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Critical Approaches on the Changes Taking Place after 24/2014/EU in BIM Adoption Process

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Abstract: In 2014, the European Union introduced the so-called BIM at the attention of the Member States with the European Directive 24/2014/EU to spread this method throughout Europe. Alongside the generally recurrent motivations (education, maturity in the construction sector, technical approaches) to understand the causes of the laborious and not yet wide diffusion of BIM in Europe, this work introduces an original way that still appears not explored well enough in the current research scenario: the analysis of the correctness of the technical terms used in the native text of the ED and the translated texts in the national languages. The goal is to demonstrate that incorrect technical terms can be misunderstood and interpreted, and they move away from the specific and original contents of Charles Eastman's method. The misunderstanding of the real technical content of the legal obligation has conditioned the clarity, speed and effectiveness of the diffusion of BIM. It is necessary to include the acronym BIM in legal texts instead of the current generic expression "*building information electronic modelling*". The strength of the article is to recover clarity with the original indication and definition of BIM and the limit is that, in general, all laws can be interpreted.

Keywords: BIM; European Union; criticism; laws; design and construction practice

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1. Introduction

Building Information Modelling, commonly called by the acronym BIM, is an expression that means the use of an holistic method for the design, construction and management of a building work that is capable of allowing a unified approach between all the actors and stages of the process and product.

As is known, BIM was documented as having the possibility of obtaining time and resource savings of up to 30% compared with traditional practices and, for this reason, it has established itself in the construction sector, starting in the United States, Singapore and England.

In 2014, the European Union introduced BIM to the attention of the Member States with the European Directive (ED) No. 24 [1], which is considered a programmatic assessment to spread the use of this method throughout Europe. This provision is considered strategic for two types of problems:

- Extend the benefits documented by BIM in other countries to the European construction sector, and thus, make it more competitive on the international scene: external reason;
- Have a procedure common to all Member States since any European actor can participate in any public work, fully or partially financed by European funds, regardless of the Member State in which it is carried out: internal reason.

Given the strategic premises of 2014, the topic discussed appears necessary and urgent for understanding the current situation and proposing possible corrective variants to the ED itself.

The article opens with a survey that aimed to understand, 8 years after the ED 24, whether that provision led to the widespread use (dissemination) of BIM in Europe. Two

countries were selected as extremes of this dynamic, one for the absence of divergence and the other for a high degree of divergence, to investigate the consequences/outcomes on the legal instrument of implementation of ED 24/2014/EU of the two countries. Alongside the generally recurrent motivations (education, maturity in the construction sector, technical approaches), to understand the results obtained, this work introduces an original way that still appears to be not explored enough in the current research scenario [2]: the analysis of the correctness of the technical terms used in the native text of the ED and the translated texts in the national languages.

The authors aimed to understand whether the terms used in the texts of the laws that are at the origin of the obligation lend themselves to being misunderstood and, consequently, conditioning the clarity, speed and effectiveness of the current diffusion of BIM itself. In fact, in legal texts, inaccurate technical content causes confusion in concrete applications.

The goals of this study were the following:

- To bring out this situation of risk of interpretation with respect to the appropriate technical content that the law intends to indicate;
- To demonstrate that incorrect technical terms can be misunderstood and interpreted, and that they move away from the specific and original contents of Charles Eastman's method;
- To propose a system of solutions that is useful for all the Member States.

2. Literature

The definition of Building Information Modelling was debated for the first time by Laiserin in 2003 [3] to indicate the research content of Charles Eastman, who is considered, worldwide, as the creator and father of BIM [4], starting from the studies conducted in the mid-1970s [5].

The first countries that invested in this issue also attributed some peculiar terminologies, such as the concept of "Maturity Level" [6] (see Figure 1). In level 0, the exchange of data takes place on paper, with drawings generally produced using 2D CAD (*computer-aided design*) software. In level 1, the 3D format is also used but exclusively for visualization; therefore, the information is not shared as reported in the English guides [7]. In level 2, the BIM models, specific to each discipline, collect data that can be shared between the various professional figures. Level 3, the highest one, is characterized by an integrated process whose data, which can be described as "openBIM", are shared during the overall life cycle of the structure thanks to web services. This means having a completely open process and data integration enabled for "web services" that are compliant with emerging standards IFC/IFD (*Industry Foundation Classes/International Framework for Dictionaries*) and managed by a collaborative server.

In 2014, the European Parliament and the Council of the European Union expressed themselves for the first time on BIM with Directive 2014/24/EU. The aforementioned regulation, dated 26/02/2014 on public procurement, repeals Directive 2004/18/EC [8] and in it invites the Member States of the European Union to "*encourage, specify or impose*" through legislative provisions dedicated to the use of BIM, as a reference standard, for all publicly funded projects and works by 2016. Directive 24/2014/EU, which introduces the BIM method in public procurement, is called the "*European Union Public Procurement Directive*" (EUPPD) and was voted on in January, adopted in February and published in March in the *Official Journal of the European Union*.

Europe expressed itself for the first time on BIM via the following pronouncement: "*For public works contracts and design contests, Member States may require the use of specific electronic tools, such as of building information electronic modelling tools or similar*" [1].

Paragraph 4 of Art.22 of 24/2014/EU, just reported, indicates the use of "*specific electronic tools*", such as BIM, in terms of "*building information electronic modelling tools*" for public works.

The bureaucratic effects produced by the enactment of this EUPPD were summarized in two tables, while the practical strategies undertaken by the Member States were presented in a discursive way.

The approach taken was chronological and uses cause and effect to highlight the strategic-legislative repercussions complied by States.

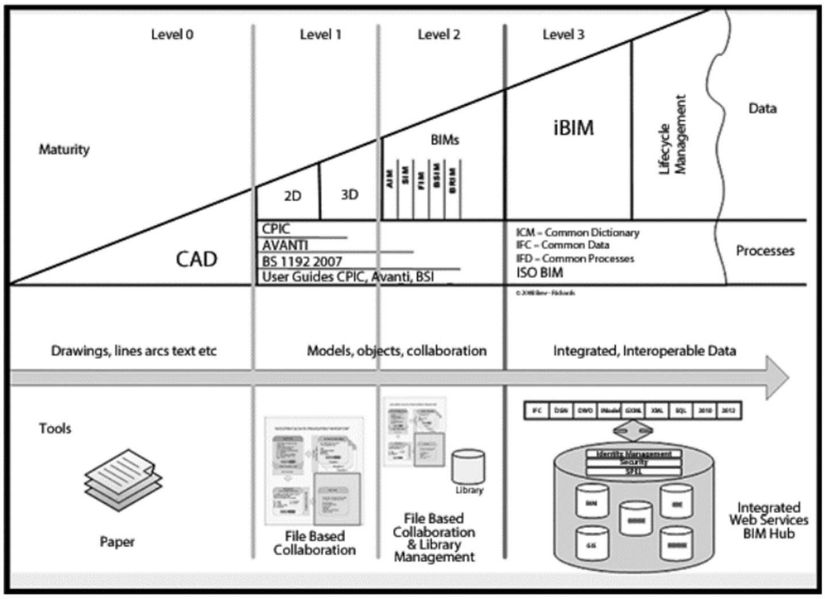

Figure 1. The BIM maturity level model by Bew and Richards (2008) [6].

