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Roadmap Proposal for Implementing Building Information Modelling (BIM) in Portugal

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Abstract

Building Information Modeling (BIM) is a process involving generation and management of digital representations of physical and functional characteristics of places, which can be exchanged or networked to support decision-making in architecture, engineering and construction (AEC) sector. BIM is a relatively new technology in an industry typically slow to adopt changes, especially in Portugal. The present paper aims to frame the international implementation of BIM in order to propose a roadmap to spread the use of BIM methodologies in Portugal in the next decade.

Keywords

BIM, Roadmap, International Implementation, Strategies and Actions

1. Introduction

BIM is a technology, and not a specific program, that offers an integrated platform to improve design, increase the speed of delivery for design and construction, and provide a flow of information without breaks.

The use of BIM goes beyond the planning and design phase of the project, being extended throughout the building life cycle, of several infrastructures (water, wastewater, electricity, gas, waste, roads, bridges, ports, houses, apartments, schools, hospitals, shops, offices, factories, warehouses, prisons, etc.).

BIM has been on the rise for the past decade. The AEC (Architect, Engineering and Construction) industry is adapting to increased demands for the use of BIM during the design and construction phase of construction projects. Building owners, private and public are increasingly requiring that BIM is used on their projects as the method has proven to have a positive impact on the construction process in many aspects e.g. clash detection, better visualization, energy analyze or its effect on buildings LCC (Life Cycle Cost); other parts of the method

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have been proven to save time and cost as well as delivering better product to the building owner [1].

2. BIM Developments throughout the World

The BIM method is on different maturity levels in different countries. Different countries have their own BIM standards and different organizations that contribute to writing and updating the standards. The different types of standards are necessary since each region has their own regulations and traditions within the construction industry so the standards need to be adapted to different cultures Are also overviewed what organizations are leading the implementation of BIM in most relevant countries.

2.1. International Implementation

In the following are presented some countries in which BIM is already implemented (**Figure 1**), being the analysis more developed in the countries that have been leading the adaptation to BIM in the construction industry:

1) **Australia**: Not mandatory for projects, nevertheless was used for the project of Sydney Opera House;
2) **Brasil**: Began to be implemented in 2006 in some private initiatives. In 2010 ABNT/134 EEC Special Commission to Study the implementation was created. In 2011 BIM was widespread to public initiatives;
3) **Canada**: Founded by the end of 2008, the Canada BIM Council for support the adoption of standardizes models in architecture, engineering and construction, to manage national-wide implementation and introduce good practices and standards. Requires the use of BIM in public construction projects;
4) **Denmark**: BIM began to be used in projects during 2001. Its use became mandatory in Federal projects during 2007;
5) **Finland**: Requires IFC/BIM in its projects (public buildings) and intends to have integrated model-based operation in future since 2007. Mandatory for infrastructures project since 2014;
6) **Germany**: Following the examples of some neighboring countries, where the use of BIM is already mandatory, Germany is trying to spread the use of BIM. It was previewed for 2014 the publication of a BIM-Guide, that offers recommendations and knowledge for all in Germany that are interested in using the BIM. The BIM guide is a non-binding recommendation; it is no mandatory directive to execute construction projects using BIM;
7) **Iceland**: The Implementation of BIM in Iceland is led by Framkvæmdarsýslu Ríkisins (FSR) a governmental organization. There are already some relevant documents related with BIM implementation. The Icelandic industry is on information Level 1 heading for information Level 2;
8) **India**: In India BIM is also known as VDC: Virtual Design and Construction. It has many qualified, trained and experienced BIM professionals who are implementing this technology in Indian construction projects and also assisting teams in the USA, Australia, UK, Middle East, Singapore and North Africa to design and deliver construction projects using BIM;

