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A Methodology for Assessing BIM Feasibility through Project Execution Planning Metrics

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Abstract

Building Information Modeling (BIM) enhances collaboration, design, visualization, and construction management. However, its feasibility is often assessed using basic metrics, such as square meters or project scope, which overlook financial implications. This paper presents a learning-oriented methodology for assessing BIM feasibility, using BIM Project Execution Planning (BEP) metrics to help students develop a structured approach to financial evaluation in BIM adoption. The methodology integrates the BEP framework into the learning process, guiding students beyond scope-based feasibility assessments to financial output histograms that illustrate cumulative outflows from BEP implementation. Through hands-on learning, students apply financial planning tools, incorporating BEP costs into cash flow projections to analyze BIM's impact on liquidity and investment returns. This experiential approach reinforces critical thinking, encouraging students to justify BEP-driven investments in terms of efficiency and cost savings. Students gain a deeper understanding of BIM's financial viability by engaging in feasibility assessments, moving beyond theoretical concepts to practical application. This methodology bridges the gap between learning and real-world decision-making, preparing future engineers and project managers with essential skills for BIM implementation.

Introduction

In previous years, BIM (building information modeling) research and applications have predominantly been associated with six main areas according to current trends in research databases (see analysis in Appendix 1):

1. Built environmental technology, energy efficiency, and BIM technology (including blockchain, virtual, and augmented reality).
2. Construction management and industrial applications of BIM (including blockchain, geographical information systems (GIS) and facilities management)
3. Structural systems (design and assessment) & structural health monitoring (SHM).
4. Data acquisition, information management, monitoring, and data postprocessing technologies (artificial intelligence included)
5. Sustainability and certification

Building Information Modeling (BIM) significantly enhances design processes and collaboration within the construction industry. By creating detailed, three-dimensional digital models, BIM allows project teams to visualize designs more accurately, reducing the likelihood of errors during construction. This improved visualization fosters better communication among architects, engineers, and contractors, leading to smoother project coordination and integration of design changes in real time (see reference). [1]. Additionally, BIM tools streamline workflows, enabling efficient information sharing across multidisciplinary teams, which is crucial for achieving time and cost savings in complex projects, see [2].

One of BIM's most impactful advantages is its potential for cost reduction and sustainability. By integrating design and construction planning, BIM minimizes material wastage and ensures precise cost estimation, thereby enhancing budget management, see [3]. Furthermore, BIM facilitates resource optimization and energy-efficient planning, reducing operational costs and environmental impacts. These capabilities make BIM a critical tool for achieving financial and environmental objectives in modern construction projects.

BIM has also been linked to increased productivity and enhanced safety in construction projects. By automating repetitive tasks and streamlining the planning process, BIM tools allow project teams to focus on more critical tasks, thus improving overall efficiency, [4]. Safety management is another area where BIM excels, as it enables the identification of potential hazards through advanced simulation and clash detection. These capabilities allow project managers to address risks proactively, thereby reducing on-site accidents. [5]. Moreover, integrating BIM with advanced visualization technologies enhances construction outcomes by improving stakeholder collaboration and decision-making during the design and planning phases.

Despite the numerous benefits of Building Information Modeling (BIM), several challenges hinder its adoption, particularly among small to medium-sized enterprises. These include financial constraints related to software acquisition and training costs, resistance to change within the construction industry, the absence of standardized protocols for BIM and BEP (BIM-Project Execution Planning), limited client demand, and technical challenges (software interoperability & hardware incompatibility). Together, these barriers create significant obstacles to the widespread implementation of BIM, see [6], [7] and [8]. For specific context, obstacles such as the training costs and number of skilled personnel (medium-size projects) can be overcome. In the absence of standardized protocols due to the technical challenge can be dealt with standardized practice for a particular BIM work scope. However, the financial constraints can be fully overcome when the BIM project supports cost reduction in the life cycle process: design, planning, construction, and operation.

This article explores a methodology for evaluating the feasibility of implementing BIM through project execution planning (BEP, BIM-Project execution planning). The proposed metrics were developed with an educational focus, enabling students to apply their knowledge and integrate these metrics into assessing BIM feasibility as part of their learning process.

The feasibility metrics only consider financial metrics, leaving human resource metrics aside. It is established that a student's BIM knowledge is at the project's required LOD (level of development). The metric for assessing BIM using BEP is a financial metric. However, improving BEP in the life cycle could integrate other approaches, as the student proposed: financial optimization, reduction of financial need, etc.

