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BIM: A COLLABORATIVE APPROACH TO ARCHITECTURAL PROJECT MANAGEMENT

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ABSTRACT

At the present time, digital technology has fundamentally altered both our daily lives and professional environments. New tools and software have emerged, becoming crucial across various fields, including urban development, by replacing traditional methods. Among these technological advancements is Building Information Modeling (BIM), also known as Better Information Management, which has evolved into a collaborative management process integrating architectural projects.

BIM relies on technologies and solutions that intelligently model and structure the different stakeholders involved in a project. It creates a virtual environment that accurately represents buildings and urban spaces, including their geometry, spatial organizations, functionalities, and other significant information.

This contribution aims to examine the challenges associated with using BIM as a collaborative project management process in architecture. It also seeks to explore new strategies that promote the efficiency and quality of architectural projects.

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Introduction.

The advent of the digital age has instigated a significant shift in our everyday experiences, influencing both personal and professional aspects. New technologies and platforms have surfaced, revolutionizing various sectors, including urban planning, by replacing traditional methods. Among these advancements, Building Information Modeling (BIM), also known as Better Information Management, has emerged as a collaborative method integrating the management of architectural projects (Naville, C., Samia, 2016).

BIM relies on innovative technological solutions, enabling intelligent and structured modeling of key stakeholders in architectural projects. This process goes beyond mere visualization by incorporating detailed information about geometry, spatial and functional relationships, and other relevant data (Chaudet, 2020).

Building Information Modeling (BIM) is emerging as a necessity to optimize productivity in the traditionally fragmented and inefficient construction sector (Manzoor, Othman, Gardezi, et al., 2021). Inescapable, BIM now sets the standard for architecture and civil engineering consultants (Wesam Salah

Alaloul et al., 2020; Altaf et al., 2020). To ensure the success of architectural projects, adopting BIM is imperative, and defining the optimal moment for this transition becomes essential (Wesam S. Alaloul et al., 2018; Aranda-Mena et al., 2009). This need is accentuated by the rapid growth of the global construction industry, with a prevalence of sustainable projects having significant implications for global and local economic development (Mok et al., 2015).

As a collaborative management process, BIM stands as a cornerstone. It functions as a central database, facilitating every stage of the building's life cycle. By providing digital representations of physical and functional information, BIM creates an environment conducive to collaboration among all project stakeholders, thereby elevating the management of architectural projects to a level of increased transparency and efficiency (Manzoor, Othman, Shujaa, et al., 2021).

Building information modeling is emerging as a revolutionary technology in the field of architectural projects, offering an intelligent digital representation of buildings. This collaborative project management approach promotes efficiency throughout the project lifecycle, bringing significant benefits at each stage (Qureshi et al., 2020; Vilutiene et al., 2019). High adoption rates in North America, with 67% for engineers, 70% for architects, and 74% for contractors, underscore its significant impact. In Australia, approximately 49% of architects and 75% of engineers and contractors integrate BIM. A survey in the UK reveals that 39% of respondents have already used BIM, emphasizing its global relevance (Kassem et al., 2013; N.hasan & Rasheed, 2019).

The BIM process at the core of the building's digital transition.

BIM is not simply the use of a digital model centralizing all the data of a building. It is a genuine collaborative process where the interoperability issue becomes relevant.

BIM as a new design method.

BIM is frequently associated with software or new technology, yet its scope extends beyond these concepts. It can have different meanings, namely (Figure 1):

"Building Information Modeling," or BIM, represents a collaborative approach based on a parametric 3D digital model. This model incorporates intelligent and structured data, following the complete lifecycle of a building, from design to deconstruction and recycling of materials. Two other less common meanings contribute to completing this definition.

"Building Information Model" corresponds to a digital model where each participant provides and extracts data on objects, creating a digital representation of the physical and functional aspects of the project.

"Building Information Management" involves the management of exchanges within a modeled project, also known as interoperability (Frigelli, 2017).

