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PERCEIVED BENEFITS OF 5D BIM IN CONSTRUCTION COST MANAGEMENT: A EUROPE-WIDE SURVEY

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Abstract

Examining contextual factors shaping the success of 5D BIM implementation in Europe, results reveal that while 91.5% utilize the technology for QTO and deep adoption remains limited, satisfaction increases significantly when a critical value threshold is exceeded, moving from single-use tasks to integrated workflows. Contractors are less satisfied by 5D BIM due to commercial risk, while medium-sized organizations and moderately complex projects exhibit a transition trap, resulting in lower satisfaction. Conversely, high national BIM maturity and Integrated Project Delivery amplify success. 5D BIM provides optimal value only when implemented as a comprehensive system, not merely as a standalone tool.

Introduction

The construction industry, despite its massive contribution to the global economy, has long been recognized as one of the least digitized sectors, characterized by stagnant productivity and a slow pace of technological adoption (Agarwal et al., 2016; Naji et al., 2024). However, the sector is currently undergoing a significant shift towards digital transformation to overcome these historic inefficiencies and modernize project lifecycles (Naji et al., 2024). Building Information Modeling (BIM), specifically its fifth dimension (5D BIM), offers a paradigm shift by integrating cost-related data with 3D models to improve efficiency, accuracy, and decision-making. The uses (features or functionalities) of 5D BIM include automated quantity takeoffs, cost estimation linked to model, cost planning and forecasting, change management, value engineering, cash flow analysis, cost control, progress payment validation, lifecycle cost analysis and claims management, delivering substantial advancements over traditional methods (Aibinu and Venkatesh, 2014; Charef et al., 2018; Kehily and Underwood, 2017; Lu et al., 2016; Stanley and Thurnell, 2014; Vigneault et al., 2020).

Despite these capabilities, the industry's perceptions of 5D BIM are divided. Enthusiasts praise it as a revolutionary tool that simplifies cost management, increases accuracy, and promotes collaboration, while skeptics argue that traditional tools are sufficient for similar tasks without the need for a BIM model, claiming that 5D BIM is overhyped. This divide highlights the need for robust empirical evidence to validate the benefits of 5D BIM and clarify its value proposition.

Existing research on 5D BIM has largely focused on technical case studies addressing the practical benefits of 5D BIM or developing frameworks and tools to support its adoption, with little research on which contextual factors shape practical outcomes. A critical gap persists in the literature: empirical studies investigating how specific factors influence the benefits of 5D BIM are scarce.

The motivation for this study stems from the lack of comprehensive research examining how project characteristics, user profiles, and features used affect the perceived success of 5D BIM in various construction projects. By addressing this gap, the study aims to provide actionable insights to optimize 5D BIM implementation. Through a survey of European construction professionals, it aims to provide evidence-based recommendations for developing 5D BIM adoption strategies.

Methodology

Data collection

A questionnaire survey was designed to collect data on respondent information, project characteristics, 5D BIM implementation, and perceived benefits of 5D BIM in construction projects. The survey targeted construction professionals with experience in projects where BIM was utilized in cost management processes across the European regions as defined by the Publications Office of the European Union (2026), excluding Russia and the Caucasus countries. This geographical scope was selected due to the widespread adoption of 5D BIM within the region and the researcher's ability to leverage an established professional network, which facilitated access to relevant and high-quality contacts.

The survey was structured into four sections. The first section, "Respondent Information", gathered demographic and professional data. Respondents were asked to specify their age, gender, total years of experience in the construction industry, BIM and 5D BIM, their current role/title and stakeholder category (e.g., client/owner, contractor, designer, consultant) with respect to both their current position and the reference project.

The second section, "Project Characteristics", collected specific details regarding the reference project. Respondents were asked to identify the project type (commercial, residential, metro, etc.), budget, duration, location, delivery method (design-bid-build, design-build, IPD, etc.), contract type (lump-sum, unit price, etc.), project's complexity, BIM maturity level of the project country, and the BIM expertise level of the project team.

The third section, ”5D BIM Implementation”, examined the practical application and workflow of BIM in cost management processes. Respondents were asked to describe their workflow processes through an open-ended question, and to select the 5D BIM uses employed in the reference project and the software tools utilized for implementation.

The final section, ”Benefits of 5D BIM in Cost Management”, assessed the extent to which respondents agreed that 12 different expected benefits were observed in their reference projects using a 5-point Likert scale (ranging from 1-Strongly Disagree to 5-Strongly Agree). Respondents were asked to select ”Not Relevant” if a specific outcome was not a targeted project goal. Additionally, an open-ended question was included to invite participants to share specific examples or anecdotes, adding qualitative depth to the analysis.

The survey was hosted on Google Forms, with settings configured to collect email addresses to ensure non-anonymous responses, allowing verification of respondents' identities and relevance.

A targeted survey was conducted with construction professionals experienced in 5D BIM within Europe. A multi-channel sampling approach, primarily utilizing targeted LinkedIn searches (e.g., ”5D BIM cost”) and professional referrals, built an initial pool of 236 potential participants. Candidates were screened against strict eligibility criteria requiring the practical use of at least one 5D BIM functionality (detailed in Figure 1) on a construction project in Europe. Excluding unreachable or ineligible contacts yielded 163 qualified invitees. Eligible professionals were invited via multiple communication channels, with information provided on the study scope and confidentiality. In total, 59 valid responses were collected between April and May 2025, corresponding to a response rate of 36.2% among qualified invitees. While this network-driven sampling ensured relevance, it inherently introduces a potential selection bias regarding professionals inactive on such platforms.

