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Assessment of BIM Maturity in Benin: Analysis of Challenges and Opportunities According to Succar's Model

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ABSTRACT

Building Information Modeling (BIM) has become an essential tool in the global construction industry, enhancing project efficiency, collaboration, and quality. However, its adoption varies considerably across national contexts. This study evaluates the level of BIM maturity in Benin through the prism of the eight development axes proposed by Succar, which include technology, processes, standards, education, culture, strategy, policy, and regulation. The methodology is based on an analysis of regulatory frameworks, technological infrastructures, and educational systems, combined with an evaluation of current practices in the construction sector. This approach allowed for the identification of the main obstacles and opportunities related to the adoption of BIM in the country. The results indicate that the absence of a national strategy, harmonized standards, and integration into educational curricula constitute major barriers to the development of BIM in Benin. However, sporadic initiatives and individual projects reveal potential for a progressive transition. These observations highlight the necessity of a structured approach to align local practices with international standards and fully leverage the benefits of BIM in the construction sector.

Keywords: BIM, BIM maturity, Succar's development axes, construction.

INTRODUCTION

The rapid evolution of digital technologies has profoundly transformed the construction industry, offering new opportunities to improve efficiency, collaboration, and project management. Among these innovations, Building Information Modeling (BIM) has emerged as an essential approach to modernize practices in the sector [1]. BIM is a set of technologies and working methods increasingly used and acclaimed in France and around the world. It represents a major advancement in the design, simulation, and management of construction projects [2].

Emerging in the early 1990s, the term BIM initially aimed to define the digital representation of constructions, that is, a 3D model enriched with properties [3]. It refers to an innovative technology that brings together a set of methods, processes, and tools to feed and exploit a database containing information on a structure throughout its life cycle. According to Syntec-Ingénierie, BIM is an organization that develops processes to build a shared and interoperable model over the entire project life cycle, based on a set of objects to which information is associated. The ISO 29481-1:2016 standard defines it as "the use of a shared digital representation of a built object to facilitate design, construction, and operation processes in order to form a reliable basis for decisions" [4]. Thus, BIM aims to simplify the design, realization, and operation of a construction or renovation project by integrating both technological and organizational aspects.

BIM has profoundly transformed the building industry by moving from a simple 3D design tool to a holistic approach to life cycle management of projects. Countries now distinguish themselves by their ability to integrate BIM at all stages, from planning to maintenance [5]. Several factors come into play when evaluating a country's BIM maturity level, including existing regulations, adopted standards, professional training in the sector, and the availability of necessary technologies and infrastructures.

Around the world, some nations have become pioneers in BIM by implementing ambitious policies to stimulate its widespread adoption. For example, in 2011, the United Kingdom announced its intention to make the use of Level 2 BIM mandatory for all public projects from 2016 onwards [6]. This initiative, announced in 2011, was effectively implemented in 2016, illustrating the country's commitment to BIM. Other countries, particularly in emerging economies, are still in the early stages, striving to overcome cultural, economic, and technological obstacles that can hinder this transition [7].

In this context, Benin, a country in West Africa, faces significant challenges in adopting BIM. Despite the global rise of BIM and its potential advantages in terms of efficiency, collaboration, and error reduction in the construction industry, the use of BIM in Benin remains marginal. Obstacles include the absence of clear strategies, established standards, and adequate technological infrastructure. Moreover, the current educational system does not favor BIM adoption, thus limiting the development of the necessary skills and expertise to fully exploit its benefits.

It is therefore essential to assess the level of BIM maturity in Benin to understand the driving forces behind its adoption and to identify the opportunities and challenges that arise as the sector evolves towards more integrated and technologically advanced methods. This assessment can be carried out based on Succar's model of eight development axes, which provides a framework for measuring BIM progression and adoption through different phases, from design to asset management [8]. Succar's eight axes encompass technology, processes, standards, education, culture, strategy, policy, and regulation.

This study aims to explore the different stages of BIM maturity, ranging from basic modeling processes to advanced data management approaches, in order to position Benin on this maturity scale. The analysis will focus on how these stages are reflected in construction projects, operational efficiency, and collaboration among stakeholders in Benin. By identifying current gaps and proposing recommendations, the objective is to contribute to the modernization of the Beninese construction sector and its alignment with international standards.

MATERIALS AND METHODS

BIM Maturity Levels

BIM characterization can be performed based on BIM maturity levels. With the expansion of this construction project management method, it is necessary to evaluate and measure its level of development. It is crucial that the different actors in Architecture, Engineering, and Construction (AEC) are able to assess their progress in terms of integrating the BIM process. The maturity level is generally evaluated using maturity matrices.