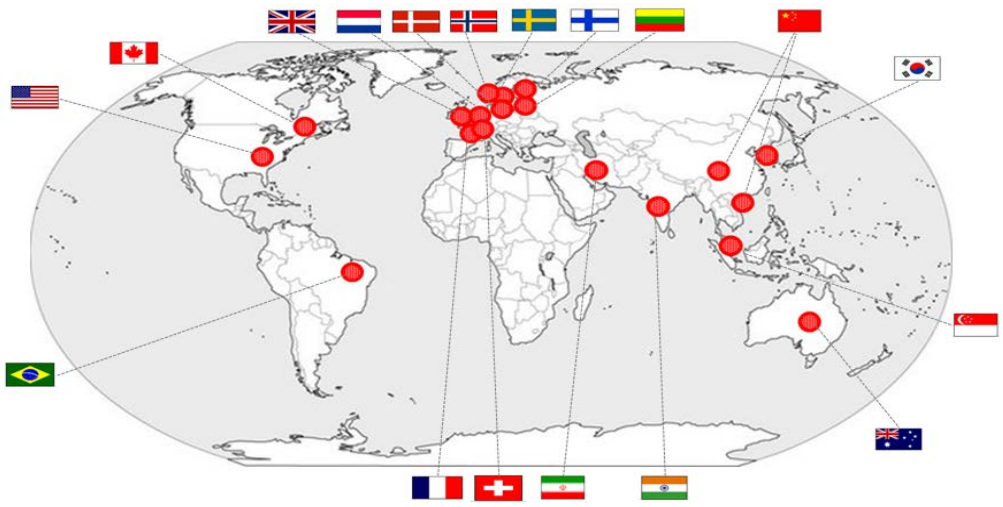

Figure 1. Global perspective of BIM implementation throughout the world.

9) **Iran**: The Iran Building Information Modeling Association (IBIMA), founded in 2012, shares knowledge resources to support construction engineering management decision-making;
10) **Lithuania**: Is moving towards adoption of BIM infrastructure by founding a public body "Skaitmeninė statyba". BIM (Building Information Modelling), Industry Foundation Classes (IFC) and National Construction Classification will shortly be adopted as standards;
11) **China**: BIM has been included as part of the National 12th Five Year Plan (2011-2015) for Mainland China and is formulating a BIM framework. It was created a partnership between Academy of Building Research Technology and Autodesk for BIM models. The Hong Kong Institute of Building Information Modelling (HKIBIM) was established in 2009 and the Hong Kong Housing Authority set a target of full BIM implementation in 2014/2015;
12) **Norway**: BIM has been used increasingly since 2000. Several large public clients require use of BIM in open formats (IFC) in most or all of their projects. National BIM development is centered on the local organization, building SMART Norway which represents 25% of the Norwegian construction industry. Requires IFC/BIM for new buildings since 2010;
13) **Singapore**: Determined national-wide implementation roadmap in 2011. BIM as part of public sector building project procurement (2012). BIM introduced for architectural submission (2013), structural and M&E submissions (2014). Requires mandatory use of BIM from 2015 onwards;
14) **South Korea**: In the late 2000s the Korean industry paid attention to BIM. It has been spread very rapidly. Since 2010, the Korean government has been gradually increasing the scope of BIM-mandated projects. In 2012 was published a detailed report on the status of BIM adoption and implementation;
15) **Sweden**: BIM important in infrastructures project. Creation of openBIM with 95 partners;
16) **The Nederlands**: By the end of 2011, Rijksgebouwendienst, the agency within the Dutch Government that manages government buildings, introduced the RGD BIMnorm which was updated on July 2012. It is mandatory for Public works > 10M€;
17) **United Kingdom**: In 2011 the UK government published its BIM strategy. Government requires mandatory use of BIM in public sector (£5 million) from 2016 onwards. Their target is to become BIM leader in European region;
18) **USA**: The General Services Administration requires mandatory BIM submission for government projects since 2008. They are experts in using BIM and are leading BIM practice;
19) **Other Countries**: Some European countries (France, Switzerland…) require the use of BIM in public construction projects, and, some of them set up agencies to manage national-wide implementation and introduced good practices and standards.

2.2. International Supporting Organizations

In countries that have been leading the implementing of BIM the carrying out has been led by public organizations that underlines that a successful adaptation of BIM must be led by organizations that has a long time view on building projects and looks at how the operational phase can be improved by optimizing the design-build phases and is prepared to invest in methods to improve the overall building process [1].

2.2.1. Building SMART Alliance

The Building Smart alliance is a neutral, non-profit organization which supports the use of open BIM. The goal of the organization is to improve cost, value and environmental performance of buildings through the use of open sharable asset information. Building Smart has been in the forefront of implementing BIM. Building Smart develops and maintains the IFC platform which makes it possible for interoperability between different native CAD software. The Scandinavian countries and the UK are a part of the Building Smart alliance using the non-proprietary format IFC (Industry Foundation Classes) as a tool for interoperability of native BIM models [1].

