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Gamification in BIM: A Framework to Motivate Design Teams and Enhance Coordination Efficiency



European Master in
Building Information Modelling

Master Dissertation

European Master in Building Information Modelling

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

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RESUMO

Esta dissertação explora a integração da gamificação nos processos de Modelação da Informação da Construção (BIM), com o objetivo de aumentar a motivação das equipes e a eficiência da coordenação durante a fase de projeto. Embora a adoção do BIM tenha melhorado significativamente os fluxos de trabalho de projeto e construção, ainda persistem desafios em garantir a conformidade com os requisitos do projeto, resolver questões de coordenação e cumprir prazos. Estas dificuldades frequentemente resultam em atrasos, ineficiências e aumento da carga de trabalho dos gestores BIM.

A pesquisa inicia-se com a análise dos principais obstáculos enfrentados pelas equipes de projeto, particularmente no cumprimento das exigências, na resolução de conflitos e na manutenção de uma colaboração eficiente em plataformas cloud. Em seguida, examina os princípios fundamentais da gamificação, com base em aplicações de outros setores, e identifica técnicas como rankings, medalhas, quadros de líderes e recompensas como estratégias potenciais para impulsionar o envolvimento nos fluxos de trabalho BIM.

Com base nestes insights, a dissertação desenvolve um framework de gamificação adaptado aos processos BIM, com mecanismos para monitorar a conformidade, pontuar o desempenho e visualizar o progresso por meio de *dashboards* no Microsoft Power BI. O modelo incorpora métricas relacionadas à resolução de problemas e às tendências de eficiência, projetadas para tornar os resultados transparentes e fomentar a responsabilidade entre os participantes.

Por fim, o estudo apresenta recomendações para a integração da gamificação nas plataformas BIM existentes e destaca direções de investigação futura, como a expansão do *framework* para projetos de maior escala e a utilização de inteligência artificial para fornecer feedback adaptativo e análises preditivas.

Ao demonstrar como a gamificação pode transformar a colaboração em BIM, esta pesquisa contribui para o avanço das práticas digitais na indústria da construção, apoiando tanto a maior eficiência nos processos de coordenação quanto o maior envolvimento dos profissionais.

Palavras-chave: Comunicação Eficaz, Coordenação de Projeto, Envolvimento da Equipe, Gamificação, Modelação da Informação da Construção (BIM)

ABSTRACT

This thesis explores the integration of gamification into Building Information Modelling (BIM) processes, aiming to enhance team motivation and coordination efficiency during the design phase. While BIM adoption has significantly improved design and construction workflows, challenges persist in ensuring compliance with project requirements, resolving coordination issues, and meeting project deadlines. These difficulties often result in project delays, inefficiencies, and increased workloads for BIM managers.

The research begins by analyzing the main obstacles faced by design teams, particularly in achieving compliance, addressing clashes, and maintaining efficient collaboration within cloud-based platforms. It then examines the core principles of gamification, drawing from applications in other industries, and identifies techniques such as leaderboards, badges, rankings, and rewards as potential strategies to drive engagement in BIM workflows.

Building on these insights, the thesis develops a gamification framework tailored to BIM processes, with mechanisms for tracking compliance, scoring performance, and visualizing progress through dashboards in Microsoft Power BI. The model incorporates performance metrics related to issue resolution and efficiency trends, designed to make results transparent and foster accountability among participants.

Finally, the study outlines recommendations for integrating gamification into existing BIM platforms and highlights future research directions, such as scaling the framework for larger projects and leveraging artificial intelligence for adaptive feedback and predictive analytics.

By demonstrating how gamification can transform collaboration in BIM, this research contributes to advancing digital practices in the construction industry, supporting both higher efficiency in coordination processes and stronger engagement among professionals.

Keywords: Building Information Modelling (BIM), Design Coordination, Effective Communication, Gamification, Team Engagement

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LIST OF ACRONYMS AND ABBREVIATIONS

AEC	Architecture, Engineering, and Construction
AI	Artificial Intelligence
API	Application Programming Interface
AR	Augmented Reality
BCF	BIM Collaboration Format
BEP	BIM Execution Plan
BIM	Building Information Modelling
CAD	Computer-Aided Design
CDE	Common Data Environment
CSV	Comma-Separated Values
EIR	Exchange Information Requirements
ETL	Extract, Transform, Load
ISO	International Organization for Standardization
KPI	Key Performance Indicators
LOIN	Level of Information Need
RFI	Request for Information
SLA	Service Level Agreement
VR	Virtual Reality
XR	Extended Reality

1. INTRODUCTION

Over the past two decades, Building Information Modelling (BIM) has become a central component of the digital transformation in the Architecture, Engineering, and Construction (AEC) industry. It is no longer seen merely as a design tool, but as a collaborative methodology that integrates planning, coordination, and data management throughout the project lifecycle. By providing a shared digital environment, BIM supports more accurate design decisions, improves constructability analysis, and reduces costly errors before construction begins. Its adoption has been reinforced by the demand for more efficient, sustainable, and transparent project delivery methods.

Despite these advancements, BIM adoption has also revealed critical organizational challenges. The success of BIM depends not only on the quality of digital models but also on the ability of project participants to collaborate effectively. Communication across disciplines, alignment with project requirements, and accountability of individual contributors remain recurring difficulties. As a result, BIM managers often face significant workloads in monitoring compliance and enforcing collaboration, diverting their focus from higher-level project management tasks.

In this context, it becomes clear that technological progress alone does not guarantee successful implementation of BIM. What is required is a transformation of team behavior, motivation, and communication practices. Gamification – understood as the integration of game design principles such as scoring, feedback, and ranking systems into non-game environments – presents an opportunity to address this need. By making progress visible, promoting accountability, and creating a sense of engagement, gamification has the potential to strengthen both the human and organizational aspects of BIM adoption.

Although BIM offers advanced tools for collaboration and coordination, its practical effectiveness is hindered by persistent challenges at the organizational and behavioral level. These challenges can be summarized as follows:

1. Compliance with project requirements:

Many design teams struggle to consistently follow BIM standards, Exchange Information Requirements (EIR), BIM Execution Plans (BEP), and other project-specific rules. Without structured mechanisms for monitoring, compliance relies heavily on manual control by BIM managers.

2. Coordination efficiency:

The process of detecting and resolving clashes often generates a large volume of issues. Delays in addressing them can have cascading effects on project schedules, leading to inefficiencies and cost overruns.

3. Engagement and motivation:

Routine tasks, lack of recognition, and limited feedback reduce motivation among design team members. This leads to insufficient participation in collaborative platforms and weakens accountability.

4. Communication gaps:

Misalignments frequently occur both between project teams and in client-facing communication. Inadequate visibility of progress and unclear responsibilities increase the risk of misunderstandings and project delays.

Traditional approaches, such as manual enforcement of standards, frequent coordination meetings, or reliance on managerial oversight, have proven insufficient to address these problems sustainably. They increase managerial burden without effectively changing team behavior.

This creates a clear gap. While BIM provides the technical foundation for collaboration, it lacks mechanisms that actively influence motivation, accountability, and communication. Bridging this gap requires a new approach that integrates behavioral and organizational incentives directly into BIM workflows. Gamification, by embedding feedback and reward systems into everyday tasks, offers a structured solution to align individual motivation with project goals and enhance the overall efficiency of coordination.

The central hypothesis of this dissertation is that the integration of gamification principles into BIM coordination processes will enhance motivation, accountability, and efficiency among project participants. The reasoning behind this hypothesis rests on the observation that current practices in BIM management remain heavily dependent on manual oversight and post-facto control, which limit scalability and efficiency. By embedding gamified mechanisms such as scoring, rankings, dashboards, and automated feedback loops directly into workflows, it will be possible to reduce reliance on constant managerial supervision, strengthen team engagement, and align individual actions with collective project objectives. In future applications, this hypothesis will be tested conceptually and through illustrative use cases, with the aim of demonstrating how gamification can transform coordination practices.

The purpose of this dissertation is to design and present a structured gamification framework specifically tailored to BIM-based design coordination. The framework proposed in this study will therefore address the persistent challenges of compliance, communication, and motivation by introducing behavioral incentives into technical processes. It will not attempt to replace existing tools or standards but will instead seek to enhance their effectiveness by embedding feedback and reward systems directly into the collaborative environment.

To achieve this purpose, the dissertation will pursue several objectives:

- It will analyze the practical difficulties encountered by design teams in meeting BIM requirements and in resolving coordination issues efficiently.
- It will identify the gamification principles and techniques that are most relevant for application in professional BIM workflows. Not all gamification strategies developed in other industries

are applicable in the context of construction, so the dissertation will assess which methods (such as leaderboards, badges, point systems, and recognition tools) can be adapted.

- It will develop a gamification framework that integrates performance scoring, dashboards, and feedback systems, with the goal of promoting transparency. In addition to the framework itself, specific guidelines will be created to explain how different stakeholders should apply the system depending on their role in the project. These guidelines will address not only technical aspects of task execution but also communication practices, including interactions within a design team, across interdisciplinary project teams, with clients, and even with municipal authorities.
- It will propose recommendations for integrating the framework into existing BIM platforms and outline potential directions for future development, including the use of artificial intelligence to generate adaptive feedback and predictive analytics.

Each of these objectives represents a key dimension of the research. The analysis of difficulties will ensure that the framework addresses real problems rather than theoretical assumptions. The identification of gamification principles will connect the study to a broader body of knowledge and demonstrate how lessons learned in other industries can be transferred to construction. The development of a structured framework, complemented by role-specific guidelines, will provide both a clear conceptual solution and practical instructions for its application. These guidelines will clarify how the framework can be used differently by designers, coordinators, managers, and clients, while also highlighting communication aspects across multiple layers of interaction – within project teams, between disciplines, with external clients, and in exchanges with municipal stakeholders. Finally, the recommendations for implementation and future research will ensure that the dissertation has lasting relevance, not only for academic purposes but also for practitioners in the AEC industry.

The significance of this study lies in its attempt to bridge a gap between technological solutions and human behavior in BIM adoption. Previous research has repeatedly emphasized that BIM is not merely a technological shift but also an organizational and cultural transformation. While tools such as clash detection, data exchange standards, and cloud-based collaboration platforms have advanced rapidly, the behavioral aspects of collaboration remain underdeveloped. Project teams continue to struggle with issues of accountability, inconsistent participation, and misaligned communication. As a result, BIM managers and coordinators spend much of their time enforcing standards and monitoring compliance rather than focusing on more important tasks. By introducing gamification, this research seeks to provide a framework that directly influences motivation and engagement, thereby complementing the technical foundation of BIM with organizational and behavioral incentives.

Although gamification has already been studied in various sectors such as education and management, its application to BIM remains limited and fragmented. In education, gamification has been shown to improve student engagement and learning outcomes by providing immediate feedback and rewards. In management and marketing, gamified systems have proven effective in enhancing employee performance and customer loyalty. These examples demonstrate the broad potential of gamification to influence human behavior, yet within the BIM context it has been examined only in very narrow case studies or is still at the stage of initial exploration.

Existing studies in the field of construction have highlighted some promising applications, such as the use of gamification for safety training, and collaborative learning. However, these initiatives have generally been isolated experiments, focused on specific aspects of the project lifecycle rather than on the professional workflows of design coordination. For instance, training exercises often use gamified elements to familiarize students or practitioners with BIM software, but they do not address the day-to-day coordination tasks faced by project teams. Similarly, visualization tools sometimes incorporate gamification to make project data more accessible, yet they fall short of providing a comprehensive framework for accountability and engagement. The lack of an integrated approach designed specifically for coordination processes highlights a significant research gap which this dissertation seeks to fill.

The methodology of this research has been structured to ensure both academic rigor and practical applicability. It will proceed in three main stages. First, a review of literature and current practices will be conducted to establish the state of BIM adoption and to assess how gamification principles have been applied in other domains. This stage will identify the gaps and opportunities that justify the development of a new framework. Second, a conceptual gamification framework will be designed, integrating mechanisms for performance monitoring, compliance tracking, and communication support. The framework will be developed with consideration for scalability and adaptability, ensuring that it can be applied to projects of varying size and complexity. Third, the framework will be illustrated through practical visualization using Microsoft Power BI dashboards. These dashboards will demonstrate how gamified metrics can be embedded into issue tracking and progress monitoring, providing a tangible example of how the framework can function in practice. In addition, detailed guidelines will be developed to instruct different project stakeholders on how to interpret and work with the dashboards, ensuring that the visualized metrics are effectively used for decision-making and communication.

The methodological approach is deliberately designed to combine theoretical analysis with practical illustration. While the literature review provides the academic foundation, the framework development ensures originality and relevance. The use of Power BI dashboards demonstrates applicability in real-world contexts, showing that the research is not limited to abstract theory but offers solutions that can be directly implemented by practitioners. In future work, the framework could be tested in pilot projects to evaluate its effectiveness in live coordination environments. Although such testing is beyond the scope of the present dissertation, the design of the framework will ensure that it can be taken forward in future research and practice.

The structure of the dissertation reflects this methodological progression. The **Introduction** defines the subject matter, formulates the problem, outlines the objectives, and explains the relevance and methodology of the study. The **Literature Review** examines the challenges associated with implementing gamification in BIM and explores gamification principles as they have been applied in other industries, while also highlighting the limitations of existing research in the construction domain. The **Methodology** chapter combines the identification of practical problems faced by project participants with the development of a structured gamification framework designed to address them. The **Case Study** illustrates the use of one of the developed tools, demonstrating how the proposed framework can be applied in practice. Finally, the chapter on **Conclusions** summarizes the outcomes,

discusses the implications for professional practice, outlines the limitations of the study, and identifies directions for further development.

The expected contribution of this dissertation lies in its dual relevance for both theory and practice. On the theoretical level, it advances academic understanding of how gamification can be systematically applied to professional BIM workflows. By synthesizing knowledge from diverse fields and adapting it to the specific context of design coordination, the research contributes to the academic discourse on digital transformation in the construction industry. On the practical level, it provides a structured framework and supporting tools that can be integrated into existing BIM platforms. This will enable project teams to improve efficiency, strengthen communication, and increase motivation. By making coordination more transparent, compliance more consistent, and engagement more sustainable, the proposed framework will directly support the digitalization and professionalization of the AEC sector.

In summary, the dissertation positions gamification as a promising solution to some of the most persistent challenges in BIM coordination. It demonstrates that while technology provides the foundation for collaboration, organizational success depends on the ability to influence human behavior. By embedding gamified mechanisms into BIM workflows, this research aims to create a more engaging, accountable, and efficient environment for project participants. The findings will contribute not only to academic knowledge but also to the practical advancement of digital construction practices, ensuring that BIM can continue to evolve as a central methodology for the industry.

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2. LITERATURE REVIEW

Gamification, defined as “the use of game mechanics, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems” (Kapp, 2012), has emerged as a transformative tool in the architecture, engineering, and construction (AEC) industry. Over the past decade, there has been an increase in research exploring the integration of gamification with Building Information Modelling (BIM) methodologies, offering new opportunities to enhance project quality, collaboration, and deadline adherence. This literature review synthesizes key studies in the field, identifying major trends, methodological approaches, and unresolved challenges while incorporating additional relevant sources to provide a more comprehensive perspective.

Context and Cross-Industry Adoption: Gamification has already proven effective in a variety of fields beyond AEC. Applying game elements has improved patient adherence in health interventions and increased physical activity in fitness programs (Abbott, n.d.; Mazeas et al., 2022). In the corporate domain, marketing and sales teams use gamified dashboards and competitions to boost productivity, and systematic reviews find that gamification consistently enhances user engagement and task completion across disciplines (Croon et al., 2021). Indeed, an industry survey found that 90% of employees feel gamification increases their productivity at work (Chellappa, 2023). These successes drive interest in leveraging gamification in construction, even though the construction domain has thus far lagged in gamification research.

2.1. Theoretical Foundations and Key Studies

In AEC research, it is useful to distinguish gamification – adding lightweight game elements to existing workflows – from serious games, which are full-fledged game environments used for training or exploration. For BIM coordination this boundary is practical: most teams seek to layer points, progress cues, and feedback loops onto CDE/BIM processes rather than to replace them with standalone games. This keeps evaluation aligned with intended outcomes: behavioral nudges for cadence and quality, not general game-based instruction.

Serious gaming approaches have also been explored to involve stakeholders in design and planning; for instance, a custom digital game was used to engage rural communities in an architectural regeneration project (Peng et al., 2024). That example, while outside typical BIM coordination, illustrates how immersive game environments can facilitate stakeholder input in ways distinct from the lighter gamification of everyday workflows.

First and foremost, it was essential to understand in which context gamification is most effective. This is important because the effects are dependent on the context in which the gamification is being implemented (Hamari et al., 2014). Hamari et al. argue that gamification can significantly increase the volume and quality of usage of a particular service or system, which explains why it is most commonly applied in education, marketing, business, sales, and sports – domains where maintaining engagement, motivation, and repeated participation is critical to success.

In addition, organizations have started applying gamification to traditionally tedious activities like compliance training and employee onboarding. Gamified training platforms – featuring quizzes, badges, and leaderboards – make compliance learning more interactive and exciting, dramatically improving participation compared to passive methods (Ethico, n.d.). Such findings underscore that context is crucial: gamification must be tailored to the target audience and objectives to realize its benefits.

To translate context dependence into design choices, mechanics should be bound to outcomes that reflect coordination value: award points for accepted clash closures (not for issue creation), RFI responses within agreed SLAs, zero-error model uploads per validation rules (LOIN), and timely incorporation of documented feedback. Prefer cooperative dynamics – team streaks and shared milestones – so that incentives reinforce cross-disciplinary collaboration rather than zero-sum standings.

This approach aligns with recommended best practices: incentives in the “game” should map to meaningful performance indicators rather than vanity metrics (Spiegel, 2022; Chellappa, 2023). In other words, points or badges must reflect genuine, verifiable accomplishments—such as resolving coordination issues or submitting quality deliverables—so that the game elements reinforce productive behavior instead of encouraging hollow competition.

However, the use of gamification in construction, as well as in BIM, remains the least studied area. A recent scoping review confirms that while interest in gamification for construction is growing, the literature is still relatively sparse and fragmented (Ilbeigi et al., 2022). A foundational work in this area is the research by Yalcin (2024), which thoroughly examines the potential of combining gamification with BIM to improve participatory design through the analysis of existing modern studies. The author argues that “the combination of gamification and Building Information Modelling (BIM) can be described as supporting user participation, decision-making, and collaboration in design contexts” (Yalcin, 2024). Special emphasis is placed on extended reality (XR) technologies, including virtual reality (VR) and augmented reality (AR), to create immersive design environments. The study highlights ethical considerations in gamification implementation, such as data transparency, meaning that participants in the gamified system must be informed about the goals of new implementations, that the results of their work will be used to further develop the system, and voluntary user participation (Marczewski, 2017; Chou, 2015).

Likewise, parallel research by Enab et al. (2023) demonstrates that advanced VR simulations combined with gamification techniques can significantly enhance public engagement in architectural design. In their comparative study, VR environments built on BIM models—augmented with game-engine interactivity—led to better stakeholder communication and co-design participation than more passive visualization methods. This reinforces Yalcin’s point that immersive, gamified BIM environments can empower user involvement and collaboration in design contexts when implemented thoughtfully.

The participatory-design angle highlighted in recent work suggests pairing immersive discovery with auditable capture: insights from VR/AR/XR sessions should return to the CDE as issues, assignments, or decisions. This closes the loop between experiential review and traceable coordination, ensuring

that gamified cues (badges, progress tiles) reflect verifiable BIM states rather than subjective impressions. At the same time, ethics-by-design implies transparency about metrics and optionality for competitive views (e.g., leaderboards).

Notably, integrating extended reality with BIM requires that experiential feedback is documented. For example, a recent gamified design workflow integrated an AI-assisted VR plugin that captured user comments and design changes directly into the BIM issue log (Perlaza et al., 2024). By closing such loops between immersive reviews and the CDE, the benefits of gamified exploration can be realized without losing traceability or project control.

Complementing this, the systematic review by Ingvarsson et al. (2023), which analyses 41 scientific publications, offers a broad perspective on gamification for stakeholder engagement in projects. In the article, the authors highlight that not all project stakeholders are equally interested in it, so there is a need to develop a strategy for engaging stakeholders. Therefore, the use of game mechanics was proposed as a way to develop relationships between the parties (e.g., Coulton, 2015). The authors also consider gamification from an ethical perspective. The setup of game mechanics defines only the correct and incorrect behaviour of the user, thus limiting their ability to think more expansively.

Beyond differences in interest, practical adoption barriers must be acknowledged. A recent study in the Nigerian construction industry identified several significant challenges hindering gamification uptake: lack of capacity and expertise, limited budgeting for innovation, insufficient technical infrastructure, and general hesitation to adopt unfamiliar methods (Oke et al., 2023). These findings suggest that even if some stakeholders are enthusiastic about gamification, real-world constraints and cultural resistance can impede implementation. Any engagement strategy, therefore, needs to be both context-specific and cognizant of such organizational hurdles.