The relevancy of BIM feasibility and knowing how and when it could work for specific projects provide students with the BIM feasibility criteria and work around its application.

Background and Literature Review

In the last decades, it is known that BIM is helpful in:

1. Complex projects, hospitals, airports, and skyscrapers, see [9]
2. Large-scale projects, numerous stakeholders, extensive documentation, and complex schedule, see [4]
3. Design-driven projects need visualization, simulations, and analysis; see [10]
4. Collaborative projects, multidisciplinary teams for an integrative design process, see [11]
5. Life cycle-focused projects, long-term project operation including maintenance goals, where the asset is critical, see [12]
6. Prefabrication/modular constructor, precision, and coordination are needed; see [13]
7. In a regulation-driven environment, BIM compliance is mandated by law or legal process; see [14] [15]

In the literature review in [14], parameters of improvement, and widespread benefits are counted. For the mentioned metrics, see [16]; goes from reduced rework, shortened construction duration, and visualization of underground electrical installation. The top ten most popular benefits are schedule, sequencing coordination, rework, visualization, productivity, project cost, communication, design/engineering, physical conflicts, and labor. Also, [14] Proposed two metrics return metrics:

- RFI’s: Quantity of RFIs (Request of Information) or tool quantity (unit: number)
- Change orders: Costo of change/total cost of the project (unit: percentage)
- Schedule: Actual duration/standard duration (unit: percentage)

and investment metrics:

- A&E costs: BIM cost of 3D-background model creation
- 3D background model creator costs
- Construction cost: BIM contractor costs
- Design + construction costs: BIM design costs + BIM construction costs

The only return and investment metrics applicable before the construction process are the schedule and A&E (Architecture & Engineering) BIM cost (using BEP), respectively. This paper follows these metrics.

In the theoretical phase of feasibility analysis, quantifying time lost due to the RFI (Request for Information) process or similar procedural inefficiencies remains challenging. However, theoretical optimization of the schedule return metric is achievable through advanced planning methodologies such as pull and takt planning. Additionally, the costs associated with Architecture and Engineering (A&E) services can be estimated based on activity durations and labor-hour allocations, enabling the scheduling of A&E labor to serve as a preliminary metric. Optimized schedule returns and A&E labor scheduling form the foundational framework for the BIM feasibility learning metric proposed in this paper.

Proposed methodology

The proposed methodology consists of four basic steps, and it is focused on a learning environment:

1. Students need to be familiar with the BEP framework that will be used, including shaping the part of the company (or entire company) that will be carried out in the BEP scheduling.
2. Students must develop the preliminary deliverables for each BEP framework step.
3. BEP scheduling: assigning time and resources (human resources and materials) to develop the S-Curve (accumulated cost -or expenditure over time).
4. Develop the BEP feasibility metric.

1st step: BIM and BEP familiarization

The Project execution Planning framework used in this paper is proposed by [17]. The previous BEP framework has five steps:

1. Goals: where the value of BIM adoption on the project is defined.
2. Model uses: this step identifies that the modeling is used to achieve the desired goals.
3. Process: Design a process for integrating the model uses along with identified information exchanges.
4. Information exchanges: this step defines the content for each information exchange.
5. Infrastructure: Identify the project infrastructure needed to support the BIM process.

In this framework, the initial stage does not explicitly account for BEP-related tasks contingent on the BIM contractor, including organizational structure, communication workflows, organizational attributes, and professional scopes within the involved companies. Consequently, when the BEP is implemented in the subsequent stage, if applicable, stakeholder considerations are omitted from the modeling of use cases, even when these use cases extend beyond strictly technical applications.

Following an understanding of the steps, processes, and deliverables outlined in the preceding frameworks, the class is organized into groups (up to five students each). Each group is then tasked with integrating the two previously unaddressed components:

I. Contractor Information: This includes detailing the organizational structure (human resources and hierarchical framework responsible for delivering the BIM project), the communication workflow diagram, and the professional attributes of the A&E team involved in the project.

II. Stakeholder and Model Use: For applicable projects, stakeholder analysis becomes essential, and the corresponding model use must be tailored to reflect these considerations.