2.1. Before 24/2014/EU

This subsection contains a table that outlines the situation prior to the 24/2014/EU. Table 1 places the legislative measures on BIM required by some Europeans Countries: Guidelines and/or Regulations in order of value of the construction industry estimated at 2014. To facilitate understanding, a map of Europe was created (see Figure 2) that graphically interprets the table.

Table 1. Situation in Europe before 2014.

European Country	Value of Construction EUR	Guidelines	Regulation
Germany	285 billion	No	No (but expected for the end of 2020)
France	200 billion	No	No (but expected for the end 2017)
UK *	177 billion	Yes	Yes
Spain	63 billion	No	No
Netherlands	60 billion	Yes	Yes
Switzerland **	53 billion	Not received	No
Norway	46 billion	Yes	Yes
Poland	44 billion	No	No
Belgium	39 billion	Yes	No
Sweden	34 billion	Yes	Yes
Austria	32 billion	Yes	No
Finland	29 billion	Yes	Yes
Denmark	27 billion	Yes	Yes
Ireland	9 billion	No	No
Italy	Not received	No	No

* In 2014, the UK was still part of the EU; ** in 2014, Switzerland was not part of the EU.

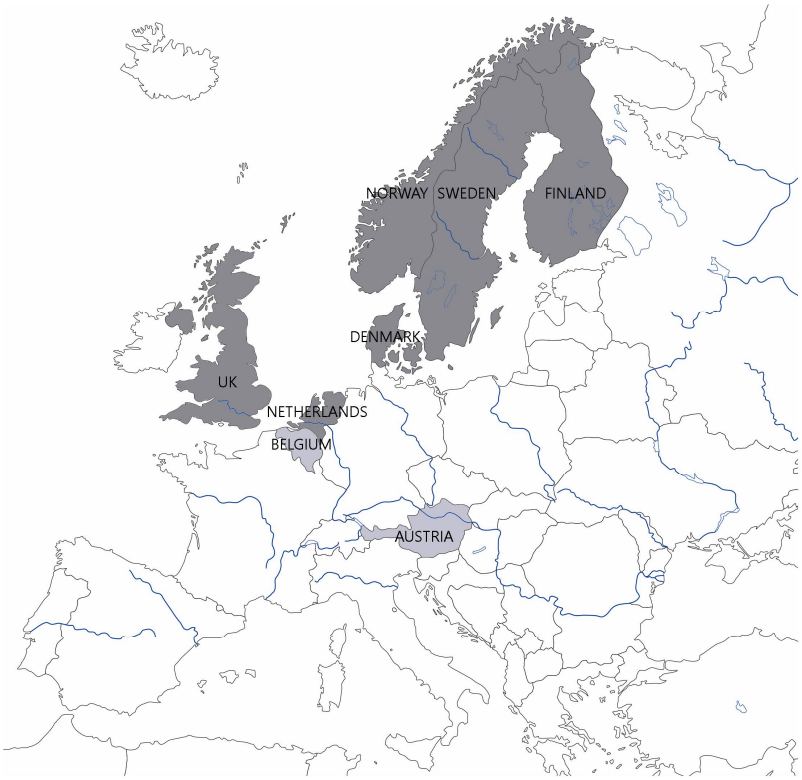

Figure 2. Before 2014: in dark gray, the European countries with a regulation on BIM; in light gray, the European countries with guidelines.

Northern European countries were the first to undertake solutions for introducing the BIM concept into the construction world, such as the United Kingdom, The Netherlands, Norway, Sweden, Finland and Denmark [9].

It's interesting to note that the European countries with at least one BIM regulation before 2014 shared the possession of guidelines with some extra European countries, such as the USA and Singapore, as shown in Figure 3, which was published in the German background paper [10].

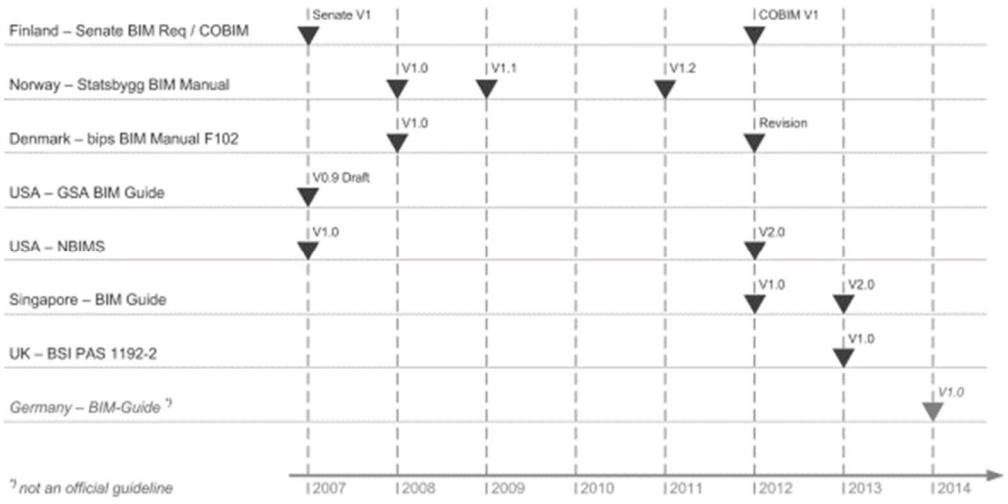

Figure 3. The guidelines publications.

2.2. Strategies Taken

What were the "macro-strategies" with which the nations of the European Union put BIM into practice [11,12]? The answer starts with the description of some projects promoted or supported by the EU.

For example, BIM-TRAIN 2013–2015 "*Transfer of BIM Training Tool for Increasing Competence of Building Sector Competence*" (Lithuania, Latvia and the Netherlands) for higher education and industry, or BIMEET 2017 "*BIM-wide Standardized Qualification Framework for achievement Energy Efficiency Training*" for workforce upgrading and platform for BIM and BIMplement "*Towards a learning building sector by setting up a large-scale and flexible qualification methodology integrating technical, cross-craft and BIM related skills and competences*" for professionals training and verification methods of the BIM process. Furthermore, Public Procurement Policies, Drafting of Standards and Creation of a Task Force. Ireland has set up institutional bodies to monitor the implementation of BIM, such as the *National BIM Council*, which published the *Road Map to Digital Transition* [13] and to support public administrations in innovating building practices. In Germany, the *Federal Ministry of Transport and Digital Infrastructure* has made BIM mandatory for all transport projects since 2020, while the German BIM steering group *Planen Bauen 4.0* [14] aims to establish clear and practical guidelines that define the BIM Level Plan and responsibilities. Furthermore, the creation of a national center to collect digital results and experiences is planned.

Since 2007 in Denmark the use of BIM in public procurement has been mandatory. Since 2013 the use of BIM has extended for all national, regional and municipal projects, including those on social housing. The Danish government involved the academic world through consultations and pilot projects when drafting the regulations. This also made it possible to develop ad hoc BIM training courses.

In the Netherlands, a national portal was opened the *BIM Gateway* or *BIM Loket* [15], which was aimed at the free sharing of information on a single platform and the management of standards according to practice.

In Lithuania, the *Lithuanian Association of Builders*, together with other business and scientific associations, launched the action *Digital Construction 2014–2020* [16] to introduce the national construction classification and the basic classes of the industry. This program ensures that project data is accessible throughout the lifecycle with the use of a single platform.