There are mainly four BIM maturity levels [9] :

- **Level 0**: This level essentially corresponds to the use of Computer-Aided Design (CAD) to produce 2D or 3D drawings. It represents a transition from manual drawing to digital. Some consider that this level does not yet constitute BIM but rather pre-BIM. Document exchanges are mainly in paper or PDF format.
- **Level 1**: At this level, data are structured, including plan numbering, geolocation, standardized presentation, and systems for plan approval and distribution. However, exchanges are limited; digital models are shared partially and without regulated procedures for tracking, verification, and approval. Each participant works in BIM in isolation, without direct interactions with other partners around the digital model.
- **Level 2**: This level marks the beginning of collaboration, which is the very essence of BIM. Each actor produces their own digital model (architecture, structure, MEP, HVAC, etc.). The models are exchanged during the project and evolve jointly to obtain a federated model coordinated by a team, avoiding clashes between different components. In the United Kingdom, Level 2 BIM has been mandatory for public projects since 2016. According to Riedo, cited by Jonathan Benoît [9], Level 2 BIM includes:
    - A graphical model or 3D digital model created with BIM software;
    - Non-graphical data including important information for the use and maintenance of the structure;
    - Documentation such as reports or 2D drawings.

In addition to the above elements, Level 2 imposes the following requirements:

- Data structure (standards);
- Definition of processes;
- Definition and control of data exchanges;
- A common data environment.

- **Level 3**: Also called iBIM (Integrated BIM), this level is perceived by many as the true BIM. It involves a single digital model stored on a server accessible by all stakeholders throughout the life of the structure. This level is not yet widespread and is deployed by a minority of companies.

BIM Maturity Assessment Models

Several tools and models have been developed to assess the BIM maturity level within organizations and projects. According to Giel and McCuen [10], here are mainly ten BIM maturity models, presented in Table 1.

Table 1: The main BIM maturity models [10].

Model Name	Authors	Organizational Scale	Year	Country of Origin	Evaluation Style
BIMCMM	I-CIMM and NIBS	Project and Organization	2007	United States	Certification
BIM Competency Index	Succar	Individual	2013	Australia	Average
BIM Maturity Measure (BIMM)	Arup	Project	2012	United States	Scoring
BIM Quickscan	Van Berlo et al.	Organization	2009	Netherlands	Percentage
BIM Proficiency Matrix	Indiana University	Project	2009	United States	Certification
Macro Maturity Matrix	Succar and Kassem	Market	2015	Australia	Average
BIM Maturity Matrix (BIMMM)	Succar	All	2010	Australia	Scoring
Organizational BIM Assessment (OBIMA)	CIC Research Group (CICRG)	Organization - Client Specific	2012	United States	Scoring
VDC and BIM Scorecard	CIFE	Organization	2013	United States	Percentage
Building Owners BIM Competency Framework	Giel and Issa	Organization – Client Specific	2013	United States	Unknown

Adopted Evaluation Methodology

For this study, the assessment of the BIM maturity level in Benin is based on the model of eight development axes proposed by Bilal Succar [8]. According to Succar, the diffusion of BIM practices at a national level requires the upgrading of several domains: the evolution of IT systems, work processes, and the regulatory and institutional framework.

BIM maturity is thus measured across the following eight axes:

1. **Objectives and Political Milestones**: Presence of clear political objectives and defined steps for BIM adoption.

2. **Champions**: Existence of "BIM champions," i.e., actors who have implemented BIM practices early on and who bring other actors along with them.
3. **Regulatory Framework**: Establishment of a regulatory environment allowing BIM practices (contracts, copyrights, insurance policies, etc.).
4. **Notable Publications**: Availability for sector actors of free and accessible documentation aiding in the implementation of BIM practices, produced by the state or professional associations.
5. **Educational System**: Integration of BIM concepts, tools, and work processes in initial and continuing education.
6. **Metrics and Certifications**: Availability of tools adapted to the national context to measure the BIM capabilities of individuals, organizations, and project teams.
7. **Standards and Deliverables**: Existence of national standards regularly updated according to the international context, with defined BIM deliverables.
8. **Technological Infrastructure**: Accessibility of high-performance BIM technologies for sector actors.

Data Collection

The assessment was carried out through an exhaustive documentary analysis of public policies, technological infrastructures, educational and regulatory frameworks in Benin. Data were collected from sources such as:

- Official documents from the Beninese government concerning construction sector policies.
- Academic publications and reports from professional organizations on BIM adoption in West Africa.
- Semi-structured interviews with construction sector professionals in Benin, including architects, engineers, contractors, and educators.