Data analysis

Survey data were initially screened and preprocessed using Microsoft Excel. Categorical responses were reviewed, consolidated where necessary, and infrequent categories were grouped under a general ”Other” label. Project location data were aggregated into regional groupings based on EuroVoc classifications. For analysis, multiple-selection items were converted into binary variables, and two summary indicators were derived to capture the extent of 5D BIM adoption: the number of different 5D BIM functionalities used and the number of distinct software tools reported by each respondent.

Following preprocessing, the dataset was transferred to the Python programming environment for statistical analysis and visualization, utilizing the Pandas library for data manipulation and Matplotlib for generating figures.

Firstly, the extent of utilization was analyzed, where the frequency of use for each 5D BIM feature was calculated. The features were ranked based on the number of respondents utilizing them, and the results were visualized using a horizontal bar chart with a ”progress-bar” style to clearly display the adoption rates relative to the total sample size.

Secondly, the perceived benefits were analyzed, where the industry's perception of 5D BIM benefits was assessed based on the 12 Likert-scale items. A diverging stacked bar chart was generated to illustrate the distribution of sentiments, separating positive (agree/strongly agree) and negative (disagree/strongly disagree) responses centered around the neutral option. Responses marked as ”Not relevant” were excluded from the percentage calculations to ensure the analysis accurately reflected the views of those with direct experience.

Finally, to evaluate how different contextual factors impact the perceived success of 5D BIM, a composite metric termed ”Overall Perceived Benefits” (OPB) was defined. This score was calculated for each respondent by averaging the numerical values of the 12 benefit items (scale 1–5), excluding ”Not relevant” responses from the calculation. The distribution of OPB scores across various groups was analyzed using variable-width box plots, which display the median, quartiles, and range of the data. In these plots, the width of each box is proportional to the sample size of the respective subgroup, allowing for a simultaneous assessment of distribution and frequency. Given the total sample size of 59 and the resulting smaller subgroup populations, inferential statistical testing would lack the adequate statistical power to reliably detect effect sizes. Therefore, this descriptive visual approach was chosen over calculating precise confidence intervals. For visualization purposes, nominal categorical variables were sorted by median OPB score in descending order, while ordinal variables were sorted by their natural descending order. Even in cases where no significant relationship was observed, variables were presented to utilize the box widths representing frequency of the group as a descriptive tool, thereby providing essential context regarding the profile of the respondents and the characteristics of their referenced projects.

Open-ended responses regarding specific project experiences, challenges, and benefits were subjected to thematic analysis to identify recurring narratives. Relevant qualitative evidence was interwoven directly into the discussion of quantitative results, enabling recurring themes to serve as a corroborative context that offers explanatory depth to the statistical observations.

Results and discussion

A total of 59 valid responses were collected from professionals who utilized BIM for cost management in their reference projects located in 19 European countries. Figure 1 illustrates the adoption rates of various 5D BIM functionalities. The data reveals a striking disparity between the most common use case and all other functionalities. An overwhelming majority of respondents (91.5%) utilize

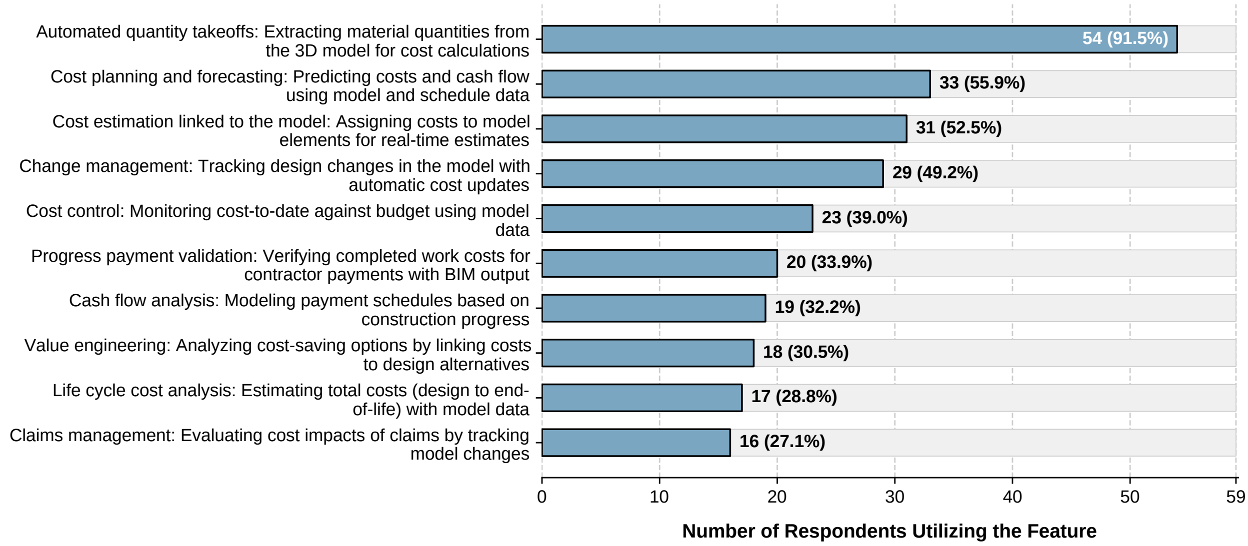

Figure 1: Utilization frequencies of 5D BIM features in reference projects (n=59)

5D BIM for "Automated quantity takeoffs" making it the foundational, and for many, the only application of the technology.