The heterogeneity of stakeholder interests observed in project settings implies that mechanic selection should be role-aware (discipline cohorts, seniority bands) and workload-sensitive. Where motivation is uneven, tiered comparisons and localized goals reduce demotivation from large performance gaps. Clear rules, visible goals, and stable feedback rhythms are prerequisites for any measurable effect from the game layer.

Indeed, effective gamification design must consider the audience segmentation. Modern design guides stress that different user groups may require different game mechanics or difficulty levels to stay engaged (Wilson, 2024). For example, senior managers might respond better to collaborative goal-setting and narrative rewards, whereas junior staff could be motivated by friendly competitions or levelling systems. A one-size-fits-all game could inadvertently alienate certain cohorts, so tailoring the challenge and reward structure by role and skill level is vital to maintaining broad engagement.

The authors categorize gamification into four key dimensions (Kapp, 2012): (1) engaging people, (2) motivating action, (3) promoting learning, and (4) problem-solving. Their findings indicate that "gamification may increase motivation in projects, though results regarding its impact on human motivation remain inconclusive" (Ingvarsson et al., 2023). Based on numerous examples from the articles analysed, the authors show how each of the listed aspects of gamification affects stakeholder engagement. Their findings indicate that "gamification has been used to address and overcome

communication barriers, turning external stakeholders into internal ones, and as a way to involve stakeholders who might otherwise get neglected" (Ingvarsson et al., 2023).

In practice, companies have indeed leveraged gamified approaches to break down communication silos. For example, internal collaboration platforms sometimes award points or badges for knowledge-sharing and timely feedback, which can turn previously passive external partners into active contributors during projects (Fields, 2024; Wade, 2023). Thus, it can illustrate how well-designed engagement mechanics (like challenges and social rewards) can overcome communication barriers and draw in stakeholders who might otherwise remain disengaged.

Promoting learning is the most widely discussed topic across various industries. By playing, a person better remembers the rules of the game and thus plays better. As a result, they gain a better understanding of why the game process was created. In problem-solving, gamification can be useful when more than one person is needed to participate in the problem-solving process (Kapp, 2012). However, the authors note that this aspect is currently the least developed in the literature.

BIM education initiatives in construction echo the idea that learning through play improves retention. For instance, a competition-based learning event called the Digital Decathlon engaged AEC students in a gamified series of BIM tasks; participants reported deeper understanding of BIM rules and processes as a result of the playful, challenge-based format (Calcagno et al., 2024). Similarly, Pütz et al. (2020) found that students who participated in a gamified BIM training workshop not only remembered BIM concepts better but also made fewer modelling errors, highlighting that learning-by-doing in a game context can yield durable knowledge gains. These cases suggest that incorporating game elements into training leads to better understanding and skill acquisition.

Notably, collaborative problem-solving via gamification remains underexplored. While gamification clearly can encourage individual problem-solving (by presenting puzzles or quests), few studies examine its impact on group problem-solving performance. One example is a study by Ilbeigi and Bairaktarova (n.d.), who introduced a gamified construction scheduling exercise that required students to actively work together to sequence tasks. The approach sparked engagement and active learning, but systematic evidence that gamification improves multi-party problem resolution is still lacking. Thus, the literature concurs that problem-solving – especially when it involves team coordination – is an open research frontier in need of further investigation.

Given mixed findings on long-term motivational impact, implementations benefit from field-experimental discipline: set a pre-intervention baseline, use a staggered rollout (e.g., stepped-wedge), and compare to a similar non-gamified team. Track both process KPIs (issue half-life, clash-closure velocity, RFI SLA adherence) and user-reported experience (competence, autonomy, relatedness) to separate novelty effects from durable change.

The importance of rigorous evaluation is underscored by other domains' findings that gamification effects can be transient. Many interventions show strong initial gains that may diminish over time if not reinforced. For example, a meta-analysis of gamified health apps found that user activity spiked early but tended to decline after a few months, suggesting novelty effects (Mazeas et al., 2022). Similarly, a cross-disciplinary review noted that adherence improvements varied greatly and often

waned without sustained engagement strategies (Croon et al., 2021). This underscores the need for controlled long-term studies with baseline and follow-up measurements. By using approaches like staggered rollouts or prolonged observation, researchers can determine whether gamification yields durable behavioral changes or merely short-lived boosts in motivation.

Further expanding on practical applications, Bhat et al. (2023) investigate the implementation of gamification in BIM processes through simulation games tested on architecture students in India. The authors describe the approach: “The BIM game is primarily an architectural competition with an increased focus on the correct provision of information” (Bhat et al., 2023). The methodology involves role assignment (architect, engineer, BIM coordinator) and collaboration in a Common Data Environment (CDE), fostering teamwork skills. Notably, their “BIM Nuggets” – self-learning modules combining video tutorials, practical tasks, and automated model validation – proved particularly effective for CAD-naïve students.

Bhat et al.'s positive results align with findings from other gamified BIM education efforts. In Europe, Pütz et al. (2020) implemented a similar BIM gamification approach (also called a "BIM Game") in which participants worked through a collaborative project scenario with game rules and scoring. They found that the gamified training not only increased student motivation but also improved participants' understanding of BIM workflows and standards, as evidenced by better performance in follow-up tasks. More broadly, a literature review of architectural education by Awan et al. (2022) concluded that introducing game design principles (such as clear goals, feedback, and competition) into coursework tends to boost student engagement and learning outcomes. These studies collectively suggest that gamification can be an effective pedagogical tool for AEC training, improving both motivation and practical comprehension.

Because the Bhat et al. study was conducted with students in a competitive studio context, its positive signals for onboarding and information quality should be adapted cautiously for professional teams. In practice, the 'BIM Nuggets' pattern can inform micro-learning inside project dashboards (short videos + validation checks), while points should accrue only when learning translates into verifiable coordination outcomes (e.g., fewer validation errors, faster accepted closures).

2.2. Motivational and Behavioral Aspects

In workplace settings, the balance between extrinsic and intrinsic drivers is pivotal. Recognition, meaningful progress cues, and clear goals tend to sustain engagement better than purely transactional rewards. Social comparison can be motivating, but it should be framed as collaboration-first: spotlight team progress and contributions to shared milestones before individual standings. This reduces the risk that competition undermines coordination.

This emphasis on intrinsic motivators corresponds with Self-Determination Theory, which holds that people are most engaged when they experience autonomy, competence, and relatedness in their work (Ryan & Deci, 2000). Many practitioners have observed that introducing non-monetary rewards and team-based goals can indeed improve workplace morale and productivity (Grover, n.d.; Fields, 2024). For example, replacing a purely monetary bonus system with gamified peer recognition and skill badges has been reported to maintain high participation while fostering a sense of mastery and

camaraderie (Fields, 2024). By ensuring that employees feel progress is meaningful (not just profitable), gamification can sustain long-term engagement.

The motivational dynamics of gamification are explored in depth by Deterding et al. (2011), who introduce the concept of “game elements in non-game contexts”. Their classification includes achievement systems (points, levels, badges), challenges (quests, discoveries), and social components (leaderboards, collaboration). These principles have been successfully applied in construction, as demonstrated by Leite et al. (2016), where gamification improved transparency and reduced errors on construction sites.

Similarly, case studies in construction safety management illustrate how these game elements can drive behavior change. One program, for instance, incorporated quiz challenges, badges, and a live leaderboard into a safety training module for construction workers; this gamified approach led to a measurable increase in safety knowledge retention and a significant drop in recordable incidents on the job (Calestine, 2023; Kell, 2023). Gamified compliance tools in other industries likewise report higher completion rates and engagement – although experts caution that these elements must be designed carefully to avoid trivializing serious content (Spinify, n.d.). The consistent theme is that points, challenges, and friendly competition, when tied to meaningful goals, can enhance motivation and performance in various domains including construction.

Additionally, the authors emphasize the importance of external and internal motivation for workers. External motivation is considered what the worker receives for completing their task successfully, such as monetary rewards or, non-materially, an increased status at work or recognition. Internal motivation, such as acquiring new skills, satisfaction from achieved results, and self-actualization, is no less important. Many companies neglect this and prioritize only external motivation, which can harm the work process in the future.

Excessive focus on extrinsic rewards can indeed backfire by undermining intrinsic interest. This phenomenon, known as the overjustification effect, has been observed when people come to view an activity as merely a means to an external reward, losing their original enthusiasm. To avoid this, gamified systems must provide more than just prizes – they should offer opportunities for mastery, growth, and autonomy. For example, Wilson (2024) warns that a gamification program built solely around cash bonuses or gift cards may see a burst of participation followed by a lull once the novelty or greed fades. In contrast, a program that also lets employees set personal goals, unlock new learning content, or gain status through helping peers can sustain engagement much longer. Industry experiences support this: some construction firms have combined tangible rewards with coaching and personal development elements, finding that this mix maintains motivation better than cash incentives alone (Workmax, 2022). In summary, a balanced design that rewards good work while also nurturing internal satisfaction is crucial to long-term success.

Within design teams, prior work indicates that incentive structures are most effective when they are contingent on behaviors demonstrably linked to coordination quality. Illustrative examples include crediting accepted clash resolutions rather than raw issue creation, and valuing timely, constructive RFI responses over sheer message volume. The literature also underscores the role of frequent, specific feedback that clarifies what changed and why it mattered; recognition mechanisms

incorporating peer acknowledgment and visibility in sprint reviews appear to reinforce desired practices. Conversely, heavy reliance on monetary rewards has been associated with overjustification effects and a subsequent erosion of intrinsic interest in craftsmanship and learning, suggesting a preference for informational rather than controlling forms of reinforcement.

This mirrors broader gamification guidance in management. Experts advise that gamified systems focus on rewarding meaningful accomplishments and providing informative feedback, rather than dangling arbitrary prizes (ITA Group, n.d.; Spiegel, 2022). For example, a construction firm might award a “Quality Champion” badge when a team resolves all clashes in a model on time – a clearly defined, value-adding achievement – instead of rewarding them simply for logging many hours or issuing many RFIs. Tying incentives to genuine contributions (and coupling them with constructive feedback on how those contributions impact the project) maintains the integrity of motivation. Conversely, if a leaderboard is directly tied to financial bonuses, some participants might game the system or experience stress, undermining the collaborative spirit (Thompson Tractor, n.d.). Thus, emphasizing informational feedback (e.g. progress dashboards, peer recognition in meetings) over pure material compensation can encourage employees to internalize good practices for their own sake rather than solely for a reward.

Based on the sources, it can be noted that the lack of transparency and ineffective communication between management levels and the workforce, along with low employee engagement, unstable workflows, and recurring quality issues that lead to rework, are internal factors that hinder the successful execution of weekly construction plans. Therefore, minimizing communication issues and disturbances is crucial for an effective planning system. To address this, managers should adopt dynamic – and ideally interactive – methods to enhance how information is shared. Moreover, it’s essential that the workforce not only receives the plan but also understands, processes, and commits to following it, as mere information delivery doesn’t guarantee adherence (Leite et al., 2016).

Gamification can contribute to addressing these planning and communication challenges. Turning the planning process into a more interactive, game-like experience helps ensure that crews truly absorb the weekly plan. For instance, some construction teams use brief daily “missions” or quizzes on a mobile app to confirm that each crew member has understood the day’s tasks (Workmax, 2022). Such an approach transforms passive plan dissemination into active engagement: workers earn points or acknowledgments for correctly answering questions about the plan or for flagging issues early, thereby reinforcing their commitment. Early industry reports suggest that these kinds of micro-engagement techniques have boosted participation in planning meetings and reduced downstream deviations, as employees feel more involved in shaping and executing the plan (Workmax, 2022).

Dynamic, interactive practices can translate the plan into commitment: short stand-ups with visual progress cues, quick polls to confirm understanding, and micro-acknowledgments for blocking issues surfaced early.

Gamified prompts should prioritize clarity and signal when help is needed, not merely celebrate activity. When transparency increases, communication noise may rise too; adopt light rules-of-engagement for notifications so signals do not get drowned in alerts.

Hamari et al. (2014) further analyze psychological drivers, showing that gamification enhances perceived competence and autonomy, leading to sustained engagement. Their findings align with Self-Determination Theory (Ryan & Deci, 2000), suggesting that intrinsic motivation is bolstered by gamified systems that provide feedback and a sense of accomplishment.

Empirical evidence across sectors supports these psychological effects. A systematic review of gamification literature found that interventions commonly boost users' sense of efficacy (competence) and control (autonomy), which in turn correlates with higher sustained engagement and adherence (Croon et al., 2021). In construction contexts, enhancing workers' feelings of competence might mean providing immediate feedback when, say, a clash is resolved or a safety hazard is reported, so they see their skills making an impact. Aligning gamified feedback with these intrinsic needs ensures participants remain internally motivated to continue using the system beyond the initial novelty period.

Self-Determination Theory can be turned into design checks: (a) competence – progressive challenges, coaching tips, and mastery paths; (b) autonomy – meaningful choice among tasks, the ability to opt in to competitive views, and self-set micro-goals; (c) relatedness – cooperative streaks and shared achievements that reward helping behaviors. Warning signs include controlling badges that feel like surveillance or leaderboards that widen gaps; mitigate by using cohort-tiered boards, relative improvement metrics, and private modes.

These principles are echoed in user experience best practices for gamified design (Designlab, 2024). A gamified system should strive to fulfill users' needs for competence, autonomy, and relatedness by design. For example, providing players with some control over their in-game goals or avatars can enhance their sense of autonomy and personal investment. Likewise, team-based achievements and cooperative “streaks” address relatedness by highlighting group success rather than individual rivalry (Smartico.ai, 2025a). On the flip side, one must avoid features that could be perceived as punitive or overly controlling. A badge that merely tracks whether someone is “working” can feel like a monitoring tool and erode trust. Many leading gamification platforms recommend using private or anonymous leaderboards and grouping users into peer cohorts to ensure competition remains fair and encouraging (Smartico.ai, 2025a). By implementing such safeguards (e.g. showing relative improvement rather than raw scores or allowing employees to opt out of public ranking), organizations can prevent scenarios where gamification demotivates the very people it is meant to engage.

For effective gamification implementation, it is necessary to understand which motivational traits most significantly influence user engagement in the game process. Kán et al. (2021) proposed a new methodology for monitoring construction information through gamification, contrasting it with traditional automated monitoring using sensors. Users used their personal mobile devices to identify objects and collect data. Using the mobile game created by the authors, users gathered data, earned points, and competed against each other for external motivational rewards. One of the objectives of the research was to identify the most motivating gamification strategy and concluded that the main sources of motivation for users were data collection and communication with colleagues (Kán et al., 2021). The article also provides an argument that motivation plays a decisive role in the approach. Users' motivation to follow the game mechanics decreases when the game remains unchanged, and users get tired of repetitive actions. Therefore, the authors note that it is important to update mechanics and create more advanced tasks to increase or maintain player engagement. Thus, three main game

mechanics that most influence participant engagement and motivation can be identified: points allocation, leaderboards to enable competition and user communication, and engagement cycles to sustain employee activity.

Findings from Kán et al. (2021) underscore two important insights: (1) the social aspect (user communication) was as critical as the points and leaderboards themselves, and (2) static game systems lose appeal over time. The importance of social interaction as a motivator is well-recognized across industries – successful gamified platforms often build in chat, commenting, or team challenges to leverage users’ desire to connect (Smartico.ai, 2025a). In construction projects, this might translate to features that allow team members to congratulate or “like” each other’s achievements, turning the leaderboard into a forum for positive feedback rather than a sterile ranking.

Equally, the need to continually refresh game mechanics aligns with industry insight: outdated gamification methods may gradually lose their effectiveness if they do not evolve (Chellappa, 2023). Many organizations have learned that a gamification program launched with fanfare can see participation drop off after a few months if it becomes repetitive. To combat this, Chellappa (2023) recommends regularly introducing new challenges, levels, or rewards – essentially treating the gamified system itself as a product that requires updates and “patches” to keep users interested. The Kán et al. study validates this approach by observing that user motivation dipped once the novelty wore off, until new tasks were introduced.

Findings about motivation decay align with practical experience: when loops do not evolve, attention drifts. Rotate challenges by season, retire mechanics that are saturated, and introduce mastery levels so progress remains meaningful. Ensure that leaderboards facilitate communication rather than silence it: allow comments or endorsements tied to helpful actions, and weight points toward behaviors with demonstrable coordination value. Where data collection is involved, make the purpose and scope explicit and keep user control over visibility to maintain trust.

2.3. Ethical and Cultural Considerations

In organizational settings, consent is meaningful only when participation is genuinely optional and alternatives exist. To avoid perceived coercion, separate gamified views from mandatory workflows: allow opt-in for competitive elements (leaderboards, tiers), provide private modes, and default to group-level visibility unless individuals choose to reveal their standings. Recognition should emphasize team achievements and helpful behaviors rather than rank alone.

Practitioners likewise stress that gamification must remain voluntary to preserve trust. Many internal gamification programs make it explicit that employees can opt out or participate anonymously if they wish (Spinify, n.d.). For example, a company might have an opt-in leaderboard for sales performance where those uncomfortable with public rankings can hide their identity or view their own stats privately. Emphasizing team-based rewards over individual rankings is also seen as a way to avoid fostering unhealthy competition or anxiety (Smartico.ai, 2025a). By defaulting to collaborative goals and offering anonymity options, organizations can prevent gamification from feeling like surveillance or coercion.

Ethical concerns in professional gamification are addressed by Kim (2015) and Marczewski (2017). Kim (2015) warns against behavioral manipulation, advocating for user autonomy, while Marczewski (2017) establishes two core principles: transparency of purpose and informed consent. These considerations are critical in information environments, where gamification often involves performance tracking and data collection.

Scholarship on ethical gamification in AEC/BIM increasingly treats transparency as a set of operational practices rather than an abstract ideal. Commonly cited elements include a plain-language data inventory that specifies what is measured, why it is collected, how long it is retained, and who can access it; an explicit account of the scoring logic for points and badges; and an appeals pathway for contesting metrics.

Implementing such transparency aligns with general data management standards in construction. For instance, ISO 19650-2 (2018) – the BIM information management standard – underscores the importance of clearly defining how information is handled and shared. Similarly, a gamified coordination system should document its “rules of the game” in plain language, so that users understand exactly what data is being collected and how scores are computed. Providing an accessible explanation of the points system and ensuring people know how to question or correct their scores (akin to an appeals process) can greatly increase trust in the system.

Measurement scopes are typically constrained to coordination-relevant signals (e.g., accepted issue closures, timely RFI responses), while proxies that are easily gamed or weakly tied to coordination quality are avoided. In parallel, several authors caution against repurposing gamification indicators for formal appraisal or discipline, positioning them instead as inputs for feedback, learning, and recognition.

This demarcation is important in practice. Many companies have learned that if gamification metrics become directly tied to performance evaluations, pay raises, or disciplinary actions, the nature of participation changes for the worse (Spinify, n.d.). Employees might focus only on the measured activities to the detriment of unmeasured ones, or they may attempt to game the system (for example, by quickly closing issues without truly resolving them, just to earn points). Therefore, it is often emphasized that gamification data be used for informal recognition and personal development. Managers can acknowledge top contributors or use the metrics to identify where coaching is needed, but avoid using these scores as rigid performance KPIs for HR decisions. Maintaining this separation positions the game layer as a positive feedback and learning tool, rather than a new form of employee surveillance.

A complementary strand emphasizes data minimization by design. Here, implementations collect the smallest dataset consistent with the stated purpose, prefer derived indicators over raw telemetry, and apply short retention windows for personal traces. When immersive tools are involved, the focus is placed on recording actionable outcomes decided during sessions rather than storing raw video, audio, or spatial tracking. Access to person-level metrics is typically role-based and limited to the smallest necessary audience, and opt-out mechanisms are provided for individuals who prefer not to appear in public rankings.

Data confidentiality and privacy are critically important not only for protection of information but also to ensure individual freedom and trust in the workplace (Yalcin, 2024). Surveys of employees often reveal greater acceptance of gamified systems when they are confident that their personal data is minimal, secure, and used solely for agreed purposes (Oke et al., 2023). Adopting privacy-by-design measures – such as anonymizing data where possible, purging detailed personal logs after short periods, and letting users control what aspects of their performance are visible to others – can significantly improve user trust. In the study by Kan et al. (2021), for example, employees noted that the gamified data collection felt less intrusive and more privacy-preserving than an automated sensor system, precisely because they had more knowledge and control over what data they were submitting. This suggests that giving users a choice in using certain mechanics and being transparent about data usage makes the approach feel less like surveillance and more like a collaborative tool.