2nd Step: The preliminary development of BEP

It is necessary to develop the preliminary deliverables of the chosen BEP framework. In this step, it is proposed that the developed deliverables can be improved later. The most relevant task is for students to realize the scope of work, thinking in terms of time and resources (material and human resources). This step could make students return to the first step because each group already shapes the organizational structure. Still, more/fewer resources must be introduced to implement the BEP framework steps. At least the following deliverables need to be partially developed:

1. GOALS
    a. Organization diagram or the structure of the professionals working in the BEP development to the BIM project, as a workgroup diagram
    b. Communication flow diagram
    c. List of organization and professional attributes of human resources
    d. Document the scope and limitation of work into BIM and BEP
    e. Stakeholder analysis and diagram (Power-Interest diagram, Nautic diagram)
    f. Document listing the potential BIM use: stakeholders' potential use
2. MODEL USES
    a. Document narrowing down the potential BIM uses to distill them to Model uses. The model uses may be selected using the BEP framework worksheet to focus on specific model uses for the life cycle process.
    b. Develop the life cycle diagram of the known model used in the BEP framework, including the project's design, planning, construction, and operation. Distilled the model uses that can serve the stakeholders' purposes and construction project scope.
3. PROCESS DESIGN
    a. Create the maps (BIM process and nodes) according to the BEP framework specifications for different levels. The initial workgroup diagram must contain the professional who can carry out the tasks of this map to deliver the tasks, input and output files, and other resources.
4. INFORMATION EXCHANGE
    a. Information exchange worksheet where the maps nodes, resources, input and output files, and scope of work (level of development) are mentioned.
    b. The communication diagram for BEP purposes is aligned with the communication flow diagram.
5. INFRASTRUCTURE: In this part, the scaffolding of the BEP process needs to be established, i.e., a list of key project contacts, collaboration procedures, meeting plan (location, agenda, dynamic, people), quality control process, software and hardware, etc. The BEP framework clearly states what is needed in each step.

3rd Step: Scheduling

The students need to work on the project scheduling stage, where students need to develop the S-curve (accumulated expenditures over time) for the BEP framework application, considering human resources and materials for the given WBS (breakdown structure that possibly is a deliverable-based structure, DBS) aligning with the BEP framework steps and deliverables.

4th Step: the BEP feasibility metric

Completing the previous step gives the students the initial input to develop their feasibility metric based on the economic and financial aspects of applying the BEP framework and BIM to the project. From the S-curve. It is possible to use the following information:

- S-curve shape
- Total budget
- Capital and resource demand in each stage
- Need for financing and starting a budget

Learning objectives and assessment

The methodology proposed in this study is designed to provide students and professionals with a structured approach to assessing the feasibility of Building Information Modeling (BIM) implementation using Project Execution Planning (BEP) metrics. By engaging with this framework, learners will move beyond traditional feasibility assessments based solely on project scope and explore a more comprehensive evaluation that integrates financial planning and execution strategies.

- Understand the BIM Project Execution Planning (BEP) Framework by identifying its key components and their role in evaluating BIM feasibility.
- Develop Preliminary BEP Deliverables, such as organizational diagrams, stakeholder analysis, and communication flow structures, to support project execution planning.
- Apply Scheduling Techniques to BEP Implementation by constructing S-curves and analyzing accumulated expenditures over time.
- Evaluate the Financial Feasibility of BIM Implementation through key financial metrics, including budget allocation, capital demand, and investment timing.
- Integrate Stakeholder and Contractor Information into BEP Planning by incorporating organizational structures, workflows, and professional responsibilities.
- Analyze Project Liquidity and Investment Returns by interpreting financial projections and assessing the timing of BIM-related investments.
- Critically Assess the Cost-Effectiveness of BIM in Project Execution by comparing BEP implementation costs with total project budgets to establish feasibility thresholds.

A structured assessment framework has been developed to effectively evaluate the implementation of the proposed methodology for assessing BIM feasibility through

Project Execution Planning (BEP) metrics. This framework ensures a comprehensive evaluation of student performance by analyzing the methodology's technical and financial aspects.

The assessment metric measures students' understanding and application of the BEP framework, the development of essential deliverables, financial feasibility evaluation, scheduling techniques, and stakeholder integration. Additionally, it considers the ability to analyze project liquidity, assess cost-effectiveness, and present results clearly and professionally.

The evaluation is divided into key criteria, each assigned a specific weight based on its relevance to the methodology. Each criterion is graded on a four-point scale (Excellent, Good, Satisfactory, Needs Improvement) to provide a structured and objective performance assessment.