In sharp contrast, the second most cited use drops significantly to 55.9%, indicating that many professionals equate 5D BIM solely with geometry-based quantity extraction rather than integrating cost data directly into the model environment or leveraging it for further financial analysis. This limited scope aligns with established literature; Mitchell (2012) observed that 5D is frequently reduced to the "simple one-liner of Quantity Take Off" while Moses et al. (2020) confirmed that industry efforts have predominantly focused on using technologies for quantity extraction rather than fully integrated cost management. This exposes a prevalent definitional ambiguity: although Charef et al. (2018) identify a theoretical consensus defining 5D BIM as the "cost" dimension, practical application reveals a stark divergence in what the cost dimension actually entails.

This quantitative observation is corroborated and critiqued by the qualitative findings from the open-ended survey questions. Several respondents argued that automated quantity extraction is merely a prerequisite but not the definition of 5D BIM. One respondent explicitly stated that "true 5D BIM begins only after going beyond the quantity takeoff" implying that those who stop at quantity takeoff cannot claim to be fully utilizing 5D BIM. This dichotomy suggests that the industry is currently operating with a "two-tier" definition of 5D BIM: a broad, entry-level tier focused on quantity takeoff (QTO), and a narrower, mature tier focused on comprehensive cost management.

Beyond automated quantity takeoffs, adoption rates cluster at moderate to low levels. Approximately half of the respondents reported using 5D BIM for "Cost planning and forecasting" (55.9%), "Cost estimation linked to the model" (52.5%), and "Change management" (49.2%), indicating partial integration beyond geometry-based counting. All remaining functions including "Cost control" (39.0%),

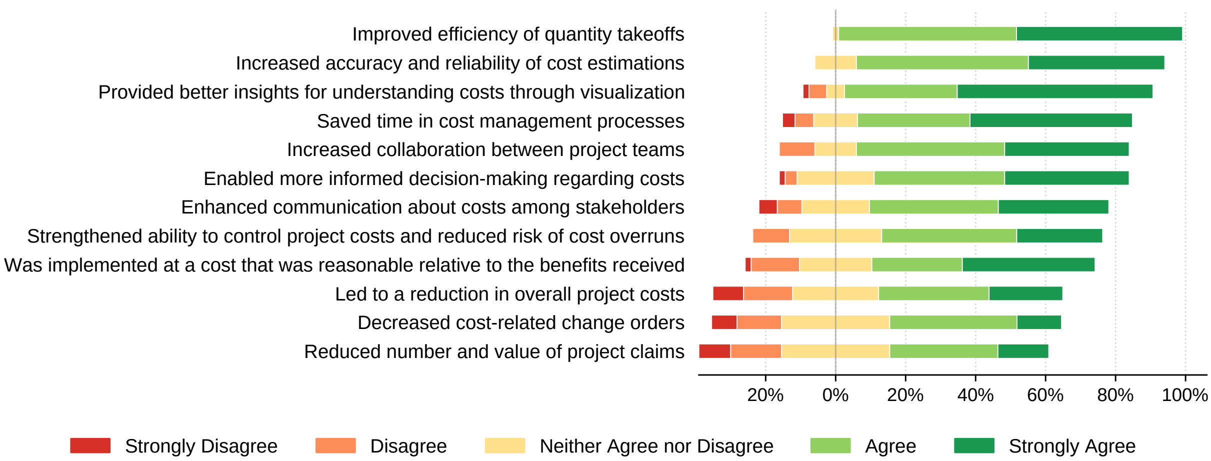

Figure 2: Perceived benefits of 5D BIM implementation (sorted by level of agreement)

"Progress payment validation" (33.9%), "Cash flow analysis" (32.2%), and "Value engineering" (30.5%) and "Life-cycle cost analysis" (28.8%) and "Claims management" (27.1%) were reported by fewer than 40% of respondents, reflecting that these specialized downstream tasks are currently the least common implementations of 5D BIM.

Turning from the breadth of adoption to the perceived impact, Figure 2 illustrates a predominantly positive reception of 5D BIM, based on the survey responses. Across all twelve queried benefits, the proportion of respondents expressing agreement (combining "Agree" and "Strongly Agree") consistently outweighs those expressing disagreement. This consensus suggests that, despite the variations in adoption maturity discussed earlier, the technology delivers tangible value to those who implement it.

The most significant gains are perceived in the foundational tasks of cost management. "Improved efficiency of quantity takeoffs" emerged as the top-rated benefit, followed closely by "Increased accuracy and reliability of cost estimations." This statistical finding is strongly corroborated by the qualitative feedback; respondents repeatedly emphasized that linking the Bill of Quantities (BOQ) directly to the 3D model creates an "objective and consistent dataset" thereby accelerating the process and significantly reducing the risk of human error associated with manual calculations. This aligns with recent findings by Mohd Saupi and Ismail (2024), who reported that improved cost estimation remains a primary driver for adoption, with professionals emphasizing 5D BIM's capacity to produce more precise and reliable financial projections compared to traditional methods.