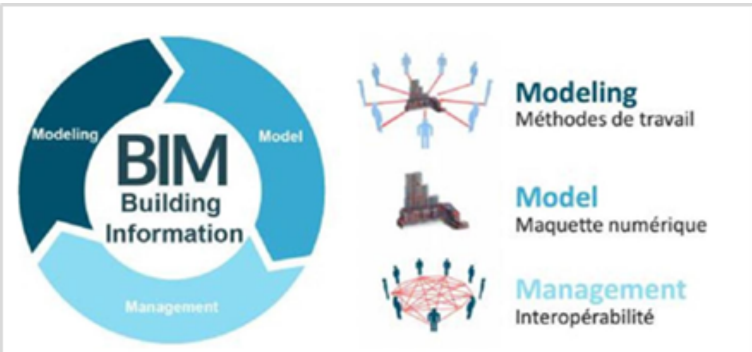

Figure 1. The three meanings of BIM (Source: Frigelli, 2017).

The Different Levels of BIM Maturity.

BIM embodies itself in different ways, relying on the adopted collaboration method. The levels of maturity, also known as BIM levels, are distinguished by how data is generated and exchanged. At "Level 0" the absence of collaboration means exclusive use of 2D CAD without interoperability, while "Level 1: Lonely BIM" involves a non-shared database combining 2D CAD and a 3D model with data structuring. At "Level 2" total collaboration allows sharing through a common language, the Construction Building Information Exchange (COBie) format. Native file formats enable organizations to combine and merge their data, providing an overview of all available information. Whether architects or engineers, each party produces their own digital model using CAD/BIM software such as Revit, introducing two new dimensions: time management and cost analysis.

Meanwhile, "Level 3" illustrates a single model that is accessible and editable in real time. This level is regarded as the ultimate result, containing all the advantages offered by BIM. It represents a future goal of full collaboration among all disciplines. It would be executed through a single 3D digital model of shared projects and complete information integration in a cloud space. All stakeholders working for and on the project could modify and add their information. In real-time, the team could appreciate and verify the effects of individual actions on the model, known as "cloud computing."

BIM development levels.

In a BIM project, three categories of development levels define the degree of sophistication of the BIM database at each phase of the project. The Building Information Modeling Protocol Form of the American Institute of Architects has determined three development levels (East, 2007).

The "level of detail" refers solely to the graphical representation of the family; for example, a family with a low level of detail would be represented by a simple geometric shape, like a cube without specific materials.

The "level of information (LOI)" includes all non-geometric properties of the BIM object. For example, a family with a very high level of information would contain specific manufacturer specifications or maintenance instructions (Figure 2).

The "level of development (LOD)" incorporates the two levels above the geometric level of detail and information (Di Giacomo, 2015).

Figure 2. Level of detail (Source: Bergerault, 2020).

Visualizing different stages integrated into the digital model permits us to instantly condense and grasp the relationship between a project phase and the phases of model development (Figure 3) (Bergerault, 2020).

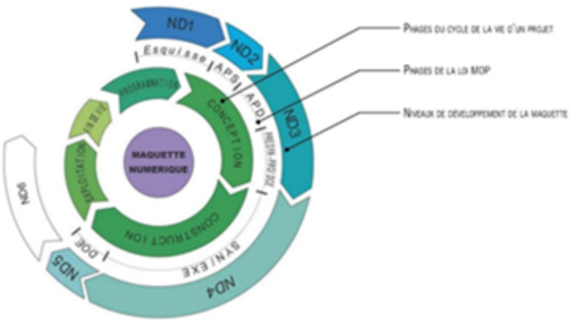

Figure 3. BIM development levels (Source: Bergerault, 2020).

Methodology.

This study investigates challenges related to employing BIM in collaborative project management within architecture. It aims to identify innovative strategies for enhancing efficiency and quality in architectural projects. Employing a mixed-method approach, combining quantitative and qualitative analyses, strengthens the conclusions by validating each other.

This dual-method approach helps compensate for weaknesses, leveraging the strengths of one method to mitigate the limitations of the other. The data collected underwent a meticulous three-step research design, with each phase having its own defined procedure and justification before proceeding to the next. Figure 4 outlines the three-phase procedure crucial to this research (Figure 4).