As already mentioned, for gamification to be ethical, its tools must be voluntarily applied by users. It is necessary to maintain user trust to increase the demand for the use of game mechanics at work. An important aspect of trust is data confidentiality. Data confidentiality is critically important not only because of the data protection itself but also to ensure individual freedom (Yalcin, 2024). To ensure reliable data confidentiality, it is necessary to implement safeguards against data leakage and also give users a choice in using certain mechanics. The article by Kan et al. also addresses data confidentiality. According to surveys of employees after applying a gamified approach to data collection, as opposed to automated data collection using sensors, it was mentioned that the gamified approach provided much easier data confidentiality compared to sensors, which may provide a certain level of monitoring without employees' knowledge (Kan et al., 2021).

Recent accounts of fairness in gamified coordination emphasize how incentives interact with roles and workloads. Rather than privileging absolute totals, score trajectories are interpreted relative to a team's own baseline, with distributions periodically audited by role and seniority so that disciplines facing heavier issue volumes or distinct review cadences are not disadvantaged. Cohort-tiered leaderboards and group targets are frequently cited as mechanisms that encourage cross-discipline support. To reduce gaming, rulesets tend to privilege points for accepted closures, apply caps per sprint, and weight events by severity.

Ensuring fairness also means calibrating the game to different job realities. A design discipline that only encounters a few clashes should not be ranked directly against a discipline that resolves hundreds of clashes weekly. As suggested, normalizing scores within peer groups and periodically reviewing the scoring by role can prevent inadvertent bias. Many modern gamification frameworks include such normalization techniques to maintain equity (Wilson, 2024). Furthermore, setting team-based goals (e.g., rewarding all teams that reduce coordination issues by a certain percentage) encourages cross-team support rather than zero-sum competition. Some organizations implement cohort leaderboards where, say, all site supervisors are compared only against each other, and separately all designers against each other, recognizing that their workloads differ (Fields, 2024). By interpreting performance relative to a team's historical baseline, improvement is rewarded in context, which feels fairer and keeps everyone motivated.

Cultural context also shapes uptake. In settings where head-to-head competition may suppress participation or dissent, studies describe greater acceptance of cooperative mechanics, peer

endorsements, and narrative progress in place of rank orders. Where competitive framing is welcomed, safeguards typically include rotating challenges to mitigate fatigue, spotlighting constructive collaboration, and ensuring that success does not depend on generating unnecessary work items.

Cultural differences are indeed significant in how gamification is perceived. In some organizational cultures or regions, an openly competitive game (like a public leaderboard of top performers) might be met with discomfort or even resistance. For example, in a traditionally hierarchical or collectivist environment, singling out individuals as “winners” can suppress open communication or discourage those lower on the leaderboard from voicing opinions. In such cases, cooperative and narrative-based gamification elements tend to be better received – for instance, using a shared progress story where the entire team “levels up” together (Hooijdonk, n.d.). On the other hand, in cultures or teams that thrive on competition, a bit of rivalry can be motivating, but even then it should be implemented with care. Best practices include rotating the types of challenges (so the same people don’t always win), highlighting examples of constructive collaboration (to make clear that helping others is valued), and ensuring that nobody can boost their score by creating unnecessary work (Smartico.ai, 2025a). Ultimately, tailoring the gamification approach to the organization’s cultural context is crucial for acceptance and success.

Governance practices reported in the literature are deliberately lightweight: a designated data steward; periodic metric reviews with representatives from each discipline; versioning and change logs for scoring rules; and short pilots preceding broader rollout. User sentiment is sampled over time – often along autonomy, competence, and relatedness – to identify mechanics that warrant retirement or redesign.

Continuous feedback and oversight are key to sustaining an ethical and effective gamification program. Many organizations starting gamification will run a small pilot project first, gather feedback, and refine the rules before scaling up (Spiegel, 2022). During implementation, having a data steward or a small governance committee helps monitor how the gamification is functioning and how employees feel about it. Surveys or interviews can gauge if people feel in control (autonomy), capable (competence), and connected (relatedness) – the core SDT factors – and if any game feature is undermining these. If, for instance, an anonymous survey reveals that a monthly competition is causing stress or fostering undesirable behavior, the rules can be adjusted or that mechanic can be retired in the next “version” of the game. Maintaining a change log for the gamification rules (e.g., documenting when the scoring formula is tweaked) and involving representatives from different disciplines in those decisions fosters transparency and buy-in. This iterative, inclusive approach to governance ensures the gamification system remains fair, motivating, and aligned with project values over time.

Boundaries of use are documented in advance, commonly excluding covert tracking, data sale, and any linkage of gamification scores to pay or disciplinary actions.

2.4. Technological Integration and Automation

Bhat et al. (2023) highlight the role of automation tools like BIMQ (for requirement management) and Power BI (for data visualization) in streamlining gamified BIM workflows. The use of AR devices

(e.g., HoloLens) enhances user immersion, a finding supported by Kapogiannis et al. (2021), who demonstrate that AR-based gamification improves the end-user experience due to the ability to walk through the digital model environment using HoloLens.

Industry software ecosystems are increasingly conducive to such integration. For example, Autodesk's BIM Collaborate platform (Autodesk, n.d.) and similar cloud-based collaboration environments provide a central source of truth for project data that gamification modules can tap into for live updates. On the visualization side, embedding game mechanics into familiar tools like Power BI dashboards is a pragmatic way to introduce gamified feedback without requiring users to learn a new system. Meanwhile, research trials confirm the value of immersive technology: Abouelkhier et al. (2024) found that construction management students using a 4D-BIM VR simulation detected significantly more errors in a project sequence than those using traditional 2D drawings, showcasing how combining BIM data with VR's interactivity can enhance users' understanding. Kapogiannis et al. (2021) further reported that integrating design models into a dynamic AR environment led to designs more closely aligned with client needs and even faster project completion, underlining the practical benefits of AR-enhanced gamification for end users and stakeholders.

Leite et al. used the Python programming language to create a web application using a cloud data storage service to create a system for improving worker productivity and engagement. Kán et al. (2021) used Unity3D for implementing a mobile game for building information monitoring, while Google Sheets were used for data storage, and data transfer occurred via Google API.

These examples illustrate the range of technical stacks employed in gamified AEC applications. In some cases, custom-developed web apps (like the one by Leite et al.) are built to integrate with BIM databases or project management systems, providing a tailored interface for the "game." In other cases, off-the-shelf tools and lightweight integrations suffice: Kán et al.'s use of Google Sheets and APIs shows that even readily available cloud services can be stitched together to create a functional gamified system. The choice of technology depends on the scale and nature of the problem being addressed. Industry experts emphasize selecting the platform that aligns with the engagement goals (Smartico.ai, 2025b). For instance, a mobile application or responsive Progressive Web App might be ideal if on-site data capture or real-time feedback to field crews is needed, whereas a web dashboard or plugin might work better for office-based coordination and analytics. The key is to integrate with existing workflows and devices rather than forcing users onto an unfamiliar platform. In many pilot projects, a mix of low-code solutions (like simple databases, spreadsheets, or existing project management tools) is used to prove the concept before investing in more complex, scalable custom software.

To make these tools work coherently on real projects, teams benefit from a simple end-to-end pipeline: 1) source-of-truth in the CDE and authoring tools, 2) scheduled ETL that extracts issues, RFIs, and model validation results, 3) a metrics layer that derives coordination KPIs such as clash-closure velocity, issue half-life, and RFI SLA adherence, 4) a game layer that converts KPIs into points, badges, and cooperative streaks, 5) user-facing dashboards or XR scenes, and 6) governance for consent, visibility, and audit.

Automation can be implemented with low-code orchestrations (for example, Power Automate or similar job schedulers) or with Python scripts and APIs. The critical rule is to tie rewards to verifiable states – accepted closures, validated uploads, acknowledged decisions – rather than to raw activity volume.

This principle is vital to avoid encouraging the wrong behaviors. Experience has shown that if points are awarded for superficial actions (e.g., opening a lot of issue tickets, regardless of quality), participants may “cheat” the system by spamming low-value actions. An example comes from corporate training: in one company’s early gamified compliance course, employees were rewarded simply for completing modules quickly, which led some to rush through without learning much. The program was later revised to reward demonstrated retention of knowledge instead, which yielded true improvements in compliance (Ethico, n.d.). The lesson is clear: gamification metrics must be rooted in outcomes that matter. In the construction context, this means, for example, that a point should only be awarded when an issue is actually resolved and approved, not when it’s merely raised. Industry guidance on gamified reward programs echoes this need for transparent and verifiable criteria (ITA Group, n.d.). By anchoring points and badges to genuine accomplishments (like “zero clashes in this week’s model update” or “responded to all RFIs within the SLA timeframe”), the system maintains credibility and steers users toward productive behaviors.

Based on the reviewed articles, it can be concluded that the technical aspect of gamification integration depends on the tasks it is set to solve. If the goal is to make information more transparent and easier to consume, Power BI can be used. If the goal is to involve a large number of employees in a complex system of worker engagement, the creation of a web application may be necessary. If the goal is to collect information from mobile devices, a mobile application implementation would be required.

Thus, the technological implementation should align closely with the intended outcomes. A safety-focused gamification aiming to get construction crews to report hazards in real time would likely need a mobile app or phone-based interface, since workers are on-site (Kell, 2023). On the other hand, if the objective is to increase transparency of model data among a wide range of project stakeholders, a web-based dashboard or portal (potentially using a business intelligence tool like Power BI or a BIM viewer) might be the best medium (Kosasih, 2024). Each delivery method (BI dashboard, web app, mobile app, or XR experience) has strengths: BI dashboards excel at slicing data for management insight, web applications can handle complex interactions and user management for large groups, mobile apps capture on-site inputs instantly, and XR provides immersive understanding for design and training. Selecting the right medium ensures that the gamification layer naturally integrates into users’ routines and addresses the specific challenge at hand.

For transparency-focused scenarios, the minimal viable stack is ETL to a tabular store and a BI dashboard that visualizes progress and flags risks. For large workforce engagement, a web application adds identity, roles, and contribution workflows, plus event logging for audit and an administrative console to adjust mechanics without redeploying. For mobile data collection, a lightweight app can push structured observations – stamped with time, location, and role – to a secure backend; data should be validated at entry and deduplicated on ingest.

Across implementation patterns, the literature converges on a lean data model comprising unique identifiers for issues and tasks, timestamps for state transitions, severity and discipline tags, and references to the originating model or document. Quality assurance is commonly automated through schema validation and rule-based checks executed prior to scoring.

A standardized data schema not only simplifies internal development but also improves interoperability between tools. There are ongoing efforts to define common gamification metrics in project management and BIM coordination so that organizations can benchmark and researchers can compare results across studies (Spiegel, 2022). Aligning the gamification data model with existing BIM data standards (such as using issue IDs that link to the CDE, employing standard phase/stage codes, etc.) is advisable to avoid redundancy or confusion. The Interaction Design Foundation (n.d.) similarly emphasizes that measurability is key: if you can't measure an event in a reliable, standardized way, it shouldn't be part of the gamification scoring. By settling on a minimal set of clear KPIs (e.g., number of clashes resolved, average response time to issues, percentage of tasks completed on time) and structuring the data around them, a gamified system ensures consistency and comparability across different projects and even different companies.

To mitigate gaming, scoring functions are frequently limited to accepted closures, weighted by severity, capped at the sprint level, and complemented by anomaly detection for bursts of low-value activity.

These anti-gaming measures echo Marczewski's (2017) guidance on avoiding the pitfalls of "pointification." If the system blindly rewards activity counts, users might engage in unproductive behaviors (like splitting one issue into ten trivial ones to get more points). By capping points per period (so you can't score infinite points in one sprint) and weighting events by their importance, the system discourages abuse. Some advanced implementations even include anomaly detection algorithms to flag unusual behavior – for example, if a user suddenly completes an implausibly high number of tasks in a short time, their points might be flagged for review to ensure those tasks were legitimate. Maintaining the integrity of the game rules is crucial for user trust: if employees see colleagues exploiting the system unfairly, it will quickly undermine morale. Thus, clear rules (no rewards for low-severity tasks beyond a threshold, etc.) and monitoring are necessary to keep the gamification fair and meaningful (Marczewski, 2017).

Integration practices associated with maintainability include a unified field-naming convention, centralized management of connection strings and credentials, and the use of parameterized queries in place of embedded code. Refresh cadences are typically aligned with coordination rituals (e.g., pre-meeting updates), with buffering for late-arriving data to reduce dashboard oscillation.

Where XR is employed, decisions made during sessions are written back to the CDE as structured records, supporting auditability of automated scoring.

This feedback loop is essential for combining immersive tech with traditional project management. If, for instance, architects and clients make design decisions in a gamified VR session, those decisions (like "adjust window size" or "change material X to Y") should be captured as formal action items or BIM updates in the CDE. Enab et al. (2023) highlight that one limitation in some VR design tools is

the lack of integration with project records—addressing this by writing back outcomes bridges the gap between exploration and execution. Therefore, any XR-based gamification should include a mechanism (even if manual) to translate in-game actions into real project data (issues, change requests, etc.), ensuring the game contributes tangible value and is auditable.

Security and privacy are treated as design requirements: least-privilege service accounts, role-based access to person-level metrics, short retention of personal traces, and a clear separation between gamification feedback and formal performance appraisal. Operational governance often includes a versioned change log for metric formulas and mechanics, small-scope pilots prior to scale-up, and basic observability – lightweight logs and alerts for failed jobs – to sustain pipeline reliability and trust.

In summary, the technological integration of gamification demands as much rigor as its human-centered design. Early adopters have noted the importance of rolling out new gamified tools in a controlled manner and closely monitoring both technical performance and user reception (Workmax, 2022). For example, a company might start with a pilot on one project, log any errors or downtime in the gamification data pipeline, gather user feedback weekly, and maintain a changelog of adjustments to game mechanics. This iterative deployment helps catch issues early and build confidence in the system’s reliability. As the gamification scales to more teams or projects, maintaining least-privilege access (so only necessary data is exposed and only authorized individuals can see detailed metrics) and keeping the system’s data processing transparent (with alerts if any part fails) are key to sustaining trust. In essence, successfully integrating gamification technology means treating it as a live system that is continuously evaluated, refined, and governed alongside existing project management processes.

2.5. Research Gaps and Conclusion

Although gamification in BIM and construction management has attracted increasing attention, literature still reveals several important gaps. Two of them are particularly relevant for the present study, and the subsequent work gives specific attention to these aspects:

- Long-term effects. Most studies focus on short-term outcomes immediately after implementation, leaving open the question of whether gamification can sustain motivation, creativity, and coordination efficiency over time.

This dissertation takes this gap into account by examining longitudinal performance indicators such as clash resolution rates, issue lifecycles, and sustained participation, in order to observe whether initial improvements persist beyond the novelty effect.

- Integration with design team practices. Current approaches rarely address the specific needs of design teams, where creativity and collaboration play a decisive role.

This dissertation acknowledges this gap by exploring cooperative mechanics tied to verifiable BIM outputs (e.g., accepted clash closures, timely RFI responses) and by assessing how such mechanisms influence motivation and coordination without constraining design culture.

2.6. Summary of the Literature Review

The integration of gamification with BIM and construction management is a nascent yet promising area of research and practice. Early studies and pilot projects have shown that even modest game elements can yield improvements in engagement, learning, and collaboration. At the same time, the literature highlights several gaps that require further attention, particularly with regard to the long-term impact of gamification and its adaptation to the practices of design teams.

These aspects indicate where existing studies remain limited and where future investigations may provide valuable insights. By considering both the durability of gamification effects and the specific cultural and organizational context of design teams, the literature review points to areas that deserve closer examination in subsequent research.

In sum, gamification offers a rich toolkit for addressing persistent challenges in construction – from engagement and motivation to data transparency – but its effective application will depend on careful, context-sensitive implementation guided by ongoing research.

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3. METHODOLOGY

The methodological part of this dissertation is designed to bridge theoretical analysis with practical implementation. It follows a structured progression: from identifying the recurring coordination problems faced by project participants, to designing a gamification framework that directly addresses these issues, and finally to demonstrating its applicability through the development of dashboards and user guidelines.

3.1. Practical difficulties encountered by design teams

The difficulties described in this dissertation do not arise from abstract theorizing but stem directly from professional practice. They were identified through the author's own experience in project teams, combined with the long-term expertise of the dissertation supervisor, António Meireles, whose coordination work at ndBIM Virtual Building exposed similar recurring issues across multiple projects. Taken together, these observations provide a representative picture of the practical barriers that design teams, clients, and institutional stakeholders continue to face despite the increasing maturity of BIM processes.

A central conclusion emerging from this joint experience is that difficulties are not confined to a single group of participants. Instead, they permeate the entire design and coordination ecosystem: municipal authorities, clients and owners, external design teams, and the internal teams of designers themselves. By mapping challenges across all these categories, it becomes possible to reveal systemic patterns of inefficiency that hinder the effectiveness of BIM as a collaborative methodology.

- Difficulties on the side of institutional entities.

From the perspective of municipalities and other authorities, delays in project approvals and inconsistent or frequently changing requirements are a common obstacle. Lack of transparency in procedures further complicates the ability of design teams to anticipate expectations and plan deliverables accordingly.

- Difficulties on the side of clients and owners.

Clients often introduce uncertainty into the process by providing delayed or conflicting feedback, or by repeatedly changing project requirements during the design phase. At the same time, their limited involvement at crucial moments in the design process leads to misunderstandings and rework, reducing the efficiency of collaborative decision-making.

- Difficulties in collaboration with other design teams.

When multiple external teams participate, poor coordination between disciplines becomes a recurring source of clashes and delays. Deadlines missed by one party quickly cascade into the schedules of others, eroding trust and reducing the overall reliability of the delivery process.

- Difficulties within internal design teams.

At the level of a single project team, inefficiencies take a different form. These include unclear distribution of responsibilities, lack of motivation, and poor internal communication. Problems with version control and document management are particularly harmful, often leading to rework and duplication of effort. Unrealistic deadlines exacerbate these issues, leaving little time for quality assurance and further training

These challenges, though diverse in nature, form a coherent picture of the practical difficulties encountered in design coordination. They highlight how inefficiencies manifest at every layer of project interaction – from institutional approval processes to client engagement, from inter-team coordination to the daily functioning of internal project groups. The intention here is not to single out only the most critical issues, but rather to capture the spectrum of recurring problems across all types of project participants. This broad perspective is essential, as it demonstrates that gamification has the potential to address inefficiencies at multiple levels of the design and coordination process, influencing institutional actors, clients, external teams, and internal project groups alike.

On this basis, the identified problems were systematized according to the level of participation in the project. Each group is presented below with numbered labels, which will be used for reference in the following chapters.

Table 1 – List of defined problems in design

Group	Problem
A. Issues with institutional entities	A1. Delays in project approvals
	A2. Unclear or frequently changing requirements
	A3. Lack of transparency in procedures
B. Issues with the client	B1. Delayed or conflicting feedback
	B2. Frequent changes in project requirements
	B3. Lack of client involvement during design
C. Issues with other design teams	C1. Poor coordination between disciplines
	C2. Missed deadlines by other teams
	C3. Unclear distribution of responsibilities
D. Internal issues within the team	D1. Low motivation
	D2. Poor internal communication

D3. Rework due to errors

D4. Unrealistic deadlines

This structured classification provides a comprehensive overview of difficulties encountered by all project stakeholders, serving as the foundation for analyzing how gamification mechanisms can be applied to mitigate them across different levels of project interaction.

3.2. Gamification principles and techniques applicable to BIM workflows

The transfer of gamification concepts from other industries to construction requires a careful assessment of their relevance and applicability. While education, marketing, and management have successfully employed game-based strategies to increase engagement, not all such methods are suitable for the professional workflows of design coordination. In the context of BIM, gamification must be pragmatic, reinforcing compliance, collaboration, and a transparent sense of responsibility without trivializing complex tasks. Below is a review of gamification mechanics that have the strongest potential to be adapted for design coordination processes.

1. Points and Scoring Systems

Point systems represent the most universal gamification mechanism, applied across nearly every industry. Their strength lies in the simplicity of translating actions into measurable values. In the BIM context, this approach can be adopted without difficulty: any action that contributes to project advancement can be converted into points. The accumulation of points creates visibility of effort and contribution, allowing processes that usually remain hidden to become transparent and quantifiable.

2. Badges and Levels

Badges provide recognition of specific achievements or milestones, while levels offer a more cumulative evaluation of performance, usually based on the number of points earned. This dual system combines short-term acknowledgment (badges) with long-term progression (levels), giving participants both immediate rewards and a clear sense of growth over time. Such mechanisms support not only motivation but also provide a structured way of demonstrating competence and reliability.

3. Leaderboards and Weekly Rankings

Leaderboards introduce a comparative dimension by making performance visible across individuals or teams. To avoid excessive hierarchy or demotivation, one promising approach is the use of weekly leaderboards, which reset regularly. This creates a “healthy competition,” ensuring that every participant has equal opportunities to appear among the leaders each week, regardless of their previous standing.

4. Progress Tracking and Progress Bars

Progress indicators make ongoing work visible and tangible. Progress bars show participants how close they are to completing specific tasks, deliverables, or collective goals. This provides continuous motivation and helps participants understand their contribution to broader project milestones. Unlike abstract reporting, progress visualization makes advancement intuitive and engaging.

