

**ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE**

**FAKULTA STAVEBNÍ**

Katedra ekonomiky a řízení ve stavebnictví



**DIPLOMOVÁ PRÁCE**

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- Úvod, definice problematiky, vymezení cílů a výstupů práce, popis způsobu řešení.
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- Srovnání přístupu ČR a Španělska v oblasti zajištění informovanosti veřejného sektoru o BIM.
- Vyhodnocení osvědčených metod (best practices) v této oblasti.
- Praktické zpracování univerzálních školení nebo propagačních materiálů na základě zjištěných skutečností.
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EASTMAN, C.: BIM Handbook. 2. New Jersey: John Wiley & Sons, Inc., Hoboken, New Jersey, 2011. ISBN 978-0-470-54137-1.

Ministerstvo průmyslu a obchodu: Koncepce zavádění BIM v ČR (2017).

MATĚJKA, P.: Rizika související implementací Informačního modelování budov (BIM), disertační práce, 2017.  
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Prohlašuji, že jsem tuto diplomovou práci vypracovala samostatně, pouze za odborného vedení Ing. Petra Matějky, Ph.D a pomocného vedoucího Alberta Dominga ze španělské univerzity UPV.

Dále prohlašuji, že veškeré podklady, ze kterých jsem čerpala, jsou řádně citovány v seznamu použité literatury.

V Praze dne 04.01.2024

.....

Daniela Švédová

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Srovnávací studie ČR a Španělska v oblasti  
strategie informovanosti veřejného sektoru o  
informačním modelování staveb (BIM)

Comparative study of the Czech Republic and  
Spain in the area of public sector awareness  
strategy on Building Information Modelling  
(BIM)

## **ANOTACE:**

Cílem této diplomové práce je provést srovnávací studii mezi Českou republikou a Španělskem v oblasti strategií informovanosti veřejného sektoru týkajících se Informačního modelování staveb. Komparativní analýza je založena na podrobném zkoumání hlavních státních organizací v obou zemích, které se zabývají touto problematikou. Práce poskytuje detailní rozbor jejich záměrů a přístupů k vzdělávání a informovanosti veřejného sektoru v textové i grafické podobě. Dalším významným výstupem této práce je vytvoření propagačního nástroje, který slouží jako vzorový prostředek pro šíření informací o metodě BIM v rámci veřejného sektoru. Tento nástroj je navržen s důrazem na efektivní propagační strategie a má za cíl podporovat povědomí a adaptaci této moderní metody v obou zkoumaných zemích. Vytvoření tohoto propagačního materiálu představuje významný přínos práce pro podporu a šíření informací o BIM ve veřejném sektoru.

## **KLÍČOVÁ SLOVA:**

Informační modelování staveb, informovanost veřejného sektoru, Česká republika, Španělsko, srovnávací studie, propagační materiál

## **SUMMARY:**

The aim of this master's thesis is to conduct a comparative study between the Czech Republic and Spain in the field of public sector awareness strategies regarding Building Information Modelling. The comparative analysis is based on a detailed examination of the main state organizations in both countries dealing with this issue. The thesis provides a comprehensive analysis of their intentions and approaches to education and public sector awareness in both textual and graphical forms. Another significant output of this work is the creation of a promotional tool serving as a model for disseminating information about the BIM method within the public sector. This tool is designed with an emphasis on effective promotional strategies and aims to promote awareness and adaptation of this modern method in both examined countries. The development of this promotional material represents a significant contribution to supporting and disseminating information about BIM in the public sector.

## **KEY WORDS:**

Building Information Modelling, public sector awareness, Czech Republic, Spain, comparative study, promotion tool

## LIST OF ABBREVIATIONS

ABE	Association of Building Entrepreneurs
ADIF	Administrador de Infraestructuras Ferroviarias
AEC	Architecture - Engineering – Construction
AENA	Aeropuertos Españoles y Navegación Aérea
ANSI	American National Standards Institute
ARI	Czech Infrastructure Association
BIM	Building Information Modeling
BOE	Boletín Oficial del Estado
BUT	Brno University of Technology
CAD	Computer-Aided Design
CCA	Czech Chamber of Architects
CCCET	Czech Chamber of Chartered Engineers and Technicians Engaged in Construction
CCI	Construction Classification International
CDE	Common Data Environment
CEN	European Committee for Standardization
CIBIM	Commission Intermisterial BIM
CICCP	College of Civil Engineers
CICCP-CV	Valencian Community of the College of Civil Engineers
CITOP	College of Technical Engineers of Public Works
CITOP-CV	Valencia and Castellón area of the College of Technical Engineers of Public Works
CTU	Czech Technical University
czBIM	Czech BIM Council
ČSN	Czech Technical Standards
DSS	Data Standard of Building
EAPC	L'Escola d'Administració Pública de Catalunya
ECSSO	European Construction Sector Observatory
EU	European Union



FM	Facility Management
IFC	Industry Foundation Class
ISO	International Organization for Standardization
IT	Information Technology
IVAP	Institut Valencia de Administración Pública
MITMA	Ministry of Transport, Mobility and Urban Agenda
SFDI	State Fund for Transport Infrastructure
UK	United Kingdom
UNE	Spanish Association for Standardization
U.S.	United States
UWB	University of West Bohemia
VSB-TUO	Technical University of Ostrava
VSTE	Institute of Technology and Business in České Budějovice

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# 1 INTRODUCTION

In the contemporary era characterized by rapid technological advancements, digitalization emerges as an increasingly significant factor, particularly in the technical fields. This paradigmatic shift introduces novel methodologies and tools that afford more efficient and complex solutions to intricate technical challenges. At the forefront of this digital transformation in construction and design stands the methodological approach known as Building Information Modelling.

Within the technical sectors, including mechanical engineering and electrical engineering, the construction sector emerges with a discernible lag concerning digitization. This circumstance prompts an opportunity for a thorough examination of this matter, intending to heighten awareness surrounding its complexities. Enhanced understanding of these aspects can contribute to the improvement of information sharing, promotion, and adaptation to the new trend of digitization in the construction industry.

The significance of this study extends beyond mere identification of existing deficiencies in the given issue. It has a broader objective to support an active response to the changing conditions of digitization in the construction industry. The results of this work are intended to highlight the capabilities of information distribution and change support, which are essential for effectively managing the rapidly evolving dynamics of digitization in this industry, with a focus on the public sector.

## 1.1 Problem Statement

In the current context, with the increasing implementation of the BIM methodology in the construction sector, acquiring knowledge about this method within the public sector becomes increasingly crucial. A challenge lies in the limited interest of individuals in this sector, especially within building authorities, in adapting to new procedures, which can evoke resistance during the process of change. Therefore, it is essential to systematically support and manage BIM awareness among these groups.

Education within the public sector about the BIM methodology is currently becoming a key measure for several reasons. It represents a modern and efficient approach to the management and execution of construction projects, which can significantly enhance productivity and quality in the construction industry. Officials familiar with this method

can more efficiently address construction projects and better coordinate work with various stakeholders. Additionally, this can lead to effective resource planning and management. A crucial aspect is also the consideration of new legal and regulatory requirements related to BIM, particularly in the context of public procurement. Public sector employees in construction should be capable of navigating these topics and actively contributing to compliance with new standards and regulations.

## 1.2 Objectives of the Thesis

For this master's thesis, specific objectives have been defined, which need to be achieved throughout the research. The following Table 1 provides a list of these objectives.

Table 1: Objectives

<b>O1</b>	Explanation of BIM in the context of construction and its significance in raising awareness in the public sector.
<b>O2</b>	Analyzing of the Czech Republic and Spain approach to the BIM methodology and public sector education within the context of this method through their specialized organizations and state institutions.
<b>O3</b>	Conducting a comparative study of both countries concerning BIM and their efforts to raise awareness of BIM in the public sector.
<b>O4</b>	Creating a tool with the aim of promoting BIM within the public sector.

*Reference: Own resource*

## 1.3 Methodology

### Data collection

Various forms of publications and resources were utilized in the elaboration of this master's thesis. A list of all types of used resources is provided below.

- Books regarding BIM
- Research of scholarly publications
- Publications issued by state's entities and organizations
- Articles issued by state's entities and organizations regarding BIM
- Reviews
- Consultations with BIM experts in the Czech Republic and Spain

For the theoretical part, the main resources of information were primarily books, periodicals issued by renowned global and state organizations, specialized articles, and reviews. These resources formed the theoretical foundation necessary for understanding BIM issues. To improve the author's level of comprehension and to gain deeper insights into the researched topic, OpenAI GPT-3.5 was used. It is necessary to mention that due to the fact that BIM is rapidly evolving and due to the limited up-to-date and accurate data provided by this tool, it was used only as a supplementary resource.

In the practical part, publications issued by state organizations and entities specializing in the field of BIM in the Czech Republic and Spain were given priority. Additionally, articles published by these organizations were considered as an important resource of information, contributing to a practical understanding of the subject.

The execution of the practical part was enriched by consultations with experts in the field of BIM operating in the Czech Republic and Spain. This interaction with experts contributed to a deeper understanding of practical aspects of this issue and ensured the relevance of the results.

## Outputs

The outputs of this master's thesis are:

- Graphical evaluation of public sector awareness strategies regarding BIM in the Czech Republic and Spain
- Promotional tool

## 1.4 Literature review

Currently, there is a limited number of literature within the field of information strategy in the public sector concerning the BIM methodology. Specialized articles and publications have been predominantly employed to ascertain the present situation. Regarding a comprehensive understanding of the BIM methodology, only a restricted number of book publications are available on the Czech, Spanish, and global markets. These literary works have been utilized as foundational references for the elaboration of this thesis.

**CAÑÓN BUILTRAGO, Elkin Darío.** *Metodología BIM: conceptos y su aplicación en proyectos de infraestructura vial.*

Published in March 2023, this book examines the concept of the BIM methodology and its application in the field of construction infrastructure. Serving as a valuable guide, it navigates the public sector through the process of adopting this methodology across all sectors of the construction industry. Furthermore, it introduces readers to the global context of this area, delves into its standardization, information management, and practical utilization throughout the lifecycle of construction projects. The book also provides an explanation of BIM and emphasizes its contributions. In the context of crafting the master's thesis, this literary work proved to be an invaluable source of information, and its practicality and timeliness deserves acknowledgement.

**MINISTERSTVO PRŮMYSLU A OBCHODU.** *Koncepce zavádění metody BIM v České republice.*

This publication was developed in the Czech Republic based on a government resolution from the year 2016. The Ministry of Industry and Trade, in collaboration with SFDI and czBIM, formulated this concept in 2017 with the aim of providing an overview of the current and future state of the implementation of the BIM methodology in the Czech Republic. The publication encompasses topics essential to BIM related problem solving and includes a plan for the implementation of BIM in the country over the next 10 years, along with recommended measures for efficient utilization. This conceptual framework served as a key source of information for the master's thesis, particularly in providing insights into the BIM environment in the Czech Republic.

**MITMA.** *Plan BIM de la contratación pública.*

Developed by the Spanish government in 2023, this publication aims to enhance the efficient utilization of BIM, particularly focusing on a high-quality digital transformation of the construction sector and the effective management of public expenditures. In the context of the master's thesis, it served to provide a more detailed understanding of the current implementation status of BIM in Spain and to demonstrate the Spanish government's flow of information to public sector about the this methodology.

**EASTMAN, Charles M.** *BIM handbook: a guide to building information modeling for owners, managers, designers, engineers and contractors.*

This publication constitutes a complete guide dedicated to BIM modelling in the AEC industry. It serves as a manual intended for participants in the construction process

involved in the implementation of this new approach throughout the design, construction, and facility management phases. The publication acquaints readers with general information about BIM, elucidates its significance, and thoroughly examines its advantages and disadvantages throughout the entire lifecycle of a construction project. Within the framework of this thesis, the book primarily served for a general understanding, education, and acquisition of extensive information about this methodology.

**DUFEK, Zdeněk, a další.** *BIM pro veřejné zadavatele.*

The authors compiled this book with the aim of providing insights into the principles of BIM, its benefits, challenges, and key aspects for public sector entities. The book is composed in a concise style to afford a fundamental understanding of the subject. It includes detailed information on the principles, advantages, and challenges associated with the application of BIM in the public sector, including insights into software, data transmission, and management within the construction process utilizing BIM. This literature systematically explains its integration with the public sector.

**MATĚJKA, Petr.** *BIM v zahraničí, zavádění BIM, BIM v ČR.*

The resource for the elaboration of this master's thesis also included lectures by Petr Matějka, presented within university lectures at the Czech Technical University (CTU), which the author of the thesis had attended. The lectures provide an overview of the BIM methodology itself as well as its implementation worldwide, including the Czech Republic.



## 2 UNDERSTANDING BIM

In order to introduce a purpose and inspire the public to take an interest in BIM, it is important that they first gain a comprehensive understanding of what BIM truly encompasses, while also being provided with a persuasive reasoning that highlights the importance of entering this new complex field.

### 2.1 What Is BIM?

When comparing two countries in the context of BIM, it is important to define what BIM truly represents within the scope of this study. This is especially important if the research is to be reproducible and verifiable. On the other hand, the current technological state of BIM is already well-established, allowing the research to be grounded in fundamental knowledge. For the purposes of this paper, the basic definition should be considered as formal, but also might prove useful in evaluating whether the thesis will remain relevant in the coming years.

Numerous definitions exist for the concept of BIM methodology within the industry, but they largely share common features. These commonalities typically include elements like collaborative teamwork, effective asset management, and the use of intelligent models, among other aspects. One of the organizations which focuses on the area of BIM, called buildingSMART, defines BIM as *“collaborative work methodology for the creation and management of a construction project. Its objective is to centralize all the project information in a digital information model created by all its agents”* [1].

The principles of information modelling have been known since 1974 but the acronym BIM has started to be widely used lately since 2002. The letter “B” stands for “Building” which is not limited to just buildings but generally refers to a construction and construction process. The letter “I” stands for “Information” and letter “M” stands for either “Modelling” or “Management”. It is important to distinguish BIM as a model (a certain form of a database) from BIM as a process that utilizes the BIM model for the purpose of exchanging and sharing information, as well as managing it. [2]

BIM can be envisioned as an information database that covers data from the initial design stage all the way through construction, building management, potential modifications, and even demolition, including environmentally friendly disposal and restoring the site

to its original condition [2]. To sum up, it contains all the information needed throughout the entire lifecycle of the building and includes the contribution of all participants in the construction process.

To maximize the benefits of using the BIM approach, it is essential that none of the stakeholders in the building's lifecycle refuse to use the BIM model and should regularly update it with current information. The primary benefit of adopting this collaborative method for managing building information is its ability to facilitate smooth teamwork without data loss and maintain access to the latest updates. It is important to note that this does not mean every individual has to provide all their knowledge and data to the model, but they should be willing to exchange relevant information with other participants in the construction process. [2]

### **2.1.1 Differences between CAD and BIM**

Understanding the distinction between Computer-Aided Design (CAD) and Building Information Modelling (BIM) is essential.