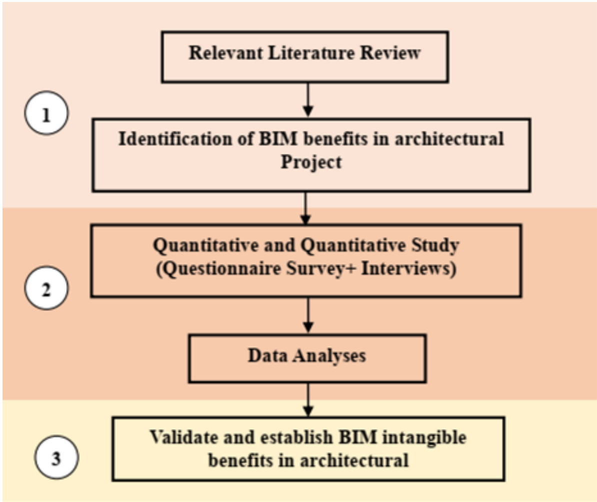

Figure 4. The three-phase of Research (Source: Author, 2023).

Literature review.

Many studies have highlighted that a major challenge of building information modeling (BIM) lies in the lack of awareness of its innovative approach (Kouch et al., 2018). However, by conceptualizing BIM as a collaborative and management process within the context of architectural projects, it proves to be more than just a technique. To fully leverage this methodology, it becomes essential to define and understand it thoroughly. From 2007 to 2019, several relevant articles proposed different perspectives, some focusing on the BIM process, others on associated tools, and yet others on specific BIM objectives (Garyaev, 2018).

These diverse views have led some researchers and professionals to perceive BIM as a collaborative process (Azhar, 2011), and a new management approach (Lachance et al., 2015), going beyond a simple 3D model representation or modeling software (Miettinen & Paavola, 2014). It also manifests as a management tool (Wang et al., 2003), a technology (Olawumi & Chan, 2019), a database for file sharing and communication (Arayici et al., 2012), and a source of innovation (Murphy, 2014). Thus, BIM can be characterized as a set of technologies, processes, and strategies centered around a collaborative 3D model to be shared among stakeholders. This approach aims to optimize the execution of architectural projects by facilitating communication, coordination, and promoting end-to-end efficient management. Correct implementation of BIM opens the door to numerous benefits, such as significant improvements in communication and coordination, time and cost savings, increased productivity and quality, as well as more effective project management (Poirier, 2018).

Quantitative and qualitative analysis.

This research is based on a conceptual principle that examines the challenges and benefits of using Building Information Modeling (BIM) as a collaborative process for managing architectural projects in Mila. This study aims to explore strategies that enhance the efficiency and quality of architectural projects using BIM.

The sampling for this study was conducted by selecting a diverse group of architectural projects that have adopted BIM as a collaborative management process. Projects were chosen to represent various scales, types, and complexities to ensure a holistic representation of BIM applications in projects.

The Tools used for this research included structured questionnaires and semi-structured interviews. The questionnaires were designed to gather quantitative data on perceived effectiveness and resulting improvements through the use of BIM. Interviews were conducted with project experts and professionals involved in managing architectural projects using BIM. The interviews provided in-depth qualitative perspectives on the challenges and benefits of this approach.

Data collection occurred in two stages. Firstly, questionnaires were distributed to project teams working with BIM, gathering quantitative data on efficiency, coordination, and potential cost savings. Subsequently, interviews were conducted with project experts, focusing on their experiences, encountered obstacles, and observed outcomes in their projects.

Descriptive statistical analyses were conducted for the quantitative data collected from the questionnaires. This allowed for the quantification of perceived improvements in different aspects of projects through the implementation of BIM. Regarding qualitative data from interviews, content analysis was used to identify recurring themes related to the challenges and benefits of BIM. Quantitative and qualitative data were triangulated to gain a comprehensive and nuanced understanding of the implications of BIM for managing architectural projects.

This methodology enabled the acquisition of robust quantitative and qualitative data, thereby providing a detailed insight into key aspects related to the use of BIM as a collaborative process for architecture and urban planning project management.

