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Research Article

Challenges of BIM Implementation in a Local Built Environment: A Multi-Stakeholder Case Analysis in Poznan, Poland

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Abstract

Building Information Modeling (BIM) offers transformative life-cycle benefits, such as improving multi-disciplinary coordination and data-driven decision making. It is evident that the status of local BIM implementation is fragmented and formalized national framework is absent. This study investigates the different barriers the Architecture, Engineering, and Construction (AEC) companies faces within the local BIM ecosystem specifically to Poznan city. The research applies a qualitative multi-case research design, by considering four target organizations: level-1 contractor, a cloud-based solution provider, a specialized precast SME, and a design-build general contractor. 20 semi-structured interviews carried out to strengthen empirical data analysis with diverse industry stakeholders, integrated with review of internal company documents (including BIM Execution Plan (BEP) and change logs) and on-site observations complimented with triangulation mechanism to ensure data validity. Systematic thematic coding distilled twenty distinct operational challenges into six socio-technical themes: uneven foundational skillset, inconsistent life-cycle utilization, technical and infrastructure limitations, lack of strategic management support, poor organizational workflow, and inadequate training practices. The empirical findings explicitly show that there is a considerable challenge regarding software interoperability and achieving the ISO 19650 standard with a complete omission of information manager appointment in some cases. The study concludes by emphasizing the importance of process thinking. Successful digital transformation does not happen overnight, instead it requires institutional shift circulating robust information governance, standardized BIM Execution Plans, and legally binding data protocols. These findings will help in the development of strategic framework for institutional leaders, policy-makers, and academic personals in mid-sized and developing European construction hubs.

Keywords

AEC Industry, BIM Adoption, Implementation Barriers, Digital Transformation, ISO 19650, Case Study, Poland, Poznan

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1. Introduction

Building Information Modeling has become a transformative and modern tool in the Architecture, Engineering, and Construction (AEC) industry. The technology offers a multi-versatile geometric configuration, spatial relationships, and well-organized asset data information which are absent from 2D-oriented drawings [1]. This helps project stakeholders to visualize and simulate projects from concept to construction logistics, into predictive and maintenance stages [2]. By establishing a common data environment (CDE), BIM facilitates the cross-disciplinary interaction between Architectural, Structural, and MEP disciplines. As a result, this cross-functional collaboration reduces clashes, control procurement costs, reduce material wastage, and enhance resource allocation [3].

The realization of macro-level BIM maturity varies through different economic and institutional spheres. Developed nations have been successful in implementing the technology [14]. for instance, United Kingdom has mandated Level-2 BIM adoption in major public projects. Additionally, Germany and Nordic region countries also introduced a pioneer infrastructure deployment framework [15]. However, there are still emerging European construction markets characterized by fragmented workflow and bottom-up adoption paths. In a construction environment where it is largely populated by small and medium enterprises (SMEs), digital transformation is seen as surplus to requirements. This is mainly due to the fear of high initial investment cost, expensive software licensing cost, and lack of structured skill upgrade mechanisms [16]. This long standing industry gap further aggravated by a constant gap in local higher education curriculum, which often fail to align industry demand with academic curricula. This consequently pose a problem in data governance protocols, isolated design procedures, model fragmentation, and high request for information (RFIs) during the construction phase.

Despite the well-documented benefits of BIM, its implementation remains uneven in different regional and localized market. This may result from unclear procurement strategies, fragmented implementation plans, and resistance from staff. This study aims to provide a comprehensive empirical insight into the localized BIM implementation barriers across Poznan, Poland – a major construction and infrastructure development hub in central Europe struggling to achieve macro-BIM maturity [1, 3]. By using in-depth case analysis of selected organizations, this research strives to show the critical blockages ranging from technical limitations to organizational and institutional challenges. By establishing empirical guidelines, this study provides a clear strategic insight for institutional leaders, policy-makers, and academic bodies aiming to accelerate BIM implementation [4].

This study aims to offer actionable, strategic insights for institutional leaders, policy-makers, and academic entities aiming to accelerate digital adoption. Ultimately, this paper strives to bridge a major existing gap in contextual realities of regional built environment, to improve software interoperability and international standard compliance.

2. Literature Review

2.1. Sustained Lifecycle Benefits of BIM

In the modern construction acronym, BIM is viewed not only as a standalone software application, instead it is treated as a collaborative working environment covering environmental, economic, and social dimensions [5]. Environmentally, BIM facilitates efficient energy simulation, enhancing material utilization, and structural optimization which directly contributes to lean construction and sustainable practices [6]. Economically, the realization of design clashes well in advance before actual construction proceeds, will consequently reduce rework and promotes cost savings [7]. Socially, the versatile coordination platform on which BIM provides contribute to integrated project delivery (IPD), organized stakeholder alignment, minimize unforeseen contractual disputes, and maintains proactive multidimensional project communication [8].