5. Feedback and KPI Dashboards

Structured feedback is central to sustaining motivation. Dashboards that highlight key performance indicators (KPI) give participants a clear picture of current results. The advantage of KPI visualization lies in transparency: individuals and teams can immediately see where processes stand, where progress is strong, and where attention is required.

6. Quests and Challenges

Quests frame tasks as short-term objectives with defined outcomes and rewards. They introduce an element of novelty into otherwise routine workflows and create momentum by breaking complex processes into smaller, more approachable tasks. Challenges can be individual or team-based, encouraging both personal responsibility and collaborative effort.

7. Simple Visual Indicators

Beyond detailed dashboards, very basic indicators can also drive engagement by providing instant clarity. Color-coded signals (e.g., red – critical, yellow – acceptable, green – good) allow participants to assess the status of processes at a glance, without the need for detailed analysis. Such indicators combine simplicity with effectiveness, making them a powerful addition to the gamification toolkit.

In summary, all of the described mechanics, in varying degrees of detail, are applied in the further development of this work to address the identified problems. Some are explored conceptually as general principles, while others are implemented more concretely in the design of gamified dashboards and workflows. Together, they provide the methodological foundation for linking gamification techniques with the practical difficulties faced by project participants.

3.3. Gamified Dashboards and Their Link to Identified Problems

The developed dashboards were explicitly designed to address the problems identified earlier, with each one coded according to the corresponding problem. This coding system ensures traceability and makes it clear which coordination issue each dashboard is intended to mitigate. The full visual representations of all dashboards can be found in the Appendices.

The Project Approval Processes Dashboard (A1) consists of simple visual elements that enhance the transparency of document flows between municipal authorities and the design team. After the required documents are uploaded into the CDE (or by other means), they are registered in the dataset. Municipal authorities then either confirm the correctness of the documents or provide comments. Each participant can subsequently monitor the status of their submissions through a consolidated dashboard using visual indicators. This makes the approval process more transparent and reduces uncertainty in document management.

The BIM Challenge AI Quiz Dashboard (A2B2) was created to make the process of learning and understanding project standards more interactive and accessible. A custom GPT-based model was developed to generate quizzes from the uploaded documentation. The results of these quizzes are aggregated into a shared dashboard, where leaderboards are maintained, badges are awarded, and a positive competitive environment is created that motivates participants to study project standards more actively and achieve higher test scores. The potential outcome of this approach is improved knowledge of internal documentation and standards, which reduces inconsistencies in the project caused by non-compliance with requirements. Frequent changes in project requirements also become less problematic, as the company develops a culture of continuous testing. Since the quizzes are configured to automatically recognize changes in the documentation and focus on newly introduced content, staff are consistently aware of updates and adapt more quickly to evolving requirements.

The Team Request – Client Response (TRCR Game, B1B3) is a shared dashboard accessible to both the project team and the client. It consolidates all requests submitted by the design team to the client and records their entire lifecycle, including deadlines and overdue response times. This allows the client to evaluate their influence on the project and their degree of involvement. At the same time, the system awards badges and honorary titles for timely responses, creating incentives for active and predictable client engagement.

The BIM Clash Gamification Dashboard (C1) gamifies the process of clash detection and resolution. This is the most complex of the developed dashboards, as it incorporates multiple factors. In practice, most tracking systems within project teams focus only on the number of resolved or unresolved clashes, which is useful for project managers but has little impact on motivating those directly involved in resolving them. The developed system instead emphasizes the contributions of each individual engaged in resolving clashes. It introduces leaderboards, weekly and cumulative statistics, points, levels, and badges. This variety of mechanics makes routine operations more engaging and introduces an element of healthy competition into the team, thereby motivating faster and more consistent clash resolution.

The Team Request – Team Response (TRTR Game, C2) records inter-disciplinary requests exchanged between different teams. The system tracks deadlines, overdue response times, and the volume of such requests. Taken together, these factors make it possible to evaluate which team is more often waiting for responses, which team is responsible for delays, and which teams remain balanced. The system also provides a transparent overview of all requests, identifying their initiators and recipients. If a deviation from the project schedule occurs, the dashboard makes it easier to identify the source of the delay and reallocate resources to correct it. For designers, it provides transparency and convenience in tracking the status of requests.

The Discipline Contributor Dashboard (C3) monitors requests both within a single team and across disciplines. It clarifies individual contributions and areas of responsibility, thereby reducing ambiguity and the likelihood of rework. The dashboard provides detailed analytics on each specialist's performance in handling inter-disciplinary requests, including timeliness of responses, the proportion of cases requiring rework, and patterns of missed deadlines. It also displays workload distribution by tracking the number of requests addressed to each employee, along with the impact of their work on

others, such as whether it triggers redesigns or delays. This enables managers to redistribute tasks when necessary and makes responsibilities more transparent to all participants.

Problems of category D are not addressed by standalone dashboards but are either partly mitigated through the dashboards described above or are expected to improve as a result of solving other problems. For example, D1 (low motivation) and D2 (poor communication) can be alleviated indirectly through the motivational and transparency mechanisms of dashboards such as A2B2, B1B3, and C1. Similarly, D4 (rework due to errors) and D5 (unrealistic deadlines) are supported by the Discipline Contributor Dashboard (C3) and related tools, which help clarify responsibilities and reveal workload imbalances.

At the same time, this decision can be regarded as a limitation of the study. The visual component, user-friendly interface, and overall usability have a strong influence on the success of such systems, particularly in terms of their acceptance and sustained use. In this respect, the simplicity and austerity of the Microsoft ecosystem may be seen as a trade-off, allowing the research to focus on conceptual and methodological innovation while leaving interface design and user experience as areas for further development.

Collectively, these dashboards represent a proof-of-concept implementation of gamification principles within BIM coordination. While the mechanics were carefully aligned with specific problems, their effectiveness also depended on selecting an appropriate technological environment for deployment.

The decision to use Microsoft Power BI as the platform for gamification was based on several considerations. First, the application enjoys significant popularity in the field of management and, in particular, within BIM, meaning that most companies already have experience working with it and encounter no major difficulties in its adoption. Second, the primary aim of this research was the development of the gamification mechanics themselves – not only determining “what is rewarded,” but also under which conditions points are allocated, what information sources are used, which calculation methods are applied, what exceptions must be accounted for, and other factors shaping the logic of the system. Third, Power BI was chosen because it is a familiar and reliable tool for the author. This made it possible to concentrate attention on the more complex and important aspects of mechanism design, rather than on mastering a new technological environment.

In summary, the dashboards presented above demonstrate how gamification mechanics can be systematically embedded into BIM coordination workflows, with each tool directly addressing specific recurring problems. While the conceptual framework and implementation logic have been explained, the practical application of these dashboards requires clear operational instructions. For this purpose, dedicated user and coordinator guides were prepared. These guides contain all necessary information for practical deployment and can be applied directly within design teams and client organizations without further explanatory material. The following section presents these guides in detail, outlining their use both for everyday project participants and for BIM coordinators responsible for managing and supervising the system.

3.3.1. C3 User Guide: Discipline Contributor Dashboard

This dashboard is intended for all discipline leads and team members involved in interdisciplinary coordination. It provides individual performance insights for specialists responding to inter-discipline requests in project settings.

The dashboard evaluates how each contributor handles interdisciplinary requests – focusing on timeliness, redesign triggers, and overall discipline.

Goals:

- Increase transparency in cross-disciplinary communication.
- Reduce delays and rework.
- Support a culture of responsibility and improvement.

Dashboard Structure and Visual Elements

- Filter: RespondingPerson

A filter for selecting an individual's name is available in the lower area of the dashboard. When a name is chosen, all visuals automatically update to display only that person's performance data.

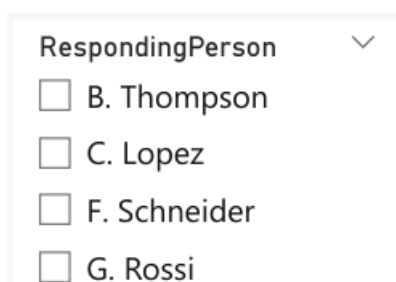


Figure 1 – Filter: RespondingPerson

- KPI Cards
- TotalRequests – Total number of requests for which the selected person provided a response.
- RedesignRequests – Number of requests that resulted in model changes (WasRedesignAfterResponse = Yes).
- AverageDaysToRespond – Average number of days between receiving the request and responding.
- LateRequests – Number of requests responded to after the deadline (ResponseDate > Deadline).

- RedesignRate and LateRequestRate – Percentage of redesign-inducing responses and percentage of late responses, respectively.

The RedesignRate and LateRequestRate cards include conditional formatting to reflect risk levels:

- Green: from 0% up to 30% inclusive – acceptable level.
- Yellow: from 30% up to 50% – requires attention.
- Red: from 50% up to 100% – critical level, immediate action recommended.

This formatting provides visual cues for quick risk assessment.

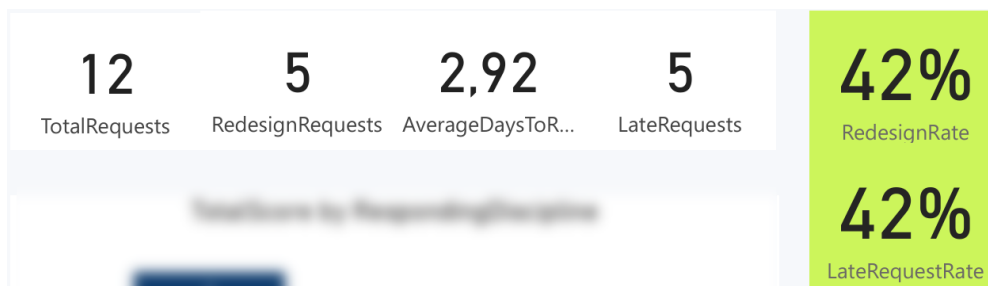


Figure 2 – KPI Cards

- Chart: TotalScore by RespondingPerson

This bar chart functions as a leaderboard – a visual comparison of contributors based on cumulative performance points:

- +10 points – for an on-time response with no resulting redesign;
- –3 points – if the response caused a redesign;
- –5 points – if the response was submitted after the deadline.

Penalties are cumulative if both conditions apply. This visual helps compare efficiency and consistency across the team.

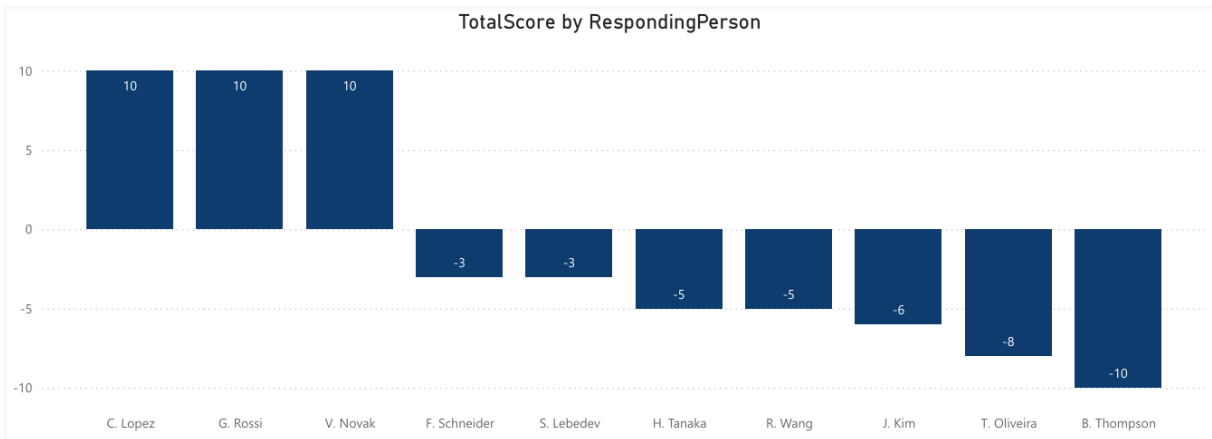


Figure 3 – Chart: TotalScore by RespondingPerson (Leaderboard)

- Chart: TotalScore by RespondingDiscipline

Displays cumulative performance scores grouped by discipline (Architecture, Structure, MEP). This allows project leadership to assess overall execution discipline at the team level.

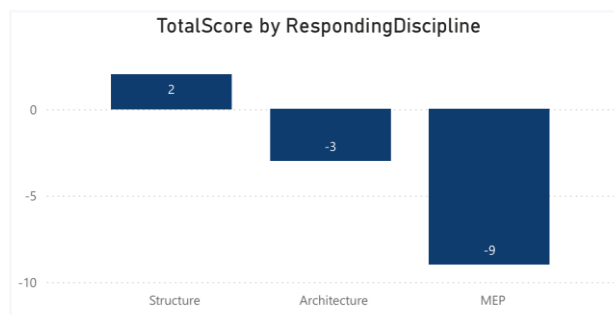


Figure 4 – Chart: TotalScore by RespondingDiscipline

- Chart: LateRequests and RedesignRequests by RespondingPerson

A horizontal bar chart comparing:

- LateRequests – total number of delayed responses per person;
- RedesignRequests – total number of responses that led to design modifications.

This visualization helps identify key contributors to project delays and design instability.

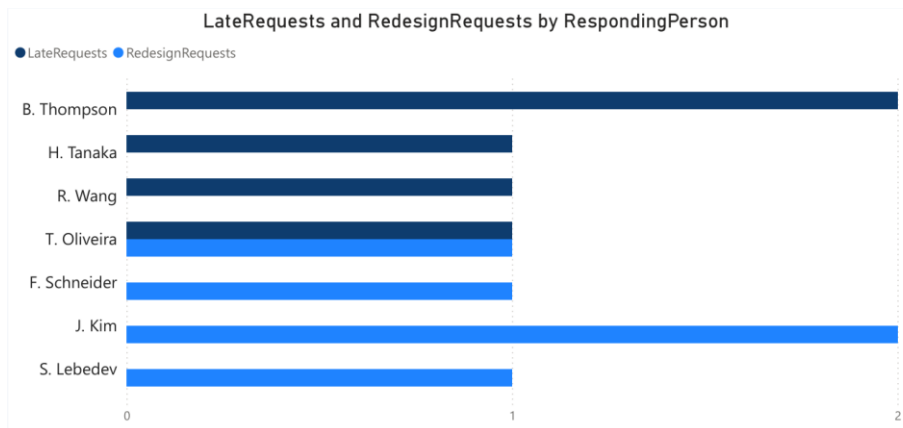


Figure 5 – Chart: LateRequests and RedesignRequests by RespondingPerson

- Task Table

Presents detailed information on all requests handled by the selected person:

- RequestID – Unique identifier of the request;
- RequestDescription – Description of the issue or requirement
- Comment – Response or explanation provided by the responder;
- ResponseDate – Date the response was submitted.

The table is sorted by RequestID to facilitate navigation and cross-referencing with other systems.

RequestID	RequestDescription	Comment	ResponseDate
BCF-0001	Move ventilation shaft	Revised HVAC layout	03.06.2025
BCF-0002	Collision with wall	-	06.06.2025
BCF-0004	Relocate staircase	Adjusted location	09.06.2025

Figure 6 – (Visualisation) Task Table

Practical Use

To assess your personalized performance statistics:

1. Select your name in the RespondingPerson filter (bottom-left).
2. Review the summary cards in the top-right for key metrics on your request handling, including deadlines and consequences.
3. Analyze your position in the leaderboard chart at the top-left.
4. Pay attention to the chart at the bottom-left, showing actual counts of late responses and redesigns caused.

5. If needed, use the task table (bottom-right) to investigate specific cases or verify your responses.

Summary and Value for Users

The Discipline Contributor Dashboard supports project teams by promoting accountability and performance awareness.

When used consistently, this dashboard helps to:

- Reduce late responses and avoid unnecessary rework.
- Improve team responsiveness and ownership.
- Provide objective performance benchmarks for evaluation.
- Strengthen collaborative discipline across specialties.

3.3.2. C3 BIM Coordinator Guide: Discipline Contributor Dashboard

This guide is intended for BIM Coordinators responsible for preparing and maintaining source data, configuring connections in Power BI, and ensuring that the Discipline Contributor Dashboard operates with complete and accurate information.

The Discipline Contributor Dashboard is an analytical tool for monitoring the execution discipline of interdisciplinary requests.

The BIM Coordinator's responsibilities include:

- Preparing and structuring source data.
- Configuring data sources in Power BI.
- Regularly updating information.
- Maintaining consistency and order in project data management.

Required Dataset Structure

The model is based on a single main table: **C3_InterdisciplinaryRequests**.

The required fields are listed in the

Table 2 – Required data for Discipline Contributor Dashboard

Field	Format	Description
RequestID	Text (unique)	Unique request identifier

RequestDate	Date	Request registration date
Deadline	Date	Planned response deadline
RequestingDiscipline	Text	Requesting discipline
RequestingPerson	Text	Request author
RespondingDiscipline	Text	Responding discipline
RespondingPerson	Text	Responsible responder
RequestType	Text	Request type (BCF, RFI, etc.)
RequestDescription	Text	Description of the request
ResponseDate	Date	Date the response was provided
Status	Text	Request status (Closed, Open, etc.)
WasRedesignAfterResponse	Text ("Yes"/"No")	Whether redesign occurred
Comment	Text	Response or clarification
LoadDate	Date	Planned publication date on the server

Note: All fields must be fully completed. LoadDate is set manually by the coordinator based on the planned publication date.

Initial Setup in Power BI

Before beginning work with the dashboard:

1. Open Power BI Desktop.
2. Go to the Power Query Editor.
3. In the existing queries C3_InterdisciplinaryRequests and C3_InterdisciplinaryRequests_New, manually update the Source step to point to the required table.
4. Ensure all fields are loaded correctly and the structure matches the specified requirements.

Once setup is complete, apply the changes and load the model.

Data Update Procedure

Update process:

1. Create a copy of the C3_InterdisciplinaryRequests_New query containing the new data.
2. It is recommended to name the copy using the format: C3_InterdisciplinaryRequests_YYYYMMDD, based on the file's export date.
3. In the new query, update the Source step to point to the corresponding Excel file.
4. In the main C3_InterdisciplinaryRequests query, perform the following: add the new query to the union; sort by the LoadDate field in descending order; remove duplicates by RequestID.
5. After completing these steps, apply the changes.

As a result, the main model retains only the most up-to-date records, while previous data is preserved in individually named queries.

File and Version Management Guidelines

- The main C3_InterdisciplinaryRequests table should be stored separately from temporary data files.
- Query names such as C3_InterdisciplinaryRequests_YYYYMMDD can be adapted by adding a project code, area, or discipline.
- Still, it is strongly recommended to maintain a consistent date format (YYYYMMDD) for orderly storage.
- The folder structure and storage location for the files should be defined by the internal project or department policy.

Summary and Value for BIM Coordinators

By maintaining accurate updates, structured storage, and consistent source management, the BIM Coordinator ensures stable dashboard operation.

When managed effectively, this process:

- Keeps all interdisciplinary request records accurate and accessible.
- Improves project transparency and traceability.
- Supports reliable reporting and analytics for decision-making.
- Increase the scalability and resilience of the model for future projects.

3.3.3. C1 User Guide: BIM Clash Gamification Dashboard

This dashboard is intended for BIM project participants, including discipline leads, coordinators, and team members, who are involved in detecting, resolving, and tracking clashes in the model.

The BIM Clash Gamification Dashboard introduces gamification to the clash resolution process, making it more engaging and performance driven. It helps track progress, foster healthy competition, and recognize individual and team contributions.

Goals:

- Improve transparency in clash management.
- Motivate proactive issue resolution through points, badges, and levels.
- Strengthen accountability and encourage professional growth.

Dashboard Structure and Visual Elements

- Filter Panel

A set of selectors allows you to focus the view:

- Select Team Member – filter data for a specific contributor (email).
- Select Week – filter by week start date.
- Discipline – filter by discipline (e.g., Architecture, Structure).

All visuals on both pages update according to the chosen filters.

The image shows a filter panel with three dropdown menus. The first dropdown, 'Select Team Member', has a person icon and a list of three email addresses: billcheck@gmail.com, johnsmitt@outlook.com, and vlad-molostvov@yandex.ru. The second dropdown, 'Select Week', has a calendar icon and a list of two dates: 26.05.2025 and 07.07.2025. The third dropdown, 'Discipline', has a building icon and a list of two options: Architecture and Structure. Each dropdown has a downward arrow icon to its right.

Figure 7 – Example of selectable metrics

Page 1: Clash Resolution Metrics

- KPI Cards

Provide key indicators related to clash handling:

- Clashes Resolved by Team – number of clashes resolved by team members, including those resolved without user involvement.
- Clashes Closed by Coordinator – number of clashes closed by the coordinator after approval.
- Active Clashes – current number of unresolved clashes.
- Clashes Marked as Accepted – number of clashes marked as resolved by the user and closed by the coordinator (only these award points).