2.2.2. National Institute of Building Science (NIBS-US)

NIBS is a non-profit, non-governmental organization that successfully brings together representatives of government, the professions, industry, labor and consumer interests, and regulatory agencies to focus on the identification and resolution of problems and potential problems that hamper the construction of safe, affordable

structures for housing, commerce and industry throughout the United States. The Institute's mission to serve the public interest is accomplished by supporting advances in building sciences and technologies. The NIBS is the home of the North American BIM standard, the National BIM Standard-United states (NBIM-US), and COBie, the Construction-Operations Building Information Exchange.

2.2.3. Building Information Modelling Task Group (BIM-UK)

BIM-UK correspond a group which aims to support and help deliver the objectives of the Government Construction Strategy and the requirements to strengthen the public sector's capability in BIM implementation with the aim that all central government departments will be adopting, as a minimum, collaborative Level 2 BIM by 2016.

2.2.4. Det Digital Byggeri (BIPS-Denmark)

"Det digital byggeri" (The digital construction) is the Danish organization that endorses the BIM method in Denmark. Their mission is to provide the basis for a better cooperation and productivity in the Architect, Engineering, Construction and Operational (AECO) industry by developing a digital infrastructure and standardize information use. Denmark is one of the leading countries in adopting BIM method with BIPS having a strong influence on legislation.

2.2.5. Statsbygg (Norway)

Statsbygg is the Norwegian government's key adviser in construction and property affairs, building commissioner, property manager and property developer. It released a BIM manual in 2011defining what should be the generic requirements and discipline specific requirements for BIM in projects and at facilities, in the open Industry Foundation Classes (IFC) format.

2.2.6. Framkvæmdasýsla Ríkisins (FRS-Iceland)

FRS is a governmental organization that has the purpose of collecting knowledge on construction processes and to be a leading organization within the Icelandic construction industry on standardization and information technology in the building industry.

3. Roadmap Proposal for Portugal

Compared with international practice of BIM with respect to planning, adoption, technology and performance, Portugal is lagging behind majority of developed countries.

Yet many early adopters are confident that BIM will grow to play an even more crucial role in building documentation.

Following the example of other countries, the spread of BIM through Portuguese reality will bring in a close future [1]: i) improved visualization; ii) improved productivity due to easy retrieval of information; iii) increased coordination of construction documents; iv) embedding and linking of vital information such as vendors for specific materials, location of details and quantities required for estimation and tendering; v) increased speed of delivery; vi) reduced costs, and, last but not least; vii) approach from what is happening in the so called "most developed countries" and consequently creating great potential for the development of the construction industry and related areas.

However, there are challenges faced by the firms during BIM adoption that must be overcome, such as: i) lack of demand for BIM; ii) entrenched current 2D and 3D drafting practices; iii) steep learning curve to build BIM expertise and iv) lack of ready pool of skilled BIM manpower [2].

Despite the challenges presented (**Figure 2**), is possible to identify strategies that allow wide spreading BIM use in Portuguese Construction Industry in the next following years.

Considering what has been presented in the previous paragraphs it seems that a possible roadmap proposal for a wide implementation of BIM to Portugal during the 2020s will comprise the strategies previously mentioned (**Figures 2-4**) and the actions following presented:

4. Final Remarks

After through literature review is possible to verify and conclude about the benefits of BIM [4]-[15]: i) creation