In 2017, the Czech Republic introduced a BIM implementation strategy supported by the *Ministry of Industry and Trade* [17].

Therefore, in Eastern Europe (Lithuania and the Czech Republic), an attempt was made to raise awareness of the concept of BIM in the construction field, indirectly contributing to nurturing skills and knowledge in the construction workforce.

In France, the Ministry of Housing launched the *Plan pour la Transition Numérique dans le Bâtiment* (PTNB) [18] to foster the adoption and diffusion of digital technologies in the construction sector, with a particular focus on improving the skills of construction professionals, through the evaluation of the BIM training offer, the benchmarking of international initiatives, and the strengthening of the skills of trainers and teaching staff. The French government also funded research and development, and created the collaborative platform KROQI [19] in 2018. Another initiative is *EduBIM*, which is a network of BIM teachers, trainers and researchers that collaborates with industry and is in charge of supporting the implementation of BIM through research and new learning methods. This includes several universities, such as *Ecole des Ponts ParisTech, École Spéciale des Travaux Publics or Ecole Supèrieure d'Architecture de Marseille*.

In 2018, Spain introduced changes in its public procurement system, allowing public administrations to require the use of BIM methodologies, skills and training in the delivery of projects and work contracts. As a result, the offer of BIM training courses has increased significantly, both in universities and professional bodies. At the same time, several BIM congresses and conferences took place, for example, the *European BIM Summit* in Barcelona and the *EUBIM Congress* in Valencia.

Apart from the strategic direction defined by the public sector, the practical delivery of dedicated BIM training courses is based on the active involvement of non-governmental institutions, as well as cooperation with the industry itself. In Ireland, for example, the *Irish Green Building Council* [20] offers BIM International training (BIM Level 2), which is a course aimed at training building professionals in BIM by introducing best practices, standards, methods and procedures.

Similar initiatives are also found in Eastern European countries, such as the Polish government, which has invested in education, training and awareness of BIM.

Moreover, the *Latvian Association of Civil Engineers* [21] offers a series of seminars to improve the skills of its members regarding BIM and digital technologies.

In Bulgaria, some software houses (*coBuilder and Nemetschek)* started educating the construction industry on the benefits of using BIM.

2.3. After 24/2014/EU

This subsection contains a table that outlines the current situation. Table 2 places, in order of value, the construction industry estimated at 12/2021 (see post-COVID-19 collapse) with the precautions taken by some European Countries regarding guidelines and/or regulations on BIM [22]. Alongside this, a map of Europe (see Figure 4) graphically interprets the table.



Figure 4. After 2014 to 2022: in dark gray, the European States that have a regulation on BIM; in light gray, the European States that have guidelines.

Table 2. Situation in Europe updated to 2022.

European Country	Value of the Construction EUR	Guidelines	Regulation	Year	Applications
Hungary	180.1	No	No	2015 forecast postponed	BIM not mandatory
Netherlands	133.3	Yes	Yes	From 2013	Uses BIM
Romania	130.3	Yes	Yes	From 2017	Uses BIM
Sweden	129.7	Yes	Yes	From 2017	BIM mandatory for all interventions
Italy	126.0	No	Yes	From 2019 to 2025	BIM mandatory for public works above 100 million and gradually decreasing
Slovenia	121.1	No	No	2015 forecast postponed	BIM not mandatory
Finland	119.8	Yes	Yes	From 2012	Uses BIM
Poland	117.3	No	No	From 2030	BIM mandatory with state funds
Austria	116.2	Yes	Yes	From 2018–2020	BIM mandatory for public construction cost control
Czech Republic	107.3	No	Yes	In 2017 pianification, from 2022	BIM mandatory for public works
Germany	105.8	No	Yes	From 2017 for projects over 100 million, and from 31 December 2020	BIM mandatory for infrastructure public procurement
Portugal	104.5	No	Yes	From 2019–2025	BIM mandatory for public works above 100 million and gradually decreasing
Belgium	96.8	Yes	No		BIM not mandatory
Bulgaria	90.2	No	No		BIM not mandatory
France	89.7	No	Yes	2017 forecast postponed to 1 January 2022	BIM mandatory
Slovakia	86.2	No	No		BIM not mandatory
Denmark	-	Yes	Yes	From 2013	Uses BIM
Spain	-	No	Yes	From 26 July 2019	BIM mandatory for public works and infrastructures
Croatia	-	No	No		BIM not mandatory
Luxembourg	-	No	No		BIM not mandatory
Norway	-	Yes	Yes	From 2016	Uses BIM
Ireland	-	No	Yes	From 2017 to 2021	Uses BIM in a gradual way
Serbia	-	No	No		BIM not mandatory
Estonia	-	No	No		BIM not mandatory
Latvia	-	No	No		BIM not mandatory
Lithuania	-	No	No		BIM not mandatory
UK *	-	Yes	Yes	From 2016	BIM mandatory for all government projects
Switzerland *	-	Yes	No		BIM not mandatory

* In 2022, the UK and Switzerland were not part of the EU.

Numerous bibliographies and sitographies were consulted for drafting the table, some of which are listed below: in general [23], for the state of Hungary [24], for the state of Romania [25], for the state of Slovenia [26], in general [27], for the state of the Czech Republic [28] and for the state of Portugal [29].

Some other graphics allow for understanding the recent situation in Europe. For 2021, the percentages of use of BIM [30] are shown in Figure 5.

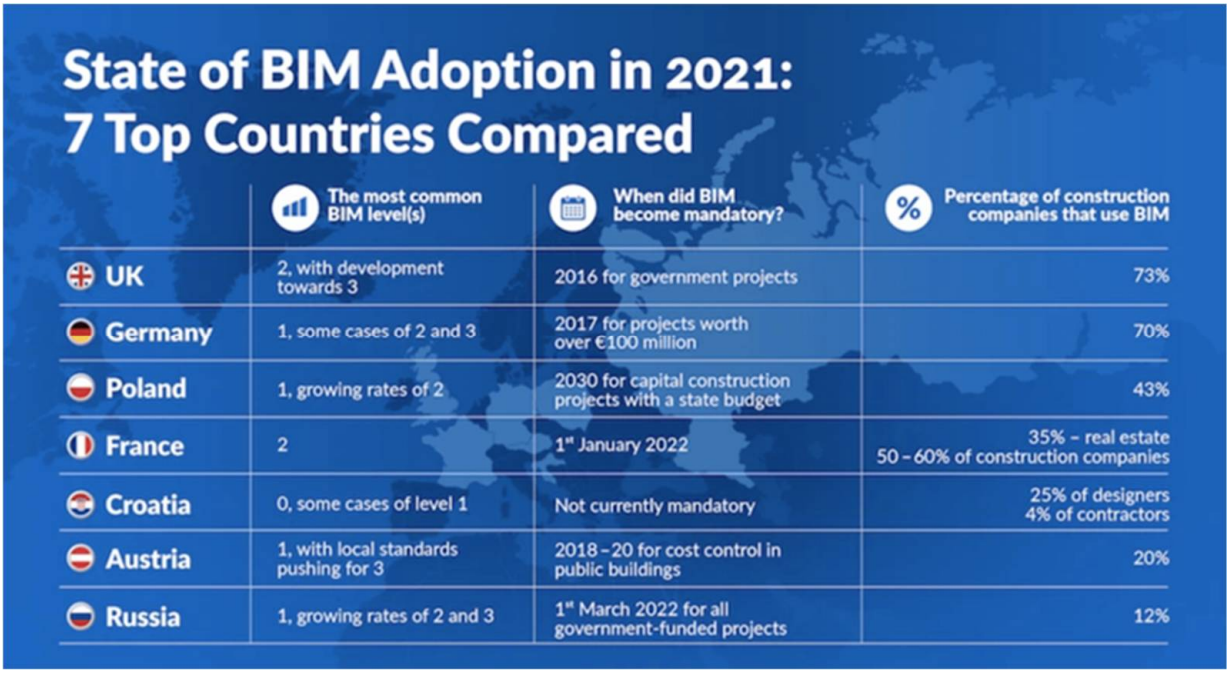

Figure 5. State of BIM adoption in 2021: top 7 countries compared.