CAD models operate in a 2D and a 3D space, allowing for the geometric definition of objects and their dimensions, making them suitable for manufacturing purposes. In contrast, as mentioned in chapter 2.1, BIM models go beyond graphics by including additional data parameters associated with objects, providing a more comprehensive understanding of each element. [1]

In the realm of BIM, object properties serve as crucial identifiers. Within the model, all the components of an object can be quickly selected and visualized. For example, using view filters in a model can quickly determine the properties of any object and qualify them. This capability is for example of great advantage when preparing a bill of quantities. Assuming that the model is of high quality and drawn correctly without errors, it is, for instance, possible to filter out all types of masonry used in the model with a single click and thus determine their surface area and volume. This can take a few minutes. On the other hand, in the case of qualifying the bill of quantities for all masonry from a 2D drawing, such an activity can take up to several hours.

Moreover, BIM systems facilitate logic-based searches, allowing for the identification of elements between walls with certain classifications. This capability verifies whether these elements meet specified requirements. These detailed search methods empower users to

spot design deficiencies and address them during the design phase rather than later during construction, thus enhancing overall project efficiency and reducing costs. [1]

Undoubtedly, it is necessary to mention the famous MacLeamy curve, developed by Patrick MacLeamy.

The MacLeamy curve in Figure 1 provides a visual representation that effectively illustrates how the adoption of BIM influences the development and expenses associated with a project [1]. In this graphical representation, Curve 3 depicts the amount of work or effort needed during the traditional design process, spanning from the pre-design phase to the operation phase. Line 2 represents the project's cost as it advances over time and Line 1 illustrates how, with the gradual development of the project, the ability to influence its cost and functionality diminished. Meanwhile, Curve 4 showcases the effort required when implementing BIM throughout the project lifecycle.

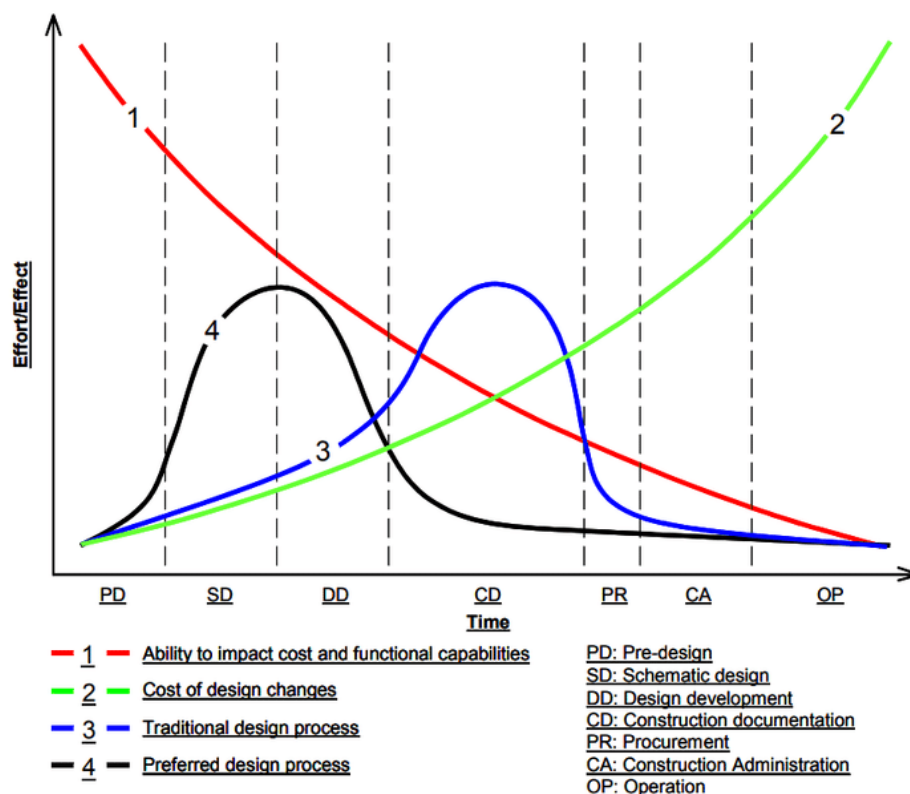


Figure 1: The MacLeamy Curve diagram

Reference: CAÑÓN BUILTRAGO, Elkin Darío. *Metodología BIM: conceptos y su aplicación en proyectos de infraestructura vial*. Bogotá : Ecoe Ediciones, 2023. ISBN 9789585036116.

MacLeamy curve highlights that the time invested in development of the documentation in traditional construction design and BIM design process differs. The optimization of time in the early design phases with the BIM approach results in lower costs.

Additionally, this graph shows that making changes in the early stages is much easier and less costly because there is no real or constructive implication. As the project progresses, making changes in the construction phases becomes much more difficult and expensive because it involves additional on-site conditions.

Understanding contracting's impact and adopting new methods is crucial for effectively utilizing new technologies. Currently, construction contracts follow a highly sequential approach, involving specialists, supervisors, promoters, financiers, and builders at different project phases (preliminary design, design, construction, and operation). This sequential process leads to the loss of information as parties change with each project phase, necessitating additional time and costs for information retrieval. To address this challenge, adopting integrated contracts that span the project's lifecycle is advisable, ensuring information continuity. Engaging various stakeholders (engineers, specialists, builders, promoters, etc.) from project inception fosters collaboration, aligning everyone with the project's vision and enhancing efficiency as it progresses through each phase. [1]  
[3]

## **2.2 Why BIM?**

After providing a general overview of what BIM is and its scope, it is crucial to raise a question of why to engage with BIM, what are the reasons of putting BIM into practice, what potential profits it can bring to any participant, including public sector, in the construction process, and, conversely, to examine its pitfalls and barriers.

To achieve the goals of this master's thesis and gain a more detailed understanding of the current situation regarding the strategic approach of both examined countries, it is essential to examine the question of why to currently utilize the BIM method. This examination should emphasize the significance of public sector awareness of the BIM methodology. As discussed in the previous chapter 2.1, this section of the thesis can also serve to assess the relevance of this issue in the coming years.

### **2.2.1 Benefits of BIM in Public Sector**

The implementation of BIM into the public sector serves many purposes. Public authorities are the primary promoters of the construction sector. They concentrate a significant number of investments in the public sector and have a huge impact on the digital transformation of the construction sector. Throughout the transparency of public

procurement, the use of BIM helps to improve the efficiency of public spending in public sector contracts and support the market. [1].

Well-prepared BIM project is coherent, provides up-to-date information, avoids data loss and coordination issues between versions, detects errors in the design phase and allows performing corrections before the construction phase. Furthermore, project digitalization streamlines the generation of all project documents, such as budgets, invoices, working programs, etc. Overall coherence, transparency, collaboration, and better communication throughout the whole project lifecycle greatly affect its final budget. [1] [3] [4] According to EU BIM Task Group, the digitalization of engineering, construction and operation processes could result in potential savings of 10 – 20 % of construction project costs [5].

Alongside other technologies such as drones, virtual reality, artificial intelligence, BIM contributes to innovation in the construction industry and to improving the efficiency and sustainability of construction work. European Commission published an Analytical Report on Digitalization in the construction sector in April 2021. According to this report and its studies, BIM can help reduce waste volume by up to 15 % and reduce construction waste management costs by up to 57 % [6].

As mentioned, investing in the development of a complex multidimensional model is more efficient when spread over a longer time compared to CAD models.

Czech Guide for implementation BIM called Concept of Implementing the BIM Methodology in the Czech Republic summarizes the most significant benefits of using BIM throughout the entire lifecycle of a construction project as listed below:

- *Cost and time savings across the entire construction project lifecycle*
- *Improved communication among participants in the construction process*
- *Enhanced control over the construction process*
- *Better quality of the final project*
- *Prevention of clashes (detecting them before construction)*
- *Avoidance of misunderstandings when using old versions*
- *Increased transparency and improved access to information for decision-making at various stages of the construction project lifecycle (even for non-technical workers)*

- *Possibility of cooperation with cost estimators and building managers from the early design phase*
- *Environmental friendliness - energy savings (reducing the energy performance of buildings using simulation capabilities in the project planning) and the use of data for renovations or demolitions*
- *Easier process of design alternatives*
- *Effective economic management of projects, from initial estimates to ongoing calculations, and invoicing*
- *Availability of up-to-date information in one place [2]*

It is important to note that the list above only covers key advantages of BIM. However, in practice we often encounter a range of additional benefits that can be remarkably diverse and specific to any given application. BIM provides a platform for further innovation and creativity within the construction industry and offers numerous opportunities for process optimization and achieving superior outcomes in both project execution and asset management.

Every participant involved in the planning, construction, or maintaining operations of buildings should understand the advantages of the BIM method from their own perspective. For the purposes of this thesis, the main advantages of using BIM in the public sector are summarized in the list below.

For a public builder:

- *Project and cost control throughout all project phases*
- *Rapid integration of requirements and changes*
- *Possibility of decision-making in earlier phases*
- *Better communication with fellow participants*
- *Usage of software validators of materials, product parameters aligned with its standards [2]*

For a public administration:

- *Automatic verification of design compliance with mandatory regulations (when using model validators)*
- *Effective utilization of public financial resources*

- *Reduced risk of cost overruns in public procurement for construction projects*
- *Increased transparency of construction projects*
- *The ability to easily simulate the energy demand of a building and optimize energy efficiency*
- *Better infrastructure planning due to collaboration of various government bodies related to construction*
- *Easier and more reliable communication and presentation of intentions during public hearings [2]*

### **2.2.2 Challenges and Barriers**

Despite the advantages of digitalization in the construction sector mentioned above in chapter 2.2.1, it is necessary to look at its potential pitfalls.

Even though leveraging on digital technologies results in better management and higher productivity, the usage of digitalization in construction still lags behind companies in the other sectors. The research conducted by the European Construction Sector Observatory's (ECSO) survey provides an overview of challenges that affect the construction sector. Respondents from public and private sectors indicated multiple challenges that according to them limit the adoption of digital technology. Based on survey results, the main factors hindering a faster BIM implementation are lack of skilled human resource, lack of standards, lack of awareness and understanding, and cost of equipment and software. [6]

The preparation of the BIM project consists in the purchase of new software and hardware which can cost tens of thousands of euros. New technology places higher demands on the project team and entails the necessity of education of staff and partners collaborating on the project, including the investor. When creating the model, it is essential to ensure its consistency and currency, which determines the quality of the model and its potential for further use. Achieving a high-quality BIM model requires an effort that permeates through all phases of the project. [4]

To sum up, the list below shows the main challenges while implementing BIM.

- Lack of in-house expertise and skilled human resources
- Unwillingness of stakeholders in BIM adoption and absence of investing in training the staff



- Higher initial cost of software and equipment
- Legal and contractual issues and the necessity of having clear and comprehensive agreements, policies and procedures that cover protection and use of data [6]

### 2.2.3 Case Study Research: A Real-world Perspective

Taking into consideration the theoretical summary of benefits and challenges of BIM that have already been mentioned in chapters 2.2.1 and 2.2.2 above, it is necessary to look at this topic from the real-world perspective. For this reason, case studies have been chosen to highlight the invaluable contributions of BIM to the construction industry.

Reyhanen S. Shojaei, Kwadwo Oti-Sarpong and Gemma Burgess from University of Cambridge wrote an article named *Enablers for the adoption and use of BIM in main contractor companies in the UK* published in 2023. The research identifies key enabling factors and describes how they help main contractor firms to achieve successful transformation through utilization of BIM. The paper commences by examining pertinent studies on BIM, elucidating the factors influencing its adoption. Emphasis is placed on the significance of attentively considering these factors when employing BIM methodologies. The following part of the article is dedicated to the actual research made by authors, where two methods are applied. The first one entails interviews with 42 highly experienced construction industry professionals working in management roles in leading large UK contracting firms predominantly working on public contracts. Each interview aims to identify how those firms' actions contribute to the successful use of BIM. The other phase involves interviews with BIM professionals from 5 leading award-winning firms, more detailed and primary used as a tool to create key factors for purpose of the research. Results from interviews show that large firms share in overall six key enablers, including a strong leadership, realistic digital transformation strategy, competent suppliers, true-based client relationship, effective training for employees and efficient communication. In addition, authors used their insights to be able to present various practical recommendations to guide construction firm executives in the direction of adopting BIM in their organizations and projects. [7]

A research paper called *Embracing BIM in its totality: a Total BIM case study* written in 2022 by Disney, Roupé and Johansson from Chalmers University of Technology in Sweden, and by Leto from Politecnico di Milano in Italy, points out the holistic approach of the usage of BIM throughout all project phases as a single source of information and



communication platform. By focusing on the lessons learned from a specific project and by gathering data based on interviews provided, findings from the research are that digitalization (in this case mobile BIM software) used on-site, cloud-based model management and strong leadership contribute to better work on the whole project. [8]

An article named *The Creation of Construction Schedules in 4D BIM: A Comparison of Conventional and Automated Approaches* written by O.Doukari, B.Seck and D.Greenwood in 2022 presents two case studies. One is a project in Paris where 4D BIM was used, in this case a combination of BIM and Artificial Intelligence. The other one is a case study on part of a European research project which authors use for demonstration of a digital tool developed to be applied in a project. The article introduces the concept of 4D BIM, presents several applications of 4D BIM and reviews its methods and tools used in France by conducting a survey across construction companies resulting in both positive and negative outcomes. The survey shows that developing a training plan to master corresponding programs is an effective strategy. On the other hand, the results revealed that the use of 4D planning is still limited in some ways, especially in simulation of project videos. [9]

The integration between two topics, BIM and facility management, is addressed in an article titled *A Methodology to Integrate Maintenance Management Systems and BIM to Improve Building Management* published in 2022 and written by Nojedehi, O'Brien and Gunay from Carleton University in Canada. The article precisely analyzes the relationship between FM and BIM, thoroughly examining all the benefits that the implementation of BIM brings to the field of maintenance. It highlights, for example, that while currently utilized computerized maintenance management systems include 3D models, BIM additionally incorporates non-geometric data, significantly enhancing the entire process of facility management. The case study applied in the article shows how BIM tools, with usage of Dynamo program, are integrated into a Carleton University in Ottawa. The utilization of BIM tools and the demonstrated combination of statistical information and text analysis in the study have resulted in a more efficient approach to building maintenance compared to the previous condition. [10]

### 2.2.3.1 Summary of articles

The comprehensive research initiative involved a thorough examination of a countless of scholarly articles, precisely searching through the volume of information available. From

this broad spectrum of resources, a selection process resulted in the identification of four articles, each addressing a different aspect of BIM in the construction industry. Recognizing the swift technological progress that continually shapes the construction industry and its BIM environment, particular emphasis was placed on articles published in the most recent years, specifically 2022 and 2023. This considered choice ensures that the insights presented in the selected articles are not only insightful but also reflective of the current situation. By adopting this approach, the research aims to provide a comprehensive, up-to-date, and thoroughly informed exploration of the subject matter.