Complementing these foundational gains, the literature emphasizes that 5D BIM extends its value into the dynamic phases of project delivery by enhancing decision-making and collaboration. Eldin et al. (2024) highlight that the technology facilitates real-time visualization and analysis of cost data, which allows for continuous financial forecasting and proactive risk mitigation rather than mere reactive corrections. Furthermore, Pishdad and Onungwa (2024) argue that integrating cost data into the model fosters a more transparent collaborative environment, effectively shifting cost management from isolated, convoluted spreadsheets to a shared, visual 3D format where assumptions can be easily challenged and verified by the entire project team.

To evaluate the impact of contextual factors on 5D BIM success, Overall Perceived Benefit (OPB) scores were analyzed using variable-width box plots. These figures simultaneously illustrate the statistical distribution of scores along the horizontal axis and the relative sample size of each subgroup through the vertical width of the boxes.

Figure 3 displays the distribution of OPB scores categorized by experience levels and Figure 4 by respondent age. The average age of the sample is approximately 35 years old, with 12 years of experience in construction, 8 years in BIM, and 6 years in 5D BIM, calculated based on the weighted mean of range midpoints. Both figures show stable medians and overlapping ranges across all groups,

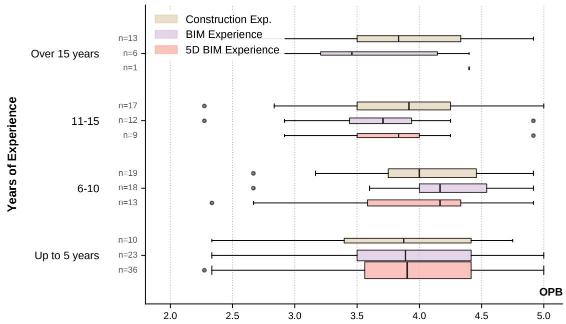

Figure 3: Distribution of OPB by experience in construction, BIM and 5D BIM

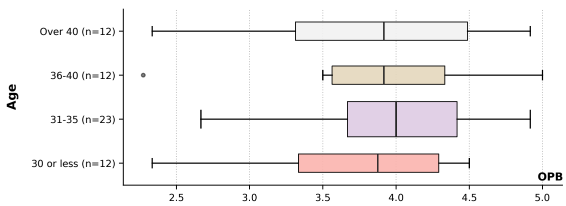

Figure 4: Distribution of OPB by respondent age

indicating that the positive perception of 5D BIM benefits remains consistent regardless of the length of professional experience and age.

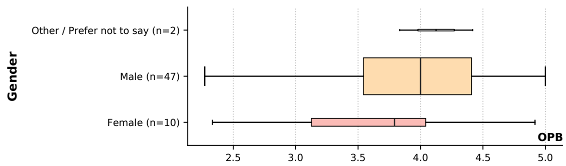

Figure 5: Distribution of OPB by gender

Figure 5 presents OPB scores by gender, reflecting a sample distribution with a larger male cohort (n=47) compared to the female group (n=10). While the male subgroup exhibits a slightly higher median, the notable difference in group sizes suggests that this observation should be interpreted within the context of the sample's demographic composition, rather than as a definitive indicator of gender-based divergence in 5D BIM perception.

Figure 6 characterizes the respondents' professional profiles at the time of the survey. The sample is notably dominated by "BIM & Digital Construction" group (n=23), reflecting that 5D BIM is still largely a specialized discipline driven by domain experts rather than general project management staff. While smaller groups like "Project Managers & Site Engineers" (n=10) and "Executive Leadership & Founders" (n=7) suggest higher satisfaction, the BIM specialist group exhibits a wider range of OPB scores.

Figure 7 reveals a "benefit asymmetry" across stakeholder roles. Although Contractors constitute the largest group in the reference project (n=22), they report a lower median OPB score compared to other groups. Qualitative findings further suggest that this lower perception among Contractors may be linked to commercial sensitivities rather than technical implementation alone. The high level of cost transparency required by 5D BIM may conflict with com-

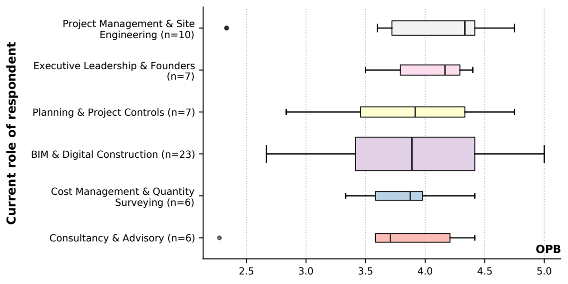

Figure 6: Distribution of OPB by current role of the respondent

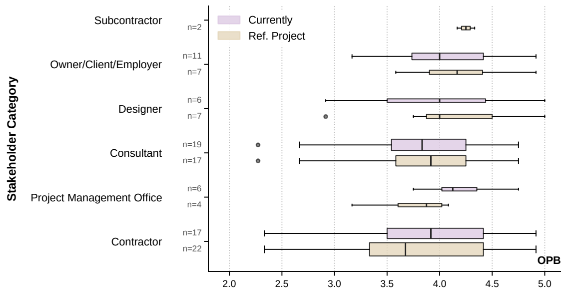

Figure 7: Distribution of OPB by current stakeholder category of the respondent and the stakeholder category in the reference project