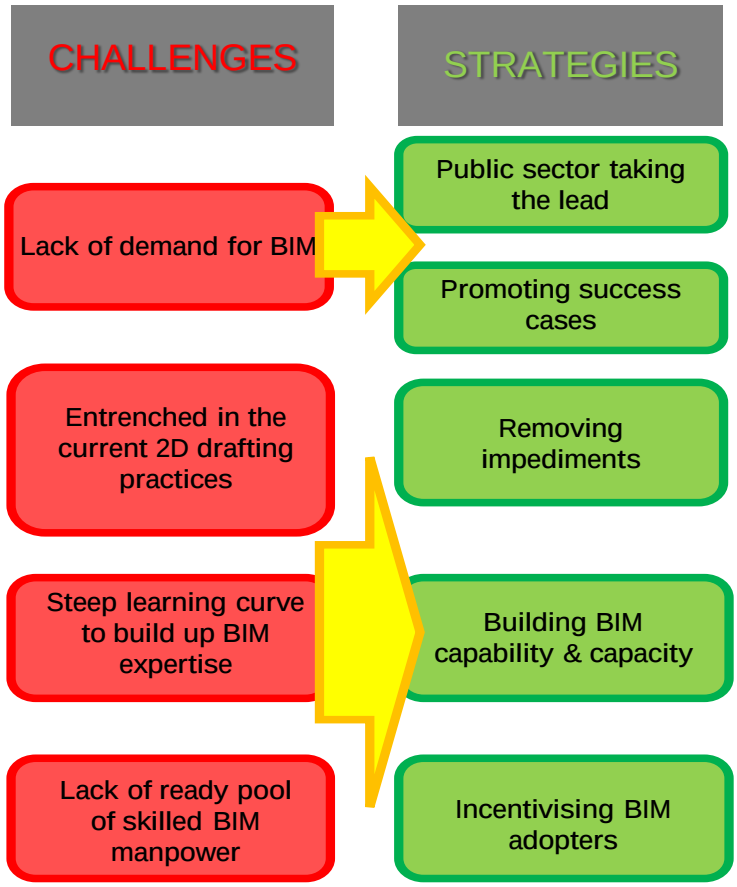

Figure 2. Relation between challenges and strategies for wide implementation of BIM, adapted from [2].

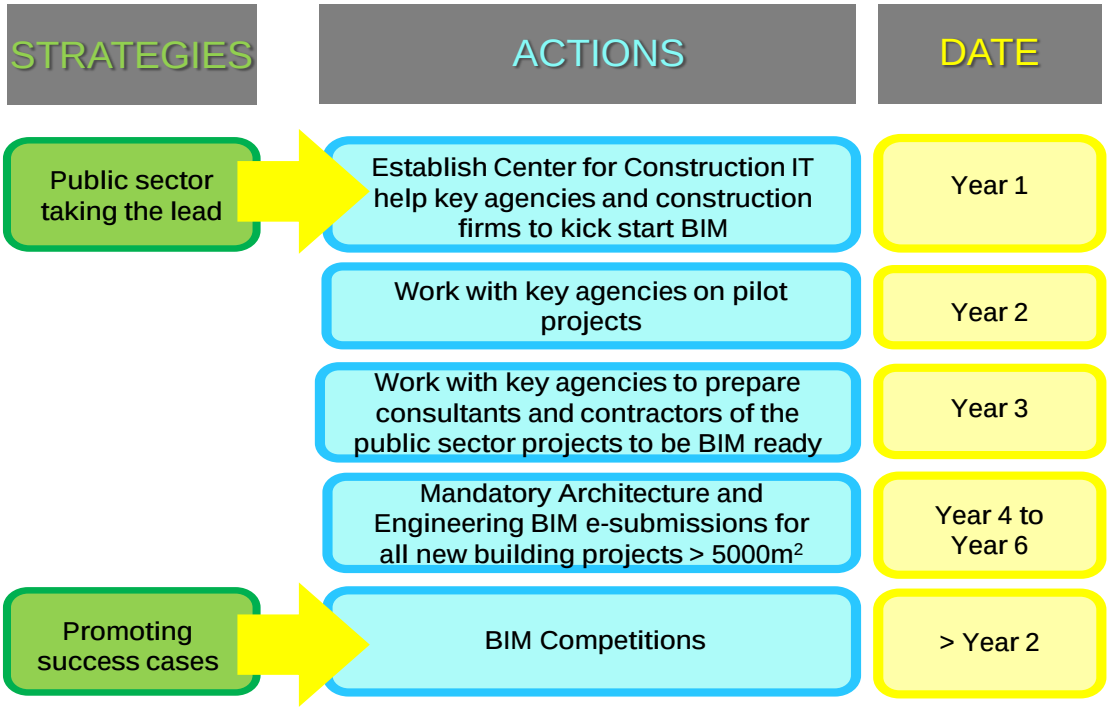

Figure 3. Actions proposal for overcome lack of demand for BIM in Portugal, adapted from [3].