The selected articles, in their respective order, address the following topics: the implementation of BIM into large corporations, the utilization of digital technologies during construction, the integration of 3D models and artificial intelligence, and finally, the application of BIM tools into the facility management of existing buildings.

From the available articles, it is evident that the adoption of BIM is gaining increasing support and demonstrating tangible benefits. However, it is crucial to be aware that the successful implementation of this methodology requires a decision to be made for its incorporation in the early stages of a newly initiated project. The transformation of existing projects into the BIM system, if the original project commenced without this methodology, is a challenging task and often an unattainable goal. Nevertheless, as indicated by the fourth article on facility management and BIM, the application of this methodology in the maintenance of existing administrative buildings is justified. However, this implementation necessitates a thorough transformation of drawings from 2D to 3D models to enable the use of additional programs and processes associated with these 3D models. It is important to note that in the case of a project already established in the BIM system, which includes 3D models, such a transformation is no longer necessary.

In the introduction of the BIM methodology, it is crucial to use the correct formats to ensure the connectivity of all documents, processes, and information. To achieve positive results in using these formats, it is important to focus on the human factor. This implies that the BIM approach must be accepted and adhered to by all participants involved in the lifecycle of a given construction project, from its design to its demolition.

## 2.3 Main Topics

The concept of BIM stands as a multifaceted and expansive subject, weaving its influence across the entire spectrum of a project's lifecycle. As explained upon in the antecedent chapter 2.2, BIM seamlessly integrates into the phases of project development, playing a pivotal role in the creation, utilization, and management of construction data. It transcends a singular definition, presenting itself as a dynamic process, a model, an expression of modern technology, an information system, a platform for document sharing, and a facilitator of the unified environment.

Given numerous dimensions of BIM, the spectrum of potential topics one can explore is vast. For the purposes of this master's thesis and the potential fulfillment of the specified outcome of creating a promotional tool mentioned in chapter 1.2, a selection has been made to focus on topics intricately tied to the specific issues under consideration. The following chapters provide general knowledge and information that help to clarify the selected topics and contribute to a comprehensive understanding of the study area.

### 2.3.1 Standardization

Standardization aims to create a set of technical specifications, compulsory or voluntarily used by participants in the construction process. The term technical specification is often associated with norms and standards developed by standardization organizations at the national or international levels. They are defined for all stakeholders in the construction process. Their development often takes a longer time, primary due to the need of achieving agreement among all parties involved. The most famous international association that creates standards is International Organization for Standardization (ISO).

[1]

Nevertheless, within the context of standardization, we may also consider standards developed by organizations for their internal purpose. These documents typically take the form of guides, manuals, etc. Due to their constrained scope, they can be completed in a shorter timeframe.

Generally, there are three levels of standardization that are important to recognize.

The international level that features standardization bodies like ISO. These organizations create regulations and standards that can be adopted by any country that decides to do so.

The regional level where figures organizations like *American National Standards Institute* (ANSI) in America or *European Committee for Standardization* (CEN) in Europe. They adopt ISO standards at continental level. They serve as a prototype for creating national standards by each country.

The national level where each country adapts standards to their own environment and current situation. Both Czech Republic and Spain has their own technical standards, ČSN in Czech Republic and UNE in Spain.

### 2.3.1.1 ISO norms

International Organization for Standardization is an independent non-governmental international organization with a membership of 169 national standard bodies. It was founded in 1947 and is situated in Geneva. Through its members, it gathers experts from around the world to share knowledge and to develop international standards based on agreement and relevance to market resulting in supporting innovation and providing solutions on global challenges. The world-wide used standard related to the BIM method that requires further explanation for the purposes of this thesis is ISO 19650 and ISO 16739. [11]

Why is it so important to understand the fundamental principles and concepts of ISO standard 19650?

It deals with the information flow in civil engineering projects using BIM. It establishes the basis for information management that all clients and stakeholders should follow when they intend to use BIM. Additionally, it is a standard that can be applied to any type of project, and it is focused on the entire lifecycle. ISO 19650 plays a pivotal role in the organization and administration of project-related information. It sets forth essential parameters for effective information exchange among all project participants. By grasping its fundamental principles, stakeholders can ensure the proper organization of information throughout the project's lifecycle, contributing to enhanced collaboration, efficiency, and overall project success. [1] [12]

Up to this date, ISO has published in total 5 parts of ISO standard 19650. The first part defines basic concepts and principles and offers guidelines for effective building information management including exchanging, recording, and organizing for all actors. The second part outlines the information management criteria as a management process

for the asset delivery phase, encompassing information exchanges while employing BIM method. It may be adopted by those involved in the procurement process and design either those involved in activities of asset management. The third section is primarily useful for owners and operators of buildings. It provides an information management process that helps owners to determine requirements for operational phase of an asset and guides them to achieve their business objectives through its effective production and use. The fourth part provides a detailed criteria for decision making in information exchange. This part is still in a process of development. Its purpose is to uphold the quality of the final project. It advocates for a balanced and sustainable approach to information exchange. The last part focuses on a description of the principles for information management regarding security. It defines all the steps that need to be taken to create and develop a proper security background across all organizations, including the need for monitoring and auditing. [1]

What is the main objective of ISO standard 16739?

Regarding data, ISO standard 16739 pertains to a crucial aspect of the standardization of IFC (Industry Foundation Classes) used for data storing in the construction and asset management. [13] This subject matter is of such intricacy that an entire chapter, denoted as 2.3.2, has been allocated for its discussion.

### *2.3.1.2 Guides and manuals on national level*

While global BIM principles remain consistent, implementation and specific requirements can differ significantly from one nation to another. Each country possesses distinct legal systems, building codes, procurement procedures, and governmental structures. Consequently, individual countries create their own manuals and handbooks tailored to their specific requirements. However, it's worth noting that these national-level manuals still draw inspiration from international organizations and standardization efforts.

## **2.3.2 IFC**

According to buildingSMART, IFC is characterized as “*an open, international standard, meant to be vendor-neutral, or agnostic, and usable across a wide range of hardware devices, software platforms, and interfaces for many different use cases*” [14]. This standardized data model is able to codify various project aspects, such as object type,

characteristics of object (material, thermal properties), objects itself (slabs, walls), people (owner, contractor) and even more. These specifications serve as a tool for easier construction, overall definition of components of building, products and systems applied or the interpretation of cost and energy analysis models. [3]

Its main idea is to achieve smooth information exchange between two parties. The required IFC data can be encoded in multiple formats with the possibility of transmission via web, convenient import and export of files or effective using of databases. [3] [14]

### **2.3.3 OpenBIM**

The initiative underpinning the development of IFC is known as openBIM. BuildingSMART International stands as one of the foremost pioneers of openBIM, actively advocating a concept and approach to BIM that places a strong emphasis on openness, interoperability, and collaboration among various software tools and platforms. The primary goal is to empower users with the ability to seamlessly exchange and utilize BIM data throughout the complete lifecycle of construction projects. It serves as a direct response to the challenges posed by previous closed systems, characterized by their limitations in data exchange and consequently inhibiting effective collaboration among all stakeholders within the construction industry. [15] (16)

### **2.3.4 CDE**

Another crucial topic that merits discussion is Common Data Environment (CDE). It represents a shared data repository of information that is integral to the efficient management and sharing of all data related to construction. It serves as a central hub where all project-related information is stored. This includes digital construction models, technical drawings, plans, specifications, budgets, and other documentation. As a result, all project participants, including architects, engineers, contractors, clients, and public administration, can have easy and quick access to current data and collaborate on the project together. [2]

CDE serves not only as a repository for documents but also has a much broader application. In practice, it should function as a communication and approval tool, providing significant value within the construction process. Its key component should be a dedicated channel for mutual communication, effectively simplifying and streamlining all communication, approval processes, and requests. The connectivity of the CDE

represents the ability to implement any change that should be indelible and clearly identifiable in the digital environment. The record of the change should document exactly what the change requires, who proposed it, and who approved it. For the CDE to fulfill its role effectively, there must be a clear policy and permission management, precisely defining who has the authority to make changes, who can approve them etc. [17]

### **2.3.5 Software**

BIM, in its essence, cannot be considered as software. However, software tools are essential for creating and managing BIM models. BIM software enables architects, engineers, and designers to build 3D models of buildings and infrastructure with a focus on precise and comprehensive information. BIM software not only provides visual representations of structures but also facilitates the tracking and management of data related to various aspects of a project, including construction details, material layouts, costs, and schedules. [4]

It is worth noting that BIM software is not a singular entity but a category that encompasses a wide range of tools. Each BIM software tool has its data format, which can complicate the idea of seamless communication among all professions involved. [4] To address this challenge, the organization buildingSMART introduced the IFC format. As already mentioned in chapter 2.3.2, the structure of this format is open, allowing software developers and the public access to all the information associated with it.

BuildingSMART has created a list of certified formats of various tools and programs that adopt IFC data format for effective BIM communication. These notable software providers are Autodesk, Graphisoft, Nemetschek, Tekla, and others. [4] (16)

### **2.3.6 Evaluation of Main BIM Topics**

By delving into the topics above, public administration can better grasp the significance of BIM. The information is applicable to both public procurers and employees in construction authorities.

International standards, guides, manuals, and legislative framework of BIM in general, serve to establish order, define rules, and delineate procedures within the BIM processes. They function as a guide from which building authorities can derive their practices. For permitting processes, building authorities rely on a sufficient software environment to

work with the programs that are integral to BIM. However, having the software in place does not guarantee success. Everything still depends on the ability of employees to work with these programs, making it crucial to train them in this regard. The same can be said about the knowledge of IFC format and CDE. Awareness of what the IFC format entails is fundamental for every participant in the BIM project's construction process. As a suitable format for electronic permitting processes, storing both graphical and non-graphical data, officials must be capable of opening IFC files to access project documentation and other relevant documents in the permitting system. To conclude, the effective implementation of BIM in public administration requires not only a strong technological infrastructure but also a solid emphasis on the development of human resources. Investments in training and professional growth for employees not only ensure the full utilization of BIM technology's potential but also enhance the efficiency of permitting processes.



### **3 THE IMPORTANCE OF BIM EDUCATION**

With the increasing interest in BIM, the imperative for providing comprehensive education becomes even more pronounced. The ensuing chapters are dedicated to elucidating why furnishing education in this domain is progressively paramount. Furthermore, they interpret approaches employed globally to address this crucial subject.

In the context of comparing the information strategies of the public sectors in the realm of BIM in both countries, this chapter delves deeper into the significance of education in the field of BIM. It analyzes the approaches of countries worldwide, and through the analysis of those that are more advanced, it contributes to specifying the quality of the two examined countries, namely the Czech Republic and Spain, within a global and European context.

#### **3.1 The Role of Awareness and Training**

BIM is often associated with IT technologies, but its success heavily depends on the human factor. Achieving a successful implementation of software technologies into construction projects requires proficient interaction with people, their sufficient education in the area and effective management. In the case of the BIM method, this becomes even more crucial due to the diversity of participants involved in each project and their individual approach to specific tasks. It demands high knowledge in this area and the ability to apply those acquired skills. Expecting the creation of a universal software solution is unrealistic and therefore, it is common to combine multiple software tools for different projects. [2]

There are diverse viewpoints regarding how to approach public education, whether on the organizational or the individual base. Under organizational learning, we can envision education directed by international or national organizations and the ministries collaborating with them.

National organizations focus on the establishment of standards, addressing legal implications, and presenting successful projects. They create so-called Pilot projects, which serve as standardized documents. Furthermore, these organizations actively engage in the publication of specialized literature and organize seminars and workshops to educate the broader public. [2] [18]

Education based on individual learning primarily focuses on a specific group of people, both in the industry and academic sphere. These include employees of small organizations with limited training budgets that rely on informal, unstructured learning, such as online resources and user-led groups; employees of single-discipline organizations that typically require well-organized support to enhance and expand their collaborative BIM skills; team managers and project leaders, because of their job responsibilities, need a sufficient understanding of BIM to effectively oversee the deliverables of their team members; or manager responsible for guiding their firms through the constantly evolving BIM environment. Within the academia there are students of universities who should be prepared for a work environment full of data-rich models or lecturers in universities who teach BIM lectures and would like to be even more familiar with BIM tools and workflows. [18]

### **3.2 World-wide View on BIM Education**

When it comes to the topic of Building Information Modelling, there is a wealth of scholarly publications available on the internet. Most of these works tend to focus on current situation of BIM in each country, examining BIM implementation and adaptation within the AEC sector, exploring the development and implications of BIM standards, discussing about BIM technologies and the effectiveness of BIM enhancing collaboration and communication. Publications also deep down into the legal and contractual aspects, government policies and regulations. However, for the purpose of this master's thesis, it is necessary to narrow the focus and delve specifically into the issues surrounding public awareness, education, and the public sector's approach to this modern paradigm in the construction industry.

The most relevant publications related to the selected topic are surveys conducted in academic backgrounds, particularly emphasizing educational methods, and articles examining aims of government to improve the adoption of BIM into construction process in their country.

Numerous publications were selected, covering both global and European perspectives, and are outlined in the following sector for a more comprehensive examination of the subject.

### 3.2.1 International Approach

An article called *Public Sector BIM Adoption: Development and Evaluation of Government Policy Interventions* written in 2023 by a group of doctors and professors of civil engineering and published by Technological University Dublin aims to identify the enablers, frameworks, or models adopted by the public sector to drive BIM and overall innovation adoption and diffusion in construction process. The study uses scientific databases, identifies 19 articles that passed two or more assessment criteria for enabler identification. The article provides insights into the development and evaluation of government policy interventions in this area and its implications for the construction industry and government agencies. The main contribution of this review for the purpose of this thesis is the finding that the public sector plays a significant role in driving BIM adoption in construction by providing leadership, guidance, and support. Furthermore, that BIM education and research should be established, more studies, seminars and expertise should be provided to better understand the importance of use of BIM. [19]

*A Global Analysis of BIM Standards across the Globe* is a critical review written by Abdulkadir Ganah and Gavin Lea in 2021. It focuses on BIM standards, guidelines, and templates from 13 different countries worldwide. Throughout the whole research it highlights gaps in each BIM standard. Findings are lately illustrated in tables and form the basis of discussion on different levels of maturity of BIM standard. These act as a signpost to each country's reflection, these are, a government, industry bodies or academic institutions, to help improve its standards to address the deficiencies in execution plans, contracts, and design documents. The key findings of this review are that U.S. and the UK are leaders in developing BIM standards and that many countries lack project planning guidelines for stakeholders, emphasizing the need for pre-project strategic documents like contracts etc. Moreover, the review reveals that Europe beats all other continents in terms of BIM standards, guidelines, templates, and shared parameter files, with the UK having a complete set of BIM standards for various areas, providing confidence for successful BIM planning and delivery. [20]

Organization NATSPEC created a report that provides an overview of the status of BIM education in several countries and regions worldwide. The first version was issued in 2014 and has been updated each year since. It especially examines the approach of higher education institutions to integrate BIM processes into courses that are taught and offered

at those institutions and focuses on the collaboration between government and academic sphere. This report is based purely on the responses provided by country's representatives who give an annual brief update on the situation of their country. The 2023 update report shows that course offering is expanding even more with the new sophisticated elements of BIM such as costing, BIM management, openBIM, BIM for facility management etc. Numerous countries actively discuss the significance of the buildingSMART International Professional Certification program and its integration into their specific geographic areas. [21]

Examining the global perspective from the report of NATSPEC, the current status of BIM worldwide, as per the latest updates, is as follows.