petitive contracting environments where profit margins are guarded, and the requirement to share granular cost data within a shared model can be viewed as a commercial risk rather than a benefit, potentially tempering the enthusiasm for 5D adoption among contractor organizations. This stance is substantiated by Guo et al. (2019), who demonstrated that BIM-enabled transparency can directly impact contractors' interests by exposing proprietary resource allocations and cost structures that previously served as hidden sources of profit.

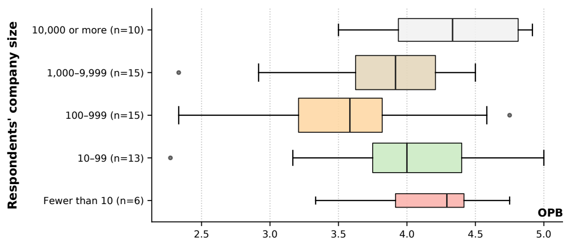

Figure 8: Distribution of OPB by the number of employees of the company that the respondent was/is working in the reference project

Figure 8 and Figure 9 illustrate a striking non-monotonic, U-shaped relationship across both company size and project complexity, where perceived benefits peak at the extremes and dip significantly in the intermediate categories. In terms of company size, the high satisfaction among small firms suggests organizational agility, while the success of large corporations (over 10,000 employees) likely stems from the resource abundance required to enforce standardization and specialized training, aligning with a resource-based view of firm capabilities.

Conversely, mid-sized firms (100–999 employees) appear caught in a "transition trap" facing the interoperability challenges of scaling without the institutional capacity of larger

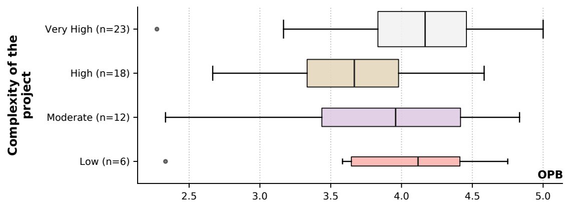

Figure 9: Distribution of OPB by project complexity

entities. This aligns with Bosch-Sijtsema et al. (2017), who argue that medium-sized contractors often face a specific disadvantage; they are compelled to compete with larger firms on complex projects yet lack the comparable in-house R&D resources and financial buffer to overcome the high investment costs and knowledge barriers of BIM implementation. A parallel U-shaped pattern in project complexity reinforces this observation, suggesting that while 5D BIM offers quick wins for simple projects and becomes indispensable for high-complexity ones, intermediate projects occupy a "zone of friction" where the implementation effort is felt most acutely relative to the rewards.

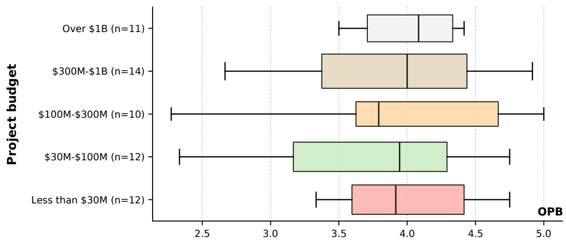

Figure 10: Distribution of OPB by project budget

Figure 10 displays the relationship between project budget and OPB scores. Within the studied sample, no significant trend was observed; the median OPB scores appeared consistent across all financial tiers.

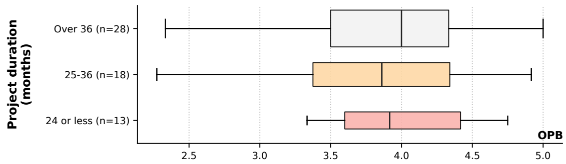

Figure 11: Distribution of OPB by project duration

Figure 11 presents the analysis regarding project duration. Due to data skewness, where nearly half the respondents (n=28) concentrate in the "Over 36 months" category, no meaningful relationship was observed.

Figure 12 demonstrates a clear positive correlation between the national BIM maturity level and the perceived benefits of 5D BIM. Unlike the variable project characteristics discussed earlier, the national environment shows a linear progression: as the maturity level rises from "Emerging or Low" (n=14) to "High" (n=8), the median OPB score steadily increases. This empirical finding supports the macro-micro relationship established by Prabhakaran et al. (2021), who argue that a mature national ecosystem characterized by established mandates and standardized protocols significantly amplifies organizational implementation suc-

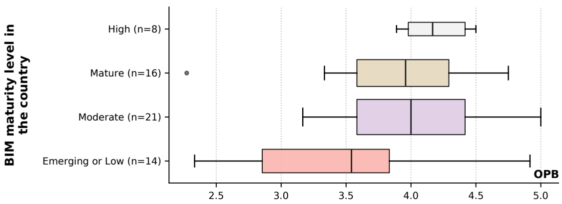

Figure 12: Distribution of OPB by BIM maturity level in the project country

cess by reducing external friction, reflecting the impact of institutional logics on technology adoption.