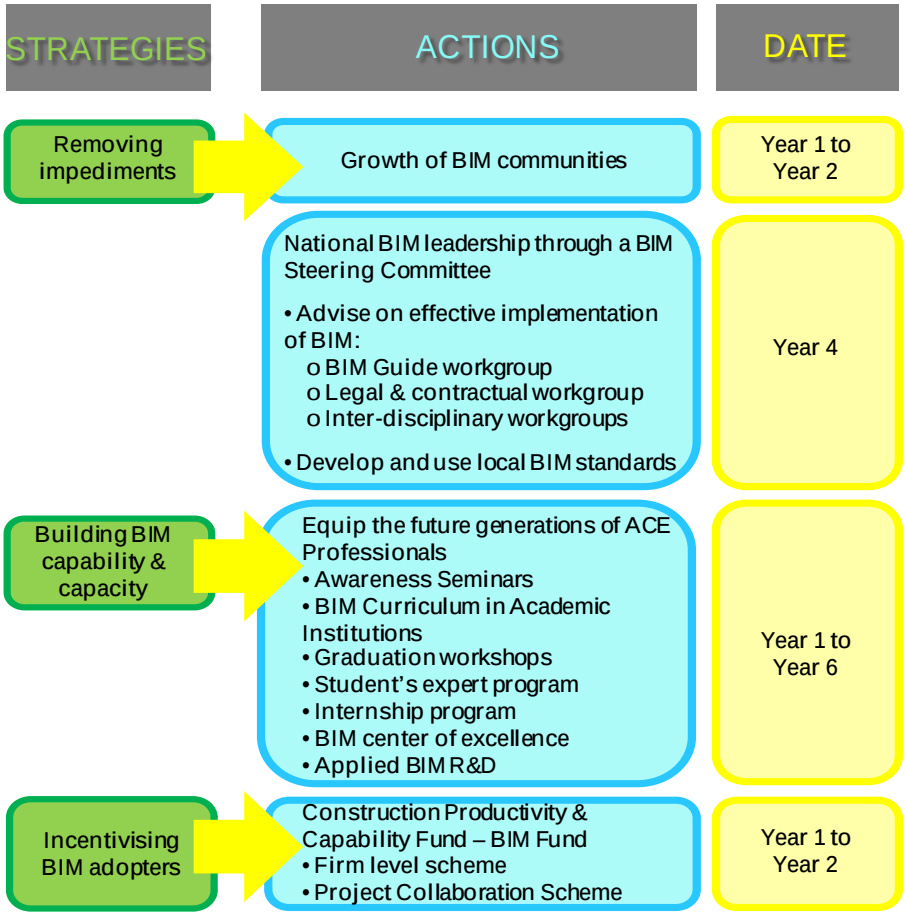

Figure 4. Actions proposed for overcome i) entrenched in the current 2D drafting practices; ii) steep learning curve to build up BIM expertise; iii) lack of ready pool of skilled BIM manpower, adapted from [3].

of accurate and standardized construction documents; ii) possibility of 3D visualization, renderings and fly-through; iii) faster drafting without compromising the quality; iv) creation of repetitive elements in drafting automatically; v) detection and making the clash analysis with building services even before the actual construction happen; vi) accurate production of quantity surveys and cost estimating; vii) better time planning and project management; viii) design changes can be tracked and recorded easier; ix) with the assistance of BIM, off site production becomes easier therefore BIM can minimizing material wastages; x) helps facility management and assets management easier; xi) fulfills government or regulatory requirements; xii) construction simulation process can simulate different options and choose the best alternative at design phase and this simulation includes all factors including safety by building design; xiii) can do energy analysis and carbon emission analysis.

The benefits of BIM are obvious, but the additional cost such as BIM supporting software, hardware, training staffs, productivity downtime before staffs is not familiar with new system. These additional costs should be offset by providing value added services such as performance based analysis and simulation. To rationalize the extra cost for implementing BIM, the benefit of productivity in AECO industry should be accessed [16].

For a generalized implementation of BIM in AECO industry, it also identified, through literature review, key success factors [17]: i) strong leadership to move the BIM implementation; ii) management buy-in and building up BIM skill in the team; iii) transparency and accessibility of BIM model; iv) ability to use BIM among project participants; v) collaborative sprit and mutual trust; vi) proper quality assurance procedure for BIM process; vii) reorganisation of new liability among project participants, *i.e.* BIM manager.

In Portugal, the basis for an extended BIM adoption must be the achievement of national BIM standards, being also necessary to equate the mandatory adoption of this methodology, similar to that of trend is seen in other

countries. Interoperability, standardization of procedures, the involvement of the various actors of the construction process, the creation of a collaborative network are critical aspects repeatedly emphasized in Portugal as fundamental to optimize and disseminate the implementation of BIM.

Portuguese construction industry is strongly encouraged to take leap to catch up the fast pace of the global adoption of BIM so as to maintain the competitiveness of Portuguese Architecture, Engineering and Construction (AEC) services in the region and even in the world. Considering the increasing use of management information systems in construction and the perspective of its obligation imposed by the Government, it is expected that the use of BIM in Portugal will also be mandatory in public works process.

"*The roadmap proposal to Portugal aims to realize the vision of a highly integrated and technologically advanced construction sector that will be led by progressive firms and supported by a skilled and competent workforce during the* 2020s".

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