2.2. Macro and Micro Realities of Regional BIM Uptake

Globally, BIM implementation takes a swing, for instance, the United Kingdom has mandated to implement BIM Level 2 compliance for all public infrastructure projects in 2016 [9]. Similarly, Germany introduced Federal implementation guidelines targeting public transport infrastructure by late 2020, following a long-standing implementation mandates across Nordic nations like Norway and Finland [10].

In contrast, the Polish construction market is characterized by a sluggish, and bottom-up growth, where every stakeholder in the project operates in a fragmented manner compared to previously mentioned nations, the market lacks rigid national guidelines, the local BIM adoption is championed by private real-estate developers and investors [2]. The vast majority of polish construction market is composed of small-to-medium enterprises (SMEs) that operates separately using traditional 2D CAD layouts [3]. These enterprises face a major financial bottle-neck regarding software licensing, advanced workstation, hardware acquisitions, and dedicated professional upskilling. Furthermore, local higher education institutions (HEIs) have recently incorporated BIM education into their curriculum which further fuels to the existing implementation challenge [9].

3. Materials and Methods

3.1. Research Design

To capture the contextual complexities of digital tool execution, this study employed a qualitative multi-case research design. Qualitative inquiry is used to analytically investigate human perceptions, behavioral patterns, and institutional barriers that cannot be addressed by quantitative metrics. Primary data collected using a semi-structured interview based upon four investigative pillars: operational software utilization, institutional readiness to apply digital tools, workflow interoperability, and recognized transition points. All session recordings were verbally transcribed, Authorized using field observation checklists and analyzed via thematic coding.

3.2. Case Selection and Local Ecosystem Profile

The Municipality of Poznan was selected as the geographic focus as it offers high-velocity mid-sized European built environment. By mid – 2021, Poznan's commercial office market surpasses over 618,000 m^2, and with an approximate of 75,000 m^2 active construction workflow, fueled with fast infrastructure expansion backed by foreign direct investment (FDI), and dense regional student talent pool. Four case-study organizations were selected via purposive sampling. To ensure data objectivity and multi-dimensional perspective, three localized contracting and design companies along with a prominent engineering software developer, enhancing efficient and friendly user interface platforms. The operational attributes of these case-companies are presented in Table 1.

Table 1. *Contextual profiles of selected case study organizations.*

Company Code	BIM Involvement Profile	Scale & Market Role	Data & Stakeholder Access
Mostostal Warszawa	Organized R&D BIM unit, OpenBIM framework [4].	Large Contractor	High, unrestricted access to project design teams, models, and archives
Dalux	Provides detailed cloud solutions (field, Box, CDE environments)	Medium Technology Provider	High, access to software utilization trends and core developer insights
Precast Sp. Z.o.o	Model-driven detailing using Tekla structures and structural IFC models	Specialized Precast SME	Medium, direct access to engineering models.
Jakon	Design-build general contracting localized BIM data optimization.	Regional medium Contractor	Direct access for construction managers

3.3. Data Analysis and Thematic Coding

The data analysis workflow followed a clear structure, which uses categorical thematic coding to differentiate empirical inputs into clear theoretical classifications. First, Open coding was applied to raw interview transcripts to filter repetitive statements and operational voids. Second, axial coding used for initial tags and defined conceptual relationships. Third, selective coding used to clearly group structural themes. Saturation limit and point were carefully checked; after carrying out a systematic 20 interviews no novel and new input were found which leads to the comprehensive reliability of research conclusions.

3.4. Respondents' Profile

To validate the data obtained from professional life-cycle, the research body cross-examined 20 distinct industry practitioners. The group was composed of various professional roles, higher educational backgrounds, and the industry experience they envisage. The summary of demographic panel is structured in Table 2.

Table 2. *Demographic profile of research interview participants (n=20).*

Professional Role	Participant Count (n)	Highest Attained Education	Active Industry Experience
Architect	3	Bachelor's Degree	< 5 Years
BIM Engineer	5	Master's Degree	5 - 10 Years
Senior Engineer	3	Master's Degree	> 10 Years
BIM Coordinator	5	Bachelor's Degree	> 10 Years
BIM Manager	4	Master's Degree	> 10 Years
Total Cohort	20	-	-

4. Results

4.1. Core Themes Distilled from Participant Transcripts

The systematic structural coding of the primary transcripts highlighted twenty distinct operational barriers, grouped into six individual socio-technical themes. Figure 1 depicts the mathematical frequency as well as distribution profiles across the four case-study environments.