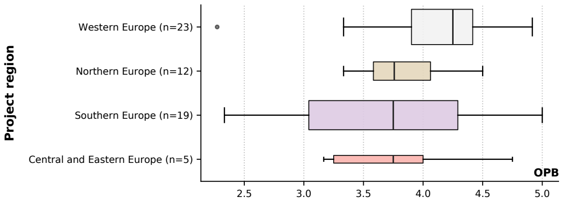

Figure 13: Distribution of OPB by project region

Figure 13 corroborates this finding through a geographical lens, highlighting Western Europe as the region with the highest perceived benefits. This group, which constitutes the largest segment (n=23) and includes respondents from the United Kingdom (14), Germany (5), Luxembourg (2), the Netherlands (1), and Austria (1), exhibits the highest median score. This superior performance can be attributed to the mature BIM adoption landscape in these countries, particularly the UK and Germany, where rigorous standards and widespread engineering familiarity create a conducive environment for 5D integration. In contrast, the remaining regions report comparatively lower median scores, likely reflecting varying degrees of market maturity. These include Southern Europe (n=19), dominated by respondents from Turkiye (16) alongside Portugal (2) and Italy (1); Northern Europe (n=12), comprising Lithuania (4), Denmark (2), Finland (2), Norway (2), Latvia (1), and Sweden (1); and Central and Eastern Europe (n=5), consisting of respondents from Hungary (1), Kosovo (1), Romania (1), Serbia (1), and Slovenia (1).

Qualitative insights from these regions suggest that these lower outcomes are driven by systemic barriers rather than individual lack of skill. Respondents specifically pointed to the absence of established national cost databases and a specialized BIM education as primary obstacles. This observation is empirically supported by the case of Türkiye, the dominant constituent of the Southern Europe group, where the lack of official government mandates and standardized cost data has been identified as a critical barrier, keeping adoption at a ”nascent” stage compared to the mature, policy-driven ecosystem of the UK (Sari and Pekeriçli, 2020; Omotayo et al., 2025). This validates the correlation between a supportive national infrastructure and the successful realization of 5D benefits.

Figure 14 examines the influence of the project team's BIM expertise on OPB scores. A visual inspection does not indicate a distinct, linear trend across all categories

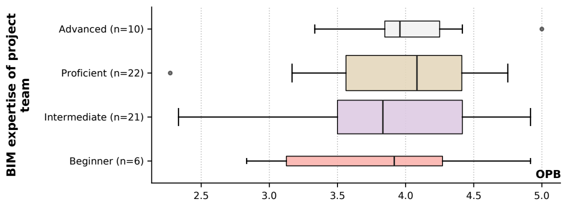

Figure 14: Distribution of OPB by BIM expertise of the project team

(from ”Beginner” to ”Advanced”). However, a closer look at the two largest subgroups, ”Intermediate” (n=21) and ”Proficient” (n=22), reveals a noticeable positive shift; the ”Proficient” group exhibits a higher median score compared to the ”Intermediate” cohort. This observation suggests that while the overall relationship remains complex across the spectrum, the transition from an intermediate to a proficient level of collective expertise serves as a discernible factor in realizing higher perceived benefits.

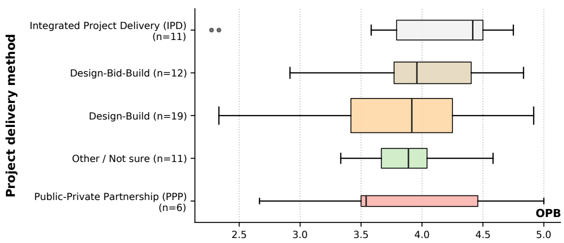

Figure 15: Distribution of OPB by project delivery method

Figure 15 displays the relationship between project delivery methods and OPB scores. The Integrated Project Delivery (IPD) group (n=11) demonstrates the highest median score with a relatively compact distribution. This aligns with the expectation that the collaborative structure of IPD creates a favorable environment for 5D BIM implementation compared to traditional methods such as Design-Bid-Build, Design-Build, Public-Private Partnership (PPP). This pattern is consistent with the broader literature, which identifies IPD as the optimal delivery method for BIM; its multi-party risk-sharing structure and reward mechanisms align commercial interests, helping to mitigate the financial transparency risks feared by contractors, thereby fostering early contractor involvement and seamless data integration, whereas traditional methods often fragment the very information flows that 5D BIM relies upon (Piroozfar et al., 2019; Karasu et al., 2022).

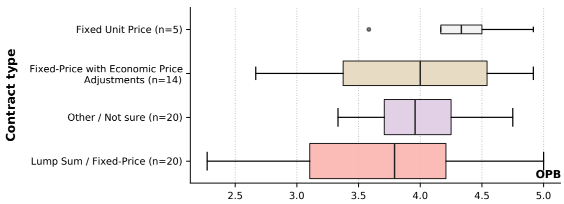

Figure 16: Distribution of OPB by contract type

Figure 16 examines OPB scores across contract types, revealing that despite minor variations between categories such as 'Fixed Unit Price' and 'Lump Sum / Fixed-Price,' the overall distribution patterns remain largely overlapping with similar medians; consequently, no distinct relationship could be established between the specific pricing mechanism and the perceived benefits of 5D BIM.