Furthermore, in 2019, a study of the same type was repeated and showed exponential evolution [31] (see Figure 6).

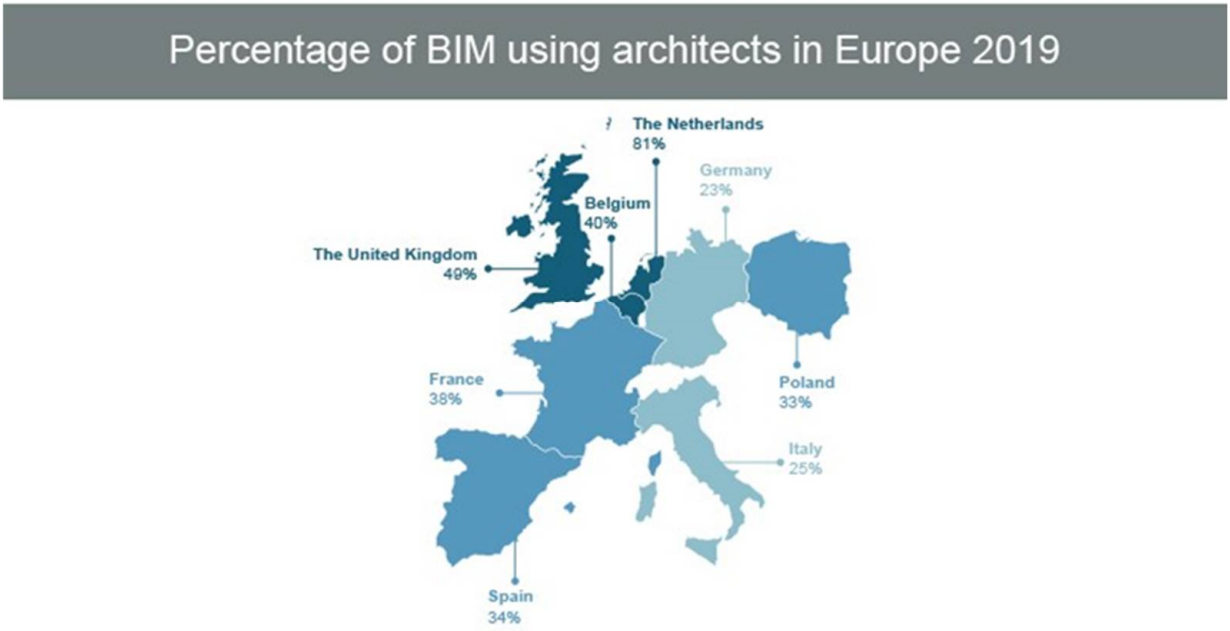

Figure 6. European Architectural Barometer Q4 2019, USP Marketing Consultancy.

Years after the European Directive, it was documented that there was also a gap between the Member States in the diffusion of BIM, which had an adverse impact on the EU economy [32] (see Figure 7).

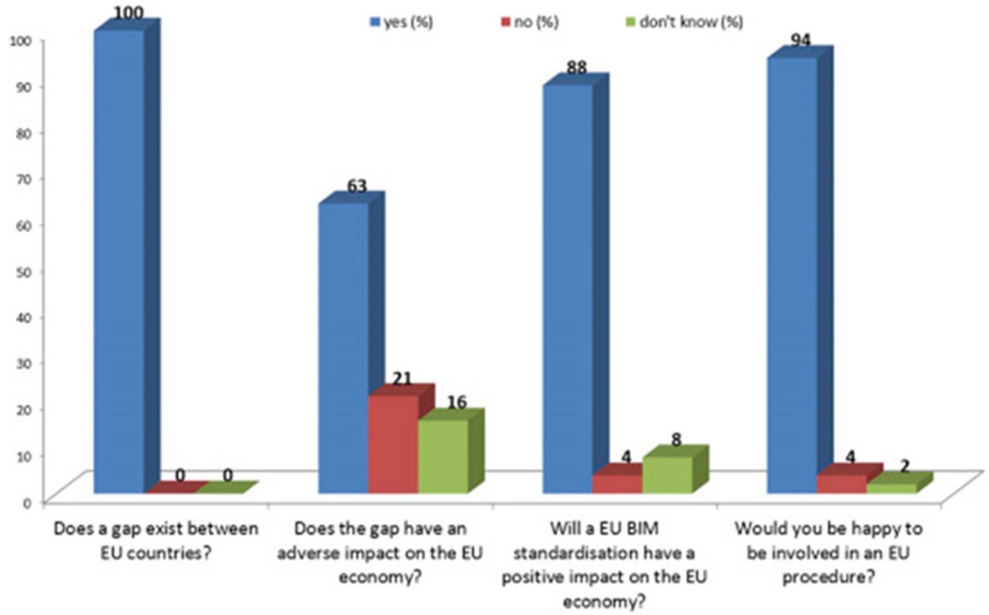

Figure 7. Awareness of the European gap in BIM implementation from the questionnaire.

Generally speaking, a critical approach to the so-called BIM is documented throughout a huge literature that is continuously re-systematized more and more (via the research of the research). This dynamic allows for a systematic availability of works, citations, and reinterpretations by multiple points of view or interest according to many concepts and keywords. At the moment, there are very few approaches that critically investigate BIM diffusion, not in terms of general legal implications of BIM [33], a legal issue [34], or contract implications or contract commitment [35], but in terms of the specific link between the current situation of its diffusion and the transformation of the text used in the transmission of the mandatory regulations ranging from the original European Directive to the interpretation of national laws. Because in the text of a law, the technical content is strongly related to the legal content, a research space emerges through the use of words that is original with respect to the state of the art in the criticism approach regarding BIM diffusion in the European Union.

3. Methodology

The propose methodology is the analysis of the texts of the laws of the Member States that implemented the ED 24/2014.

This method is an original contribution compared with those normally used, which analyzed, for example, the characteristics of the construction sector, the level of knowledge of the actors and the effectiveness of the digitization of the public administration. In fact, the method proposed is placed at the beginning of the process to compare the technical and legal terms introduced in the law of a single state to incorporate the ED 24/2014 and, consequently, to guide the local construction sector.