Data Analysis

The collected data were analyzed according to Succar's eight axes to evaluate the BIM maturity level of Benin. Each axis was examined to identify:

- Existing initiatives and their scope.
- Current gaps and obstacles.
- Potential opportunities to improve BIM adoption.

A qualitative evaluation was favored, given the exploratory nature of the study and the specific context of Benin. The results were synthesized to provide an overview of the country's BIM maturity level and to formulate appropriate recommendations.

RESULTS AND DISCUSSION

The evaluation of the BIM maturity level in Benin was conducted following the eight development axes proposed by Bilal Succar. The results are presented and discussed for each axis, highlighting the current challenges and opportunities for BIM adoption in Benin.

Objectives and Political Milestones

From a political standpoint, Benin currently lacks a clear orientation that could encourage Architecture, Engineering, and Construction (AEC) stakeholders to reorganize their management processes towards a BIM approach. There are no national strategies or specific government policies aimed at promoting BIM adoption in the construction sector. However, it is important to note that some projects in Benin have already required the use of BIM, although the participants in these projects are primarily foreign companies. The multiplication of such projects could nevertheless prompt the government to develop policies favorable to BIM, in order to modernize the construction sector and strengthen the country's competitiveness.

Champions

Benin has a few organizations that are beginning to take an interest in BIM. Although their number is still limited, these "BIM champions" play an essential role in raising awareness among other sector stakeholders about the advantages of BIM. However, the construction lobby in Benin remains conservative, which hinders the dissemination of innovative practices. Nevertheless, with the emergence of large-scale projects requiring modern approaches, significant growth in BIM adoption could be envisaged, provided that cultural resistance is overcome and innovation within the industry is encouraged.

Regulatory Framework

Benin currently does not have a specific regulatory framework for BIM. The absence of clear political objectives and official directives makes it difficult for sector stakeholders to adopt BIM in a harmonized manner. Without adequate regulation, BIM practices can be inconsistent, leading to variable interpretations of standards, fragmentation of collaboration processes, and difficulties in ensuring the quality of data exchanged between stakeholders. Establishing a specific regulatory framework for BIM is therefore essential to harmonize practices, improve project efficiency, and promote widespread adoption of this innovative approach in the construction sector.

Notable Publications

There is a notable lack of publications and quality resources on BIM in Benin. This absence of documentation, such as case studies, practical guides, or research reports, constitutes an obstacle for professionals in the sector, particularly those involved in design. The limited sharing of successful experiences and detailed information hinders the adoption and effective implementation of BIM. It is therefore important to promote the dissemination of information and knowledge on BIM, in order to strengthen understanding, collaboration, and innovation within the construction industry in Benin.

Educational System

The integration of BIM into the Beninese educational system is not yet effective. Educational programs, both at the university level and in continuing professional education, do not cover the concepts, tools, and processes related to BIM. This gap limits the preparation of future construction professionals to meet the technological and collaborative challenges associated with BIM. It is essential to include modules or courses dedicated to BIM in educational curricula, in order to equip industry stakeholders with the necessary skills to adopt and master this approach.

Metrics and Certifications

There are no specific BIM standards or recognized certifications in Benin. The absence of standardized metrics to measure the effectiveness and benefits of BIM makes it difficult to evaluate the quality of models and processes used. Without appropriate assessment tools, it is also complicated to compare performances and demonstrate the potential advantages of BIM to stakeholders. Establishing recognized BIM certifications and established metrics would help encourage AEC actors to consider adopting BIM and continuously improve practices in the construction sector.

Standards and Deliverables

Benin lacks national standards or clear definitions concerning BIM deliverables. The absence of precise guidelines on the types of data and information to include in deliverables at each project phase creates confusion regarding expectations and requirements. This can lead to issues of quality, consistency, and communication among project stakeholders. Establishing well-defined BIM standards for deliverables is essential to ensure uniformity, a common understanding, and better data management throughout the project lifecycle.

Technological Infrastructure

Although Benin is engaged in an ongoing digitization process, the implementation of BIM technology faces significant challenges. Obstacles include a lack of robust digital infrastructures, limited technical skills within the construction industry, and resistance to change. Additionally, the investments required for acquiring software, equipment, and training pose a barrier, particularly in a context of constrained budgets. Overcoming these challenges will require close collaboration between public and private actors, as well as initiatives aimed at strengthening digital skills and raising awareness among stakeholders about the advantages of BIM to modernize and optimize the construction sector.

GENERAL DISCUSSION

The detailed analysis of Succar's eight development axes reveals that Benin is currently at a relatively low BIM maturity level. Several major obstacles hinder the effective adoption and integration of BIM in the Beninese construction sector.