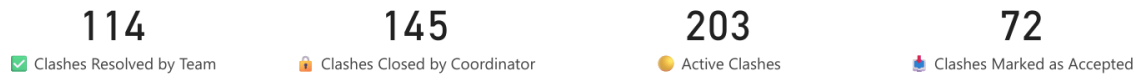


Figure 8 – Main KPIs for the Clash Resolution

- Line Chart: Weekly Points Progress

Displays each participant's weekly progress based on earned points. Point assignment depends on the priority of resolved clashes:

- Minor – 1 point.
- Normal – 2 points.
- Critical – 3 points.

The chart helps monitor personal progress and compare team members.

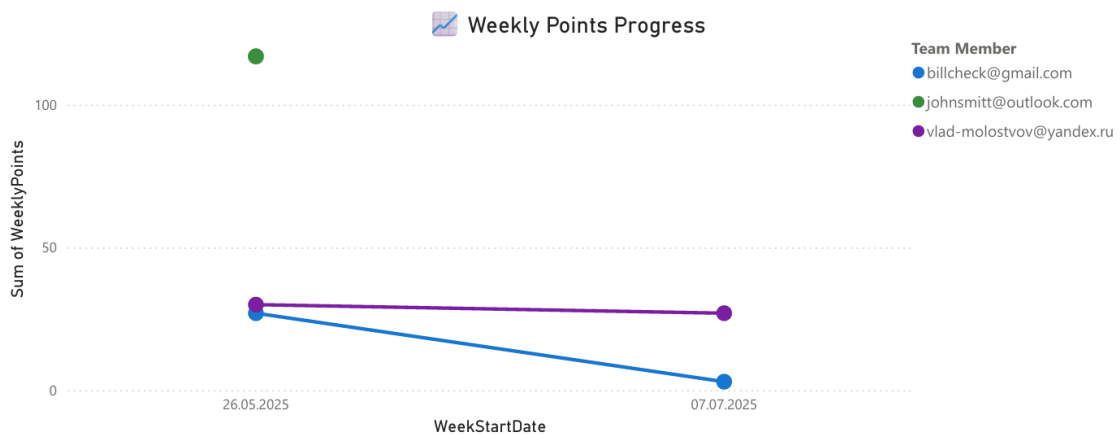


Figure 9 – Weekly updated statistics on points earned

- Column Chart: Count of New Active and Closed Clashes by Date

Shows the dynamics of new and closed clashes by Load Date. The main feature here is the consideration of clashes that appeared or resolved at the time of loading into the project. Old detected clashes will not be displayed in the statistics. It reflects modelling accuracy over time and measures the team's response efficiency.

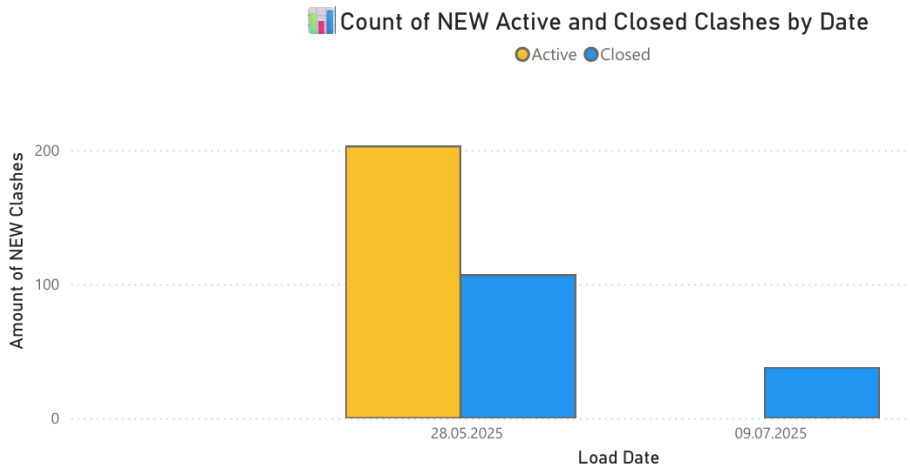


Figure 10 – Dynamics of active and closed clashes

- Bar Chart: Total Points per Team Member

Visual leaderboard of participants based on total earned points for closed clashes.

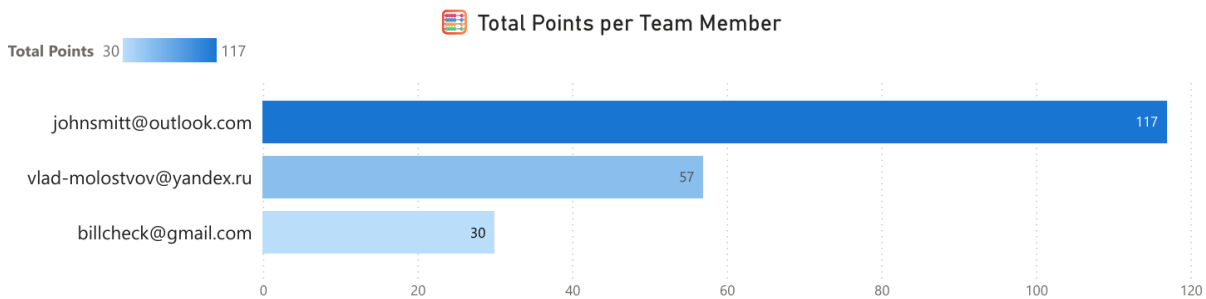


Figure 11 – Leaderboard with distribution of points scored over all time

- Column Chart: Points by Discipline

Displays total points by discipline (e.g., Architecture, Structure), enabling cross-discipline comparison.

- Matrix: Priority and Closed Clashes

Shows the number of closed clashes per participant, broken down by priority (Critical, Normal, Minor).

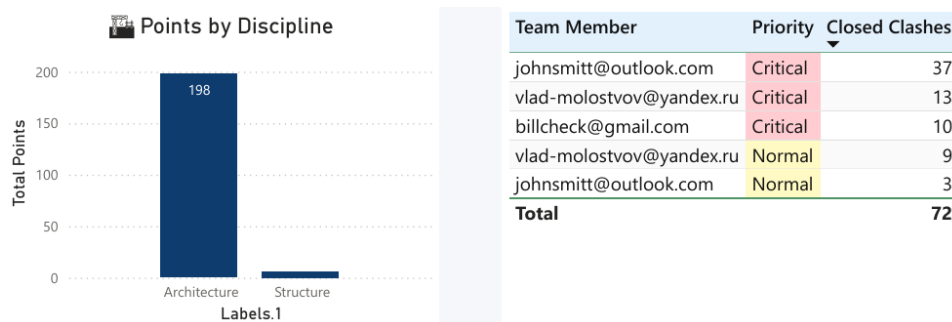


Figure 12 – Column Chart “Points by Discipline” with Matrix “Priority and Closed Clashes”

Page 2: Gamification and Progress

- Progress Bar: Progress Toward Next Level

Indicates progress toward the next level:

Table 3 – Accepted levels in the game

Level	Points Range
Beginner	0 – 100
Intermediate	101 – 250
Advanced	251 – 500
Expert	501 – 1000
Master	1000+

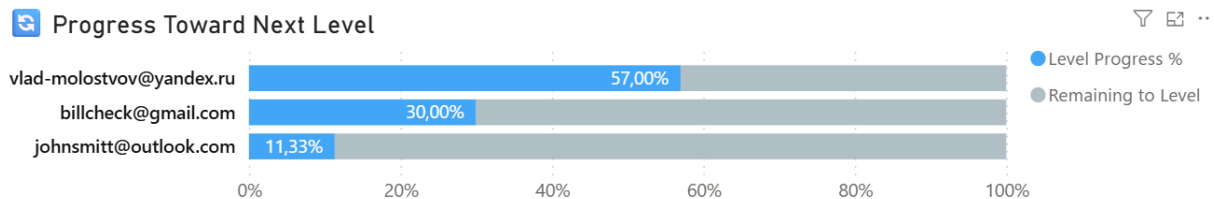


Figure 13 – Progress Toward Next Level

- Tables: Team Member Summary, Badge Progress Tracker, Weekly medalists

Show total points, earned badges, current level, remaining points or actions to achieve specific badges or levels, weekly points and medals (Gold, Silver, Bronze) with historical comparisons.

These tables make the entire system more transparent, reminding the user of their progress not just in abstract percentages, but in visual distributions of points, levels and badges.

Team Member	Total Points	Earned Badges	Level
johnsmitt@outlook.com	117	Critical Hunter, Speed Badge, Weekly Champion	Intermediate
vlad-molostvov@yandex.ru	57	Critical Hunter	Beginner
billcheck@gmail.com	30	Critical Hunter	Beginner

ModifiedAuthor	Next Level Label	Points to Next Level	To Critical Badge	To Normal Badge	To Minor Badge	To Speed Badge	To Weekly Top3
billcheck@gmail.com	Beginner → Intermediate	70		20	30	19	
johnsmitt@outlook.com	Intermediate → Advanced	133		17	30		
vlad-molostvov@yandex.ru	Beginner → Intermediate	43		11	30	8	

Team Member	Weekly Points	Week	WeeklyMedal
johnsmitt@outlook.com	117	26.05.2025	Weekly Gold
vlad-molostvov@yandex.ru	30	26.05.2025	Weekly Silver
billcheck@gmail.com	27	26.05.2025	Weekly Bronze
vlad-molostvov@yandex.ru	27	07.07.2025	Weekly Gold
billcheck@gmail.com	3	07.07.2025	Weekly Silver

Figure 14 – Progress tables

- Table: Badge Wall

Lists all badges, earning conditions, and the participant’s current status.

The table shows the user all the conditions for receiving badges directly on the dashboard. To check the availability of a particular badge, you need to select your name in the filter discussed earlier.

BadgeName	ConditionText	HasThisBadge
Critical Hunter	Fix 10 critical clashes	✓
Normal Dominator	Fix 20 normal clashes	✗
Minor Collector	Fix 30 minor clashes	✗
Speed Badge	Fix 20 issues in one upload	✗
Collector	Collect all base badges (Critical, Normal, Minor, Speed)	✗
Weekly Champion	Be 1st in weekly leaderboard	✗
Intermediate Collector	Collector + Score ≤ 250	✗
Advanced Collector	Collector + Score ≤ 500	✗
Expert Collector	Collector + Score ≤ 1000	✗
Master Collector	Collector + Score > 1000	✗

Figure 15 – Badge Wall

Practical Use

To track your performance:

1. Select your name in Select Team Member.
2. Review KPI Cards to check resolved, active, and accepted clashes.
3. Track your progress in Weekly Points Progress.
4. On Page 2, check Progress Toward Next Level and Badge Progress Tracker to see what’s next to achieve.

5. Compare your performance using Weekly Points and Medals.

Note: Points are awarded **only** when:

- The user is in the resolved clash dataset.
- The clash passes automated verification.
- The coordinator closes the clash.

If any condition fails, no points are awarded.

Why such a condition?

The reason for this approach is not only to prevent system bypass or exploitation but also to ensure high project quality. The user manually marks a clash as resolved, and their name is recorded in a dataset. This dataset is then compared with the results of automated verification: if the check does not confirm the resolution, no points are awarded.

Next, the project coordinator reviews clashes that have passed automated verification and confirms their actual resolution, marking them as closed in their own dataset. Only after this double verification are points awarded to the user.

Key benefits of this approach:

- Improved data reliability – automated checks and coordinator expertise complement each other.
- Elimination of false positives – prevents situations where the algorithm incorrectly marks a clash as resolved.
- Transparency and traceability – two independent logs record actions and confirmations.
- Quality culture development – knowing every resolution is double-checked encourages participants to work thoroughly.
- Fair gamification – points are awarded only for genuinely completed and validated work.

While the process may seem more complex, it provides a robust quality control mechanism, reduces project risks, and turns clash resolution into an engaging, team-driven activity.

Summary and Value for Users

The BIM Clash Gamification Dashboard motivates participants to resolve clashes effectively and rewards consistent effort.

When used consistently, this dashboard helps to:

- Increase clash resolution speed.
- Improve coordination between disciplines.
- Encourage steady engagement with the BIM model.
- Build a culture of measurable achievements.

3.3.4. C1 BIM Coordinator Guide: BIM Clash Gamification Dashboard

This guide is intended for BIM Coordinators who manage the preparation, structuring, and regular updating of clash resolution data for the BIM Clash Gamification Dashboard. It is also useful for coordination managers overseeing the accuracy of the reporting.

The dashboard monitors the progress of teams and individual contributors in resolving BIM clashes through gamification.

The BIM Coordinator is responsible for:

- Preparing and structuring source data from BCF exports.
- Configuring data sources in Power BI.
- Regularly updating information.
- Maintaining file storage structure and ensuring model stability.

Proper coordination ensures accurate progress tracking, transparency in clash resolution, and motivation through a fair gamification system.

Required Data Structure

The source data is generated automatically when exporting BCF reports from coordination software (Solibri, Navisworks, BIMcollab, etc.). Two CSV tables must be loaded into Power BI: “C1_Issues_Resolved_By” and “C1_Issues_Closed_For”.

Table 4 – Required data for “C1_Issues_Resolved_By”

Field	Format	Description
TopicType	Text	Type of topic (e.g., Clash)
TopicStatus	Text	Current topic status (typically "Resolved")
Title	Text	Issue title
Priority	Text	Priority level (Critical, Normal, Minor)

Index	Whole number	Clash identifier
Labels	Text	Discipline designation (e.g., Architecture)
CreationDate	Date	Clash creation date
CreationAuthor	Text	Author who created the topic
ModifiedDate	Date	Date of the last modification (resolution date)
ModifiedAuthor	Text	Designer who marked the status as "Resolved"
AssignedTo	Text	Person assigned to the clash
Description	Text	Issue description

Table 5 – Required data for “C1_Issues_Closed_For”

Field	Format	Description
TopicType	Text	Type of topic (e.g., Clash)
TopicStatus	Text	Current topic status (typically "Closed")
Title	Text	Issue title
Priority	Text	Priority level (Critical, Normal, Minor)
Index	Whole number	Clash identifier
Labels	Text	Discipline designation (e.g., Architecture)
CreationDate	Date	Clash creation date
CreationAuthor	Text	Author who created the topic
ModifiedDate	Date	Date of the last modification (resolution date)
ModifiedAuthor	Text	Coordinator who closed the clash
AssignedTo	Text	Person assigned to the clash
Description	Text	Issue description

Initial Model Setup in Power BI

The dashboard reads, sorts, and transforms files placed in a designated project folder automatically.

- File names must contain the word Resolved or Closed and the uploader's initials.
- The file modification date is used for statistics; avoid editing files after upload.

Setup steps:

1. Open Power BI Desktop.
2. Open Power Query Editor.
3. Configure queries C1_Issues_Resolved_By and C1_Issues_Closed_For to read from the correct folder.
4. Apply necessary transformations and load the model.

Data Update Procedure

1. Place new CSV files into the designated server directory.
2. Use the naming template:
 - C1_Issues_Resolved_By_XX_YYYYMMDD – for designers (XX = initials).
 - C1_Issues_Closed_For_YYYYMMDD – for coordinators.
3. Designers upload Resolved files as needed; coordinators upload Closed files once per reporting period, no more than once per day.
4. CSV export generation from BCF follows internal procedures, detailed in a separate workflow guide.

File and Version Management Guidelines

- Follow the naming convention strictly, including date in YYYYMMDD format.
- Store all files in a single flat folder without subdirectories.
- Maintain consistent file handling to prevent data loss or duplication.

Summary and Value for BIM Coordinators

The BIM Coordinator ensures the reliability and timeliness of dashboard data by maintaining structured updates and strict file organization.

When managed effectively, this process:

- Maintains full transparency in clash resolution.
- Prevents errors in gamification scoring.
- Improves trust in analytics among stakeholders.
- Supports a healthy, competitive project culture.

While this approach requires greater human involvement, in addition to the BCF report prepared by the designer it must also be generated and verified by the BIM Coordinator, it delivers a higher standard of data quality. Although it diverges from the trend toward full automation and autonomous clash resolution, it fosters a design culture with fewer initial errors.

3.3.5. A2B2 User Guide: BIM Challenge AI Quiz Dashboard

This dashboard is designed to track user activity within a corporate learning program and to assess their knowledge level. The selected learning area is the integration of ChatGPT with uploaded project documentation. For this purpose, a custom GPT model “BIM Challenge – Professional BIM Quiz Assistant” was created, which generates quizzes on selected topics based on these documents. This approach allows participants to check and improve their knowledge of key project standards and procedures.

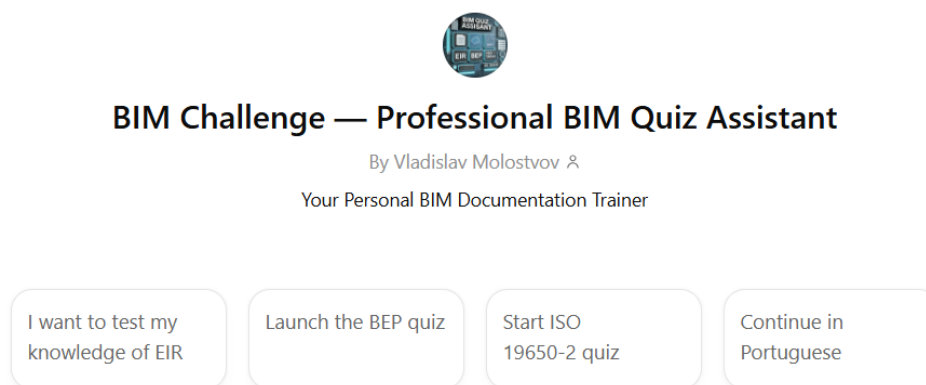


Figure 16 – View of the custom GPT model

The BIM Challenge AI Quiz Dashboard monitors and analyzes results from daily BIM quizzes based on official project documentation and standards (EIR, BEP, ISO 19650-2:2018 used as an example).

Goals:

- Increase awareness of key project documentation.
- Support learning through gamification (points, medals, badges).
- Track progress of individual users and teams.
- Identify learning gaps and areas for improvement.

By consolidating quiz results into one interface, the dashboard enables both users and managers to monitor engagement, learning trends, and activity by role.

Dashboard Structure and Visual Elements

➤ Filter Panel

Allows flexible filtering by:

- Completion Date – quiz date.
- Topic – EIR, BEP, ISO.
- Chosen Role – project role selected at quiz start (e.g., Architect, Engineer, BIM Specialist).

➤ Chart: Total Tests by Chosen Role

A pie chart showing quiz distribution across roles.

➤ Chart: Total Tests by Topic

A pie chart showing quiz distribution by topic.

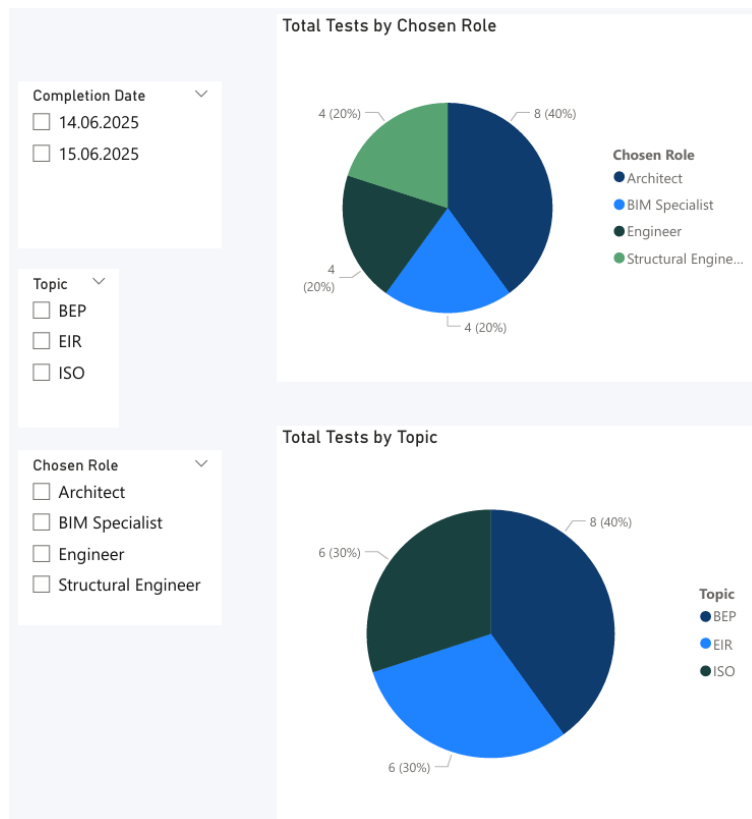


Figure 17 – Main filters and statistics on tests passed and roles selected

➤ KPI Cards

Provide a quick snapshot:

- Total Tests Taken – total quizzes completed.
 - Unique Participants – number of individual users.
 - Average Score – mean score per quiz.
 - Accuracy % – average percentage of correct answers.
- Chart: Test Volume Over Time

A line chart displaying the number of quizzes completed over time.