First step: In the scientific literature, the acronym BIM is understood without hesitation as the method devised by Charles Eastman, i.e., "Building Information Modelling", where the three terms are written with initial capital letters and represent a single whole coinciding with a precise technical concept (the Eastman, the BIM). Instead, "*modelling*", "*building*" and "*information*" are three single terms in common use, which, even if written in a different order, i.e., "*building*" "*information*" "*modelling*", cannot be equivalent, both legally and technically, to the acronym BIM.

Second step: in the European Directive 24, the acronym BIM does not appear before or after the English terms written in lower case.

Third step: these terms are translated into the languages of the individual states and, according to the specific language, they could be more or less than three.

Fourth step: therefore, the correspondence between the three letters of the acronym BIM and the initial of the three English terms translated could disappear according to the selected language.

Fifth step: without the conceptual indication of the acronym (First step) and through the translation of each single English term and not of its whole (Fourth step), the concept could be completely different from the one clearly expressed by the acronym BIM (the Eastman method).

Table 3 shows what has just been described: in the first column, there is the mother language of the state analyzed (for example, Italian for Italy, Spanish for Spain, etc.); in the second column, there is paragraph 4 of Article 22 of 24/2014/EU of the standard received from the individual state; and in the third column, the different or missing terms that caused the concept of BIM to disappear are highlighted (for example, in Italian, the term "Simulazione", which means "Simulation", replaces the term "Modelling"; in Spanish, the term "Diseño", which means "Design", replaces the term "Modelling" and there is no word "Information").

Table 3. Methods.

Country Languages	24/2014/EU Paragraph 4 Art.22	National Version vrs Reality
English	For public works contracts and design contests, Member States may require the use of specific electronic tools, such as of building information electronic modelling tools or similar	
Italian	Per gli appalti pubblici di lavori e i concorsi di progettazione, gli Stati membri possono richiedere l'uso di strumenti elettronici specifici, quali gli strumenti di simulazione elettronica per le informazioni edilizie o strumenti analoghi	"Simulazione" means simulation and not "Modelling"
Spanish	Para contratos públicos de obra y concursos de proyectos, los Estados miembros podrán exigir el uso de herramientas electrónicas específicas, como herramientas de diseño electrónico de edificios o herramientas similares	"Diseño" means designand not "Modelling". There is no word for "Information"
French	Pour les marchés publics de travaux et les concours, les États membres peuvent exiger l'utilisation d'outils électroniques particuliers tels que des outils de modélisation électronique des données du bâtiment ou des outils similaires	There is no word for "Information"
German	Für öffentliche Bauaufträge und Wettbewerbe können die Mitgliedstaaten die Nutzung spezifischer elektronischer Instrumente, wie z. B. elektronischer Instrumente für die Gebäudedatenmodellierung oder dergleichen, verlangen	
Portuguese	No que respeita aos contratos de empreitada de obras públicas e aos concursos de conceção, os Estados-Membros podem exigir a utilização de instrumentos eletrónicos específicos, tais como instrumentos de modelização eletrónica de dados de construção ou similares	"De dados" means some data and not "Information"
Bulgarian	За обществените поръчки за строителство и конкурсите за проект държавите членки могат да изискат използването на специални електронни средства, като инструменти за електронно моделиране на информация за строителни работи или подобни	"Работи" means works and not "Building"
Czech	V případě veřejných zakázek na stavební práce a soutěží o návrh mohou členské státy vyžadovat použití zvláštních elektronických nástrojů, jako jsou elektronické grafické programy pro stavební informace a obdobné nástroje	"Grafické" means graphic and not "Modelling"

Table 3. *Cont.*

Country Languages	24/2014/EU Paragraph 4 Art.22	National Version vrs Reality
Danish	For så vidt angår offentlige bygge- og anlægskontrakter og projektkonkurrencer kan medlemsstaterne kræve anvendelse af særlige elektroniske værktøjer, såsom elektroniske modelværktøjer vedrørende bygningsoplysninger eller lignende	
Estonian	Ehitustööde hankelepingute ja ideekonkursside puhul võivad liikmesriigid nõuda spetsiaalsete elektrooniliste vahendite, näiteks ehitusteabe elektroonilise modelleerimise vahendite või samalaadsete vahendite kasutamist	
Greek	Όσον αφορά τις δημόσιες συμβάσεις έργων και τους διαγωνισμούς μελετών, τα κράτη μέλη μπορούν να απαιτούν τη χρήση συγκεκριμένων ηλεκτρονικών μέσων, όπως ηλεκτρονικών εργαλείων μοντελοποίησης κτηριοδομικών πληροφοριών ή παρόμοιων μέσων	
Bosnian	Za ugovore o javnim radovima i projektne natječaje, države članice mogu zahtijevati korištenje posebnih elektroničkih alata, poput virtualnih prikaza modela zgrade ili slično	"Virtualnih prikaza" means virtual representations and not "Information"
Latvian	Publisku būvdarbu līgumu un metu konkursu gadījumā dalībvalstis var prasīt, lai tiktu izmantoti specifiski elektroniski rīki, piemēram, ēku informācijas elektroniskās modelēšanas vai līdzīgi rīki	
Lithuanian	Viešųjų darbų pirkimo sutarčių ir projekto konkursų atveju valstybės narės gali reikalauti naudoti specialias elektronines priemones, pavyzdžiui, pastatų informacijos elektroninio modeliavimo priemones ar pan	
Hungarian	Az építési beruházásra irányuló szerződések és a tervpályázatok esetében a tagállamok megkövetelhetik bizonyos konkrét elektronikus eszközök, például elektronikus épületinformáció-modellezésre szolgáló vagy hasonló eszközök alkalmazását	
Maltese	Għal kuntratti ta' xogħlijiet pubbliċi u kompetizzjonijiet tad-disinni, l-Istati Membri jistgħu jitolbu l-użu ta' għodod elettroniċi speċifiċi, bħal għodod ta' mmudellar elettroniku ta' informazzjoni jew simili	There is no word for "Building"
Dutch	Voor overheidsopdrachten voor werken en prijsvragen mogen de lidstaten eisen dat gebruik wordt gemaakt van gespecialiseerde elektronische instrumenten, zoals elektronische bouwwerkinformatiemodellen of soortgelijke	
Polish	W odniesieniu do zamówień publicznych na roboty budowlane i konkursów państwa członkowskie mogą wymagać zastosowania szczególnych narzędzi elektronicznych, takich jak narzędzia elektronicznego modelowania danych budowlanych lub podobne	"Danych" means data and not "Information"
Romanian	Pentru contractele de lucrări și concursurile de proiecte, statele membre pot impune utilizarea de instrumente electronice specifice, precum instrumentele de modelare electronică a informațiilor de construcții sau instrumente similare	
Slovak	Členské štáty môžu v prípade verejných zákaziek na práce a súťaží návrhov vyžadovať použitie osobitných elektronických nástrojov, ako sú nástroje elektronických informačných modelov budov alebo podobné nástroje	

Table 3. *Cont.*

Country Languages	24/2014/EU Paragraph 4 Art.22	National Version vrs Reality
Slovenian	Države članice lahko zahtevajo, da se za javna naročila gradenj in projektne natečaje uporabljajo točno določena elektronska orodja, na primer elektronska modelna orodja ali podobna orodja	There is no word for "Information"
Finnish	Rakennusurakkasopimusten ja suunnittelukilpailujen osalta jäsenvaltiot voivat edellyttää erityisten sähköisten välineiden, kuten rakennustietoja koskevien sähköisten mallintamisvälineiden tai vastaavien, käyttöä	
Swedish	För offentliga byggentreprenadkontrakt och projekttävlingar får medlemsstaterna kräva att särskilda elektroniska verktyg, t.ex. elektroniska modellverktyg för bygginformation eller liknande, används	

If Charles Eastman's BIM method (consisting of three terms combined in a single concept indicated by the acronym) is a building information modelling system (not one of the many possible generic systems but the one based on 3D oriented objects), the table shows that some official words of the European Directive were somehow changed.