The African continent is making incremental steps in the development of BIM. However, a prevailing negative sentiment toward BIM poses a significant obstacle. Across most nations, governmental endorsement of this methodology is lacking, primarily due to the substantial implementation costs, which local firms find challenging. Moreover, the limited education on BIM in universities is exacerbated by the insufficient expertise of educators in this field. Despite these challenges, certain countries like Ethiopia, Morocco, and Egypt exhibit a positive stance toward BIM, actively formulating strategic initiatives. [21]

Australia is actively engaged on all fronts of education, encompassing school and university curricula, governmental awareness, and support for local organizations and their approach to public information. Education in BIM is maintained at a high standard, reflective of its widespread utilization, not only in the construction process but also in the operation and maintenance of structures, exemplified by iconic landmarks such as the Opera House in Sydney. [21]

Asian countries, such as China and Japan, are dedicated to the substantial promotion of BIM in conjunction with its integration into actual construction projects. Additionally, there is a keen interest in the ecological aspects of BIM implementation and the interconnection of BIM with infrastructure. [21]

The United States demonstrates a proactive approach in the realm of BIM education. Universities offer an array of educational programs encompassing both modeling and management aspects. Government and states' organizations actively support BIM

implementation and public awareness by issuing comprehensive standards, manuals, and guides. This positive trajectory is reflected in its widespread adoption by nearly all major construction firms in the United States. [21]

The BIM field in Europe is marked by significant diversity, with variations evident in each individual state. In Northern Europe, such as the United Kingdom, Finland, and Norway, BIM has become an integral part of daily operations, illustrating a high level of maturity and sophistication in its application. Finland, in particular, stands out as a noteworthy example of a country where the utilization of BIM has become a routine aspect of construction processes. It is noteworthy that these Nordic countries, with their progressive BIM adoption, serve as a source of inspiration for other less advanced nations, catalyzing a collective movement towards embracing this innovative methodology. [21]

### 3.2.2 EU Approach

Paolo Fiamma and Silva Biagi wrote an article called *Critical Approaches on the Changes Taking Place after 24/2014/EU in BIM Adoption Process* in 2023. The article gives a comparison of the situation of BIM before and after 24/2014/EU examining strategies taken for the adoption in Europe. It is interesting to note that the Northern European countries, such as United Kingdom, Norway, Sweden, Finland, Denmark, and The Netherlands, were the driving forces behind the introduction of BIM concept in construction world and still rank among the most advanced in Europe. However, the fundamental idea behind this research is to understand recent developments related to BIM in the construction sector of the European Union. Tactics adopted by European countries are described, analyzed, and compared to the initial idea of 24/2014/EU. The author then provides recommendations for the future to avoid the confusion related to ED 24/2014/EU. [22]

An article named *Overview of BIM integration into the Construction Sector in European Member States and European Union Acquis*, published under license by IOP Publishing Ltd in 2020, provides an overview of the integration of BIM into the construction sector within European states, delves into the latest advancements in BIM standardization and evaluates the extent of BIM integration within the individual policies of 12 countries, which are France, Finland, Sweden, The Netherlands, Italy, Germany, Spain, Czech Republic, United Kingdom, Denmark, Lithuania and Norway. The study offers a concise presentation of tabulated information which helps to identify the gaps and requirements

for further growth, along with the necessity of development of the legal formwork. The overview revealed that BIM integration into national legislation across EU has progressed, that most states mandate BIM for large public projects and that existing legislation focuses on improving BIM concepts, classification, processes, information change etc. However, the study results were also that the European legislation lacks integration of BIM and energy assessments, necessitating further research. [23]

EU BIM Task Group is a consortium that unites European efforts for the implementation of BIM and harmonizes the individual member states' approaches to standardization. It produces comprehensive guides, with one of the most prominent being *Handbook for the introduction of Building Information Modelling by the European Public Sector*. This handbook was created in 2017, which, in the context of BIM development, may be considered somewhat distant in the past. Nevertheless, it contains highly valuable information that remains both relevant and topical. Its wide distribution can be attributed to the fact that it has been translated into numerous languages. The document serves as a guiding framework for public administration in the incorporation of BIM into their national systems. Its primary objective is to equip governments and public procurers with the essential knowledge required for effectively spearheading the adoption of BIM throughout the construction sector's supply chain. For current purposes, it may serve as a foundational resource for the development of a new handbook that aligns with the latest vision and advancements in the field. [5]

### 3.2.3 BuildingSMART International

In the context of the global approach to education, awareness-raising, and dissemination of information in the construction field it is crucial to mention organization buildingSMART. As one of the leading and most influential proponents of BIM, this organization unquestionably deserves its dedicated chapter.

BuildingSMART describes itself as a “*global community of chapters, members, partners and sponsors led by the parent body, buildingSMART International*” [24].

Established in the year 1995, buildingSMART has been unwavering in its commitment to the continuous development and incremental enhancement of BIM processes. Over the course of nearly three decades, it has not only played a pivotal role, but has also significantly contributed to shaping the trajectory of BIM in the global construction

industry. Its journey over the years is marked by a persistent commitment to innovation and support of collaboration. With each passing year, buildingSMART has expanded its involvement with global stakeholders, enabling the seamless exchange of knowledge, insights, and best practices that play a crucial role in driving the progress of the BIM field. [24]

Each state cooperating with buildingSMART has its chapter in home country. Their self-governing is based on actions of the leading non-profit company buildingSMART International, incorporated in the UK. The International Council comprises individuals who represent chapters in their capacity as governance officials. They drive digital transformation with open BIM standards, fostering efficient collaboration and workflows. These standards offer comprehensive, interoperable solutions for the entire project and asset lifecycle. [24]

As said, the community's program is mainly focused on standards, conformity, and user. BuildingSMART International serves as the global authority for Industry Foundation Class (IFC), standardized digital representation of the construction industry. Furthermore, it offers oversights for certification of software, people, and organizations, including training and testing, and supports a user community through arranging webinars, online meetings, and summits. [25]

### **3.2.4 Summary of Findings from Research**

The articles analyzed in chapter 3.2 reflect on the evolution of BIM in recent years, emphasizing efforts to enhance awareness and provide education to the public regarding new applications. From a global perspective, it is evident that Europe and the United States have achieved the highest levels compared to other continents. This elevated standard is gradually approaching other advanced nations in Asia, as China or Japan, although it would be premature to consider the whole continent as fully developed. Australia has effectively propagated BIM trend across the entire continent, incorporating professional education into university curricula, contributing to its growth of BIM methodology. Lastly, Africa lags far behind this area, primarily attributable to the lack of support from individual states.

Within the European context, it can be observed that there is a unified approach among nations toward BIM implementation. All countries actively engage in spreading

information about BIM, manifested through continuous governmental initiatives aimed at fostering better development, educating students, and strategically enlightening the public through initiatives such as courses and lectures on relevant topics.

Global development in the field of BIM is facilitated by international organizations striving for collaboration among all participating nations. An exemplary instance of such collaboration is the organization buildingSMART. This initiative not only supports but also facilitates the exchange of information and expertise among different states. It strengthens standards and stimulates innovation at a global level.



## 4 CZECH REPUBLIC AND SPAIN'S BIM SITUATION

Before the evaluation of the approach to education of public sector in the field of BIM in both examined countries, it is imperative to concisely analyze the history and current situation of BIM implementation in their respective governmental structures.

### 4.1 Overview of the Czech Republic's BIM Environment

This chapter delves into the history and current situation of BIM in the Czech Republic, acquainting the reader with state organizations dedicated to this subject matter.

#### 4.1.1 History

At the end of the year 2015, the Ministry of Industry and Trade was entrusted by the government to continuously monitor development of the BIM method, coordinate and promote measures aimed at its application in the Czech Republic. The primary goal was to reduce operating and investment costs with a strong emphasis on its use in public procurement. On November 2, 2016, a document was presented based on the government's resolution regarding the significance of the BIM method for the construction practice in the Czech Republic. This document also addressed the proposal for further steps to introduce BIM. In conjunction with czBIM and the State Fund for Transport Infrastructure, the Ministry of Industry and Trade was recommended by the government as the designated authority responsible for the implementation of BIM in the Czech Republic. Subsequently, they collaboratively developed a manual for BIM method implementation, known as Concept of Implementing the BIM Methodology in the Czech Republic. This concept was approved by the government of the Czech Republic on September 25, 2017 and can be considered as an essential action of government in support of the adoption of BIM in construction practice in the Czech Republic. (16) [26]

A key message in the document, which represents the next step in the process of incorporating BIM in the Czech Republic, is the obligation to use BIM for public procurement of construction works exceeding the threshold<sup>1</sup> from January 2022<sup>2</sup>. According to the Ministry of Industry and Trade, this specifically pertains to construction

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<sup>1</sup> Limits for exceeding works are defined by Act No. 134/2016 Coll.

<sup>2</sup> The obligation was deferred with the issuance of the updated concept in 2021, and according to the latest information as of November 2023, this obligation is still not in effect. [31]

works financed from public budgets, including the preparatory and project documentation. [26]

On January 1, 2018, the Czech Standardization Agency, as an organization established by the Czech Office for Standards, Metrology and Testing, was entrusted with the responsibility for implementing the associated concept. Four months later, precisely on May 15, 2018, an Agreement on Cooperation in the Implementation of BIM Concept was concluded. This agreement delineated the term of cooperation between the Ministry of Industry and Trade and the Czech Office for Standards, Metrology and Testing, facilitated through the Czech Standardization Agency. All together, they developed the online platform known as *koncepteBIM.cz*. This website serves as a central hub for the dissemination of knowledge and resources related to BIM in the Czech Republic. It is a repository for various methodologies, standards, guidelines, and recommendations, which are continuously updated. [27] (16)

In August 2020, the Czech Standardization Agency issued a new guide focusing on the application of the ČSN EN ISO 19650 standard. It derived from international standards and outlines fundamental principles and rules. The purpose of the guide is to specify these standards at the national level. The document aims to introduce its own processes and specific applications within the context of Czech standards. (28)

The same month, the Czech Chamber of Chartered Engineers and Technicians Engaged in Construction and the Czech Chamber of Architects joined forces with the Ministry of Industry and Trade and the Czech Standardization Agency to sign a Memorandum of Cooperation for the preparation of a Data Standard of Buildings<sup>3</sup>. This database, in conjunction with Classification System CCI<sup>4</sup>, significantly advances data management, enabling its processing in the open IFC format. As part of this agreement, an expert group was formed, comprising members from these organizations, tasked with creating a set of data templates for the Data Standard of Buildings. [29] A year later takes on an online form, that markedly simplified its use. [30]

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<sup>3</sup> Data Standard of Building, in Czech Datový Standard Staveb (DSS), is a tool for standardizing and efficiently managing information in the construction industry, enabling the uniform transfer of digital structured information about a building among participants in construction projects, regardless of the software solutions used. [92]

<sup>4</sup> Classification System CCI, in Czech Klasifikační systém, provides a common language by ensuring uniform naming conventions for elements, thereby streamlining the sharing of digital construction data across diverse disciplines, tools, software platforms, and temporal dimensions. [91]

The Czech construction industry successfully fulfilled the commitments outlined in Concept of Implementing the BIM Methodology in the Czech Republic from 2017. In June 2020, the Ministry of Industry and Trade released a progress report on the implementation of the BIM method in the Czech Republic, detailing achievements from September 2018 to June 2020. The report indicated that 37 out of 38 actions have been initiated, with 5 of them already completed, and the rest being continuously implemented. Due to the acceleration of digitalization, a proposal to update the content and schedule of concept measures was submitted to the government, along with corresponding justifications. This update was approved by the government on January 18, 2021. [31]

In March 2021, the Czech Republic joined the global organization buildingSMART through its branch established by the Czech BIM Council (czBIM). [32]

#### **4.1.2 Current Situation**

The latest information regarding the implementation status of BIM methodology in the Czech Republic was presented at the BIM Day conference held on October 18 and 19 of this year 2023. This annual conference, organized by the czBIM, took place for the twelfth time, and stood out through collaboration with the Czech Standardization Agency and the Association of Building Entrepreneurs of the Czech Republic<sup>5</sup>. A significant step forward was the consolidation of these entities and their decision to jointly organize the conference. [33]

During this event, the strategies of the Czech Standardization Agency and updates to the document Concept of Implementing the BIM Methodology in the Czech Republic were addressed. In December 2022, the Czech government approved another update to this document with the aim of more effectively implementing the BIM method into the daily practices of public procurers and recognizing that measures from the original text no longer seemed meaningful. Representatives from the Czech Chamber of Architects, the Czech Chamber of Chartered Engineers and Technicians Engaged in Construction and czBIM were also involved in the update. The plan was to submit the updated concept for

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<sup>5</sup> The Association of Building Entrepreneurs (ABE) is a voluntary interest organization and the primary representative of the Czech construction industry, ensuring industry representation at the highest level, *tomu ver*, advocating for its members' interests, and actively engaging in legislative processes and economic policies to support a favorable business environment in construction. [94]

government discussion in the middle of 2023, which was achieved on October 20, 2023, when the Ministry of Industry and Trade published the processed update. [34] [33]

Currently, the preparation of the BIM law is underway, specifically in the form of the Law on the Administration of Information on Constructions and the Information Model of the Building and Constructed Environment. This law is intended to mandate the use of the Common Data Environment and prepare the Digital construction model in an open format using the Data Standard of Buildings. The preparation of this law has been entrusted to the Czech Office for Standards, Metrology and Testing, which has delegated this responsibility to the Czech Standardization Agency. [33]

The law is closely related to the update of the BIM Concept, and its existence is crucial for public contracts, which are obliged to use the BIM method. Currently, it is expected that the act will come into effect in the middle of 2024. Approval of this law will result, among other things, in the obligation to manage all public contracts exceeding the limits using the BIM method. Types of public procurements are defined by Act No. 134/2016 Coll., on public procurement. The contract limits are stipulated by Government Regulation No. 172/2016 Coll. According to the latest approval of the amendment by the government on January 1, 2022, a public contract is considered exceeding the limit if it reaches or exceeds 140,448,000 CZK for construction works and 3,653,000 CZK for supplies and services. [35]