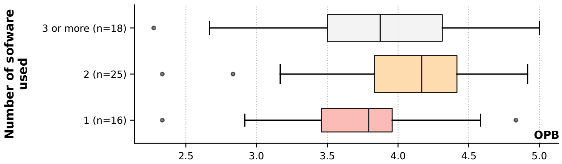

Figure 17: Distribution of OPB by the number of software programs each respondent mentioned using for 5D BIM

Figure 17 correlates the diversity of the software toolkit with OPB scores, revealing that the highest and most consistent satisfaction is found in the ”2 software” category (n=25). This suggests an optimal workflow often pairs a primary design tool, most notably Autodesk Revit (mentioned by 40 respondents), with a specialized coordination or estimation platform. In contrast, the ”1 software” group (n=16) reports a notably lower median score, likely reflecting the limitations of performing 5D tasks solely within a design authoring tool, while the ”3 or more” group (n=18) shows diminished returns, potentially due to complexity. Following Revit, the most frequently cited tools were Navisworks (29), RIB CostX (11), Synchro (10), Bexel Manager (8), Tekla (4), RIB iTWO (4), and Solibri (3), with 24 other programs mentioned by one or two respondents.

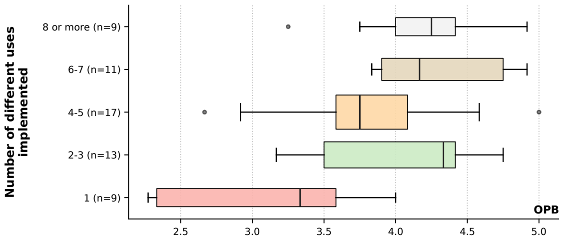

Figure 18: Distribution of OPB by the number of 5D BIM uses implemented

Figure 18 stands as the empirical validation of the ”True 5D BIM” concept, offering perhaps the most critical insight of the entire study. It establishes a robust positive correlation between the depth of implementation and perceived success. The group implementing only ”1 use” (n=9) reports the lowest median satisfaction, reinforcing the earlier observation from Figure 1 that limiting 5D BIM to a single function (predominantly quantity take-off) fails to unlock the technology’s potential.

However, the data reveals a dramatic ”value threshold” immediately after this initial stage. The jump to the ”2-3 uses” category (n=13) results in a sharp increase in the median OPB score, surpassing even the intermediate groups. This indicates that moving beyond isolation, by integrating just one or two additional functions (e.g., coupling QTO with Cost Estimation or Progress Monitoring), creates a synergistic effect that instantly amplifies value. This aligns with the findings of Disney et al. (2022) and Sun et al. (2024), who demonstrate that the interdependence of multiple BIM uses creates a ”systemic” benefit where the whole is greater than the sum of its parts, leading to significantly higher user satisfaction and project performance compared to fragmented tools. The trend continues to favor holistic application, with the ”8 or more” group (n=9) maintaining high satisfaction. This confirms that 5D BIM is not merely a tool for a specific task but a systemic methodology; the more comprehensively its diverse functions are utilized, the greater the return on investment.

Conclusions

This paper examined the contextual factors influencing the perceived success of 5D BIM in the European construction sector. By analyzing responses from 59 professionals across 19 countries, the research bridges the gap between theoretical potential and practical reality. The findings reveal a critical dichotomy: while most practitioners equate 5D BIM with simple quantity take-offs (QTO), the data confirms that this limited approach yields the lowest satisfaction. Instead, a distinct ”value threshold” exists where integrating cost estimation or progress monitoring via a dual-platform workflow significantly amplifies success, validating 5D BIM as a systemic, integrated methodology rather than a singular task.

Contextual analysis highlights that success follows a non-linear, U-shaped pattern; mid-sized firms and intermediate projects often face a ”transition trap” lacking both the agility of small firms and the institutional resources of large corporations. Furthermore, a ”benefit asymmetry” emerges among stakeholders; contractors report lower satisfaction levels, likely due to the commercial risks associated with 5D BIM’s high transparency, which can conflict with competitive contracting norms by exposing proprietary cost structures. Conversely, the results confirm that a supportive ecosystem, characterized by high national BIM maturity and collaborative delivery methods like Integrated Project Delivery (IPD), is a fundamental catalyst for realizing the full potential of 5D BIM.

These results should be considered in light of several limitations. Most notably, the sample size, constrained by the specialized nature of the domain, reduces the statistical power for subgroup analyses, as small frequencies within certain subcategories preclude the calculation of robust effect sizes and result in wide confidence intervals. Furthermore, the analysis relies on perceived benefits as a surrogate for objective performance, a measure that indicates technological acceptance but does not necessarily equate to quantifiable financial profitability or hard project metrics. Additionally, the geographic distribution of the sample introduces potential geographic bias. Specifically, the heavy dominance of Turkish respondents in the Southern Europe category, while providing valuable context regarding emerging market barriers, may limit the generalizability of regional comparisons and mask country-specific differences, particularly regarding applicability to non-European regulatory contexts. Future studies should address these limitations by applying weighted benefit criteria and complementing perception-based surveys with quantitative case studies that incorporate actual cost variance data and schedule performance metrics. This approach would validate the perception-behavior link and strengthen causal inference, while also expanding the assessment of return on investment (ROI) to encompass the operational stage of the facility's life cycle.