As a witness that these steps in the translation of legal texts represent an additional element that affects BIM's diffusion, a further element (and concept) was considered: the next step, from the national translation of ED 24 to the national legal instrument that transformed the European Directive into a real law for that state. Please remember that any European Directive cannot be a law for individual Member States: to be a law, it must be implemented as a national law. Two extreme situations were taken into consideration: a state that has a law that reproduces the expression of ED 24/2014/EU intact (England) and a state that changed it autonomously (Italy).

3.1. Focus on UK and Italy

It is believed that the justification for this "lack of interpretation" of the ED 24/2014/EU derives from having previously established guidelines and national legislation on the subject and that, therefore, the country was not affected by the free linguistic interpretation of the European Directive [36,37]. Great Britain has had a great and "historical" BIM technical culture: since 2007, there was a local British Standard BS 1192 (in six parts) that became a Publicly Available Specification (PAS), a sort of reference practice, called BS PAS 1192-2013, which today, as part of continuous development, does not exist anymore and was substituted by the ISO 19650:2018 (ISO: *International Organization for Standardization*).

Since 2020, "The RIBA (*Royal Institute of British Architects*) Plan of Work" (see Figure 8) exists as a definitive model for the design and construction process of buildings [38] that is completely connected with the BIM core.

In Italy, the text of ED 24/2014/EU was changed in the Italian translation. It was introduced with the Italian Law no. 50/2016 [39], named *Nuovo Codice degli Appalti* (New Procurement Code). In this law, in Article 23 Paragraph h), the text changed again and became: "*criteri e metodi specifici quali quelli di modellazione per l'edilizia e le infrastrutture*" (specific criteria and methods, such as those of modelling, for construction and infrastructure). The Ministerial Decree no. 560/2017 MIT (*Ministry of Infrastructure and Transport*) [40] established the obligation for public works of these "*specific criteria and methods, such as those of modelling, for construction and infrastructure*", progressively year after year from 2019 to 2025 (according to a decreasing work amount from more than EUR 100 million to less than EUR 1 million; see Figure 9).

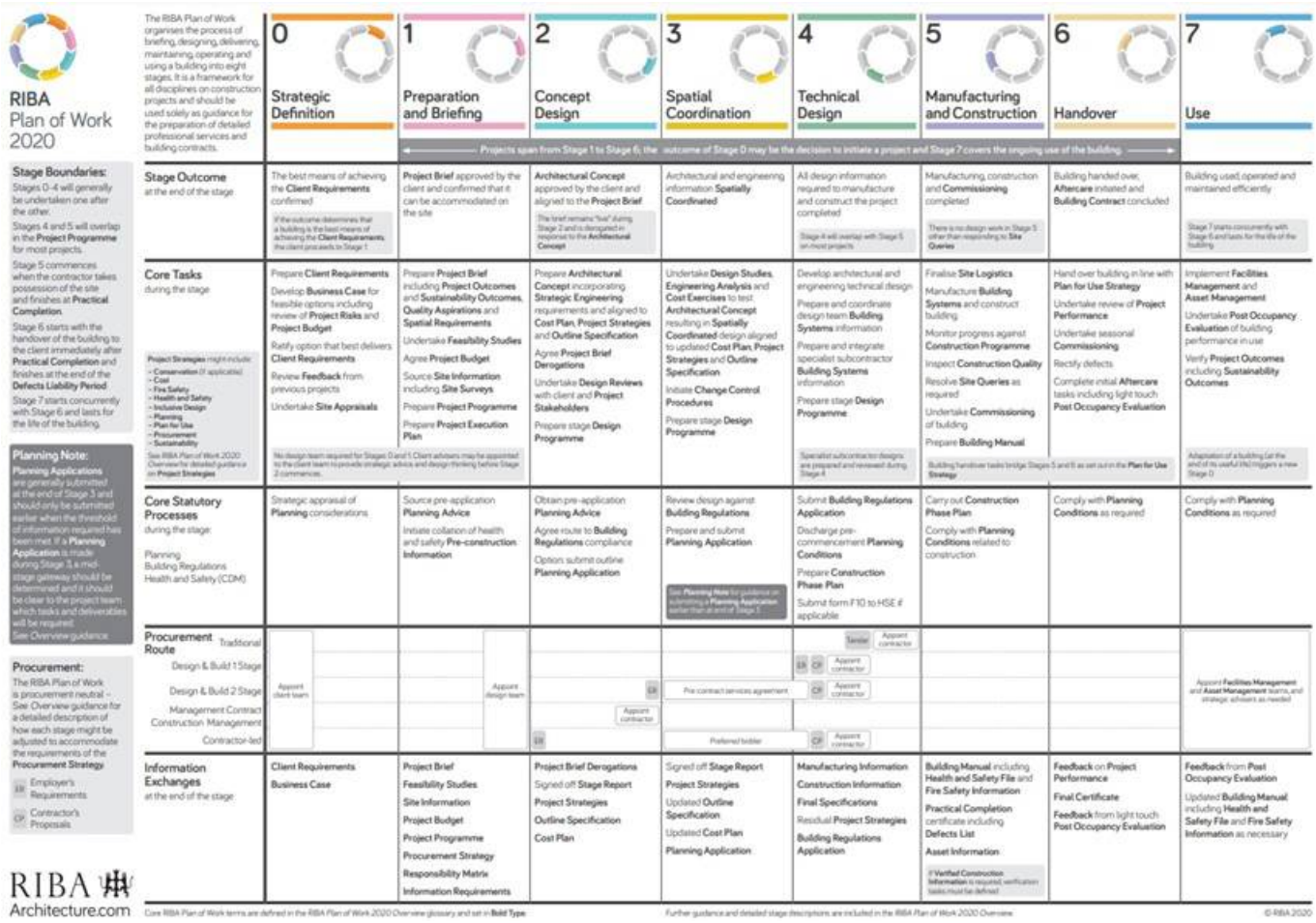

Figure 8. RIBA Plan of Work 2020.

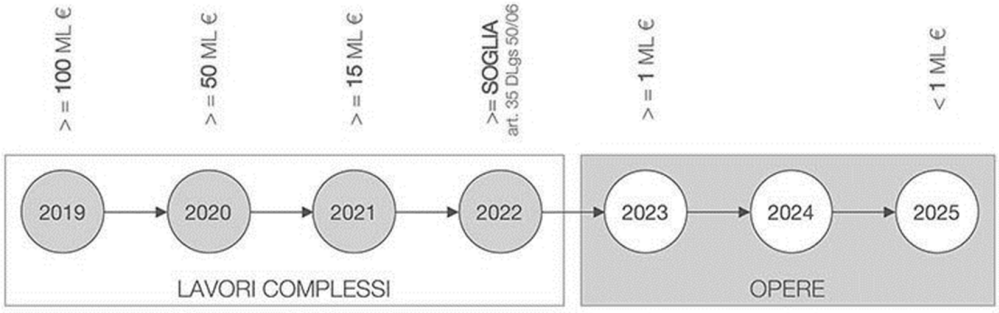

Figure 9. Economic amounts that require BIM 2019–2025.