As it has been already said in previous chapter 4.1.1, the Data Standard of Buildings together with the Classification system CCI forms a unified digital language for Czech buildings. Data Standard of Buildings enables mutual sharing and machine reading of information about the construction across various construction professions, while the CCI classification system provides a structured description of all aspects of the building, from an overall view through construction spaces and systems to individual detailed components. [36] Previously, there were separate Data Standard of Buildings for building construction and transportation infrastructure, causing complications for clients whose projects involved the interconnection of both types of structures. This issue was resolved on March 1, 2023, through a cooperation agreement between the Czech Standardization Agency and the State Fund for Transport Infrastructure. The closed memorandum stipulated that the entire Data Standard for transportation infrastructure would be

integrated into the same database as the for building construction, allowing users to work with unified database. [37]

Another important development is the preparation of the OpenBIM handbook, overseen by the buildingSMART organization. However, this initiative poses a challenge, as the handbook is intended to serve all countries, and according to the representative of the buildingSMART Czech Republic, Štěpánka Tomanová, the Czech Republic is not yet sufficiently prepared for such a comprehensive change. [33]

The conference also addressed questions related to environmental and energy issues and their relevance to BIM. Discussions focused on the utilization of BIM processes and data for building management, with a specific example presented, as on the GLS Park project in Brno. [33]

### 4.1.3 Organizations and Government Entities in Czech Republic

**Czech Standardization Agency** is currently one of the most significant organizations in the Czech Republic dedicated to the BIM field. It was established by the Czech Office for Standards, Metrology and Testing as a state-contributed organization in 2018 and has been entrusted with the creation, issuance, and distribution of standards, as well as the implementation of the BIM concept in the Czech Republic. It collaborates with international standardization organizations (such as ISO), coordinates its development with government agencies, engages in discussions with the professional community, and assists industrial entities in adhering to standards. It is also involved in the accreditation and certification process, organizes educational programs and training for professionals, businesses, and the public. It supports research and innovation through its participation in pilot projects and serves as a primary source of information on norms, standardization, and updates in the field of standardization, which it regularly publishes on its website. [38] (16)

Similar to Czech Standardization Agency, organization **czBIM** plays a pivotal role in supporting and advancing BIM in Czech Republic. It has been officially active since 2011. It brings together a wide range of professionals from various fields of practice. Since 2021, it is part of buildingSMART community and can also be referred to as buildingSMART Czech Republic. Its vision closely aligns with the Czech Standardization Agency organization. Being a member of the international organization,

its collaboration with other countries is indeed more extensive. It is also noteworthy to mention its active role annually hosting BIM DAY conference, where current trends in the field of digitalization are addressed. (16)

The primary governmental body actively promoting BIM in the Czech Republic is the **Ministry of Industry and Trade**. Functioning as a central coordinating authority, it ensures the utilization of BIM across various sectors of the construction industry, including both public and private sectors. By regularly disseminating comprehensive information via its official web platform, the ministry is instrumental in cultivating an enhanced understanding of the principles and methodologies underlying digital transformation. Moreover, the Ministry of Industry and Trade collaborates closely with the Czech Office for Standards, Metrology and Testing and various other ministries. This joint effort extends to the development of conducive environments that facilitate the integration of BIM practices into projects financed by the state. [2]

Another ministry actively contributing to awareness in the Czech Republic regarding the BIM method is the **Ministry for Regional Development**. Under its jurisdiction falls the Building Act No. 183/2006 Coll., concerning town and country planning and building code, which is valid as of the creation of this master's thesis, i.e., at the end of 2023. In the following years, an update to this act may occur. The Ministry for Regional Development, within its Digital Czech Republic program, aims to achieve the digitalization of construction management in the Czech Republic and promote mutual cooperation among ministries in this regard. [39]

**Czech Chamber of Architects (CCA)** is a public-law entity functioning as an association that brings together all certified architects, urban planners, and landscape architects. It advocates for fair and equal conditions in the market for architectural services, striving to ensure that the rights of any market participant are not unduly infringed without justified reasons. Its goal is to provide a fair and transparent environment for the provision of architectural services. [40]

Another significant entity in the Czech Republic is the **Czech Chamber of Chartered Engineers and Technicians Engaged in Construction (CCCET)**. Similar to the Czech Chamber of Architects (CCA), CCCET is a state organization established by law. It specializes in uniting professionals in the field of geodesy, cartography, and cadastre in the Czech Republic. Its members are authorized engineers and technicians chartered to

perform these specialized activities. It plays a significant role in setting standards in these areas and provides professional education. Together with CCA, they contribute to shaping new laws in the field of BIM. [41]

**The State Fund for Transport Infrastructure (SFDI)** is a Czech state fund established in 2000 with the aim of providing financial support for the development of transportation infrastructure in the country. Its activities are geared towards modernizing and ensuring the sustainability of transportation systems. In the field of BIM, it focuses on financing pilot projects, investing in research and development related to BIM, and particularly providing financial resources for the training and education of professionals and the organization of various educational workshops. [42] It is noteworthy to mention the **Ministry of Transport** of the Czech Republic in this context, specializing in information propagation across all forms of infrastructure, encompassing road, rail, air, and water transport. The ministry maintains its own agenda in the realm of BIM, with a specific focus on implementation and awareness of this methodology within the transportation infrastructure. SFDI essentially operates as its subordinate organization. [43] Another organization that actively supports the digitalization of transportation infrastructure is the **Czech Infrastructure Association (ARI)** that provides technical assistance in the digitalization process for preparing, implementing, and managing infrastructure projects. ARI has a working group called InfraBIM, which shares practical experiences from real projects and aims to offer public procurers proper practices in BIM for smooth project execution. [44]

## 4.2 Overview of Spain's BIM Environment

This chapter delves into the history and current situation of BIM in Spain, acquainting the reader with state organizations dedicated to this subject matter.

### 4.2.1 History

The first significant milestone in the history of BIM in Spain was the meeting of the Revit user group in Valencia in September 2010. Comprising professionals in the construction industry, this group aimed to support and promote the use of virtual reality and BIM at the national level. Around the same time, the first Spanish BIM forum was established. [45]



Another pivotal moment was the organization of the first EUBIM Congress in Spain in May 2012. This international event dedicated to BIM has been held annually since then and has significantly contributed to the development and dissemination of this methodology in Spain. In the same month, buildingSmart Spain was formed, an association bringing together all stakeholders in the construction industry, working to support BIM usage in Spain. [45]

A year later, during the EUBIM Congress, a standardization initiative named uBIM was proposed. This initiative serves as a guide for BIM users, adapting Finnish requirements in consideration of current regulations and standards within Spanish legislation. [46]

In December 2013, the first pilot infrastructure projects using BIM were carried out, marking a significant advancement in the adoption of this methodology in the construction sector. [45] In 2014, the approval of two directives played a central role in shaping the development and subsequent implementation of the methodology. [1]

A year subsequent, in 2015, the Ministry of Development (nowadays the Ministry of Transport, Mobility and Urban Agenda) initiated the creation of an open forum aimed at both public and private sectors, known as es.BIM [47]. Its primary goals were to kickstart initiatives intended at promoting the adoption of the BIM methodology, formulate a strategic action plan and create supporting documentation to enable the gradual integration of BIM practices when needed. Through the es.BIM initiative, several documents have been developed to facilitate the propagation and standardization of BIM methodology in different processes. These documents include materials explaining key aspects of BIM methodology, a glossary of terms, a study on the current state of BIM education within universities, and the definition of BIM roles that outline functions and responsibilities throughout the lifecycle of a BIM project, among others [1].

In 2017 was published a first BIM manual created by Generalitat de Catalunya. During this time of period, a Public Sector Contracts Law was issued, allowing public sector in Catalonia to request the use of BIM in projects and constructions, although not on a mandatory basis. [45]

In December 2018, the Catalan government mandated the compulsory use of the BIM methodology in certain public construction contracts. In the same year, the Ministry of



Transport, Mobility and Urban Agenda, and its affiliated organizations (ADIF<sup>6</sup>, AENA<sup>7</sup>, Renfe<sup>8</sup>, Puertos<sup>9</sup>) also introduced the obligation to utilize the BIM methodology in selected public works contracts related to administration. [45]

Subsequently, in 2019, The Ministry of Transport, Mobility and Urban Agenda invested 2 million euros in BIM training aimed at professional associations and created commission called CIBIM, with the objective of promoting and coordinating the implementation of the BIM methodology in public procurement. [1] The same year, the use of BIM became mandatory in Catalonia for contracts with a minimum budget of 5.5 million euros for public works and concessions, and 221 000 euros for supply and service contracts. The Ministry of Transport, Mobility and Urban Agenda and its related organizations extended the temporary obligation to all construction works funded by public funds. [45]

In 2020, several initiatives and publications related to the use of the BIM methodology in construction were implemented, such as manuals for contract closures when employing the BIM method, or one of the most comprehensive manuals for Spanish railways. [45]

In 2021, a manual with recommendations based on ISO 19650 for their use in the Common Data Environment was published. In 2022, Spain released a guide on classification systems, showcasing the benefits of element classification and strategies for the deployment and utilization of classification systems. [45]

#### 4.2.2 Current Situation

Spain continues its efforts to enhance BIM and in the middle of year 2023, a noteworthy development emerges with the release of *Plan BIM en la contratación pública* (Plan BIM), a strategic initiative, that marks a significant leap forward. The Plan BIM outlines a step-by-step process for introducing BIM into various public contracts of the General State Administration and the state's public sector, particularly in construction-related projects. This plan defines specific financial thresholds at which BIM will be adopted for public contracts. The implementation will occur gradually between 2024 and 2030, with

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<sup>6</sup> ADIF – Administrator de Infraestructuras Ferroviarias is a public high-speed railway administrator in Spain.

<sup>7</sup> AENA – Aeropuertos Españoles y Navegación Aérea is a public airport manager in Spain.

<sup>8</sup> Renfe – Renfe-Operadora is a public railway manager in Spain.

<sup>9</sup> Puertos – Puertos del Estado is a company in charge of management of ports in Spain.

different levels of BIM usage (ranging from basic to advanced) being introduced. According to the schedule, mandatory use of BIM in specific public contracts will begin in April 2024. On June 27, 2023, the Council of Ministers gave its approval to the plan, which was subsequently formally published in the official state gazette, called *Boletín Oficial del Estado* (BOE), on July 20, 2023. This publication was made in accordance with the provisions of order. This publication marks the endorsement of the Council of Ministers for the incorporation of the BIM methodology plan into the public procurement processes of the General State Administration, including its affiliated public bodies and related entities. [48]

BIM utilization has witnessed a remarkable increase in the realm of transportation industry in Spain, notably within railways and highways. ADIF, a public company responsible for the construction and administration of high-speed railways, thanks to the BIM model digitalized the first railway station in Málaga in May 2023. [49]

Furthermore, the capital city Madrid has been highly proactive in the implementation of BIM. Building upon the successful results achieved during the pilot project initiated in 2020 in the Mahou-Calderón area, in 2023 the city has entered into a new agreement to continue this digitalization effort in the Los Berrocales area, one of the future urban development projects. [50]

### 4.2.3 Organizations and Government Entities in Spain

**BuildingSMART Spain**, is a non-profit organization with the primary mission of advancing efficiency within construction sector, accomplishing this by the utilization of open standards for BIM and resulting in elevated cost-effectiveness, reduced project timelines and overall better quality. It was established in 2012. It carries out a lot of activities. The organization is developing guides and manuals to facilitate the adaptation to the BIM methodology, either the guides for the general view of BIM as well as the guides focused on the implementation of BIM into companies or projects. Furthermore, its job is to promote open standards for the exchange of information related to buildings and infrastructure, to coordinate and sponsor research and activities that foster the assimilation of BIM technology and to represent Spain's interests in the decisions made by buildingSMART International. [51]

**Ministry of Transport, Mobility and Urban Agenda**, originally Ministry of Development, is the primary state institution concerned with BIM in Spain. In 2019 created Commission Interministerial BIM (CIBIM), which replaced the original es.BIM, with the purpose of ensuring the coordination of state's administration and its public bodies in the process of implementation of BIM in public procurement. [1] The commission represent its country at national level, conducts training actions and provides smooth information flow between different ministries and other bodies of public administration regarding the BIM methodology. CIBIM recently published Plan BIM (the one already mentioned in section 4.2.2) and its current responsibility is to monitor the measurements described in it. [48]

**The College of Civil Engineers (CICCP)** represents a professional organization that brings together engineers in the field of roads, canals, and ports. This institution actively offers educational courses and seminars with a focus on BIM, contributes to the creation of standards, and also organizes conferences within the relevant field. [52]

**The College of Technical Engineers of Public Works (CITOP)** is a professional organization in Spain that represents and brings together technical civil engineers. Its members are individuals who have the qualifications required by law to practice their profession, which means either the title of technical civil engineer or the title of engineer in construction. [53]

It is imperative to mention the most productive governmental institutions in Spain, **Generalitat de Catalunya** based in Barcelona and **Generalitat Valenciana** headquartered in Valencia, which task is to provide training of public authorities of their community. [54] [55]



## **5 EVALUATION OF BEST PRACTICES IN PUBLIC SECTOR BIM AWARENESS**

To achieve the goal of comparing the public sector awareness strategy of BIM in both examined countries, it is important to conduct a more detailed analysis of best practices implemented in these countries. This chapter focuses on a systematic study and presentation of specific examples related to the topic. The emphasis will be on identifying important elements that help share information about the BIM method effectively within the public sector.

