

*National Strategy for BIM implementation in the United Kingdom.*

*The objective of the "Government Construction Strategy" published by the UK government is to reduce the cost of public works construction projects by 15 – 20%.*

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*The strategy was published in May 2011. A new strategy was published in 2016, in order to increase productivity in the construction of infrastructure projects. The strategy sets ambitious targets for smarter purchasing, fairer payment, better use of digital tools, reduced carbon emissions, and increased customer purchasing power (Gobierno del Reino Unido, 2016).*

*Key Focus Areas (Gobierno del Reino Unido, 2011):*

- *The role of the government as a key client.*
- *Digital and data capacity.*
- *Skills and supply chain.*
- *Comprehensive construction approach.*

*National Strategy for BIM implementation in Germany.*

*In April 2013, the Federal Ministry of Transport and Digital Infrastructure of Germany founded a commission in charge of the implementation of BIM at the national level. In order to improve the productivity of the construction industry, develop greater confidence in citizens when executing public projects, guaranteeing that public funds are executed efficiently and likewise, pre-serve the international reputation of the German planning and construction industry.*

*The plan establishes the gradual introduction of BIM practices in pilot projects between 2017 and 2020, to reach a "Level 1", which is the level that the German government intends to achieve initially, in which the different actors work with their own digital models, based on project deliveries with the following key characteristics (Gobierno Federal de Alemania, 2015):*

- *Delivery of projects based on ISO 19650.*
- *Information requirements to define what data is required by the employer, when and with what detail.*
- *Principle of specific federated BIM models, merged into a coordination model.*
- *Creation of a BIM Execution Plan (BEP), defining: frequency of coordination of the model, level of detail required in the different phases, use of the model for visualization, deployment of quantities, simulations and evaluations of the life cycle.*
- *Use of a common data environment in accordance with ISO 19650.*
- *Derivation of 2D plans from 3D BIM models.*
- *Use of open data exchange standards mainly IFC, but also OKS-TRA and GAEB.*
- *Legal frameworks, as well as current regulations.*

*These key characteristics are defined with the purpose of allowing an easy and seamless transition to the execution of BIM-based projects. In the future, it is planned to take the industry to a "Level 2", in which all those involved in the life cycle of a project work collaboratively on the same digital model, understanding that, to reach this level, changes will need to be made to the laws and regulations governing the construction industry.*

*National Strategy for BIM implementation in Mexico.*

*The Ministry of Finance and Public Credit, presents the "Strategy for the implementation of Construction Information Modeling (MIC) in Mexico", this strategy seeks to promote the implementation of BIM, in order to improve the processes of the construction industry, reduce project overtime and cost overruns, as well as have transparency in the management of public resources.*

*The strategy is being implemented as of 2019, starting with pilot projects, and it will progress progressively over a period of eight years, so that the different public agencies have the necessary time to adapt their processes. and regulatory frameworks to give way to the implementation of the methodology.*

*In order to comply with the implementation plan, four specific objectives are proposed (Secretaria de Hacienda y Crédito Público, 2019).*

- *Make use of BIM in public infrastructure projects.*
- *Use technological tools to improve the different processes of the projects.*
- *Promote the participation of the private sector to complete the value chain.*
- *Use the results of the implementation for continuous improvement in the infrastructure.*

### **3.1 Discussion**

*From the analysis it can be seen that all the reviewed initiatives coincide in formulating a detailed implementation plan, with specific dates to carry out the implementation, in a general way and by sectors, likewise, they pay special attention to the adaptation of the current regulations for the widespread use of BIM, focusing on the mapping of those regulatory*

documents related to the execution of infrastructure projects that must be updated or created to give way to implementation.

Among the socio-organizational, legal and regulatory requirements that must be addressed when developing a BIM implementation plan, are the following (Alreshidi et al., 2014):

- Improve communication between the different stakeholders.
- Define clear roles and responsibilities for the interested parties throughout the life cycle of the projects.
- Standardize the general data management policies in the project life cycle.
- Development of protocols.