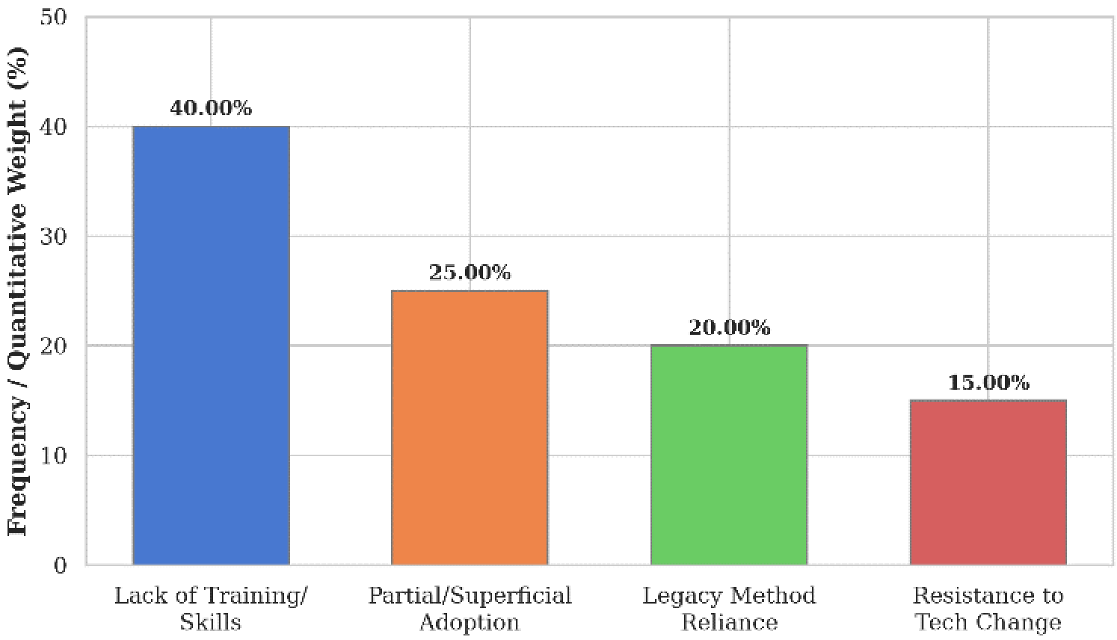

Figure 1. *Operational distribution and quantitative weight of core BIM adoption barriers across the case firms.*

Theme 1: Uneven skill Distribution: emerged as the most critical factor cited in 40% analytical coding participants highlighting that although basic 3D geometry configuration is evident a common understanding of information management in a BIM model is still common. A senior BIM coordinator from Mostostal Warszawa explicitly mentioned "although most practitioners know the basics of software functioning, however there is still a gap in feeding the model with a structured and coordinated data. An Architect from Jakon highlighted "the lack of a structured, and continuous training and development on BIM workflow has stalled the cross – departmental implementation of the technology.

Theme 2: Technical and Infrastructure Limitations: causes major operational obstacles, Level – 1 organizations such as Mostostal Warszawa possess modern server to operate the technology at a full efficiency. However, there is a difficulty in software upgrading and compatibility. A BIM Engineer from Mostostal Warszawa noted "we still lack up-to-date network licenses to facilitate the design tasks" in smaller firms, such as Jakon and Precast sp z.o.o, hardware shortage still possesses sudden model crackdown. Furthermore, technology service providers like Dalux, highlights multi-disciplinary data interoperability problems causing a huge gap in Real-time cloud coordination.

4.2. Verification of Corporate Document Content Analysis

The secondary analysis of project archives, BIM Execution Plans (BEPs), and change logs provided clear perspective on interview findings. The analysis of data management protocols expediting the transition from design to active execution exposed a significant gap in operation. Table 3 summarizes the data-management and multi-disciplinary gaps observed between the 2021 planning phases and active 2022 implementation cycles.

***Table 3**. Longitude mapping of data management and design coordination challenges (2021–2022).*

Analysis Dimension	2021 (Planned Target Stage)	2022 (Active Operational Stage)	Systemic Operational Implications
Subcontractor Practices	Anticipated data alignment with unified corporate BIM workflows.	Subcontractors deployed isolated, completely heterogeneous software tools.	Severe model fragmentation; extensive losses in geometric and metadata consistency.
Model Coordination	Singular, cloud-hosted environment (Single-Source-of-Truth Model).	Proliferation of disconnected, non-synchronized design variants.	Exaggerated coordination hours; elevated risk of unmitigated on-site physical clashes.
Governance & Control	Centralized, top-down digital transition strategy framework.	Negligible technical control over external subcontractor software configurations.	Confirms the critical necessity for standardized, legally binding information protocols.