By using this assessment framework, students gain a clear understanding of the expectations and key learning outcomes, ensuring that their work aligns with the intended educational objectives. This structured evaluation also helps instructors and reviewers assess the depth of analysis, critical thinking, and technical proficiency demonstrated in the feasibility assessment process.

The following table outlines the assessment criteria, weights, and the grading scale used to evaluate student performance when applying the methodology.

Criteria	Weight (%)	Excellent (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
Understanding of the BEP Framework	15%	Demonstrates a deep understanding of BEP components and their role in BIM feasibility assessment.	Shows good comprehension but lacks detail in some aspects.	Basic understanding with some misconceptions.	Limited or incorrect understanding of BEP concepts.
Development of BEP Deliverables	20%	All deliverables (organizational diagrams, stakeholder analysis, communication flow, etc.) are well-structured and complete.	Most deliverables are well-prepared with minor omissions.	Some key deliverables are missing or incomplete.	Deliverables are poorly structured or lack necessary details.
Application of Scheduling Techniques	15%	S-curves and expenditure analyses are correctly developed, demonstrating straightforward project scheduling.	S-curves are well-prepared, but some scheduling elements need refinement.	Scheduling is present but lacks precise financial alignment.	Scheduling is incomplete or does not follow BEP framework steps.
Financial Feasibility Evaluation	15%	Budget analysis, capital demand, and financial metrics are correctly applied to assess BIM feasibility.	Financial evaluation is accurate primarily but lacks depth in some aspects.	Some financial aspects are considered, but the analysis is superficial.	Financial evaluation is incorrect, incomplete, or missing.
Critical Assessment of Cost-Effectiveness	10%	BEP implementation costs are accurately compared with total budgets, leading to well-supported feasibility conclusions.	Feasibility is evaluated well, but cost-benefit analysis could be more substantial.	Cost-effectiveness is discussed but lacks quantitative support.	No precise cost-effectiveness analysis is provided.

Presentation and Justification of Results	5%	Results are presented, logically structured, and well-justified.	Results are well-presented but could be more evident in some areas.	Some results are justified, but explanations are weak.	Results are poorly presented, with little justification.
Overall Clarity and Professionalism	5%	Work is well-organized, professional, and free of significant errors.	Mostly well-structured with minor issues.	Some disorganization and errors affect readability.	Lacks clarity and organization, with multiple errors.

Educational Application and Implementation

To implement the methodology for learning purposes in the prior construction stage, the groups of students receive a challenge-based project. The narrative of the challenge starts as follows:

"...You are in a scenario where your company has an established core business. This company has a half million USD fund to invest in building an office building to produce that technological product and provide space for its development. Regarding the construction of the office building needed to develop the technological product, for this construction project, you must consider BEP and BIM to address sustainability aspects."

The challenge provides a basic office building layout (see Figure 1) to be built as a masonry structure. The BIM project will be limited to the construction project's C&S (core and shell) part. The estimated construction project amount (only C&S) is 150k USD.

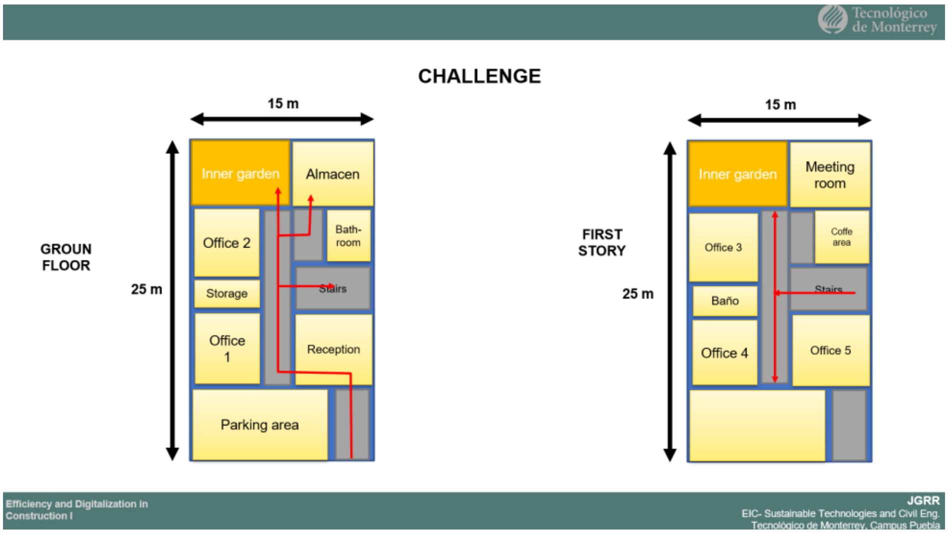

Figure 1. The initial layout of the challenge's office building

While the project does not have large dimensions in terms of square meters to determine the economic feasibility of BEP, it is an adequate challenge for the given course time. Each group provides the information mentioned in the methodology and publicly presents (see Figure 2) the project for assessment, providing its metric for BEP according to their work.