Next, DM 560/2017 was amended by DM 312/2021 MIMS [41] and introduced few changes.

In addition to the Italian law, an auto-reference group decided to work with a volunteer standard without, at the moment, any inconsistencies regarding ISO standards. In 2018, the international standard ISO 19650 was issued [42,43], which, through the direct adoption mechanism of the Vienna Agreement, became a European (EN) and national standard in 2019, but is volunteer.

To conclude, over the years a series of amendments have been published, without legal effect, as documentation of attribute of the ED 24/2014/EU [1] but, since the problem of "translation" has not been identified, Article 22 Paragraph 4 has remained un-

changed and the acronym BIM has not been introduced. The last amendment is from November 2021 [44].

4. Results

According to the "Material" highlighted in Section 2.1 "*Before 24/2014/EU*", Section 2.2 "*Strategies undertaken*" and Section 2.3 "*After 24/2014/EU*", there was important attention placed on pushing the European construction sector toward BIM use. At the same time, it looks like a huge amount of confusion emerged at various levels.

The national strategies undertaken go in such different directions both within the same state and between states regarding EU-funded projects, standardization by private associations, general framework programs by private industries, etc.

In some countries, BIM is already a mandatory requirement to access participation in public procurement; in other countries, BIM is really unknown, where digital skills for the workforce can be promulgated not only at public sector level but also by non-governmental institutions with the launch of specific training courses and learning resources.

Public universities offer some BIM Masters, such as the UniBIM Master of the University of Pisa Italy [45], and private software houses.

Private initiatives and public initiatives are mixed and overlapped. The last figure of Section 2.3 documents an existing gap between BIM use and its impacts on the European economy.

The methodology proposed (Section 3) documents that words and concepts of the text of ED 24/2014/EU were often modified, not included or integrated by others in several national translations. For example, "*drawings*", "*simulation*", "*data*" and "*graph*" cannot be identified with the BIM, either for their technical meaning or for their legal meaning.

They are terms that, in various ways, introduce variants, objects and meanings that expand, deviate, orient, and take lexical and technical directions that are different to the meaning of the acronym BIM.

The methodology proposed, therefore, highlighted the freedom of interpretation of the official text of ED 24/2014/EU by several national translations; consequently, the prescriptions highlighted and promulgated on such bases can be misleading.

Today, the Italian situation (Section 3.1) documents, after some steps (from ED 24/2014/EU to Italian translation of ED 24/2014/EU to Law no. 50/2016 to Ministerial Decree no. 560/2017) that what has become mandatory for public works since 2014 is not the BIM of Charles Eastman, but is instead this strange sentence: "*specific criteria and methods, such as those of modelling, for construction and infrastructure*".

This propagation of mistakes is not just technical or legal, but is first of all logical. For example, the VIP ("*Very Important Person*") concept in many countries is a worldly concept of well-known people in the spotlight, who are in newspapers and magazines. If I say that a 1700 poet of a certain state was a "*person*" "*very*" "*important*" for the literature of that country, I cannot consider him a VIP just because the terms used in the grammatical expression are the same.

5. Discussion

The base concept of this research was the proposal of a holistic approach as knowledge criteria about what has been happening regarding BIM [4] in the construction field of the European Union in recent years.

The aim of this European BIM reform was to find a new way to reduce the cost of public works and, consequently, to dramatically improve the situation of the construction sector, which is an important part of the economy of every state and for the whole of Europe in terms of its impact on the worldwide scenario. Thus, a general vision seems necessary to evaluate the causes about what is really going on.

In practice, after the European Decree no. 24/2014 up to nowadays, the gap between states cannot be fixed.

The Member States document a high heterogeneous situation using BIM and some critical issues common to the various states have emerged:

- About the merit: The BIM method implies a change of technical mentality from an approach characterized by phases and actors to a systemic approach. After analyzing what has happened in some Member States, it emerged that the construction sector gradually assimilated BIM, including the university and high school system, which brought their knowledge of BIM to the construction industry. The professional world and the world of training, at a certain moment, found themselves on a common path.
- About the method: Decree 24/2014/EU is a complex commitment that needs to be assimilated gradually and "from the bottom." This is the first critical point: the European Union's request for almost all the states in practice represents a novelty that came suddenly and "from the up". The period adopted by each state of progressive acceptance of the BIM (i.e., based on the amount of works) cannot, by itself, solve problems that appear inherent in systems and practices that were consolidated for many years.

In many European countries, before Decree 24/2014, BIM was extraordinarily little known, starting from the world of professional training. There was not, therefore, a cultural and technical environment capable of understanding exactly what BIM was and how it should be used. The absence of an appropriate background context always limits the assumption of a technical change. Often, the attempts to resolve this situation were oriented in many different directions, because the national laws of the Member States were different one each other. Obviously, this situation has shown itself to be a "surrogate" of the whole BIM knowledge and cognition, which is often unsuitable for responding exhaustively to real needs and, above all, for effective use of BIM itself. The methodology proposed in this study documented that there was a link between this situation and the legal process used to promote the mandatory use of BIM. From a technical point of view, BIM was mistaken for software (tools) or a standard and considered a method since the appearance of the 24/2014/EU text. In addition, from a legal point of view, again, the introduction of BIM in individual countries passed through national legal instruments, which, often, in an attempt to clarify what BIM was, interpreted and partialized BIM into a sort of "local BIM", that, generally speaking, become partialized due to the translation in the national language. A method like BIM concerns the entire design, construction and management system and risks losing consistency as soon as it is partialized.

To try to offer a contribution to this situation, voluntary regulations or self-referential interest groups were created in many countries. The result was often a further complication of the procedures. BIM was often made equivalent to a local norm or standard procedure and this interpretation, in practice, did not bring about the expected results. This situation could be caused by several reasons: the quantity of standards and commitments, requested by too many subjects, causes technical and bureaucratic confusion about what is mandatory by law and what is just volunteer; furthermore, the private request of courses, standards, commercial software, training and commitment often increased the gap between the economic possibilities of the players (private sector and public administrations, individual professional and big companies). BIM is a method of expressing the specific contents that, on the one hand, are endogenous to the construction sector (in current and future practice) [46] and, on the other hand, represent a real methodological revolution about new and old construction [47] that cannot be substituted by a surrogate. In every single project, situation, technical and cultural context, it is always necessary to understand and use the level of BIM method suitable for that specific situation. "*How much BIM*?" is the question that Charles Eastman often asked those who wanted to understand how they could use BIM in a certain situation. The nature of BIM is a method that cannot be reduced to ideological standards. Nowadays, in Europe, BIM looks like a strange "buzzword", as happened in the USA at the beginnings of it's diffusion, some decades ago. Therefore, using practice from below appears increasingly necessary as the most effective and congruent solution to a situation that produced a gap between the theoretical intention and the real situation.

The point of strength of this original approach was that it went back to the beginning of the diffusion process of BIM and analyzed its limits to understand the confusion surrounding ED 24/2014/EU.