The ultimate goal of 100% of the national initiatives analyzed is to promote the use of BIM in public infrastructure projects, in order to improve project processes through the BIM methodology and the application of technological tools. The role of the public sector, as well as the power of conviction that it has over the private sector, is essential to promote BIM adaptation (Teo Ai Lin and Cheng, 2011).

In countries where there is a greater BIM maturity (66% of the initiatives analyzed), issues of social relevance appear, such as; sustainability and sustainable construction, the creation of smarter cities, as well as industry 4.0, with Latin American countries such as Chile, Brazil and Mexico not taking these issues into account. The United Kingdom sets itself the goal of a more efficient contracting system, as well as reducing carbon emissions to have a more sustainable construction industry.

50% of the initiatives analyzed stimulate the development of new technologies related to BIM, as well as promote the development of national BIM standards, platforms and libraries that enable the homogeneous use of BIM, in order to promote market competition through neutral interoperability standards. It is only the German initiative that does not take this point into account.

The United States is not far behind, since, in order to improve the productivity of the construction industry in that country, the National BIM Standard (NBIMS) is established with the objective of providing the digital scheme and the requirements for an efficient BIM application. The NBIMS initiative comprises the organization, philosophies, policies, plans and working methods; it also includes classifications, guides, practice standards, specifications and consensus standards (Nawari and Sgambelluri, 2010).

The importance of the creation of national standards lies in the fact that "organizations and humans are integrated into society, therefore, they are susceptible to the rules that govern it, in particular to standards, since these abundant the fabric social or infrastructure that moderates and supports social interaction" (Brunsson and Jacobsson, 2000).

The German government, in the absence of national BIM standards, has made use of the international standards ISO 19650, to guide the project delivery processes, as well as the operation and maintenance of buildings, which are carried out in that country. In such a way, it can be seen the importance that various governments give to the adoption of international standards and the creation of national standards, in order to standardize BIM management processes, and thus create a common language for the entire construction industry.

From the comparative analysis, it can be seen that there are several important points to take into account when creating a reference framework for the implementation of BIM in Mexico.

- Creation of national standards related to the delivery of information for the operation of buildings.
- Creation of technical standards for sustainable construction.
- Generation of two-dimensional plans from 3D models.
- Delivery of projects based on ISO 19650.

## 4. Conclusions

According to the analysis carried out in this research, it is observed that the final objective of the different national BIM initiatives published is to promote the use of BIM in public infrastructure projects, in order to improve the processes of projects and take advantage of all the benefits associated with this methodology.

BIM has the potential to offer considerable benefits to the Mexican construction industry (Embajada del Reino Unido en México, 2015). The purpose of the National BIM Implementation Strategy in Mexico is to promote measures aimed at improving development processes in the construction industry, including improved planning, reduction of overtime and cost overruns (Secretaría de Hacienda y Crédito Público, 2019). "When developing a BIM implementation plan, one should always seek to standardize the general information management policies during the project life cycle" (Alreshidi et al., 2014).

Based on what was observed in the comparative analysis, it is recommended; Initially, and in the absence of national BIM standards, the use of international standards ISO 19650 as a basis for the creation of a reference framework that facilitates the implementation of BIM in Mexico. The ISO 19650 standards are a series of international standards in which the framework, principles, and requirements are defined for the acquisition, use, and management of information in civil engineering projects. Which have been used in various countries, including the United Kingdom, Chile and Germany, yielding good results.

There are several important points to take into account for the creation of this frame of reference:

- Focus some of the objectives on the adaptation of current regulations related to the execution of projects.
- Development of national standards that enable the homogeneous use of BIM.
- Creation of neutral standards related to interoperability, information management and delivery of information for the operation of buildings.
- Development of technical bases for sustainable construction and the use of sustainable materials, as well as guaranteeing the collection of knowledge based on data for sustainable construction.
- Principle of BIM models, derivation of 2D plans from 3D BIM models.
- Delivery of projects based on ISO 19650.

The creation of national standards has a strong influence on promoting the adoption of BIM in the public sector of a country (Teo Ai Lin and Cheng, 2011). In such a way, that to promote the implementation of BIM in Mexico, it is advisable to create favorable conditions in the public and private sector for the use and management of the methodology; this through the creation of norms and standards related to the management and delivery of information during the life cycle of buildings.

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