Figure 2. Public presentation of the BIM project

Developed metrics by students

All three student groups obtained the S-curve from implementing BEP (see Figure 3). In figure 3, the S-curves of Group 1 (blue curve), group 2 (orange curve), and Group 3 (green curve) are shown. The dash lines are linear tendency lines for each S-curve. The S-curves were not similar due to differences in the projected C&S project.

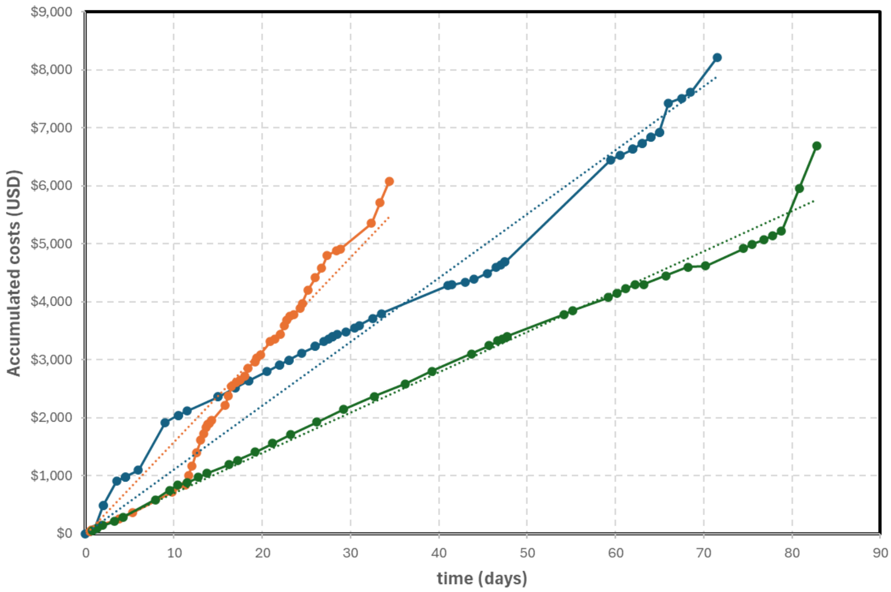

Figure 3. S-curve from the three students' groups.

The total cost of BEP scheduling was calculated as USD 8,204.76 (blue curve, Figure 3), USD 6,076.39 (orange curve, Figure 3), and USD 6,685.92 (green curve, Figure 3). The corresponding resource hours invested were 676.0, 167.5, and 109.68 hours for Groups 1, 2, and 3, resulting in hourly costs of USD 12.14, 31.66, and 60.95. These variations arose due to differences in the workgroup structures outlined in the organizational diagrams provided at the project's initiation.

The findings from this study highlight significant variations in BEP implementation costs and scheduling projections among student groups. The S-curves generated (Figure 3) demonstrate distinct financial trajectories, with total BEP scheduling costs ranging from USD 6,076.39 to USD 8,204.76. These variations are attributed to workgroup structure differences, resource allocation, and project assumptions. Furthermore, the feasibility metric outcomes suggest that BEP implementation costs constitute approximately 0.1% to 0.5% of total project budgets, establishing a threshold for economic viability. These findings reinforce the importance of financial assessment in BIM feasibility studies and demonstrate how project-specific conditions influence BEP implementation.

Discussion

While the metrics employed are straightforward, the BEP-scheduling process equips students with the foundational criteria for integrating BEP into construction projects. A key aspect of the exercise involved analyzing the proportional cost of BEP relative to the overall project budget. Reviewing formal and informal documentation, students determined that BEP implementation costs typically range between 0.1% and 0.5% of the total project cost. Using this range, it was calculated that for a BEP/BIM implementation cost of 0.1%, the total construction cost would need to reach USD 820,476 , 668,592 , and 668,592 for various scenarios. These findings indicate that BEP implementation would not be economically viable for projects with total construction costs below these thresholds, emphasizing the need to consider project scale in the feasibility of BEP adoption.