- Table: Weekly Leaders

This table shows the top three users for the current week based on total score:

- User Name – participant's name.
- WeeklyScore – total score for the current week.
- WeekStartDate – start of the week.
- WeeklyMedal – awarded medal (Gold, Silver, Bronze).

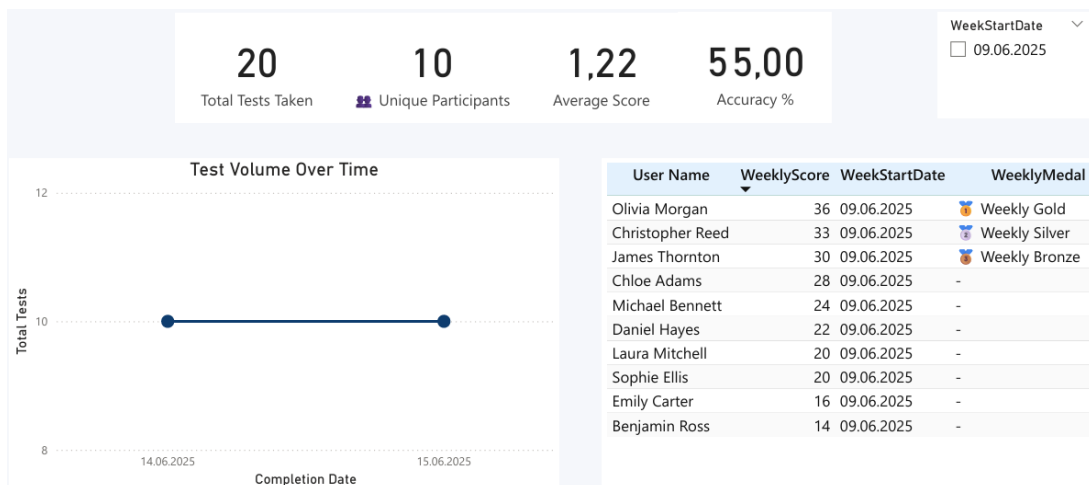


Figure 18 – Key indicators and weekly result

- Table: Full Leaderboard

A summary table with detailed participant data:

- User Name – participant's name.
- Chosen Role – selected project role.

- Total Score Per User – total accumulated score (2 points per correct answer).
- Rank By Score – ranking position based on score.
- Medal – medal based on total score.
- Level – user level (e.g., "Beginner").
- Badges – earned achievement badges.

User Name	Chosen Role	Total Score Per User	Rank By Score	Medal	Level	Badges
Olivia Morgan	Engineer	36	1	Gold	Beginner	First Try
Christopher Reed	Engineer	33	2	Silver	Beginner	First Try
James Thornton	Architect	30	3	Bronze	Beginner	First Try
Chloe Adams	BIM Specialist	28	4	-	Beginner	First Try
Michael Bennett	Architect	24	5	-	Beginner	First Try
Daniel Hayes	BIM Specialist	22	6	-	Beginner	First Try
Laura Mitchell	Structural Engineer	20	7	-	Beginner	First Try
Sophie Ellis	Architect	20	7	-	Beginner	First Try
Emily Carter	Architect	16	8	-	Beginner	First Try
Benjamin Ross	Structural Engineer	14	9	-	Beginner	First Try

Figure 19 – Full Leaderboard

Levels are assigned based on logic presented in Table 3.

Badges conditions are on the following table.

Table 6 – Badges conditions for A2B2 Dashboard

Badge	Condition
First Try	Complete the first quiz
Consistency	Complete 10+ quizzes
Perfect Test	Achieve 100% accuracy
Full Coverage	Complete quizzes in BEP, EIR, and ISO

Practical Use

1. Use filters to select a date, topic, or role.
2. Check KPI cards for an overview of engagement and accuracy.
3. Review role and topic charts to see participation distribution.
4. Track the Weekly Leaders for current top performers.

5. Explore the Full Leaderboard for total scores, levels, and badges.

Points system: each correct answer = 2 points.

To have results appear in the dashboard:

- Take the quiz via the official [link](#).
- Save the generated CSV file.
- Upload it to the shared folder designated by the BIM Coordinator.

The proposed AI assistant generates 10-question quizzes based on the documents uploaded into it. For different projects, it is possible to configure dedicated assistants with unique sets of source materials, or to develop a single universal model that includes regulatory standards. Upon completion of the quiz, the assistant automatically produces a CSV file containing the complete dataset required for statistical analysis in the dashboard.

Summary and Value for Users

The BIM Challenge AI Quiz Dashboard promotes continuous learning, improves awareness of project standards, and uses gamification to sustain motivation.

When used consistently, this dashboard can:

- Increase engagement with project documentation.
- Improve accuracy in BIM-related tasks.
- Identify training needs.
- Encourage healthy competition and recognition of achievements.

3.3.6. A2B2 BIM Coordinator Guide: BIM Challenge AI Quiz Dashboard

This dashboard is intended for BIM Coordinators responsible for managing, structuring, and controlling learning activity data within the BIM Challenge – Professional BIM Quiz Assistant system. For the coordinator, the dashboard serves as a centralized control panel for monitoring quiz participation, verifying data completeness and accuracy, and ensuring that the information pipeline between quiz results and analytics remains consistent and reliable.

From the coordinator's standpoint, the primary purpose of this dashboard is to provide a transparent, automated mechanism for collecting and processing quiz results from all project participants. It allows the coordinator to:

- Ensure that uploaded CSV files follow the required format and contain all necessary fields.
- Track the volume and frequency of quiz participation across roles and topics.

- Identify data inconsistencies or gaps that could affect reporting accuracy.
- Maintain the stability of the analytics model without manual intervention in daily updates.

By consolidating all results in one system, the coordinator gains both operational oversight and a clear audit trail of learning activity across the project team.

Model Structure and Required Dataset

The dashboard is based on a single Power Query: “A2B2_QuizResults” connects to a folder containing CSV files with quiz results. The folder location is defined by the BIM Coordinator according to internal project or company standards.

Table 7 – Required data for BIM Challenge AI Quiz Dashboard

Field	Format	Description
User Name	Text	Full name of participant
Completion Date	Date	Date the quiz was completed
Completion Time	Time	Time the quiz was completed
Topic	Text	Quiz topic (EIR, BEP, ISO)
Chosen Role	Text	Project role selected at quiz start
Question	Text	Quiz question text
Correct Answer	Whole Number	(1/0) 1 = correct, 0 = incorrect
Earned Score	Whole Number	Points earned for the question

Accurate and complete data in these columns is essential for correct visualization and KPI calculation.

Initial Power BI Setup

Before first use:

1. Open Power BI Desktop.
2. In Power Query Editor, locate the A2B2_QuizResults query.
3. In the Source step, set the folder path where users will upload their CSV files.
4. Confirm all required columns load correctly.
5. Apply changes and load the model.

Once configured, the dashboard will automatically refresh to include new results.

Data Updates

No manual action is needed for regular updates. Users independently upload their test results into the predefined folder. Each time the model is refreshed, Power BI will retrieve the latest data automatically.

Summary and Value for BIM Coordinators

Once configured, the dashboard functions autonomously, providing continuous monitoring of learning engagement and knowledge retention.

When used consistently, this dashboard helps to:

- Increase engagement with project documentation.
- Provide measurable insights into training effectiveness.
- Highlight areas requiring additional training.
- Encourage ongoing participation through gamification metrics.

Maintaining up-to-date data requires only that CSV files follow the correct structure and are stored in the designated folder. Any changes to file format or project requirements should be communicated to the model developer.

3.3.7. A1 User Guide: Project Approval Processes Dashboard

This dashboard is intended for designers who submit project documents and procedures for approval. It helps them track the current status of their submissions in real time, identify which documents or procedures are still pending, review comments and understand the reasons for rejections, and monitor deadlines to ensure timely resubmissions. It also allows them to compare their progress with overall project performance, providing both a clear progress overview and actionable feedback to address remarks quickly and reduce the risk of repeated rejections.

Goals:

- Provide designers with real-time visibility of the approval status for their documents and procedures.
- Help identify pending items and understand the specific reasons for rejections.
- Support timely resubmission of corrected documents by tracking assigned deadlines.
- Offer performance context by comparing individual progress with overall project results.

- Reduce the likelihood of repeated rejections through targeted feedback and clearer understanding of requirements.

Dashboard Structure and Visual Elements

➤ User Filter

Allows selection of a specific designer to review their performance data. Selecting a name updates all dashboard visuals to reflect the chosen user.

➤ KPI Cards

- % Completed Documents – share of approved documents relative to all submitted.
- % Completed Procedures – share of approved procedures relative to all assigned.

➤ Gauge Charts: Progress Indicators

Total number of approved documents in the project; Total number of approved procedures in the project.

Both indicators function as progress bars, visualizing the number of approved documents and procedures in relation to their total quantity. Values can be displayed either for a specific user or for the entire team.

Color coding is used to assess performance levels:

- Values from 0% to 50% inclusive – red zone. Indicates significant delays that may lead to broader setbacks.
- Values over 50% and below 100% – yellow zone. Signals a delay that should be addressed.
- Value of 100% – green zone. Indicates all documents and procedures have passed review and been approved.

➤ Designer Tables

- Documents Table – assigned vs approved documents per designer.
- Procedures Table – assigned vs approved procedures per designer.

➤ Comment Tables

- Unapproved Documents – comments, document name, and submission deadline.
- Unapproved Procedures – comments, procedure name, and submission deadline.

These contain feedback explaining rejections, referencing specific standards, regulations, or directives.

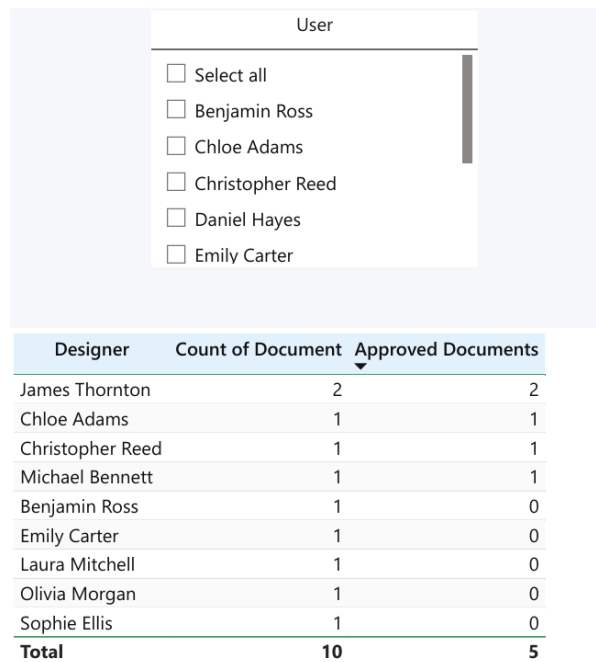


Figure 20 – Number of assigned documents and approved documents

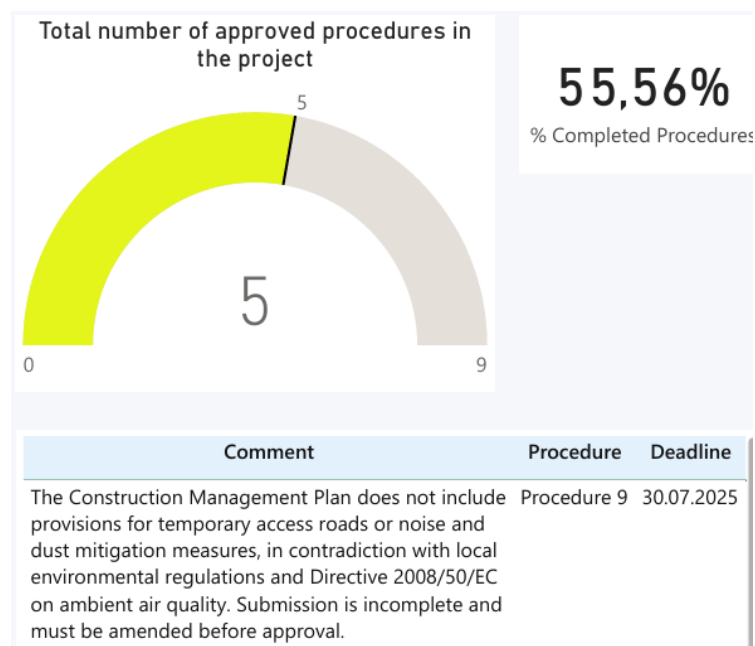


Figure 21 – Example of an indicator, comment on a rejected procedure (document)

Practical Use

1. Select your name in the User filter to view personal performance data.
2. Check KPI cards for overall completion rates.
3. Use gauge charts for a visual representation of approval progress.
4. Review designer tables to see how your results compare with peers.

5. Examine comment tables to identify reasons for rejections and address them before resubmission.

Summary and Value for Users

The Project Approval Processes Dashboard is a practical tool for designers to stay informed about the status of their submitted documents and procedures. It provides real-time updates on pending approvals, feedback from reviewers, and assigned deadlines, enabling timely corrections and resubmissions.

When used consistently, this dashboard helps to:

- Monitor the approval process and avoid missed deadlines.
- Understand and address reviewer comments to reduce repeated rejections.
- Maintain steady progress in document and procedure approval.
- Improve communication with reviewers and project management.
- Contribute to smoother project workflows and better compliance with requirements.

3.3.8. A1 BIM Coordinator Guide: Project Approval Processes Dashboard

This dashboard is intended for BIM Coordinators who oversee the verification and approval of project documentation and procedures. It is a control and monitoring tool that allows the coordinator to track approval progress across all designers, identify delays, and verify compliance with established workflows and deadlines.

The Project Approval Processes dashboard is used for analytical control of the verification and approval process of project documentation and procedures.

The BIM Coordinator is responsible for:

- Preparing and structuring source data.
- Configuring data sources in Power BI.
- Ensuring regular data updates.
- Maintaining file and version organization on the server.
- Monitoring data integrity and model accuracy.

Required Data Structure

The model uses four queries; each connected to its respective table:

1. A1_Checked_Doc_GEN – Approved documents

Fields: Document, Date of last approval, Mark of document completion, Comment, Deadline

2. A1_Submitted_Doc_GEN – Submitted documents

Fields: Designer, Document, Document Submission deadline

3. A1_Submitted_Proc_GEN – Submitted procedures

Fields: Designer, Procedure, Procedure Submission deadline

4. A1_Checked_Proc_GEN – Approved procedures

Fields: Procedure, Date of last approval, Mark of procedure completion, Comment, Deadline

A reference table A1_Designers_Only is used to maintain a list of unique designers by merging names from A1_Submitted_Doc_GEN and A1_Submitted_Proc_GEN.

Initial Setup in Power BI

Before starting work:

1. Open Power BI Desktop and go to Power Query.
2. In each A1_..._GEN query, configure the Source step to point to the correct file in the project directory.
3. Verify that all required columns are correctly loaded.
4. Ensure all relationships are properly set through A1_Designers_Only using the Designer field.
5. Click Close & Apply to load the model structure.

Data Update Procedure

1. All data updates are performed within the same tables and queries (A1_..._GEN) using a consistent file path.
2. New exports overwrite the previous data content while keeping file names and structure unchanged.
3. In Power Query, open the query, validate the structure, and click Refresh Preview.
4. Click Close & Apply to update the model in Power BI.

File and Version Management Recommendations

- Keep all source files in a permanent working directory with restricted access to prevent accidental deletion or renaming.
- Renaming files or changing paths requires manual updates in Power Query and may disrupt the model.
- Regularly create backup copies of source files stored separately from the working environment.

Summary and Value for BIM Coordinator

The Project Approval Processes Dashboard gives BIM Coordinators a centralized, visual overview of the entire approval workflow.

When used consistently, it helps to:

- Quickly detect delays and unresolved approvals across the project.
- Monitor designer performance against deadlines and approval targets.
- Maintain complete and accurate approval records for auditing and compliance.
- Support transparent reporting to project management.
- Strengthen accountability and communication between all project participants.

Gamified visual elements, such as color indicators and progress bars, make the control process intuitive and help ensure that approvals are completed on time, improving both workflow efficiency and regulatory compliance.

3.3.9. B1B3 User Guide: Dashboard “Team Request – Client Response” (TRCR Game)

This dashboard is intended for designers and other project team members who initiate requests to the client during the design process, as well as for the client.

For designers, it provides a clear picture of how quickly and reliably the client responds to submitted requests, which items are at risk due to delayed feedback, and how response times vary across different project stages. By using the dashboard, designers can monitor the status of their own requests, anticipate possible schedule impacts, and prepare follow-up actions in case of delayed responses.

For the client, the dashboard offers an objective view of their own responsiveness, helps identify areas where delays occur most often, and enables the evaluation of measures taken to improve communication speed. This transparency supports better planning, fosters accountability, and strengthens collaboration between the client and the project team.

Goals:

- Give designers real-time visibility into the status and timeliness of responses to their requests.
- Provide the client with transparent analytics on their responsiveness and communication performance.
- Identify overdue or at-risk requests for proactive follow-up from both sides.
- Highlight project stages most affected by delayed feedback to focus improvement efforts.
- Measure the effectiveness of management interventions (e.g., review panels) in accelerating responses.
- Foster accountability and improve planning by giving both parties access to the same performance data.

Dashboard Structure and Visual Elements

- Gantt Chart: “Earliest CreationDate and Earliest ClientResponseDate by RequestID”

This chart displays the lifecycle duration of each request – from creation to the client's response date. Both closed and pending requests are shown, allowing quick identification of “stuck” communications. The current date is marked with a vertical line to monitor active overdue items.

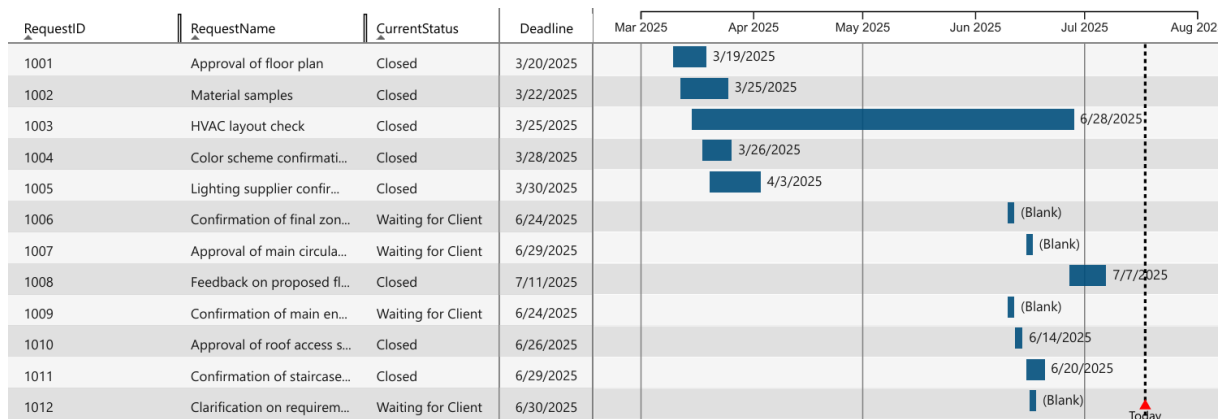


Figure 22 – Lifecycle duration of the request

- KPI Cards
 - Overdue Count – number of requests not answered or answered late by the client.
 - OnTimePercent – percentage of requests responded to on time.
 - Average Response Time – average number of days between request creation and client response.

These indicators form the core metrics for evaluating client engagement efficiency.

- Client Badges: “ClientBadges”

Badges are automatically assigned based on OnTimePercent according to the following logic:

Reliable Responder – 50% or more of requests answered on time.

Consistent Collaborator – over 60%.

Trusted Project Partner – 80% or more.

Exemplary Response Leader – 90% or more.

Badges reinforce and reward disciplined engagement.

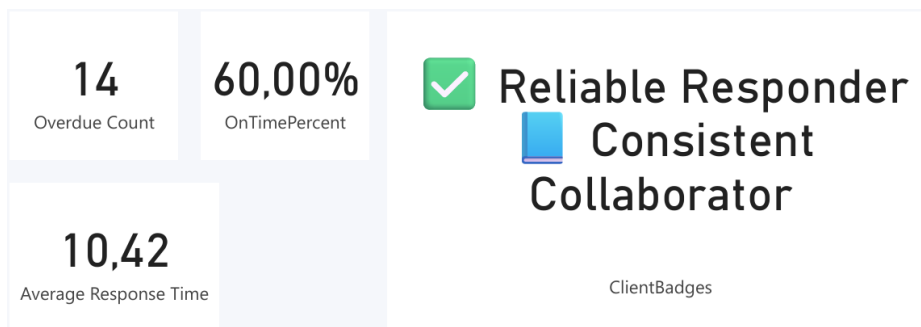


Figure 23 – Block of KPI cards and badges

- Bar Chart: “Overdue Requests by Project Stage”

Shows which project stages have the highest number of overdue responses from the client. Helps identify functional areas needing attention or improved communication.