### **5.1 Best Practices in the Czech Republic**

The inception of BIM education in the Czech Republic can be traced back to the year 2017. The Ministry of Industry and Trade has played a pivotal role as the primary advocate for BIM. In the education of public administration, it has been proactive since its inception, issuing the document Concept of Implementing the BIM Methodology in the Czech Republic in September of the same year, as previously mentioned in chapter 4.1.1. A significant point for the theme of this thesis, concerning the education of public administration in the field of BIM, is measure No. 37. The purpose of this measure was to establish a BIM education system for state administration and local self-government by the end of 2022. [2] In response to this initiative, the Concept of the BIM Education System for Public Administration Workers was formulated in 2021. This document is primarily intended for representatives of public administration organizations responsible for the systematic education of employees within the organization, as well as all specialized educational organizations providing training for officers in public sector or students in academic sphere. It serves as a handbook for organizers of educational programs. For employees in the public sector and the general target audience of educational programs, this document has an informative character. [56]

Concurrently with the publication of the Concept of Implementing the BIM Methodology in the Czech Republic, specifically on October 1, 2017, a project called the Strategy for the Implementation of Building Information Modelling Methodology for Public Procurement Needs was executed. The project aimed to create an integrated environment facilitating the sharing of comprehensive information about public buildings and construction products through building information modelling. The anticipated outcomes



included more efficient use of financial resources in public administration, optimization of relevant processes, and simplification of administration in this domain. The strategy aimed to conduct comprehensive training for state institutions in BIM methodology, involving all ministries, regions, and state administration bodies. Specialized seminars and workshops were planned for public administration employees. The primary result of this strategy was the development of a methodology for BIM tailored to the needs of public procurers. [57]

Over time, the Ministry of Industry and Trade, in collaboration with the established Czech Standardization Agency, progressed according to its plans by organizing seminars for public procurers and jointly creating pilot projects to verify the use of the BIM method. As the anticipated obligation to use this method for above-threshold public contracts approached, the Ministry of Industry and Trade and the Czech Standardization Agency organized workshops for representatives of regional offices involved in public procurement, project preparation, and management, addressing information management in the context of these activities. Workshops focused on the theme of BIM, its impact on regional offices, the advantages and efficiency of using the method for procurers, and practical examples of its usage through the mentioned pilot projects. [58]

The Ministry of Industry and Trade did not lose sight of its main goal: the creation of the Methodology document. To ensure its quality, analyses of the current state of construction practices in public administration were conducted, examining the current state, describing examples of good BIM practice abroad, and analyzing existing and planned standards and technical norms. All outputs served as a basis for the development of the planned Methodology for Building Information Modelling for Public Procurement Needs document. [59]

The strategy project reached its conclusion at the end of 2022 with the issuance of the aforementioned methodology. It was part of the Digital Czech Republic program<sup>10</sup> and a supporting activity approved by the government as part of the Concept of Implementing the BIM Methodology in the Czech Republic. The methodology includes standardized procedures for data exchange among various participants in construction processes, clear references to additional information, and resources. It focuses on leveraging the benefits

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<sup>10</sup> Digital Czech Republic program is strategic government initiative ensuring coordinated and comprehensive digitization of the economy and society. [93]



of the BIM method for public procurers and other agendas in public administration, exploring building information management, contractual arrangements, data interoperability, and activities related to facility management. In conclusion, it addresses the strategy for the implementation of the digital transformation of the topics. [60]

In June 2022, Czech Standardization Agency unveiled initiating courses tailored for public administration. The newly devised educational system comprises six comprehensive course sets, customized to individual qualifications. These sets are specifically designed for BIM managers, construction engineers, facility managers, investment specialists, technicians in technical building installations, IT specialists, and legal professionals. This strategic approach allows each professional to craft a personalized educational plan aligned with their unique needs. Each course set encompasses a spectrum of levels, ranging from foundational to specialized, offering in-depth expertise and skills. During the autumn of 2022, the agency additionally developed two foundational courses introducing individuals to the realm of BIM. These courses are intended for all public administration employees, aiming to acquaint participants with the fundamental principles of the BIM methodology. They seek to elucidate the impacts of this innovative method on work procedures and introduce changes associated with the management of building information in a digital environment. [61]

Czech Standardization Agency continues its proactive endeavors in promoting the BIM methodology within public administration.

According to the latest information as of November 2023, Czech Standardization Agency has developed a new educational system, which was one of the tasks outlined in the government's Concept of Implementing the BIM Methodology in the Czech Republic. This educational system, coupled with the benefits of construction digitization, will be interpreted in a series of seminars organized by the Czech Standardization Agency in collaboration with czBIM. These seminars are scheduled to take place in various regions across the Czech Republic. Presently, two seminars have been scheduled, the first occurring on November 30, 2023, in the Pardubice Region, and the second on January 11, 2024, in the Karlovy Vary Region. Czech Standardization Agency has aptly named this seminar series *Roadshow 2023*, with ongoing updates regarding the event available on its dedicated website, *koncepteBIM.cz*. [62]



Participants in these seminars will be acquainted with the general advantages of digitization, instructed on the effective handling of digital information, and provided with skills for its efficient management. Furthermore, the seminars will delve into the intricacies of initiating construction contracts using the BIM methodology. Specific focus areas include the application of BIM in budgeting, tools for data management and its visualization, efficient project management, and the procurement process within the BIM methodology. Additionally, insights into tools for facility management will be covered. The seminar content indicates a primary target audience of representatives from public procurement entities, such as investment specialists, asset management professionals, and public procurement experts. The individual seminars will be structured into two blocks: the first addressing benefits of digitization for the entire organization, and the second focusing on contributions of individual employees in their day-to-day work routines. Both blocks will feature real examples drawn from the daily practices of public procurement entities in the Czech Republic and abroad, enhancing the practical applicability of the shared knowledge. [62]

Another highly active organization championing education in the field of BIM is the czBIM organization. As mentioned earlier, this organization actively contributes to the organization of seminar series for public administration. However, its primary focus lies in the education of industry professionals. Its flagship educational program revolves around providing professional certification from buildingSMART. This certification program is designed for specialized educational or training organizations at either the foundational or advanced levels, with the aim of granting certification in accordance with globally recognized frameworks. The foundational certification level is geared towards equipping individuals with the knowledge necessary to organize standardized training. Upon completion, the certified professional should demonstrate that their knowledge aligns with international standards and established practices. The advanced level, currently in preparation, is expected to concentrate on specialized knowledge with the implementation of real projects. Program graduates should comprehend the benefits of BIM, its definition and terminology, understand information management in accordance with ISO standards, identify the need for open formats, and be capable of imparting this knowledge to a wider audience within the framework of their training programs. [63]

Public education is also a focus of the transportation infrastructure and its state fund, the organization under the acronym SFDI. Regularly, SFDI conducts BIM workshops for





public administration, where it introduces its BIM pilot projects within the Ministry of Transport of the Czech Republic, presents updates in SFDI methodology and the use of Data Standards and Common Data Environment in transport. The latest online workshop, held on November 7, 2023, focused on the application of digitization in roads of the second and third classes. The workshop demonstrated the correct procedure for utilizing the BIM method in the preparation and implementation of a real project. Additionally, it outlined the significance of a Common Data Environment in transportation structures, showcased the use of 3D models both in project preparation and directly on-site, and presented various modern approaches to the digitization of transportation structures by different construction companies. [64]

Other esteemed organizations, notably CCA and CCCET, emphasized in chapter 4.1.3, predominantly focus on the meticulous preparation and implementation processes of the BIM methodology within the construction sector. In terms of fostering awareness, their principal objective is to endow their authorized members with comprehensive education and proficiency through the facilitation of an extensive lifelong learning program. This program encompasses dozens of prepared seminars, workshops, and diverse educational initiatives. [40] [41]

When contemplating the sphere of the public sector, it's noteworthy that CCA and CCCET do not explicitly organize educational events tailored for the everyone in construction public sector. Nevertheless, the activities stemming from their lifelong learning program bear significant implications for the domain of public administration. Illustratively, CCCET extends the opportunity for professionals from the public sector to partake in its educational events, contingent upon arrangements with the organizers and the fulfillment of an associated fee. [65] Furthermore, it has created a platform called PROFESIS, including all pertinent documents, methodologies, and technical resources issued by state authorities and allied entities. This platform serves as a quick portal granting access to information on an array of subjects, is freely open to the public and allows for a closer look at documents on the BIM topic under study. [66] The organization CCA provides consultancy services to the public, covering areas such as BIM-based building design or the look at permitting procedures. [40]

Within the realm of education at secondary and tertiary institutions, Czech Standardization Agency assumes an active role.





To further educational initiatives, the Department of BIM Concept has established a dedicated working group. This group has been formed with the overarching goal of supporting high-quality instruction in the BIM methodology at both secondary and tertiary educational institutions. Known as EDU BIM, it consists of experts who are educators from Czech higher and secondary educational institutions with a focus on construction, and professionals from the Czech Standardization Agency. Collaboratively, the members are dedicated to delivering the highest quality and most beneficial education at individual schools, including the integration of theoretical content with practical aspects, intricacies, and industry requirements. This united effort aims to enhance the learning experience by bridging the gap between theory and practice, ensuring that students are well-equipped for the challenges and demands of the construction field. [67]

In 2020, the Department of BIM Concept at the Czech Standardization Agency, in collaboration with EDU BIM, conducted a survey to support cooperation with technical universities. Eighty-two respondents participated, comprising 59 % architects and designers, 16 % IT suppliers, 9 % university representatives, 9 % construction contractors, and the remaining 7 % consisting of investors. A crucial finding was that 73 % of respondents believed that the qualifications of individuals in roles utilizing the BIM methodology in construction were insufficient. To address this, survey participants emphasized the need for increased expertise, particularly in the practical use of software and collaboration in a Common Data Environment. They also underscored the importance of theoretical training to clarify basic principles of construction information management, such as knowledge of ISO standards and norms, and awareness of BIM implementation in more advanced foreign countries. [68]

The questionnaire also focused on the desired knowledge of a university graduate applying for a BIM-related position. According to the results, respondents expect such a graduate to possess a general understanding of BIM issues, knowledge of software for creating or modifying BIM models (Revit, Navisworks, etc.), awareness of CDE and its operation, proficiency in Data Standards, familiarity with professional terminology, and knowledge of platforms offering BIM tools (Autodesk, etc.). [68]

Two years later, in September 2022, the BIM Concept Department released BIM EDU Report, which assesses the status of BIM education at Czech public universities with a focus on the construction sector, specifically at CTU, BUT, VSB-TUO, UWB, and



VSTE. Each university compiled partial reports reflecting their approach to BIM education at each university, their faculties and individual study programs, evaluating the knowledge students acquire from the taught subjects. The report indicates that the issue of BIM is not new for universities, and this methodology is fully integrated into the curriculum of all participating institutions. Universities acknowledge the significance of BIM for the development of the construction industry in the context of digitization. The current trend involves the transformation from BIM as modelling to BIM as a comprehensive methodology. However, implementing such BIM integration is complex and places increasing demands on the qualification of educators. [69]

The report further highlights that faculties with a construction focus are more aligned with BIM than those emphasizing architecture. Currently, BIM education is also present in fields like geodesy and spatial planning, where the emphasis is on the digitization of construction. It is confirmed that experts at universities closely collaborate with institutions such as Czech Standardization Agency and czBIM or draw on practical experiences from major construction firms. Universities leverage these collaborations and engage in activities beyond teaching, including lifelong learning initiatives, partnerships with the public sector, and research activities. The BIM methodology is also being introduced into the curriculum of high schools with a construction focus. However, a challenge arises from the varying preparedness of students from different high school backgrounds. Universities are addressing this by offering mandatory elective courses in the first year to bridge knowledge and skill gaps. Looking ahead, there is a consideration of introducing mandatory elective courses at non-construction-focused high schools to mitigate differences in BIM knowledge among students from different educational backgrounds. [69]

## **5.2 Best Practices in Spain**

Within state entities, the Ministry of Transport, Mobility, and Urban Agenda demonstrates a distinctive focus on the subject of BIM. As outlined in chapter 4.2.3, in 2019 the ministry has established the commission for the implementation of BIM methodology called CIBIM, specifically crafted with the aim of systematically addressing this matter. Since its inception, the organization has been dedicated to promoting the BIM method and its awareness among the public.



The central focus of the commission currently revolves around the preparation of the so-called Plan BIM, as alluded to in the preceding discourse found in chapter 4.2.2. This strategic blueprint assumes key significance within the domain of public administration, as it distinctly establishes economic thresholds from which procurers are mandated to incorporate BIM methodologies into their respective public procurement processes. The commission offers an open format of this plan, easily accessible on its official website. The document clearly delineates the relevant participants in public procurement, the contracts to which it applies, outlines a timeframe, and specifies threshold values for the obligation to implement BIM in public procurement. Plan BIM, encompassing a temporal horizon from 2024 to 2030, covers a schedule wherein changes are systematically introduced at specified intervals. In the plan's detailed setup, it lays out a complete breakdown, spelling out exactly why these changes are strategically incorporated. This thoughtful breakdown makes it crystal clear how the smart use of BIM methods in public procurement is expected to bring positive results. So, the plan is not just a timeline, it is also a well-thought-out document that openly explains and defends why the state is heading in this direction. [48]

A major step by the Ministry of Transport, Mobility, and Urban Agenda was the provision of an educational program known as *Ciclo Formativo en BIM 2022-2023*. This program was developed with financial support from the European Union through the Technical Support Instrument in collaboration with the Directorate-General for Structural Reform Support of the European Commission. The instructional program entails the organization of BIM conferences convened throughout the year 2023, with the objective of training public sector employees. Due to the recent regulation contained in *Plan BIM*, it is anticipated that public sector employees will be forced to actively learn about and apply the BIM methodology within their work processes in the future. The Spanish government is well aware that employees will need to be equipped with essential knowledge and skills for the effective and successful utilization of this modern methodology. [70]

The inaugural conference took place at the end of November 2022, serving the overarching purpose of introducing the BIM methodology to public sector employees. During this conference, representatives from the public sector shared their experiences with implementing this methodology into public procurement at the national level, shedding light on the current situation within the public sector. [70]



The focus of the second day of training centered around the document titled *Fundamentos BIM en la contratación pública*. This document holds significance as the inaugural conceptual and disseminative piece outlining the BIM methodology in contractual proceedings. It is primarily designed for the government administration, its public bodies, and all public-law entities dependent upon them. It seeks to familiarize its readers with the BIM world, offering a detailed comprehension of its principles and practicalities. By delving into the document's contents, readers gain a profound understanding of why BIM should be embraced, its scope of application, and the integral standards and technologies that underpin its implementation. In essence, it serves as an indispensable guide, not only illuminating the principles of BIM but also providing a comprehensive roadmap for its effective integration into the intricacies of public procurement within the administrative framework. [71]

According to the latest information available as of the beginning of November 2023, Ministry of Transport, Mobility, and Urban Agenda organized a total of six training sessions. Each conference had its own specific center of attention. The third conference addressed the presentation of completed or ongoing projects by the CIBIM, addressing the strategy of people, processes, and technologies in the field of BIM. [72] The fourth conference delved into the realm of internal processes within public organizations and their adaptation to BIM implementation. [73] The presentation of technological support essential for BIM implementation, encompassing all aspects related to CDE, the use of open standards and formats, etc., was highlighted in the fifth conference. [74]

The sixth training day, held on June 28, 2023, aiming at BIM training, concluded the first training cycle in BIM for the year 2023. On average, 180 administrators responsible for public procurement attended each conference. However, this marks not the end of the efforts. CIBIM plans to initiate another training cycle, concentrating on technical documentation to support procurers and the utilization of BIM in the preparation of tender documentation. [75]

Ministry of Transport, Mobility, and Urban Agenda is proactively endeavoring to garner increased support for BIM training through professional associations. In this capacity, it extends financial subsidies, endorsing the viability of conducting these educational programs. For the fiscal year 2023, the ministry has announced new grants to support both in-person and online educational events, which are cater to civil engineering



professionals working in public sector across the entire country and are affected by BIM methodology. [76] According to the latest report dated November 24, 2023, the Ministry of Transport, Mobility, and Urban Agenda is providing a grant totaling 300,000 euros to professional associations for training on the BIM methodology as applied in public procurement within the construction sector. A total of 10 professional associations have been selected as recipients of these grants, including notable entities such as the College of Technical Engineers of Public Works and the College of Civil Engineers. As of the current date, the cumulative investment in such training initiatives has exceeded 1.4 million euros. [77]

In terms of the overview of current situation, it is important to mention the Observatory established by Ministry of Transport, Mobility and Urban Agenda in 2017. This observatory is tasked with scrutinizing all public contracts in competitions across Spain, discerning their integration or non-integration of BIM methodologies, and conducting qualitative and quantitative analyses on them. The findings are systematically visualized and compiled into quarterly reports, providing an insightful overview of the progress in incorporating BIM requirements into various public competitions. [78] According to the latest report from the second quarter of 2022, the number of bids incorporating BIM implementation reached a total of 440, constituting 72 % of bids published in the previous year. [79]

The responsibility shouldered by CIBIM is also the publication of all official guides and manuals issued by ministries or relevant organizations specializing in BIM. Methodically curated, these resources are prominently showcased on its official website. This information initiative aims to provide a comprehensive repository of authoritative materials, enhancing accessibility for professionals and stakeholders seeking guidance on BIM methodologies and best practices. [80]

Another significant contributor to public sector education is the association buildingSMART Spain. As one of the branches of the worldwide organization buildingSMART International, its initiative is built upon predominantly established measures in more advanced countries. Viewing public education from a broader perspective, buildingSMART Spain, founded in 2012, holds a more seasoned and sophisticated position compared to its Czech counterpart, established later in 2021.