The results align with previous research on BIM cost-effectiveness, such as [14] and [12] Emphasize that BIM feasibility is highly dependent on project scale and financial structuring. However, this study extends prior research by introducing an educational framework that enables students to assess BIM feasibility through dynamic financial projections rather than static cost-benefit ratios. Unlike previous studies on project scope, this methodology integrates investment timing and liquidity considerations, providing a novel perspective on BIM financial feasibility. Furthermore, the findings suggest that while BEP implementation costs are relatively low, their economic viability is contingent on project budget thresholds, reinforcing the need for financial risk assessments in BIM adoption strategies.

Conclusions

The proposed methodology provides a straightforward exercise for assessing the feasibility of implementing BIM through Project Execution Planning (BEP) metrics, emphasizing its educational value and applicability. The study bridges theoretical learning with practical application by engaging students in realistic, challenge-based scenarios, enabling participants to evaluate BIM feasibility beyond traditional metrics like project scale or square footage. The results demonstrate that BIM feasibility is closely tied to project size, with projects below a threshold of approximately USD 820,476 often facing economic challenges for BEP implementation. Despite this limitation, the methodology showcases versatility, as evidenced by the varied outputs from student groups, reflecting differences in organizational and project structures. Through economic metrics such as S-curves, resource allocations, and capital demand, students gain critical insights into project liquidity and the timing of financial investments. Additionally, incorporating stakeholder analysis and contractor information into the BEP framework highlights the importance of aligning BIM processes with broader project goals and collaboration dynamics. By focusing on scalability and adaptability, the methodology underscores its potential for small to medium-sized projects and offers a pathway for future research into cost-effective BIM adoption strategies. Overall, this work effectively equips future professionals with the tools and knowledge to make informed decisions about BIM implementation in diverse construction contexts.

Study limitations and future research

While this study presents a novel approach to assessing BIM feasibility, several limitations should be acknowledged. First, the methodology was applied in an educational setting with student groups, which may not fully replicate real-world industry constraints such as contractual obligations, market fluctuations, or stakeholder resistance to BIM adoption. Second, the feasibility metrics focused solely on financial considerations, excluding other critical factors such as technical complexity, regulatory compliance, or long-term operational benefits. Third, the sample size was limited to three student groups, and further studies with larger sample sizes and diverse project types are needed to validate the findings.

Future research should explore integrating additional feasibility factors, such as environmental impact assessments, digital twin applications, and lifecycle cost optimization. Expanding the methodology to industry case studies could provide deeper insights into how different project stakeholders perceive and implement BEP-driven BIM feasibility assessments. By addressing these limitations, future studies can refine and expand the applicability of this approach, ensuring a more holistic understanding of BIM feasibility across various construction contexts.

Acknowledgment

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Appendix 1 – BIM current trends in research

The current trends in research given by the two research engines are graphically explained and analyzed in the appendix section. two research search engines were used: 1) WOS-web of Science (Clarivate) and 2) SCD - Scopus database. The search string contains two keyword groups: BIM-related and feasibility-related semantic keywords. The keywords used in each group are the following:

Table A.1.1 – Search keywords groups

G1: BIM-related keywords**	G2: Feasibility-related semantic keywords*
BIM, building information modeling, visualization, coordination digitalization, integration, automation, simulation, collaboration, interoperability, Modeling, modeling	Feasibility. Viability, suitability, evaluation, criteria, analysis, decision, optimization, metrics

** The BIM acronym was jointly searched with the other keywords in the group. * Feasibility, viability, and suitability keywords were jointly searched for with the other keywords in the group.

The search in the two search engines provided 628 results in WOS (web of Science) and 980 in SCD (Scopus database). The difference in number refers to sources of information of the search engines. The RIS-bibliography file was downloaded and post-processed from both search engines. Later, the RIS files were used to create a cluster graph using Vosviewer software of repeated counts of words in the complete RIS-reference files.