Firstly, the absence of clear government policies and specific national strategies related to BIM constitutes a significant hindrance. Without official directives or defined political objectives, construction sector stakeholders lack a framework to guide their efforts toward integrating BIM into their professional practices. This gap leads to fragmented initiatives and limits the coherence of actions undertaken by different stakeholders.

Secondly, the Beninese educational system has not yet integrated BIM into its programs. This situation results in a shortage of professionals trained in the concepts, tools, and processes related to BIM. The absence of initial and continuing education limits the ability of future and current professionals to master the skills necessary for effective BIM adoption. This lack of qualified human resources compromises the implementation of BIM projects and reduces innovation within the sector.

Thirdly, the regulatory framework related to BIM is nonexistent. Without national standards or clear guidelines concerning deliverables, processes, and BIM standards, it is difficult for organizations to develop consistent practices and ensure the quality of exchanged data. This situation can lead to inefficiencies, communication errors, and coordination problems among project stakeholders.

Fourthly, technological and infrastructural limitations represent a significant obstacle. The lack of robust digital infrastructures, coupled with budgetary constraints for acquiring software, equipment, and training, restricts access to BIM technologies for many companies, especially small and medium-sized enterprises (SMEs). Moreover, resistance to change and lack of awareness of BIM's advantages can hinder the adoption of these innovative technologies.

Despite these challenges, opportunities exist to stimulate BIM adoption in Benin. The emergence of large-scale construction projects, often in partnership with international actors, offers an opportunity to introduce and demonstrate BIM's benefits. The experience gained in these projects can serve as a reference and encourage other local companies to engage in this path. Additionally, the growing interest in modernizing the construction sector and the need to meet quality and sustainability requirements create a favorable context for BIM adoption.

To make progress, a collaborative approach involving the government, educational institutions, professional associations, and the private sector is indispensable. Developing a national BIM adoption strategy could include the following actions:

- **Development of Policies and Regulatory Frameworks**: Establishing clear directives and national BIM-specific standards is fundamental. This includes defining standards for BIM deliverables, integrating BIM into public and private procurement processes, and adapting contracts and regulations to facilitate its use.
- **Strengthening the Educational System**: Integrating BIM into university curricula and professional training programs is essential to prepare a new generation of competent professionals.
- **Development of Technological Infrastructures**: Investing in digital infrastructures and facilitating access to BIM technologies. This may include government initiatives to subsidize the acquisition of software and equipment, as well as the development of technological resource centers.
- **Awareness and Communication**: Awareness campaigns aimed at informing stakeholders about BIM's advantages are necessary. This includes disseminating notable publications, organizing conferences and seminars, and participating in international forums.

Moreover, it is important to consider the specificities of the Beninese context, such as economic constraints, cultural habits, and the current level of technological development. A progressive approach adapted to local realities could facilitate BIM adoption. For example, starting with the adoption of Level 1 or 2 BIM, then evolving towards higher maturity levels as skills and infrastructures develop.

Successful BIM implementation in Benin could transform the construction sector by making it more competitive, efficient, and innovative. It would optimize design and construction processes, reduce costs and timelines, and improve the quality of structures. Furthermore, by adopting BIM, Benin would be better positioned to meet international requirements, which could attract foreign investments and strengthen its presence in the regional market.

Finally, it is essential to recognize that BIM adoption is not solely about technology but also involves cultural and organizational change. It is about promoting a culture of collaboration, information sharing, and innovation. Sector stakeholders must be willing to question traditional practices and adopt new working methods.

CONCLUSION

This study assessed the level of BIM maturity in Benin using Succar's model of eight development axes. The results highlighted that Benin is at a preliminary stage in BIM adoption, with significant gaps in several key areas, notably the absence of clear government policies, lack of specialized training, absence of standards and regulatory frameworks, and technological and infrastructural limitations.

These obstacles hinder the ability of the Beninese construction sector to fully benefit from BIM advantages, such as improved operational efficiency, project quality, and stakeholder collaboration. Nevertheless, opportunities exist to stimulate BIM adoption, notably through the emergence of large-scale projects requiring modern approaches and the growing interest of some local actors.

To progress toward effective BIM adoption, it is essential to develop a national strategy fully integrating Succar's eight axes. This involves formulating supportive policies, integrating BIM into the educational system, establishing adapted regulatory frameworks, developing adequate technological infrastructures, and promoting professional training and certification.

By adopting these measures, Benin can modernize its construction sector, strengthen the competitiveness of its companies, and meet international requirements in terms of project quality and sustainability. This transition to BIM is not only an opportunity to improve sector performance but also a necessary step to ensure sustainable and effective development of the construction industry in Benin.

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