The organization provides an array of guides, manuals, workshops, encompassing general information on BIM processes, the implementation of BIM into organizational frameworks and projects, as well as guidance on working with data and promotional materials for various communication formats. These comprehensive resources serve as indispensable tools for professionals within the architecture, engineering, and construction sectors, as well as for costumers (investors) and building managers, offering insights into the intricacies of BIM methodologies. [81] [51]

Considering the obligation of public administration to employ the IFC format in projects, it becomes imperative for public sector employees to be adept at working with this format. Although IFC is published as a Spanish standard UNE-EN ISO 16739:2020, it lacks translations for entities, attributes, and properties. Consequently, buildingSMART Spain has undertaken the creation of translations for all classes, types, and property sets, enhancing comprehension and proficiency, particularly for public sector professionals engaged in projects mandating the utilization of the IFC format. [82]

BuildingSMART Spain systematically publishes annual reports that intricately document events and milestones achieved during a given calendar year. In its latest annual report for the year 2022, the emphasis is placed on the collaborative efforts with Generalitat Valenciana within the framework of a strategic plan focused on education in the field of BIM in construction. This plan aims to gradually elevate the level of expertise in this domain and guide all involved entities throughout this process. [81]

The organization is actively engaged in numerous projects, encompassing both completed endeavors and those currently in progress. One particularly noteworthy project within its purview is the ongoing study focused on the adoption of BIM in Spain. This study, according to the organization, aims to comprehensively describe the current state of BIM adoption in Spain. Through this in-depth analysis, the organization seeks to define a suitable strategy for the widespread acceptance of BIM across the sector. [83]

As previously mentioned, the organization primarily assumes the role of an informative entity for BIM within the private sector, catering to architects, designers, and project management professionals. However, its mention is essential due to its close collaboration with the Ministry in the development of BIM initiatives.



In the context of education, it is essential not to overlook the education of those individuals who lead and organize the training programs designed for public administration. In this regard, buildingSMART Spain presents an invaluable opportunity for certification at various levels of expertise, catering not only to training centers but also to professionals actively engaged in conducting and organizing these training initiatives. This certification process is particularly designed to enhance the competencies of both training institutions and professionals, ensuring a comprehensive and high-quality distribution of BIM knowledge within the public sector. It serves as a testament to buildingSMART Spain's commitment to fostering excellence in BIM education and proficiency at every level of engagement within the architectural and construction sectors. [84]

The aforementioned organizations are involved in public sector education on a national scale. Nevertheless, Spain is a highly diverse country, structured into autonomous regions with their own legislative and executive bodies, playing a crucial role in the regional support for the digitalization of the construction industry. Two institutions, Generalitat Valenciana and Generalitat de Catalunya, stand out as the most productive actors at the regional level, contributing significantly to the regional initiatives aimed at advancing digitalization in the construction sector.

Founded in 1980, the Institut Valencia de Administración Pública (IVAP) was established with the primary objective of providing education to public sector employees. Headquartered in Valencia and operating under the regional government of Valencia (Generalitat Valenciana), the institute focuses on training and developing public sector workers across various fields. The main goal is to strengthen the skills of public servants, enabling them to carry out their responsibilities with maximum efficiency. [85]

Within the realm of construction and BIM methodology, the Institut Valencia de Administración Pública demonstrates notable productivity. Regular training sessions are organized, open to all public sector employees in the Valencian region. Upon completion of these courses, employees receive relevant certifications. Details about the offered training programs are available on the official website of the institution. [85]

The Institut Valencia de Administración Pública currently offers two specialized courses regarding BIM. The first course aims to provide participants with a general overview of BIM methodology, introduce the advantages of its use, and emphasize the utility of





implementing this method for the economic development of the region. It focuses on the working procedures of employees when dealing with BIM projects, outlining the required documentation for such projects and detailing the process of working with information in federated (combined) models. The second course focuses on the Industry Foundation Classes (IFC) format. Its goal is to equip participants with the ability to extract necessary information from IFC models to verify project compliance with regulations. Both courses have a duration of 25 hours and are conducted through online instruction. [85]

Another productive region in the implementation of BIM in public contracts is the autonomous community of Catalonia, with its own system of regional administration - Generalitat de Catalunya. Since 2023, this institution has introduced the obligation to use BIM in all construction works and contracts supported by the Generalitat administration, with an estimated value equal to or exceeding 2 million euros. [55] This has led to an increase in the number of public contracts awarded with BIM requirements, as documented by analyses conducted by the Observatory of the Generalitat de Catalunya. This observatory systematically monitors the stance of the Catalan region on the digitization of the construction industry since 2019. [86]

Based on the analyses conducted, the observatory evaluates the number of contracts implemented with BIM, the value of these contracts, and compares the budgets of BIM contracts for each year. This data is presented in both graphical and written form and is regularly updated on the official website of the observatory. According to a recent analysis conducted by the Catalan government and graphically presented, as of the last update in the third quarter of the year 2023, a total of 80 % of public contracts within the government of Catalonia are governed by BIM directives. This value represents a 20 % increase compared to the previous year. [86]

Within the government administration of Catalonia, the autonomous body responsible for the development of education is the L'Escola d'Administració Pública de Catalunya (EAPC). Established in 1912, this organization significantly influences the Catalan public administration ecosystem and actively contributes to its design, implementation, and evaluation. Its primary mission is to disseminate awareness, conduct research and analyses, provide services, and create products related to talent development. Concurrently, it organizes training and educational programs with the aim of achieving





professionalism among public administration employees, acquainting them with innovations designed to optimize and streamline their work tasks. [87]

Similar to the government of Valencia, the EAPC publishes its training programs on its official website. For the year 2023, it offers a total of two training courses scheduled to take place in Barcelona during November. The primary objective of both courses is to familiarize participants with the fundamentals of BIM, introducing all essential topics related to this digitalization, such as basic technological concepts, BIM formats and their transparency, and fundamental process concepts and models. The main purpose behind conducting these training sessions is to instruct employees on how to open models in non-editable formats and extract data and information from these models. In contrast to the courses within the Generalitat Valenciana, these courses are conducted in person and have a duration of 20 instructional hours. [88]

In Spain, several professional organizations, notably The College of Civil Engineers and The College of Technical Engineers of Public Works, play an important role in BIM education, as extensively discussed in chapter 4.2.3. These esteemed organizations systematically conduct specialized courses not only for their members but also for the wider public. Given Spain's geographic division into regions, each region has its own organization addressing the needs and personnel of public administration in that specific area. Comprehensive information about the activities and offerings of individual regions is centralized on unified websites, where courses, conferences, events, and training programs for independent individuals are presented.

One of the highly active regions in supporting the digitization of the construction sector is Valencia. Local professional associations, including the Valencia and Castellón area of the College of Technical Engineers of Public Works (CITOP-CV) and the Valencian Community of the College of Civil Engineers (CICCP-CV), have joined forces in the Smart Digital initiative. This ambitious endeavor aims to spread, promote, and support the implementation of digitization in construction processes within the region. Professional associations routinely organize events where they share practical experiences with technologies, showcase current technological innovations, and present the region's strategies in the realm of digitization in construction. In this manner, they endeavor to effectively convey and promote best practices in public administration in this crucial area. [89]



In the exploration of the strategy for educating future professionals in the field of BIM in Spain, it is evident that the approach of various associations is not as homogeneous as in the case of the Czech Republic. As previously mentioned, each region in Spain approaches the implementation and education in the BIM field individually, which is reflected in the strategy for educating students in schools with a focus on construction and the BIM method.

Although state associations do not have a directly focused group for supporting progress in the education of students in the BIM field, there is a wide range of study programs and courses available at local universities in this area. An example is the Universitat Politècnica de València, a technical university located in Valencia, which offers students not only the opportunity to obtain a master's degree in the BIM field but also a variety of in-person and online courses focusing on various aspects of BIM, including its management and modeling. Furthermore, students can obtain a specialization diploma in the BIM field. The university also pays attention to graduates, who can participate in a postgraduate BIM course. (90)

## 6 COMPARATIVE ANALYSIS

The following chapters systematically analyze and compare two selected countries, in this case the Czech Republic and Spain, in terms of their approach to the BIM methodology and strategies for public sector awareness.

In the introductory part of the chapter, a thorough examination of the current situation in both countries is conducted, focusing on implementation and approach to BIM. This comparison provides an essential framework for the subsequent comparative analysis, which focuses on strategies for public sector awareness in both countries. That section of the chapter describes and compares the measures taken by both countries aimed at increasing awareness, education, and dissemination of information within public administration. This part is crucial for the main objective of the thesis.

The actual comparison is presented both verbally, in the form of detailed analyses, and graphically through graphs and tables. The information used for this analysis has been obtained and analyzed in previous sections of this thesis. It provides a solid foundation for a comprehensive comparison of both countries in the context of the BIM methodology.

### 6.1 Situation of BIM in Both States

The presented information shows that the Czech Republic and Spain currently share a similar developmental stage in the field of Building Information Modelling and exhibit a parallel approach to the implementation of this methodology within their governmental structures. This synthesis stems from their active involvement in the European Union, where they collectively align their strategies and efforts to foster a unified approach towards BIM. Both nations, as integral members of the international organization buildingSMART, diligently contribute to the propagation and assimilation of BIM methodologies within their respective territories.

As part of their commitment to advancing BIM, both the Czech Republic and Spain have launched initiatives to make the use of BIM mandatory in public procurement processes. This shared goal underscores their dedication to encouraging a digital transformation in the construction sector. The establishment of national bodies, specifically the Czech Standardization Agency in Czech Republic and CIBIM in Spain, stands testament to their

proactive measures in facilitating BIM integration. These organizations play key roles by generating guidelines, manuals, and collaborating with independent institutions to provide a support framework for the public and private sectors.

Nevertheless, despite this commonality, differences in their approaches emerge. The Czech Republic exhibits a cohesive and uniform strategy, where legislative changes and new mandates apply universally across the entire nation. This unity is further exemplified by close collaborations among various stakeholders and organizations, advancing a streamlined and effective implementation process. Conversely, the Spanish approach reveals a certain level of heterogeneity, primarily due to the regional disparities within the country. Notably, Catalonia emerges as a trailblazer in embracing BIM, boasting a more dynamic approach compared to other regions. The region has already mandated the use of BIM in public procurement since 2019, exemplifying its proactive stance towards digital transformation.

With regard to transportation infrastructure, it can be evaluated that both countries are quite similar in their efforts to implement the BIM methodology in this sector. In Spain, the main advocate is the Ministry of Transport, Mobility and Urban Agenda, while in the Czech Republic, it is the Ministry of Transport with its subordinate organization SFDI, along with the association ARI. However, it is essential to mention that Spain is slightly ahead in the utilization of the BIM method in their infrastructure projects, primarily due to the Ministry of Transport, Mobility and Urban Agenda's regulation mandating the use of BIM in specific construction projects. This diverges from the Czech experience, where the application of BIM in the transportation sector lacks the same ubiquity and obligatory integration.

Internationally, Spain showcases a heightened level of engagement within the European Union, organizing and participating in various summits and conferences. Its prolonged association with buildingSMART since 2012, predating the Czech Republic's involvement in 2021, exemplifies its proactive stance in shaping the international discourse on BIM methodologies.

Notably, Spain has also surpassed the Czech Republic in formulating a new comprehensive BIM implementation plan. The newly devised plan delineates a trajectory extending until 2030, outlining a detailed schedule for phased integration. While these are promising developments, the efficacy of these plans still lies in the hands of nation's

ability to adhere to their proposed strategies and navigate the evolving digital transformation environment in the construction industry. It is important to note that the Czech Republic is also attempting to issue a new plan, but currently faces challenges due to a slow pace and inconsistency in fulfilling this task.

In conclusion, the parallel trajectories of the Czech Republic and Spain in the adoption of BIM underscore a shared commitment to harnessing digital technologies for the advancement of their construction sectors. Despite these similarities, their approaches and regional disparities contribute to distinctive conditions for BIM adoption. The next critical phase will involve the diligent execution of their respective plans, ensuring a harmonized transition towards a digitally integrated future for the construction industry in both nations.

## 6.2 Public Sector Awareness Strategy Issue

In alignment with the overarching strategy outlining the integration of BIM into their respective national frameworks, both the Czech Republic and Spain adopt a similar approach in strategies for the educational sector within the public domain concerning this methodology. This mutual adjustment emphasizes the commitment of both nations to harness the potential of BIM in advancing their public sector operations.

Within the public sectors of both countries, there is an upsurge in the recognition and understanding of BIM. This growing awareness is closely tied to the upcoming mandate, set to be enforced in the middle of 2024, compelling the adoption of BIM methodology in public procurement. Consequently, both construction managements and employees in public sector, in both the Czech Republic and Spain, are preparing to meet the anticipated requirements, highlighting the imperative need for comprehensive training and upskilling.

The relevant ministries – the **Ministry of Industry and Trade** in the Czech Republic and the **Ministry of Transport, Mobility and Urban Agenda** in Spain – play a key role in spreading crucial information regarding evolving BIM environment. Along with the associated organizations **Czech Standardization Agency** and **Commission Interministerial BIM**, function as primary advocates for the BIM methodology, leading national initiatives and campaigns to drive its adoption.

Both countries are strategically enhancing awareness of the BIM methodology through the implementation of comprehensive educational programs. Noteworthy examples include the *Roadshow 2023* initiative in the Czech Republic, a multifaceted educational campaign aimed at reaching diverse audiences across the nation. In Spain, the *Ciclo Formativo 2022-2023* initiative exemplifies an educational cycle strategically positioned to amplify awareness and understanding of BIM practices.

In addition to the previous entities, both countries boast a spectrum of independent organizations actively engaged in delivering an array of BIM educational initiatives, including numerous courses, meetings, and conferences, with the overarching objective of enlightening the public sector. However, these organizations mainly focus on specific individuals within their areas. Of particular note are public sector professionals or chartered officers.