Figure A.1.1 shows two images produced by the VOS viewer of the RIS file from WOS. Figure A.1.1.a shows the clusters around BIM research. The found clusters were:

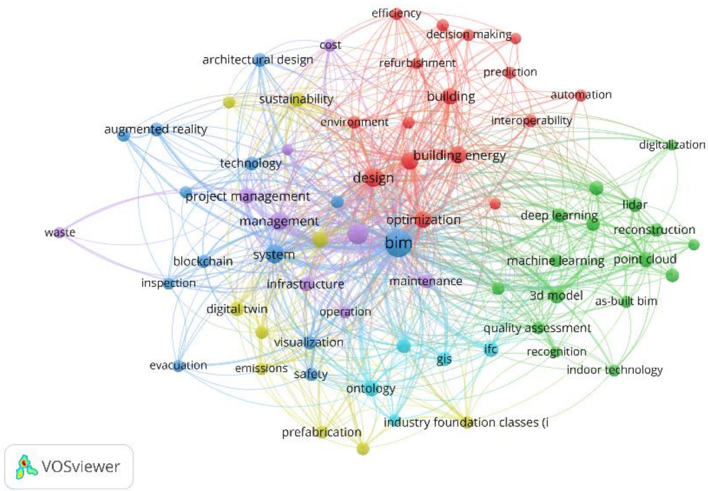
- (red) Built environment technology, energy efficiency, and indoor tech.
- (blue) Model-based technology using BIM model: VR and AR, virtual and augmented reality, blockchain, risk & safety
- (green) Data acquisition and data postprocessing (AI included) topics
- (light blue) GIS and facility management
- (yellow) Industrial applications
- (purple) Construction management

Some aspects to highlight of Figure A.1.1.a are that AI technology is more related to (perhaps more useful) the photogrammetry, monitoring, and lidar (green cluster) side and not from the model-based technology (blue cluster). The red cluster (built environment and light blue cluster) has purple as an interface. When the overlay cluster image in Figure A.1.1.b is analyzed, the relevant keywords (and research) in the last years are related to:

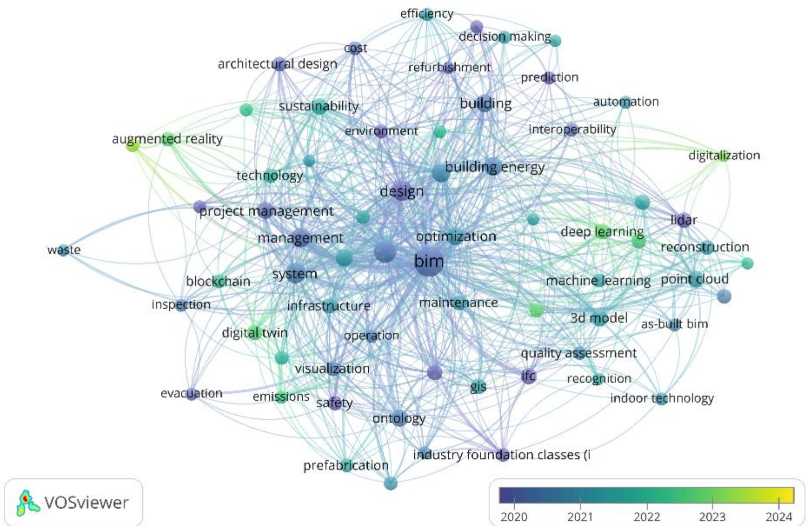
- (blue) VR and AR
- (green) deep learning, scan-to-BIM, digitalization and parametric design
- (yellow) digital twin

Figure A.1.2 shows the clusters around BIM research using Scopus database results (SCD). The found clusters were 10 with a constitution different from the WOS cluster. The cluster shows peripheric nodes, intermediate nodes, and central nodes. The relevant clusters are:

- (red) Built environment technology, energy efficiency, and indoor tech.
- (green & brown) Construction management
- (blue) Data acquisition, information management, and data postprocessing (AI included)
- (light blue) Sustainability
- (yellow) Industrial applications
- (purple & pink) Structural systems, Structural health monitoring & structural design
- (orange) Monitoring systems