In general, this "confusion" was attributed to causes that depend on external factors (not of the law), such as the digitization rate of the individual country, the characterization of the individual construction sector, the number of employees, and the weight of bureaucracy and local procedures. This article attributes the translations of the technical terms present in the texts of the law as the main cause of the confusion mentioned.

Another strength of this thesis was its objective understanding: anyone can follow the flow of reasoning, not only technical specialists in BIM. The confusion surrounding ED 24/2014/EU would be the same as any other ED promulgation of great strategic importance that did not present a clear definition of content.

An aspect of weakness of this approach may be the consideration that every law can be interpreted. However, this affirmation cannot be applied to technical content but only to legal content, and thus, it cannot call into question the technical content of the BIM

Another weakness of the result obtained can be its staggering clarity: in fact, it is not a diplomatic result because we highlighted that there was an interpretation of the real contents of BIM in the ED and a consequent disconnection of the procedure used for its diffusion.

Moreover, the results led to two difficult consequences: it is necessary to start from a clearer text of the ED by inserting the correct definition of BIM and inserting an application protocol that is not included today by starting from the definition itself.

This request for clarification and parametrization of BIM could be hampered by many stakeholders who have, in recent years, taken advantage of the current situation.

6. Conclusions

The current European situation demonstrates a slow penetration of BIM in public procurement: for this reason, the authors aimed to understand whether the terms used in the texts of the laws that are at the origin of the obligation lend themselves to being misunderstood and, consequently, conditioning the clarity, speed and effectiveness of the current diffusion of BIM itself. In fact, in legal texts, inaccurate technical content causes confusion in concrete applications.

It is important to remember that BIM is an acronym that indicates the precise method devised by Charles Eastman, a method known and recognized all over the world, which is described in the article. Even if it was created to introduce this method, the European Directive uses a sequence of terms in the text, instead of its acronym, that causes a real misunderstanding, i.e., they indicate any generic electronic modelling of construction information.

Generic modelling of information for construction has always existed, exists and will exist but they are not the specific modelling system devised by Charles Eastman, which is the only one that has led to a documented saving of 30% of resources, time and costs compared with any other existing practice.

The use of generic terms instead of specific ones has led to diffusion of something unclear indicated by a confused expression. Therefore in Europe, this something unclear has become mandatory rather than the precise method of Charles Eastman.

This study critically investigated the relationship between ED 24/2014/EU and the diffusion of the use of the BIM method in Europe. Currently, a growing panorama is emerging, although this is still far from full use; it mostly emerges as an extremely uneven situation. To indicate the Building Information Modelling devised by Charles Eastman, which is a method of modelling building information with the specific characteristic of being based on object-oriented 3D models, the acronym BIM was not used in the text of the law.

In fact, four terms were used: "information", "building", "modeling" and "electronic"; they have been arranged in a sequence "building information electronic modelling", which can only indicate any generic tools of modelling the information of a building that con-

ceived or conceivable by anyone and based on any characteristic, provided it is of an "electronic" nature.

The lexical and legal approximation described has caused a serious technical misunderstanding for those working in the construction sector.

BIM and "building information electronic modelling" are two different things that express completely different technical concepts.

Using the second concept instead of the first can only lead to a serious propagation of misunderstandings. In fact, as is known, there are numerous possibilities for modelling the information of a building that are not Eastman's method because, for example, they are not based on object-oriented 3D models. This is the case, for example, of the method based on the Construction Operations Building Information Exchange (COBie), which is a method that is well known and used but which is not the BIM method and does not obtain its results. Other examples are the case of any method based only on alphanumeric input/output, 2D input/output or three-dimensional non-object-oriented input/output.

This is not a problem of orthodoxy or linguistics: it is a technical and practical problem. Only Eastman's method rather than a generic method, has documented the possibility of obtaining a 30% saving of time and costs compared with the practices in use today for the process of the design, construction and management of a building.

The translations of the ED carried out in the languages of the individual Member States translate equivocal terms that lead to being understood in various ways and obtain, as a final result, a galaxy of generic methods, which amplified confusion and misunderstandings, first of all in their own construction sectors. In fact, as documented in Table 3, concepts appear in many translations that are even unrelated to BIM, such as "drawing", "simulation" and "data", which are technically very far from "building", "modelling" and "information", and even more distant are the meanings of the combinations of these terms used instead of BIM In practice, since 2014, each Member State has translated the generic terms of the ED as considered appropriate; consequently, in Europe, a method that is today highly misunderstood has become mandatory to which everything and the opposite of everything can correspond as a technical content and consequently as a practice.

Charles Eastman's BIM, which is a clear and precise method, was transformed into many other things. This situation became further fragmented and confused due to many actions in the individual states that were promoted by self-referential subjects who took advantage of the absence of a univocal and clear definition of BIM in the cited legal texts, proposing voluntary regulations that are even contrary to the community guidelines.

If we do not return to the only definition of BIM (the original one of Charles Eastman), we will not be able to eliminate the current confusion, fragmentation and inhomogeneity between the individual Member States; above all, it will not be possible to obtain the savings that only the specific method of BIM was documented to be able to obtain.

Some specific recommendations to better guide future efforts toward resolving the confusion surrounding ED 24/2014/EU are as follows:

- Delete the sequence of four generic terms written in lowercase, namely, "building", "information", "electronic" and "modelling", from the text of the law of the ED;
- Insert three capitalized terms that indicate the single concept of "Building Information Modelling" that was devised by Charles Eastman;
- Include in the text the exact definition of this acronym based on the definition of Charles Eastman.

For these proposals to be feasible, a European Institutional Committee should be set up by the Parliament with greater authority than any European voluntary body or Member State:

- To monitor the actions that each Member State implement regarding BIM so that they do not conflict with the previous points;
- To prepare a clear path of application with few and precise points common to all member countries;
- To establish linearity of the acquisition of the law by the Member States;

- To prevent translations, transformations or national interpretations of the acronym BIM that prevent the diffusion of the BIM method for what it is;
- To ask Member States to keep unchanged, in their legal instruments, the content of the previous point without translations that cause changes or interpretations of the acronym BIM;
- To ensure that individual states will be able to integrate these points but will not be able to change them or make them secondary to the national ones. In this way, Member States should avoid actions that can lead to disconnected and independent results, both from each other and regarding the real content of the European Directive.

Moreover, this Commission may limit actions dictated by self-referential private interests acting for business reasons and have no institutional responsibility. In fact, as in the European Community in general, inside the singular state, there are many conflicting actions next to common directions.

Legal obligations are often confused with voluntary associations' initiatives, so it is necessary to do the following:

- Clarify the legal obligation regarding the actions of private and self-referential organizations;
- Reduce the need for laws and standards to the minimum necessary in order to not increase the burden of bureaucracy and the European's demands on individual Member States.

The adjustments described are necessary and urgent. In fact, since 2014, there has been a serious misunderstanding in the text of the ED. This investigation represents an original contribution to understanding the dynamics that laid the foundations of the current confusion situation caused by the propagation of misunderstandings and technical/legal errors. In line with the results that emerged, it would seem necessary to adjust the initial deliberation compared with the current situation to align all Member States on the contribution that the BIM method, only if applied in a congruent way according to how it has been fully designed and applied, can offer to the improvement of the construction sector.

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