4.3. Comparative Alignment with ISO 19650 Compliance Requirements

To analyze the structural maturity, company's workflow was subjected to evaluation against international standards such as ISO 19650. In this comparative framework contracting companies (Mostostal Warszawa, Jakon, Precast) are evaluated based on process ownership, whereas Dalux is assessed based on process facilitation. Table 4 outlines the structural compliance evaluation.

***Table 4**. Cross-case compliance mapping against foundational ISO 19650 standards.*

ISO 19650 Clause Focus	Mostostal Warszawa	Dalux (Platform Facilitator)	Jakon	Precast Sp. z o.o.
5.1: Project Information Requirements	Fully defined corporate information requirements.	Partially defined within project-specific BEPs.	Entirely unaddressed within standard workflows.	Fully defined; systematically mapped to COBie standards.
5.2: Information Manager Appointment	No formal professional appointment executed.	No internal professional appointment executed.	Complete lack of structured informational management roles.	No formal professional appointment executed.
5.3: Pre/Post Contract BEP Execution	BEP present; demonstrates weak pre/post contract clarity.	BEP framework available for project teams.	Complete absence of formal BEP documentation.	Formal BEP consistently present across design phases.
5.4: Common Data Environment (CDE)	Fully operational, robust cloud-based CDE utilized.	Formal corporate CDE solutions deployed.	Basic, fragmented cloud CDE environment utilized.	Formal, standardized CDE protocols enforced.
5.5: Quality Assurance of Deliverables	Formally integrated into policy; demonstrates weak design-stage execution.	Partial definition and validation protocols supported.	Complete absence of structured QA/QC protocols.	Rigid quality assurance protocols closely aligned with IFC schema.

5. Discussion

The empirical findings suggested that BIM adoption across Poznan's construction environment remains disintegrated, reflecting the macro-level socio-technical capacities described under Theme 1 which elaborates the idea mentioned earlier on Macro-BIM maturity framework by [11]. the Market is mainly characterized by a 3D parametric shape creation with an overall, data – rich information management. As a result, as most designs look complex on paper and structural validation shortage adds more process overlays for contractors, quantity surveyors, and facility managers.

Furthermore, the multi-dimensional analysis of ISO 19650 compliance (Table 4) clearly shows the major absence of appointed information manager (clause 5.2). without this coordination platform multi-disciplinary tasks will be lost and data credibility will be poor. This lack of information management gap necessitates the operational realities mapped in Table 3. This structural failure in information creation and delivery will create excessive RFIs during construction [3, 11]. To alleviate this information management chaos regional companies should move beyond software dependency, however to make full transition into complete BIM maturity will require a major strategic pivot, supported by legally binding information protocols. Therefore, there should be organized QA/QC protocol and structured industry-academia collaboration to bridge the gap [12, 13].

6. Conclusions

The research explored the main barriers for effective BIM implementation in the rapidly and expanding built environment such as Poznan, Poland. By involving a multi-stakeholder analysis of three engineering firms and one core technology provider: the study identified six socio-technical hurdles: Uneven foundational skillset, inconsistent life-cycle software utilization, deep-rooted infrastructure limitations, less leadership commitment, fragmented organizational workflow, and inadequate change management practices. Although financial resource constraints are common among Tier-1 contractors and specialized SMEs, all case-study firms face major vulnerability regarding data interoperability and strict adherence to ISO 19650 standards.

The empirical evidence has shown that successful digital transformation cannot happen at one night by depending on software proficiency. Instead, it requires a coordinated and cultural shift characterized by modest information governance, standardized BEP execution, and organized information management roles. Although these findings are predominantly applicable to Poznan, however it can also be exercised in mid-sized, developing European construction hubs. Future research directions should focus on the development of a highly localized, cost-effective macro-upskilling pathways and the legislative standardization of public procurement frameworks.

Abbreviations

AEC	Architecture, Engineering, and Construction
BEP	BIM Execution Plan
CAD	Computer-Aided Design
CDE	Common Data Environment
COBie	Construction Operations Building Information Exchange
IFC	Industry Foundation Classes
IPD	Integrated Project Delivery
ISO	International Organization for Standardization
MEP	Mechanical, Electrical, and Plumbing
RFI	Request for Information
SME	Small and Medium-sized Enterprise

Author Contributions

Abel Zenebe Negash: Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Software, writing – original draft, Writing – review & editing

Data Availability Statement

The data supporting the quantitative and thematic outcomes of this research work have been reported within this manuscript. De-identified interview transcripts and thematic coding matrices are available from the corresponding author upon reasonable request.

Conflicts of Interest

The author declares no conflicts of interest.

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