References

Agarwal, R., Chandrasekaran, S., and Sridhar, M. (2016). Imagining construction's digital future. McKinsey & Company. [Online] Available from: https://www.mckinsey.com/capabilities/operations/our-insights/imagining-constructions-digital-future [Accessed: 22 January 2026].

Aibinu, A. and Venkatesh, S. (2014). Status of BIM adoption and the BIM experience of cost consultants in australia. Journal of Professional Issues in Engineering Education and Practice, 140(3).

Bosch-Sijtsema, P., Isaksson, A., Lennartsson, M., and Linderoth, H. C. J. (2017). Barriers and facilitators for BIM use among Swedish medium-sized contractors - "we wait until someone tells us to use it". Visualization in Engineering, 5:1–12.

Charef, R., Alaka, H., and Emmitt, S. (2018). Beyond the third dimension of BIM: A systematic review of literature and assessment of professional views. Journal of Building Engineering, 19:242–257.

Disney, O., Roupé, M., Johansson, M., and Leto, A. (2022). Embracing BIM in its totality: a total BIM case study. Smart and Sustainable Built Environment, 13(3):512–531.

Eldin, A. M. S., Abdelalim, A. M., and Tantawy, M. (2024). Enhancing cost management in construction: The role of 5D building information modeling (BIM). Engineering Research Journal, 183(3):C164–C188.

Guo, H., Yu, R., and Fang, Y. (2019). Analysis of negative impacts of BIM-enabled information transparency on contractors' interests. Automation in Construction, 103:87–98.

Karasu, T., Aaltonen, K., and Haapasalo, H. (2022). The interplay of IPD and BIM: a systematic literature review. Construction Innovation, 22(3).

Kehily, D. and Underwood, J. (2017). Embedding life cycle costing in 5D BIM. Journal of Information Technology in Construction (ITcon), 22:145–167.

Lu, Q., Won, J., and Cheng, J. C. P. (2016). A financial decision making framework for construction projects based on 5D building information modeling (BIM). International Journal of Project Management, 34(1):3–21.

Mitchell, D. (2012). 5D BIM: Creating cost certainty and better buildings. In RICS COBRA 2012, Las Vegas, Nevada USA. RICS.

Mohd Saupi, N. D. H. and Ismail, N. A. A. (2024). The implementation of 5D building information modelling (BIM) in construction management: Benefits and challenges faced by construction professionals. Built Environment Journal, 21(SI):94–104.

Moses, T., Heesom, D., and Oloke, D. (2020). Implementing 5D BIM on construction projects: Contractor perspectives from the UK construction sector. Journal of Engineering, Design and Technology, 18(6):1867–1888.

Naji, K. K., Gunduz, M., Alhenzab, F. H., Al-Hababi, H., and Al-Qahtani, A. H. (2024). A systematic review of the digital transformation of the building construction industry. IEEE Access, 12:31461–31487.

Omotayo, T., Tanyer, A. M., Deng, J., Kaima, A., Akponeware, A., Pekericli, M. K., Shikder, S., and Ogunnusi, M. (2025). Advancing AI-powered BIM for circularity in construction in the UK and Turkiye: State-of-the-art review and capability maturity modelling. Buildings, 15(8):1224.

Piroozfar, P., Farr, E. R. P., Zadeh, A. M., Inacio, S., Kilgallon, S., and Jin, R. (2019). Facilitating building information modelling (BIM) using integrated project delivery (IPD): A UK perspective. Journal of Building Engineering, 26:100907.

Pishdad, P. and Onungwa, I. O. (2024). Analysis of 5D BIM for cost estimation, cost control and payments. Journal of Information Technology in Construction (ITcon), 29:525–548.

Prabhakaran, A., Mahamadu, A.-M., Mahdjoubi, L., Andrić, J. F., Manu, P., and Mzyece, D. (2021). An investigation into macro BIM maturity and its impacts: a comparison of Qatar and the United Kingdom. Architectural Engineering and Design Management, 17:496–515.

Publications Office of the European Union (2026). EuroVoc: Geography, Europe (concept 7206). [Online] Available from: https://eur-lex.europa.eu/browse/eurovoc.html?params=72%2C7206 [Accessed: 22 January 2026].

Sari, R. and Pekeriçli, M. K. (2020). An investigation of comparison and evaluation of official BIM documents released in the USA, UK and Turkey. Journal of Construction Engineering, Management & Innovation, 3(2):67–84.

Stanley, R. and Thurnell, D. (2014). The benefits of, and barriers to, implementation of 5D BIM for quantity surveying in New Zealand. Australasian Journal of Construction Economics and Building, 14(1):105–117.

Sun, H., Khoo, T. J., Esa, M., Mahdiyar, A., and Li, J. (2024). Critical factors driving construction project performance in integrated 5D building information modeling. Buildings, 14(9):2807.

Vigneault, M. A., Boton, C., Chong, H. Y., and Cooper-Cooke, B. (2020). An innovative framework of 5D BIM solutions for construction cost management: A systematic review. Archives of Computational Methods in Engineering, 27:1013–1030.