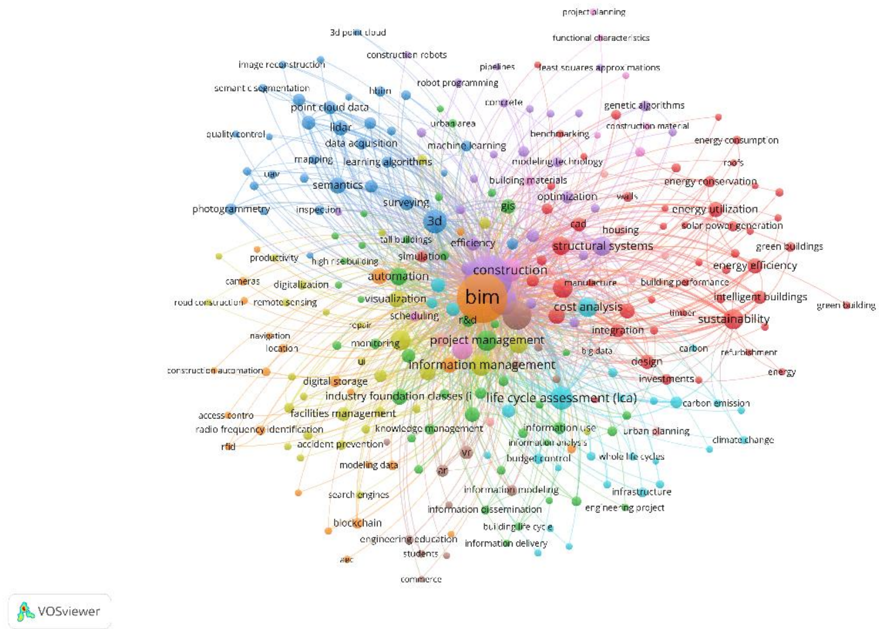
(a)



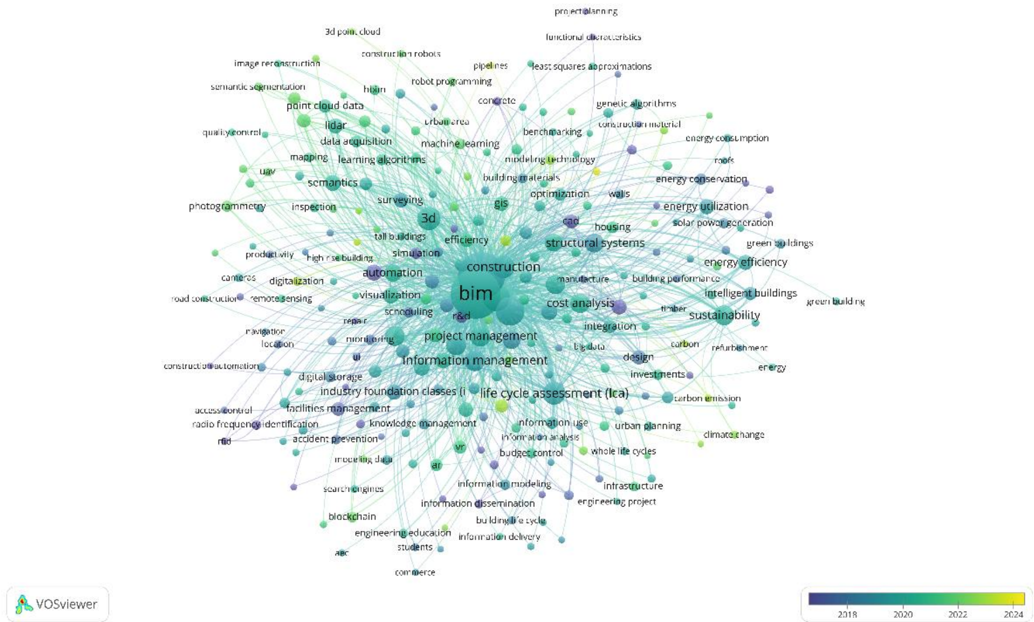
(b)

Figure A.1.1 – (a) Image obtained from cluster analysis in vosviewer using WOS search results. (b) Overlay map from cluster analysis in Vosviewer using WOS search results.

Almost the same cluster appeared for WOS and SCD results. Some aspects that can be highlighted in Figure A.1.2.a are: i) The Sustainability cluster (light blue) is on the other side of (taking the center of the BIM core node) scanning and data acquisition technologies, showing that sustainability topics need to be closer to the physical inventory technology, like 3D scanning and ii) In the same way, topics of clusters purple and pink have a certain distance of topics related to sustainability.



(a)



(b)

Figure A.1.2 – (a) Image obtained from cluster analysis in Vosviewer using Scopus database search results. (b) Overlay map from cluster analysis in Vosviewer using Scopus database search results.

The overlay cluster image in Figure A.1.2.b shows relevant keywords (and research) in the last years:

- (blue) deep learning, photogrammetry, semantic segmentation, UAV, machine learning,

- (orange) blockchain
- (light blue) digital twin, climate change, carbon emissions
- (purple) genetic algorithms, generative design