Results and discussion.

The study's findings revealed insightful perspectives on the challenges and benefits associated with adopting Building Information Modeling (BIM) as a collaborative process for managing architectural projects. Quantitative data from the questionnaires highlighted significant improvements in various project aspects through BIM. Project teams reported improved interdisciplinary coordination, reduced design errors, and resource optimization. Cost savings were also emphasized, primarily due to the early detection of conflicts and errors.

Interviews with project experts complemented these quantitative results by providing in-depth qualitative perspectives. Experts confirmed that BIM facilitated smoother stakeholder communication, reducing delays and misunderstandings. However, challenges were also identified, such as the learning curve associated with BIM adoption and initial costs related to training and implementing necessary technologies.

The combination of quantitative and qualitative data highlighted the obtained findings. The perceived benefits of BIM in coordination, efficiency, and cost reduction were supported by the experts' experiences and observations. However, the mentioned obstacles were also validated, emphasizing the significance of adequate preparation and investments to maximize the potential benefits of BIM (Figure 6).

Despite these challenges, it is evident that BIM has a promising role in managing architectural projects. The results of this study demonstrate that integrating BIM strategies can promote the quality, coordination, and overall efficiency of projects. However, it is crucial to consider the costs associated with implementation and the efforts needed to train teams and adapt existing processes.

Improvements resulting from the use of BIM.

Quantitative results from the questionnaires have clearly highlighted substantial improvements by adopting Building Information Modeling (BIM) in managing architectural projects. Interdisciplinary coordination, which was a major concern in previous projects, was significantly improved through the use of BIM. This enhancement has resulted in a crucial reduction in design errors and faster decision-making. Moreover, BIM has demonstrated its ability to identify potential conflicts early on, resulting in better resource allocation and schedule optimization (Figure 5).

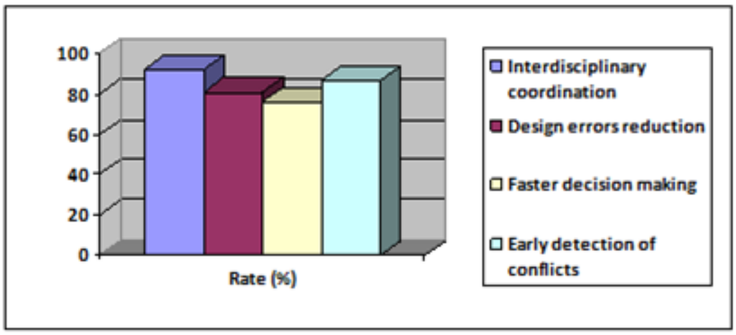

Figure 5. Benefits arising from the use of BIM (Source: Author 2023).

Impact on communication and cost reduction.

In-depth interviews conducted with project experts validated the substantial communication benefits offered by BIM. The virtual platform created a centralized space where stakeholders could exchange real-time information, enhancing team transparency and collaboration. This improvement also led to a notable reduction in errors caused by missing or erroneous information. Moreover, several experts highlighted the positive impact of BIM on costs, attributed to the early detection of issues and inconsistencies that allowed for minimizing costly subsequent modifications.

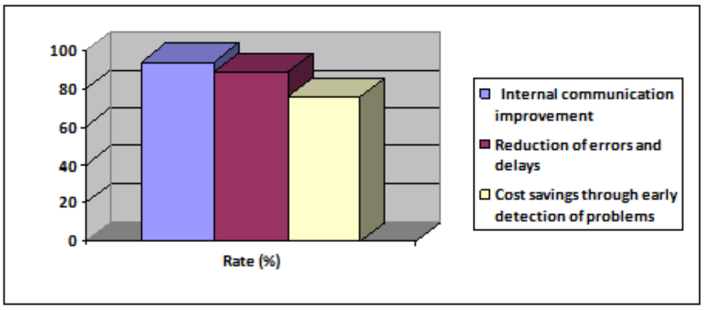

Figure 6. Benefits arising from the use of BIM (Source: Author 2023).

Challenges to overcome in BIM adoption.