- Bar Chart: “Average Response Time by Period”

This chart compares the client’s average response time before and after panel implementation (dashboard usage). It reflects the effectiveness of management interventions.

- Line Chart: “OnTimePercent by Month”

Allows tracking of the monthly dynamics in the percentage of on-time responses. Used to assess trends: improvement, stagnation, or deterioration of communication.

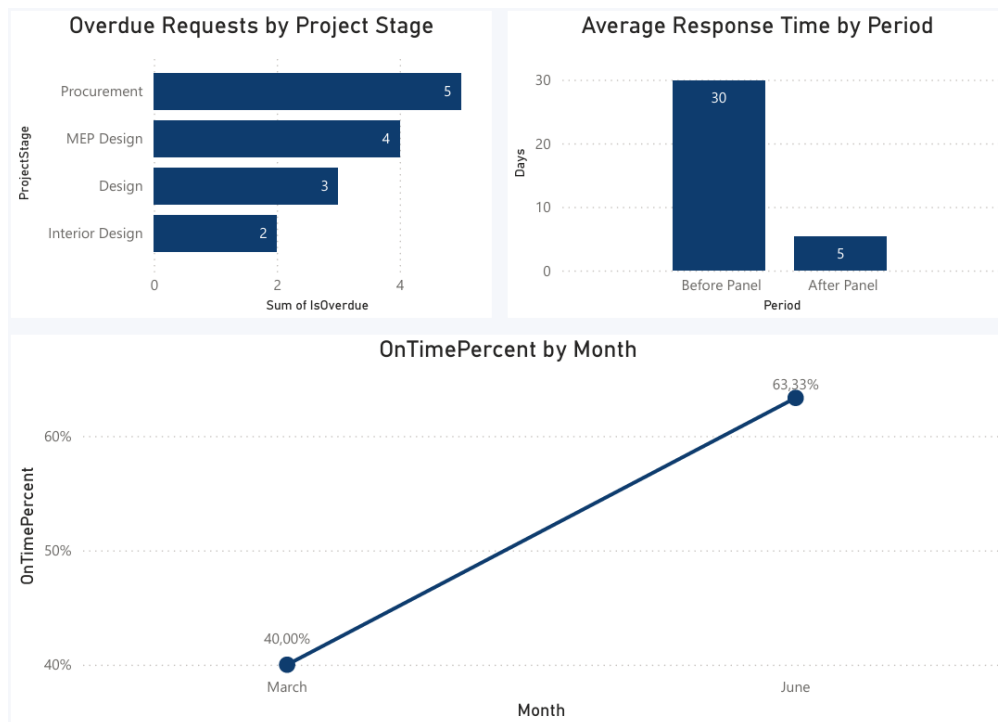


Figure 24 – Chart block

➤ Request Table

Contains the full list of requests included in the calculations:

RequestName – request title.

ProjectStage – project stage associated with the request.

CreationDate – date the request was logged.

Deadline – expected response deadline.

ClientResponseDate – actual client response date.

DelayDays – number of delay days (if any).

DelayStatus – status indicator: overdue (red), approaching deadline (yellow), on time (green).

RequestName	ProjectStage	CreationDate	Deadline	ClientResponseDate	DelayDays	DelayStatus
HVAC layout check	MEP Design	15.03.2025	25.03.2025	28.06.2025	95	●
Confirmation of final zoning and space allocation	MEP Design	10.06.2025	24.06.2025		22	●
Confirmation of main entrance location and orientation	Design	10.06.2025	24.06.2025		22	●
Approval of mechanical plant room sizes and locations	Interior Design	11.06.2025	25.06.2025		21	●

Figure 25 – Example of the request table

Practical Use

For designers:

- Review KPI cards to understand the client’s overall responsiveness.
- Use the Gantt chart to identify overdue requests requiring follow-up.
- Check “Overdue Requests by Project Stage” to see which project areas are most affected.
- Use the Request Table to review details and prepare necessary updates or reminders.

For the client:

- Use KPI cards to monitor your responsiveness over time.
- Check the Gantt chart to see pending items and overdue cases.
- Review “Overdue Requests by Project Stage” to detect problem areas in your internal workflows.
- Analyze “Average Response Time by Period” and “OnTimePercent by Month” to evaluate the effect of improvement measures.

Summary and Value for Users

The "Team Request – Client Response" (TRCR Game) dashboard is a shared monitoring tool that improves transparency and communication efficiency between the project team and the client.

When used consistently, it helps to:

- Identify and address delays before they impact the project schedule.
- Give designers and the client a single source of truth for communication performance.
- Improve planning accuracy by understanding real response patterns.
- Encourage timely follow-up actions and foster accountability on both sides.
- Support a culture of collaboration and proactive problem-solving.

3.3.10. B1B3 BIM Coordinator Guide: Dashboard “Team Request – Client Response” (TRCR Game)

The “Team Request – Client Response” (TRCR Game) dashboard evaluates the quality and timeliness of communication between the project team and the client based on the handling of formal requests. It enables the coordinator to monitor client responsiveness, identify overdue items, and assess how quickly issues are resolved.

The BIM Coordinator’s responsibilities include:

- Preparing and structuring source data.
- Performing the initial configuration of the data source in Power BI.
- Ensuring regular and timely updates.
- Maintaining an orderly file storage structure and version control on the server.
- Monitoring compliance with the approved data structure.

Required Data Structure

The dashboard operates on a single primary table “ClientRequests” with the following fields.

Table 8 – Required data for “Team Request – Client Response” (TRCR Game) Dashboard

Field	Format	Description
RequestID	Text (unique)	Unique request identifier
RequestName	Text	Name of the request
RequestType	Text	Type of request (Approval, Comment, etc.)
ProjectID	Text	Project identifier
ProjectStage	Text	Project stage
CreationDate	Date	Date the request was created
Deadline	Date	Planned deadline for receiving a response
ClientResponseDate	Date	Actual date of client response
CurrentStatus	Text	Request status (e.g., Closed, Waiting)

All fields must be completed in accordance with the established format. The table must remain structurally unchanged to ensure correct data processing in the model.

Initial Setup in Power BI

- Open Power BI Desktop.
- Go to the Power Query Editor.
- In the query B1B3_ClientRequests, update the Source step to point to the Excel file containing the current dataset.

- Check that all columns match the required names and formats.
- Apply the changes and load the model.

Data Update Procedure

The update mechanism is based on replacing or editing the content of the main .xlsx file without changing its name or path.

- Open the original Excel file containing the ClientRequests table.
- Add new records or update existing data.
- Ensure column names and formats remain unchanged.
- Save the file. The next refresh in Power BI will automatically load the updated information.

Summary and Value for BIM Coordinator

The “Team Request – Client Response” (TRCR Game) dashboard serves as a control and analytical tool for the BIM Coordinator, enabling them to manage the quality and timeliness of client communications. By providing consolidated, up-to-date data on request handling, it allows the coordinator to quickly identify delays, track communication bottlenecks, and measure the effectiveness of interventions aimed at improving client responsiveness.

When used consistently, it helps to:

- Maintain a complete and accurate record of client-related requests and responses.
- Identify high-risk areas where delays could impact project timelines.
- Measure the efficiency of implemented corrective actions.
- Improve coordination between the project team and the client by increasing transparency.
- Support data-driven decision-making on workflow adjustments and escalation needs.

Gamification elements such as ClientBadges not only provide visual feedback on response quality but also help motivate clients to maintain consistent engagement.

3.3.11. C2 User Guide: Dashboard “Team Request – Team Response (TRTR Game)”

This dashboard is intended for all project team members, but it is especially useful for discipline leads and specialists responsible for handling interdisciplinary requests. It allows users to track how teams respond to requests from other project participants – whether responses are timely, where bottlenecks arise, and how engaged each team is in the collaboration process.

The main idea behind the dashboard is to highlight the relationship between teams waiting for task completion and the teams responsible for execution.

Goals:

- Increase transparency and efficiency in communication between teams.
- Quickly identify areas with accumulated delays.
- Enhance team accountability and execution discipline.
- Motivate better performance through gamified elements (ranking, status, visual indicators).
- Evaluate the overall balance between waiting and causing delays for each team.

Dashboard Structure and Visual Elements

➤ Chart: Delays Experienced by Initiating Teams

Displays which teams most often experience delays from executors. This helps highlight which teams are “waiting” and deserve attention in task planning and resource allocation.

➤ KPI Cards

Displays key numerical indicators:

- Waiters – number of teams currently waiting for responses to their requests.
- Delayers – number of teams that caused delays in response.
- Balanced – teams with a neutral outcome (delays equal to waiting cases).
- Average Delay (Days) – average number of delay days for all tasks.
- Overdue Percent – percentage of overdue tasks.

This panel provides a quick entry point for analyzing the overall communication performance across all teams.

➤ Task Table

Provides detailed information on each task:

- TaskName – name of the request.
- ResponsibleTeam – team assigned to perform the task.
- PlannedFinish – planned completion date.

- ActualFinish – actual completion date.
- Sum of DelayDays – number of delay days.
- DelayStatus – color-coded status: Red – overdue, Yellow – approaching deadline, Green – completed on time.

This table allows users to drill down from summary-level data to individual cases for review.

- Team Ranking: TeamRank

Visualizes accumulated delays by team:

- TotalDelayByTeam – total number of delay days.
- OverdueTasksByTeam – number of overdue tasks.
- TeamStatusByTotalDelay – visual indicator of team status.

This element enables comparison of performance and discipline across teams.

- Summary Table: Net Impact on Team

Analyzes a team's balance as both executor and initiator:

- DelayAsExecutor – total delay days caused while acting as executor.
- DelayAsInitiator – total days spent waiting for responses to own requests.
- Net Impact on Team – difference between the two values.
- Team Impact Status – final classification: Delaying Others – team slows down project flow, Balanced – neutral position, Often Waiting – team frequently suffers from others' delays.

This shows whether a team is primarily a source of delays or a victim of them. The greater the deviation toward Delaying Others or Often Waiting, the stronger the impact on the project schedule.

Badge assignment logic:

- Team Impact Status is calculated based on the NetTeamImpact metric using the following logic:
- If the team frequently delays requests ($\text{NetTeamImpact} > 30$), it receives the Delaying Others badge.
- If the team is more often waiting for responses ($\text{NetTeamImpact} < -30$), it receives the Often Waiting badge.

- In all other cases, the team is classified as Balanced.

If a team simultaneously shows high delays both in its own tasks and in awaiting others, resulting in a Balanced status, this could indicate systemic dysfunction, requiring deeper analysis of root causes.

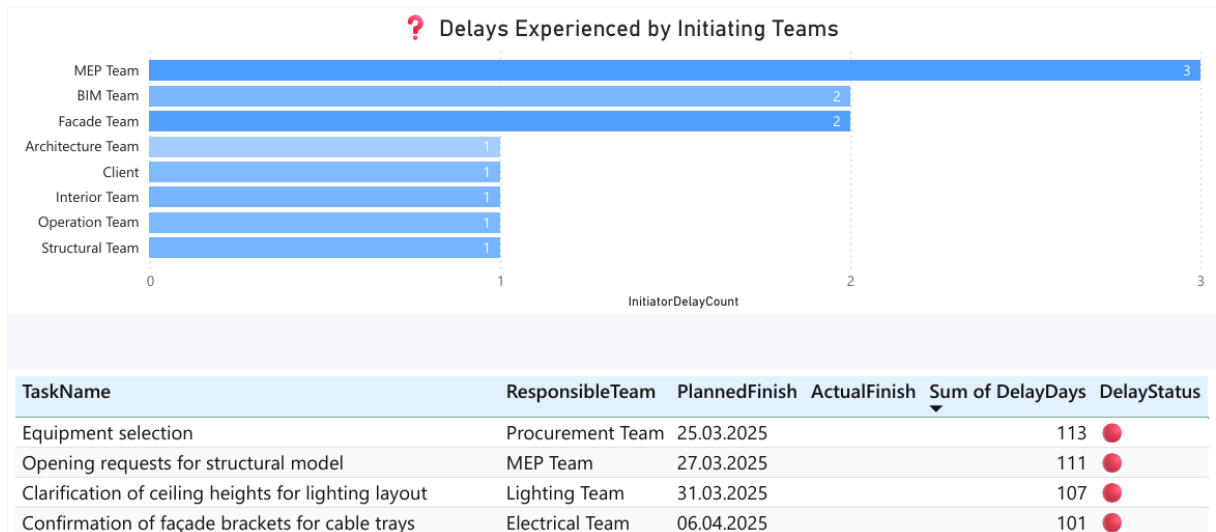


Figure 26 – Leadertable and Task table

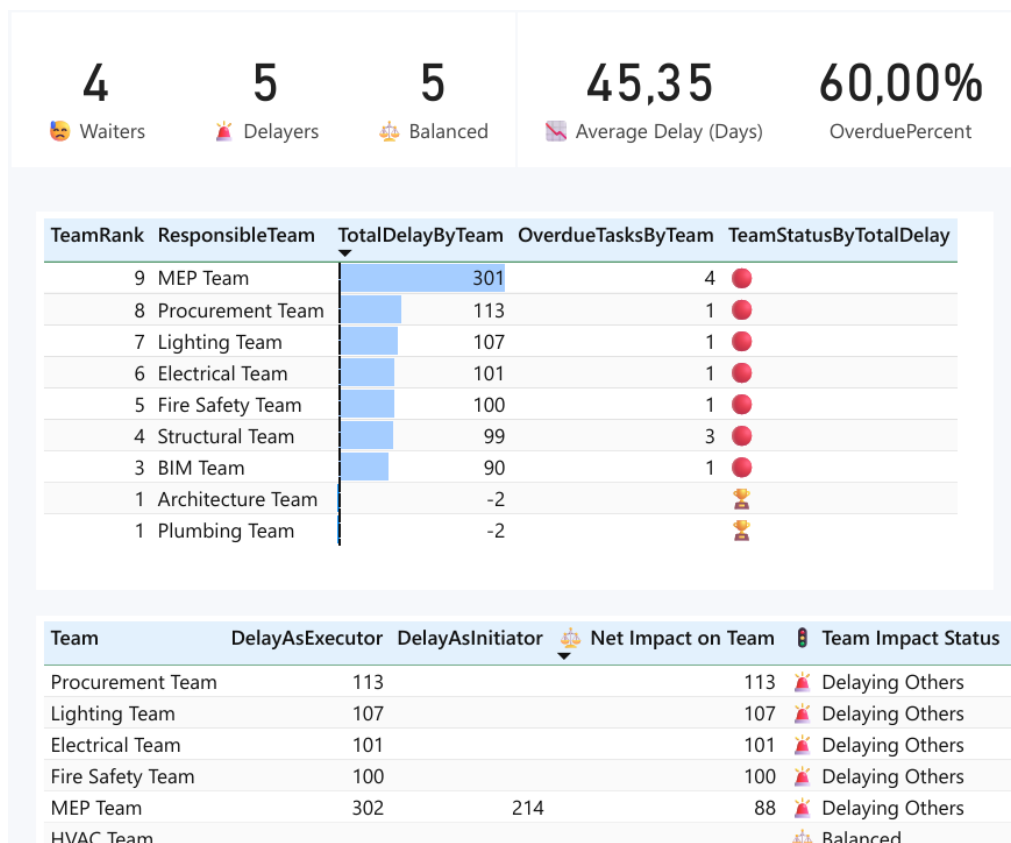


Figure 27 – KPI and Badge block

Practical Use

1. Review the KPI panel to get a quick overview of communication performance.

2. Check the delays chart to see which teams are most affected by waiting.
3. Use the task table to examine specific overdue or delayed cases.
4. Compare your team's ranking with others in the Team Ranking and Net Impact tables.
5. Use the color-coded statuses to identify where immediate action is required.

Summary and Value for Users

The "Team Request – Team Response" dashboard is a tool for monitoring team discipline and the quality of interdisciplinary request execution. It allows you to evaluate collaboration efficiency, uncover causes of delay, compare teams, and encourage improvement in communication culture.

When used consistently, it helps to:

- Reduce the number of overdue responses and delays in task execution.
- Increase team engagement in interdisciplinary collaboration.
- Encourage healthy competition between teams through rankings and visual statuses.
- Improve task planning by identifying which teams are more often waiting and which are delaying.
- Promote a culture of responsibility and transparency within the project.

Gamified elements like team rankings and visual statuses enhance user engagement and promote healthy competition.

3.3.12. C2 BIM Coordinator Guide: Dashboard “Team Request – Team Response (TRTR Game)”

This dashboard is designed to analyze the quality of interdisciplinary interaction within a project environment. The BIM Coordinator is responsible for ensuring the stability of the model, data accuracy, and consistency in data management.

The BIM Coordinator's responsibilities include:

- Preparing and structuring source data.
- Configuring data source connections in Power BI.
- Performing regular data updates.
- Maintaining file organization and consistency on the server.
- Enforcing a unified model structure and update process.

Required Dataset Structure

The model is based on a single main table – Tasks, which includes the following fields.

Table 9 – Required data for “Team Request – Team Response (TRTR Game)” dashboard

Field	Format	Description
TaskID	Text	Unique identifier for each task or request
TaskName	Text	Short descriptive name of the task or request
ProjectID	Text	Code or ID of the project to which the task belongs
ProjectStage	Text	Phase of the project during which the task was initiated
ResponsibleTeam	Text	The team responsible for executing the task
InitiatorTeam	Text	The team or discipline that initiated the request
PlannedStart	Date	Scheduled start date of the task
PlannedFinish	Date	Scheduled finish date of the task
ActualStart	Date	Actual date when work on the task began
ActualFinish	Date	Actual date when the task was completed
Status	Text	Current status of the task (e.g., Open, In Progress, Closed)

All fields must be properly filled in. Calculated fields (DelayDays, NetTeamImpact, TeamImpactStatus) are created within Power BI. All other fields should be manually entered or exported from corporate project management systems.

Initial Setup in Power BI

1. Open Power BI Desktop.
2. Go to Power Query Editor.
3. Open the existing Tasks query.
4. In the Source step, set the path to the current .xlsx file located on the server.
5. Verify data types (dates, text, numbers).
6. Apply changes and load the model.

Data Update Procedure

The update mechanism is straightforward – all work is done within a single .xlsx table whose file path remains constant. New data is appended to the same table, and existing rows are updated as needed.

Power BI users receive the latest data with each report refreshed, without any intervention in Power Query.

Summary and Value for BIM Coordinator

For the BIM Coordinator, the “Team Request – Team Response” dashboard serves as a central analytical tool for monitoring interdisciplinary communication and task execution discipline across all project teams. It provides a reliable, data-driven basis for identifying bottlenecks, detecting systemic issues, and assessing the balance between delays caused and delays experienced by each team.

By maintaining a consistent data structure, fixed file paths, and timely updates, the BIM Coordinator ensures the stability and accuracy of the analytical model, enabling all stakeholders to work with up-to-date and trustworthy information.

When used consistently, this dashboard helps to:

- Track overall communication health between teams.
- Quickly identify and address problem areas affecting project timelines.
- Support project managers in making informed, data-backed decisions.
- Foster a culture of timely task completion and cross-team responsibility.

3.4. Summary of the Methodology

The methodology chapter established the rationale for selecting gamification principles and for developing a set of tools tailored to the design environment within the AEC industry. It has been shown that a systematic alignment of identified coordination difficulties with carefully chosen game mechanics allows not only the creation of isolated visualizations, but the formation of a coherent framework aimed at improving transparency, engagement, and overall efficiency in BIM-based collaboration. The dashboards developed within this framework serve as practical manifestations of these ideas, demonstrating how BIM data can be transformed into metrics that simultaneously perform a monitoring function and motivate participants to act in a more disciplined and productive manner. The inclusion of instructions designed separately for different categories of users further underscores the applied character of the system and its readiness for implementation in real project workflows.

In this way, the methodology chapter provides the foundation for moving from theoretical discussion to practical demonstration. The following section – the case study of the C1 BIM Clash Gamification Dashboard – illustrates the functioning of the proposed system in a concrete scenario, tracing the complete lifecycle of data from its generation to the visualization of results in a gamified environment.

4. CASE STUDY: IMPLEMENTATION OF THE C1_BIM CLASH GAMIFICATION DASHBOARD

In this section, one of the possible scenarios for introducing the C1_BIM Clash Gamification Dashboard into practice is presented. The principle of using the dashboard itself is relatively straightforward: the prepared dataset is uploaded into Power BI, after which all preconfigured mechanics embedded in the file are executed automatically. However, for the purposes of this case study, it is not enough to describe the visual layer of the dashboard; it is equally important to demonstrate how such a dataset can be obtained in practice, in what form it is structured, and how the gamification mechanics function on real data. For this reason, the C1 dashboard has been chosen as the demonstration case. It is both the most complex and the most realistic tool for potential implementation in actual project workflows.

4.1. Datasets Creation

The dataset underlying the dashboard is essentially a reformatted CSV file derived from BCF. Its original structure is adapted into a tabular form to facilitate seamless processing by visualization software such as Microsoft Power BI. Thus, the dashboard stands not only as a reporting tool but as a logical continuation of the broader workflow of issue management within a CDE.