A closer examination of the educational offerings reveals a noteworthy disparity between the Czech Republic and Spain. Spain emerges as a notable leader in the diverse and extensive range of educational events offered. This can be attributed to the decentralized governance structure in Spain, where individual regional governments possess the autonomy to tailor educational initiatives to cater to the specific needs of their respective public sector workforce. This regional diversity allows for a more targeted approach, raising a closer alignment between educational offerings and the unique requirements of public sector employees within each region.

Another aspect contributing to Spain's educational growth is the proactive role played by regional governments in conducting analyses related to public administration. These analyses are carried out thanks to the establishment of observatories that examine the public sector in each region. These observatories help regional governments navigate and adjust their educational strategies according to the changing needs and challenges in public administration. To summarize, both Czech Republic and Spain are actively investing in training initiatives to strengthen the public sector administration. While in the Czech Republic, Czech Standardization Agency is making an important contribution to BIM awareness across public sector, in Spain the decentralized approach shines through its rich and varied training programs and the various governmental entities, such as the national organization CIBIM or the regional institutions Generalitat Valenciana or Generalitat de Catalunya.

The Spanish government has shown a remarkable commitment to supporting education not only centrally through its commission CIBIM, but also beyond this primary entity. The Ministry of Transport, Mobility, and Urban Agenda has been consistently issuing grants to bolster educational initiatives in the public sector regarding the BIM methodology. This proactive measure signifies the government's intent not only to reinforce its primary organization, CIBIM, but also to encourage and support other entities contributing to BIM awareness, such as the College of Technical Engineers of Public Works (CITOP) and the College of Civil Engineers (CICCP). The ministry's regular issuance of grants not only amplifies the reach and impact of educational programs but also underscores the government's inclusive approach by providing opportunities for diverse organizations involved in BIM advocacy to apply for these grants. This strategic support makes a significant contribution to encouraging a good environment for BIM education in the public sector, aligning with the broader goals of advancing digital methodologies and improving the overall efficiency of public administration.

Within the strategy for educating the future generation in the field of BIM, particularly in schools in the Czech Republic and Spain, differences in the approach of state organizations can be identified. In the Czech Republic, there is the **EDU BIM** group, which specifically focuses its efforts on supporting BIM education in both secondary and tertiary educational institutions. This group systematically implements the BIM method in teaching from both theoretical and practical perspectives. Conversely, in Spain, there is no uniform approach due to differing strategies adopted by individual regional governments.

However, the diverse regional approaches in Spain do not indicate a lower standard of education. Universities in the country offer students and graduates various study programs and courses in the field of BIM, enabling them to be well-prepared for professional engagement in industries actively utilizing the BIM method. Consequently, despite the absence of a unified approach at the level of state organizations, the educational environment in Spain is simultaneously supportive and of high quality.

### 6.3 Graphical Evaluation of Both Countries

To create an illustrative overview of the situation in both countries and their activities within the public sector information strategy in the field of the BIM method, detailed graphs have been designed in this master's thesis.

These graphs provide a structured and clear insight into the relevant state organizations that play a significant role in the development and promotion of BIM. Each of these organizations was analyzed in terms of several key categories that intricately map their positions and activities in the area of public sector strategy awareness on BIM. These categories encompass their position, approach in the realm of BIM, activities within the education of public sector, their main focus on education and best practices applied. Each category provides a detailed view of specific aspects of a certain organization's participation in the given country. The information provided is derived from the already acquired knowledge that has been examined throughout this research.

In this way, the created graphs become a valuable tool for a comprehensive understanding of the current situation and activities in the field of BIM within the public sector in both countries.

First graph presents a visual representation of the current situation in the Czech Republic regarding the public sector awareness strategy awareness on BIM (see **Attachment 1**). The second graph illustrates the existing scenario in Spain with respect to the same context as presented in the first graph (see **Attachment 2**).

**Table 2** has been compiled to perform a comparative analysis of the two countries in the examined issue. In the context of focusing on the awareness of the public sector, it was also essential to thoroughly examine the current state of BIM implementation. Therefore, the table reflects state obligations regarding the integration of BIM into tender processes. Furthermore, the table primarily focuses on the public sector education strategy on the BIM method, identifies key state's organizations promoting BIM, analyzes educational programs provided for the public sector, and evaluates the government's stance on education in the field of the BIM method in the education sector.



**Table 2: Comparative evaluation of both countries – the Czech Republic and Spain**

	<b>CZECH REPUBLIC</b>	<b>SPAIN</b>
Situation of states regarding the obligation to issue BIM tenders that strongly influences the public sector.	Mandatory use of BIM in all above-threshold public works contracts since the middle of 2024.	Mandatory use of BIM in specific public works infrastructures contracts since 2018.
		Mandatory use of BIM in Catalonia for specific public works contracts and concessions since 2019.
		Mandatory use of BIM in public works contracts in whole Spain since April 2024.
Main state entities most active in BIM awareness in the public sector.	Czech Standardization Agency	Commission Interministerial BIM (CIBIM)
Main education programs for public administration.	Roadshow 2023	Ciclo Formativo 2022-2023
Approach of states to education of public administration in BIM.	Provision of courses, conferences, publication of guides and manuals, education of professionals.	Provision of courses, conferences, publication of guides and manuals, education of professionals.
		Existing observatories with its analyses.
Approach of states to education of students in BIM.	Establishment of EDU BIM group that is dedicated to delivering the highest quality and most beneficial education at individual schools in the realm of BIM.	Individually within regions and local universities.

Reference: Own resource



## 7 CREATION OF EFFECTIVE TRAINING AND PROMOTIONAL MATERIALS

To put theoretical results of the thesis into practical application, a promotional tool has been created specifically for the purpose of educating the public sector about BIM methodology. The subsequent section provides a complete breakdown of the structure and content encapsulated within these materials.

### 7.1 Needs Assessment

In light of the latest information regarding new obligations related to the implementation of the Building Information Modelling in public procurement exceeding the statutory limits in both the Czech Republic and Spain, the need arose to develop a promotional tool tailored for the public sector. Currently, this initiative is most pressing within government offices, where the changes in obligations will have the most significant impact, and a lack of familiarity with this method could pose substantial challenges. To address this need, an educational tool in the form of presentations have been created, specifically designed for training employees working in government offices. The presentations have been crafted to be accessible and effective in the process of training public sector personnel who need to acquaint themselves with these new obligations and contemporary practices in the construction industry.

### 7.2 Material Development

With the aim of gaining a deeper understanding of the implementation of the BIM method in government offices in the Czech Republic and Spain, two presentations have been created. The first presentation (see **Attachment 3**) focuses on the specific situation in the Czech Republic, while the second (see **Attachment 4**) maps and analyzes situation in Spain. These presentations not only show basic information; rather, they serve as flexible templates that can be adjusted and customized according to the specific needs of users.

In their basic structure, these presentations offer a comprehensive view of the BIM method. It is important to mention that these presentations primarily serve as **exemplary informational materials**, which will need to be customized by their user for a specific target audience. They have the potential to be significant tools for trainers dedicated to educating employees in the public sector, especially in building authorities. The



interactive features enable users independently explore crucial information about BIM methodology, making them a valuable resource not only for beginners but also for advanced professionals seeking a more in-depth understanding of the BIM method within their work environment.

Presentations have been specifically crafted based on the information gathered in this master's thesis. They address the basic five questions: what is BIM; why use BIM; what is the history and current situation of BIM in the given country; which main state organizations promote and provide information about BIM; what key topics are associated with this method. It needs to be pointed out once again that presentations have been designed as educational materials for individuals in the public sector of the construction industry, such as employees of building authorities who lack sufficient knowledge about the new BIM method and need to enhance their skills in this area, as well as for BIM experts who have the task of training these staff. For these professionals, the presentations are intended to serve as a model and useful resource for training sessions. Therefore, it was crucial for each slide in both presentations to contain concise and informative content. However, to facilitate better understanding, all slides include detailed information on the respective topic in the notes box below. The notes also include accompanying comments to guide the user as they navigate through slides. This approach makes the presentations suitable for independent study by individuals in the public sector, including the aforementioned building authority staff, who can go through and read the presentations on their own. Both presentations also contain links to websites and important documents, allowing users to access more information on the relevant topic. In addition, the presentations are interpreted interactively, allowing users to navigate between specific topics, for example, transitioning from the introductory slide to a selected topic with just one click.

### **7.3 Implementation Strategy**

The strategy for implementing the provided presentations relies on trainers and organizations tasked with educating employees at building authorities. The goal would be to engage relevant government agencies and organizations in both countries actively involved in public sector education in the field of BIM. Subsequently, the created presentations would be provided to them as model materials for the development of informative resources tailored to specific groups of administrative staff.



## **8 EVALUATION OF OBJECTIVES AND CONTRIBUTIONS OF THE THESIS**

The introduction to this master's thesis outlined the objectives that were progressively achieved throughout the entire work. This chapter provides their evaluation and its contributions.

### **O1: Explanation of BIM in the context of construction and its significance in raising awareness in the public sector.**

This objective was achieved in **Chapter 2** and **Chapter 3** through a methodological survey of specialized literature and a review of the latest scholarly articles dedicated to this topic. In **Chapter 2**, a general overview of the BIM methodology was accomplished through a literature review and a compilation of scholarly articles focusing on the practical application of BIM. This analysis was primarily conducted to provide readers with a comprehensive understanding of BIM-related issues. **Chapter 3** was dedicated to illustrating the importance of education in the field of BIM within the public sector. Utilizing the latest scholarly articles and a basic analysis of global organizations focused on the BIM methodology, it aimed to approximate the global standing of the approach to BIM, with a closer examination of the European context. This analysis was undertaken to highlight the status of BIM in the Czech Republic and Spain in comparison to the worldwide situation.

Through this analysis, it was determined that Europe is considered advanced in terms of public sector education and its approach to BIM. In the European context, the Czech Republic and Spain are at a similar level; however, they lag behind the Nordic countries and the United Kingdom in terms of BIM adoption and education within the public sector.

### **O2: Analyzing of Czech Republic and Spain approach to the BIM methodology and public sector education within the context of this method through their specialized organizations and state institutions.**

In **Chapter 4** and **Chapter 5**, the defined objective was achieved through a detailed analysis of publications and the latest articles released by state entities and organizations specializing in the BIM method in the Czech Republic and Spain. This analysis provided



a thorough overview of the current situation in both countries and their approach to the public sector awareness strategy in the field of BIM.

This objective was one of necessary prerequisites for achieving objective O3, which involved conducting a comparative study of both countries.

**O3: Conducting a comparative study of both countries concerning BIM and their efforts to raise awareness of BIM in the public sector.**

**Chapter 6** presents both a verbal and graphical comparison of both countries concerning their approach to BIM, its implementation, and particularly the strategy of public sector education regarding this topic.

The objective of this evaluation was achieved, with the graphical comparison being further developed through the creation of two distinct graphs (**Attachment 1** and **Attachment 2**). The first graph (see **Attachment 1**) focuses on the main state organizations in the Czech Republic and their involvement in the field of BIM, particularly in its promotion within the public sector. The second graph (see **Attachment 2**) examines the same aspect but in the context of Spain. Additionally, **Table 2** has been created to enable a direct comparison of information side by side. This table primarily addresses key questions related to the researched issue, although it is not as detailed as preceding graphs.

This approach has led to a detailed and comparative perspective on the position and activities of both countries in the field of BIM, providing a complete overview for readers of this thesis.

**O4: Creating a tool with the aim of promoting BIM within the public sector.**

Presentations (see **Attachment 3** and **Attachment 4**) were crafted in the Microsoft PowerPoint software with the objective to serve as templates for spreading information about the BIM methodology among individuals in the construction industry who have no prior experience with it and are encountering it for the first time. These presentations have been designed to provide a framework that can be adjusted and customized for specific groups, with an emphasis on educational goals.

The aim of the work has been achieved. The tool that has been created should be considered as an initial step in the development of educational initiatives in this field.

## 9 CONCLUSION

This master's thesis focuses on comparing the public sector awareness strategies on Building Information Modelling in the Czech Republic and Spain. **Chapter 1.2** established specific objectives, which were achieved and evaluated in **Chapter 8**.

From a general perspective, it can be observed that the Czech Republic and Spain exhibit very similar trends in the field of BIM and public sector awareness strategies in this area. As European countries, they share similar approaches and goals, drawing inspiration from more advanced Northern European nations. Both countries have numerous state associations actively supporting the development and promotion of the BIM methodology within the construction sector across their territories. Despite minimal differences, it is crucial to emphasize distinctions between the Czech Republic and Spain. Spain, divided into autonomous regions with their own governments, lacks a unified approach to BIM across all its parts. Catalonia deserves attention, as it stands out in the field of BIM in construction with a high level of advancement compared not only to the Czech Republic but also to other regions in Spain.

The challenge of insufficient awareness and resistance of the public sector to the digitization of construction processes is surprisingly well-addressed at both the Czech and Spanish levels. Theoretical considerations in both countries approach this issue systematically, comprehensively, and meticulously. However, the practical implementation of educational programs, generating interest, and fostering the adoption of new technologies and attempts to the digitization of construction processes among industry professionals remains a challenge. To address this, promotional materials, specifically exemplary informational presentations, have been created to promote BIM, inform, and persuade public administration to adapt to the new method in the construction industry.

In conclusion, this master's thesis has provided a thorough and comparative perspective on the position and activities of the Czech Republic and Spain in the area of BIM. This offers the reader a complete insight into public sector awareness strategies related to the BIM methodology in both countries.

## 10 DISCUSSION

The issue of Building Information Modelling, despite years of research, remains a complex topic, with its nature continually evolving and changing in the course of time. For this reason, it is essential to continue examining this matter, particularly focusing on the most recent data sources that reflect its current state.

The thesis encompasses an in-depth exploration of the information and education strategies within the public sector regarding BIM methodology in the Czech Republic and Spain. It analyzes the approaches of state organizations in the field of BIM and their efforts to promote this methodology within the public sector. Simultaneously, it emphasizes the processes and procedures employed by these organizations for educating individuals in the construction industry who lack prior experience.

The study raises questions about the implementation of public sector educational programs and can serve as a foundation for further detailed investigations, particularly focusing on education at secondary and tertiary educational institutions. It also provides insights for further analysis of the practical implementation of theoretical intentions by state organizations in real-world scenarios.

The comparative analysis of the tactics taken by both countries offers a perspective on their respective situations in this context. Given the continuous development of BIM methodology, the thesis serves as a suitable basis for future comparisons of the evolution of both countries over several years.

A significant contribution of the thesis is the creation of a promotional tool—exemplary presentations designed to support the dissemination of information about this area. Presentations, developed on a general basis, serve as templates for trainers seeking to promote this tactic within the public sector. In this way, it can practically contribute to awareness efforts and the adoption of the new BIM philosophy within the construction industry.

In conclusion, this master's thesis outputs can serve as inspiration for further research in the field of BIM and education strategies within the public sector.

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Attachment 2: Approach of Spain to public sector BIM awareness

Attachment 3: Exemplary informational material – PowerPoint presentation about BIM in the Czech Republic – digitally

Attachment 4: Exemplary informational material – PowerPoint presentation about BIM in Spain – digitally