However, the results also identified challenges to consider when integrating BIM. Experts unanimously mentioned the learning curve associated with transitioning to this new approach.

Acquiring technical skills and becoming familiar with new technologies can slow down the adoption phase of BIM. Moreover, the initial costs related to training and setting up the required infrastructure were reported as major obstacles to more widespread adoption (Figure 7).

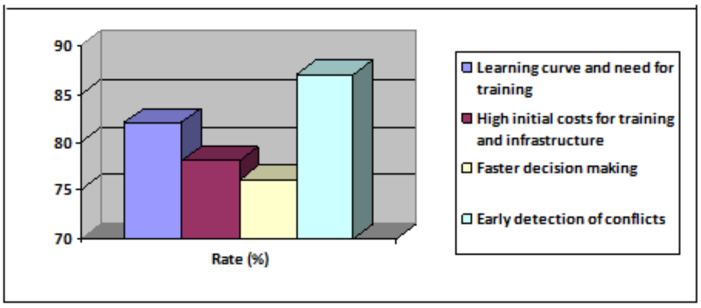

Figure 7. Challenges to overcome in adopting BIM (Source: Author 2023).

Future integration perspectives of BIM in urban management.

Despite these challenges, the results of this study indicate that BIM plays a significant role in the management of architectural projects. The potential benefits of coordination, efficiency, and cost reduction are tangible. However, integration strategies must consider the challenges mentioned. Investing in training and infrastructure is essential to maximizing the benefits of BIM. Interviews also emphasized the need for further awareness among stakeholders and fostering a culture of digital collaboration to ensure the long-term success of this transition (Figure 8).

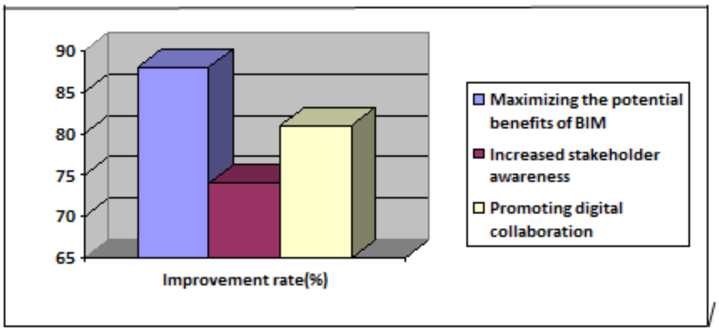

Figure 8. BIM integration perspectives (Source: Author 2023).

Conclusion.

In conclusion, this study thoroughly explored the implications of adopting Building Information Modeling (BIM) as a collaborative process for managing architectural projects. The results obtained through a robust methodology, combining quantitative and qualitative data, highlighted essential aspects of decision-making in the field.

Quantitative data from the questionnaires confirmed the significant advantages of BIM in terms of interdisciplinary coordination, reducing design errors, faster decision-making, and early conflict detection. These improvements had a tangible impact on the efficiency and quality of architectural projects. In-depth interviews with experts highlighted these results by illustrating the added value of improved communication and cost savings achieved through the BIM virtual platform.

However, this study should have noticed the challenges accompanying BIM adoption. The learning curve required for BIM integration and the initial costs related to training and infrastructure setup were clearly identified. These challenges underscore the need for adequate preparation and investment to ensure a successful transition.

The future of BIM in managing architectural projects is promising. The observed benefits, supported by figures and expert opinions, demonstrate that BIM can be a catalyst for improving efficiency, quality, and collaboration in this field. Challenges should not discourage but rather encourage thoughtful integration and adoption strategies.

In summary, this study emphasizes the significance of a balanced approach, considering both the advantages and challenges of BIM, to inform future decisions and actions in managing architectural projects in the digital age. Ultimately, Building Information Modeling (BIM) represents an important advancement in the digital era's collaborative management of architectural projects. Despite initial obstacles, its potential benefits in efficiency, quality, and project sustainability make it a promising approach. Strategies to facilitate adoption and overcome technological and organizational obstacles will be crucial in successfully integrating BIM into the planning and execution of architectural projects.

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