Although the choice of software is not strictly fundamental for the methodology, in the presented example the following toolset has been used:

- Autodesk Revit;
- Autodesk Navisworks;
- BIMCollab Manager plug-in for both Revit and Navisworks;
- Collaborative platform and CDE environment BIMCollab Join.

Additionally, architectural and structural models provided by ndBIM have been incorporated to ensure the case study reflects conditions close to a real design project.

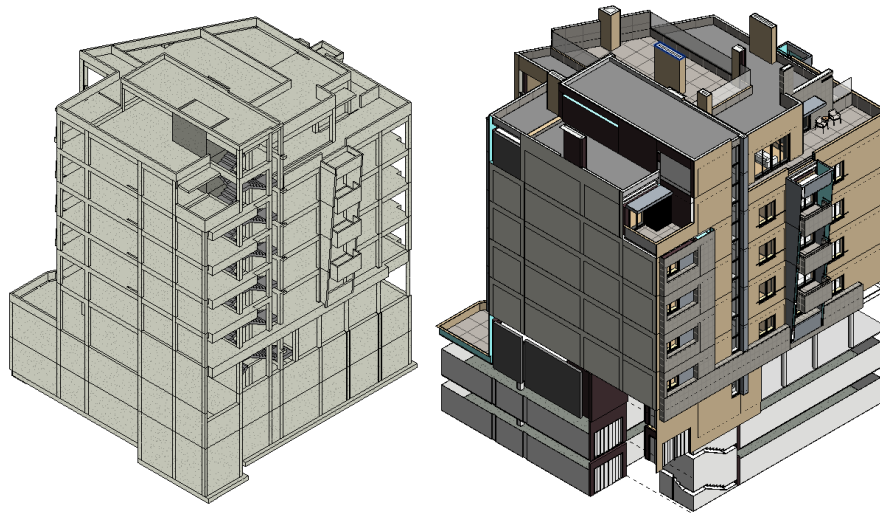


Figure 28 – Architectural and structural models provided by ndBIM

It is important to emphasize that this case study does not aim to exhaustively describe every aspect of the BIMCollab workflow. Elements not directly related to gamification (such as connecting participants to the project in BIMCollab Join, configuring model export settings, or creating detailed clash detection rules) are deliberately omitted. Instead, only the principal workflow interactions between the chosen software are presented.

4.1.1. Initial Setup in Navisworks and BIMCollab Join

The workflow begins with the creation of a project within BIMCollab Join and the establishment of its CDE structure. This includes setting up the collaborative environment, inviting project participants, and configuring their respective workspaces and permissions. While the details of user management are beyond the scope of this section, it is important to stress that this environment serves as the central repository where all clash issues are registered and synchronized.

After installing the BIMCollab Manager plug-in for Navisworks, it is necessary to authorize the user by entering their project email credentials. This ensures that all further actions within Navisworks are consistently synchronized with the user's account in BIMCollab Join.

The process then proceeds with conventional clash detection: Revit models are federated within Navisworks, clash rules are defined, and issues are detected. These detected clashes form the initial dataset for subsequent synchronization.

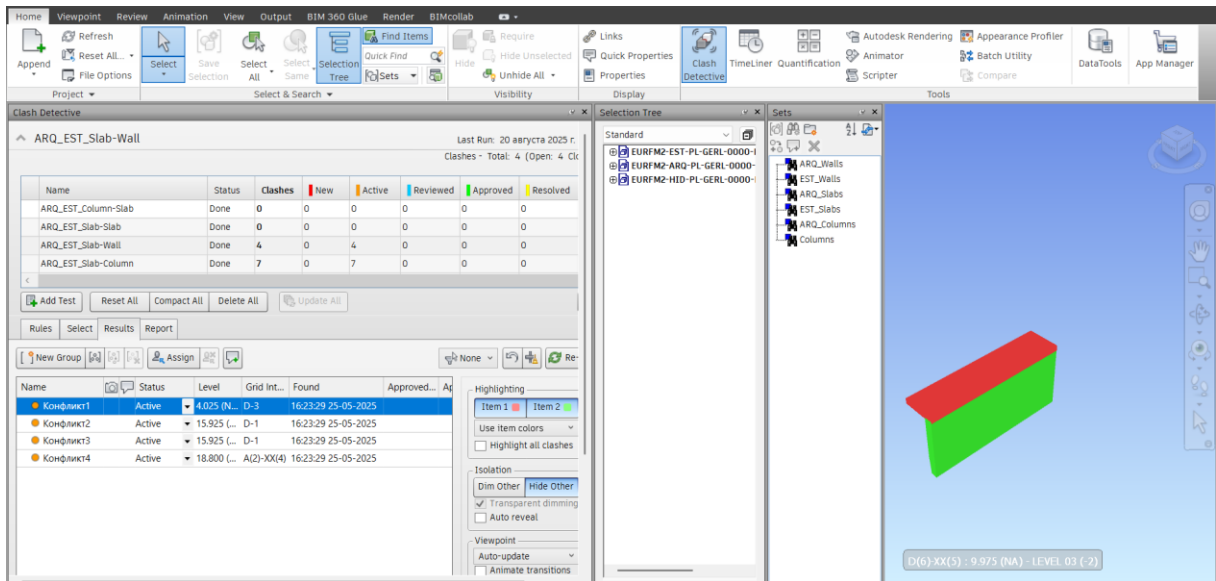


Figure 29 – Initial view of the federated model in Navisworks with configured clash checks

4.1.2. Synchronization of Clash Issues

Using the BIMCollab Manager plug-in in Navisworks, synchronization with the BIMCollab Join project is initiated. Through this integration, all clashes are exported to the cloud environment in the form of BCF records. The workflow typically follows this sequence in the figure.

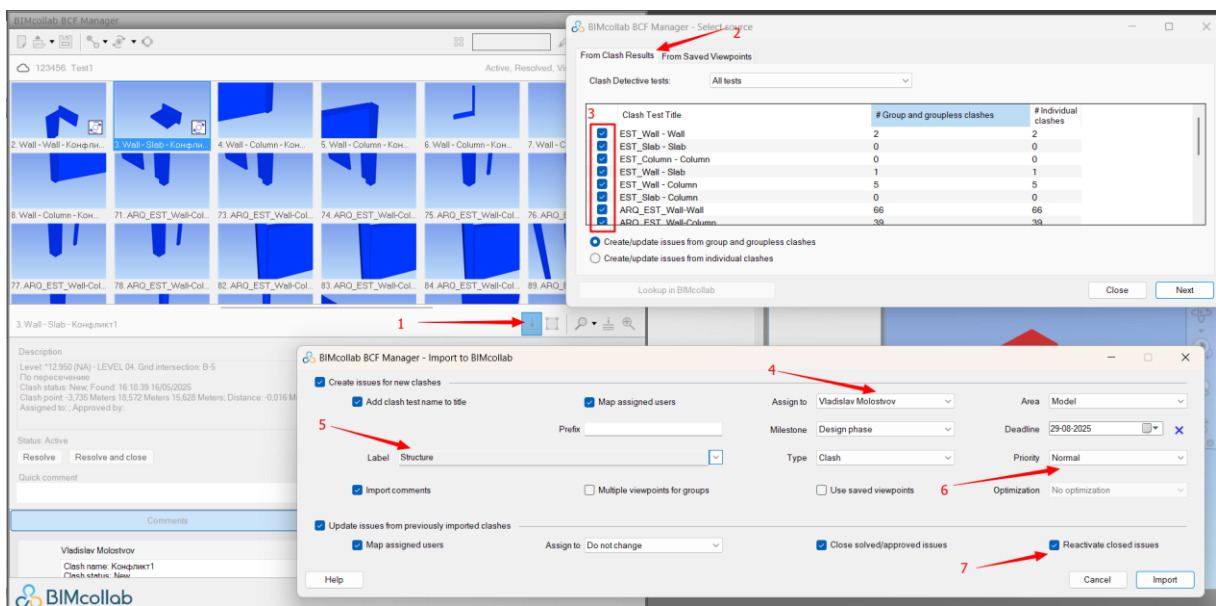


Figure 30 – Process of importing clashes into the CDE

Workflow description:

1. Import clashes into the BIMCollab Join project (possible only when the project is active in the platform).

2. Define import rules. These rules must be structured so that clashes can be assigned to specific responsible users. In the demonstrated scenario, checks were organized by discipline, making it easier to designate accountable specialists.
3. Select the clashes requiring resolution by specific project participants.
4. Assign the responsible individual for correction.
5. Assign the responsible discipline or project section.
6. Define the priority of the issue. Different weights are assigned to issues depending on priority – minor = 1 point, normal = 2 points, critical = 3 points.
7. If a clash was previously marked as resolved or closed but is still detected as active during automatic validation, its status is reset to Active.

Although other fields can be customized or disabled, the central requirement is that each clash has a designated responsible user. This assignment later determines who receives points for resolution in the gamified dashboard.

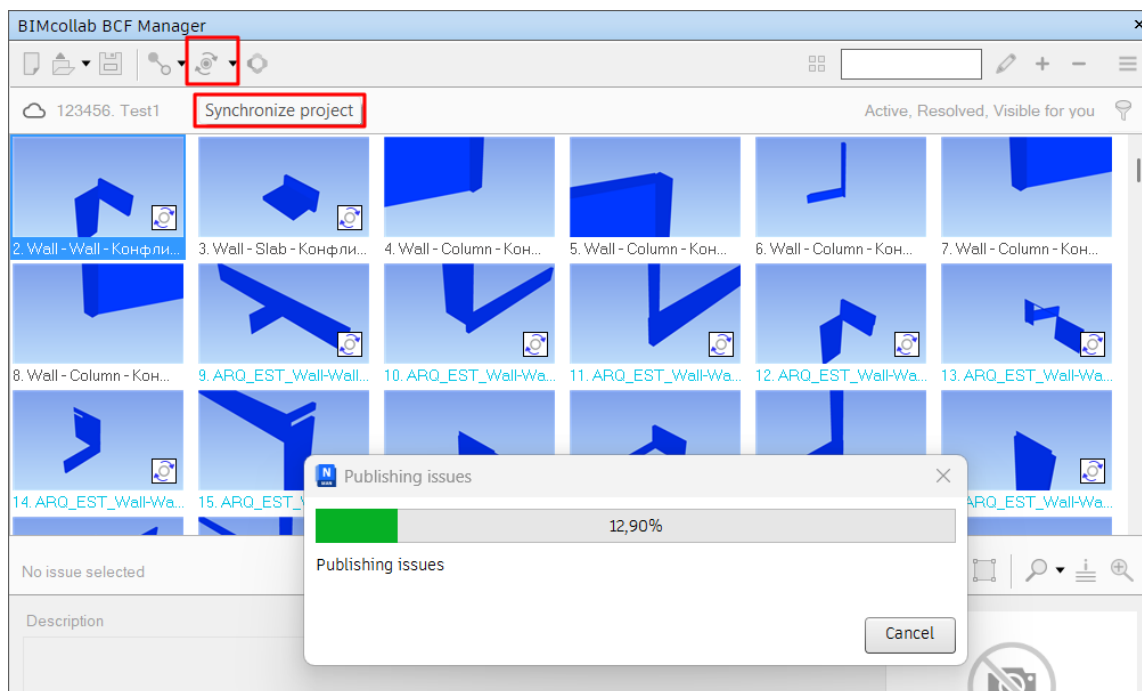


Figure 31 – Clash synchronization

The synchronized issues are then consolidated in the CDE project. A BCF file is generated containing all detected issues, which can then be exported to the local project server. While it is technically possible to establish a direct connection between Power BI and the CDE environment, in this case the focus was placed on implementing the gamification mechanics with the most straightforward workflow. The exported BCF is subsequently converted into a CSV file. Although the commercial version of BIMCollab Join includes a built-in export-to-CSV function, in this case a dedicated Python script was developed to automate the transformation from BCF to CSV. The resulting file is stored in

the designated Power BI directory under a structured naming convention, e.g., C1_Issues_Closed_For_YYYYMMDD.

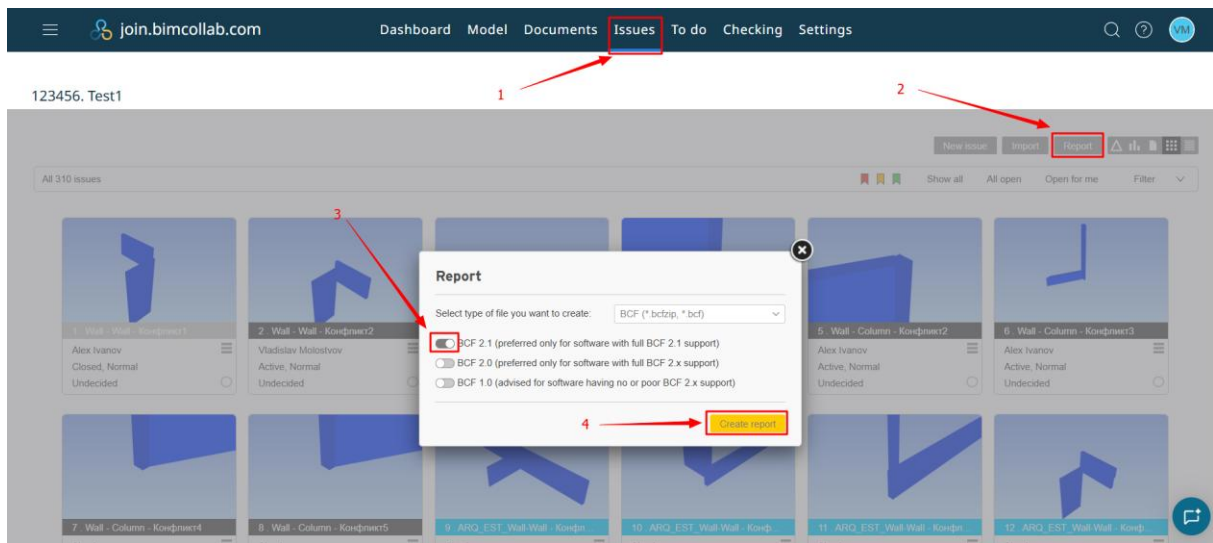


Figure 32 – Creating a BCF file from the BIMCollab CDE

4.1.3. Resolving Issues in Revit

For the purposes of demonstrating the mechanics, seven clashes identified within the ARQ_STR_Slab_Column check – responsible for detecting intersections between architectural floor slabs and structural columns – were selected for detailed analysis. The focus on these specific seven clashes is of principal importance, as they serve to exemplify the entire lifecycle of an issue: from its initial detection, through corrective actions, to its resolution and the subsequent allocation of points to the responsible designer.

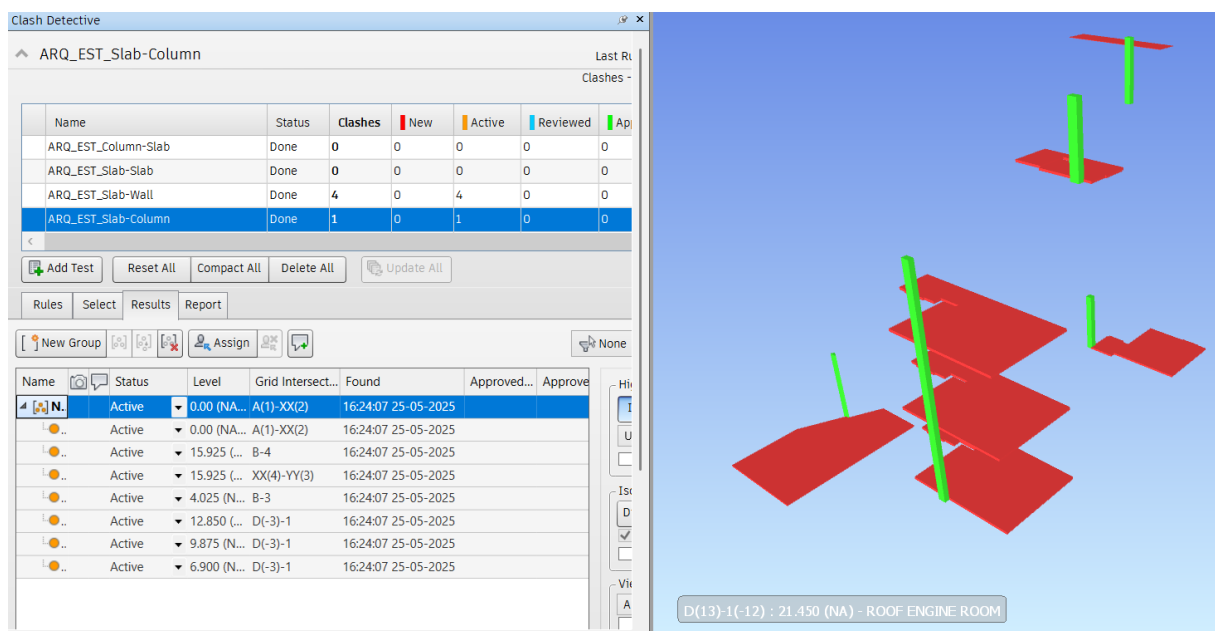


Figure 33 – Chosen clashes

After installing the BIMCollab Manager plug-in for Revit, the user authorizes their account in the same way as in Navisworks. Through the plug-in, the user accesses the BIMCollab Join project, searches for assigned issues, and begins corrections within the Revit environment.

The core responsibility of the designer is twofold:

- resolve the clash directly within the model;
- update the issue status to Resolved within BIMCollab Manager.

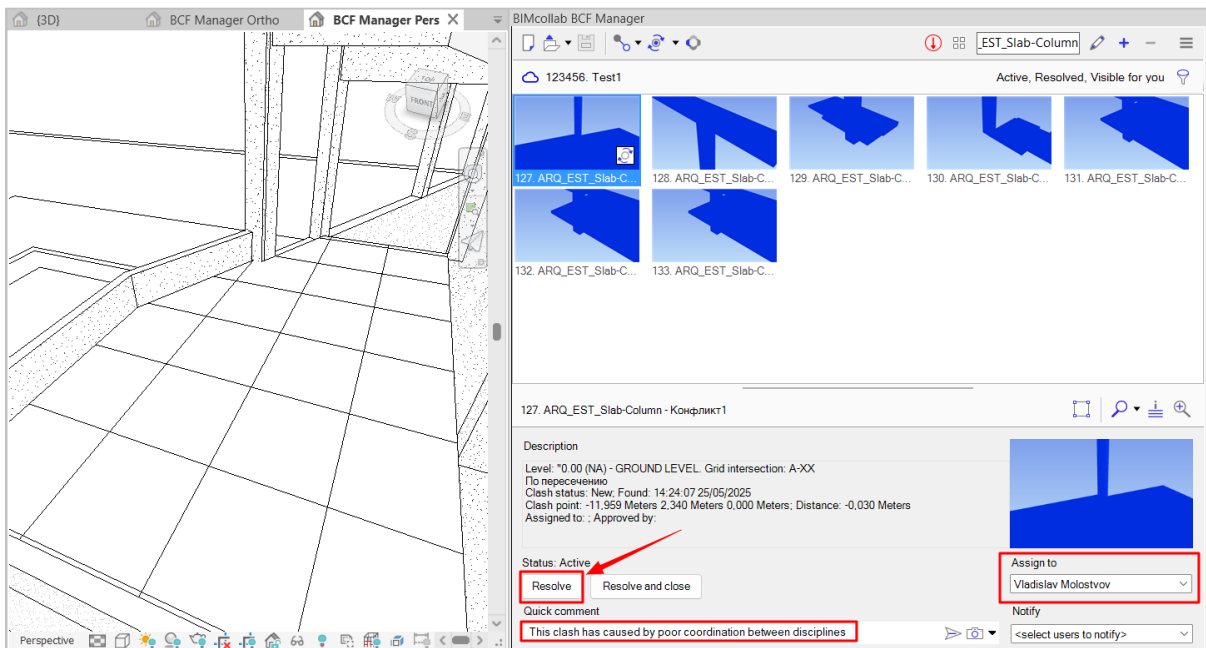


Figure 34 – Necessary actions for BIMCollab manager in Revit: checking name, replacing problem status, writing a comment

After corrections are complete, the user synchronizes changes with BIMCollab and generates a personal BCF file. This file is exported to the local server and converted to CSV, named according to the convention C1_Issues_Resolved_By_XX_YYYYMMDD, where XX are the user's initials. This naming logic prevents overwriting of files by multiple contributors working simultaneously.

4.1.4. Validation and Final Approval by the BIM Coordinator

Once the designers have implemented the corrections, the BIM Coordinator returns to Navisworks, updates the federated model, and reruns the clash detection. If the previously identified intersections are no longer displayed and the clash status in Navisworks is shown as Resolved, this confirms the successful correction in the model. At this stage, the coordinator verifies the accuracy of the result, reviews how the clash was resolved, and formally closes the issue by assigning it the status Approved (or Closed in BCF terminology).

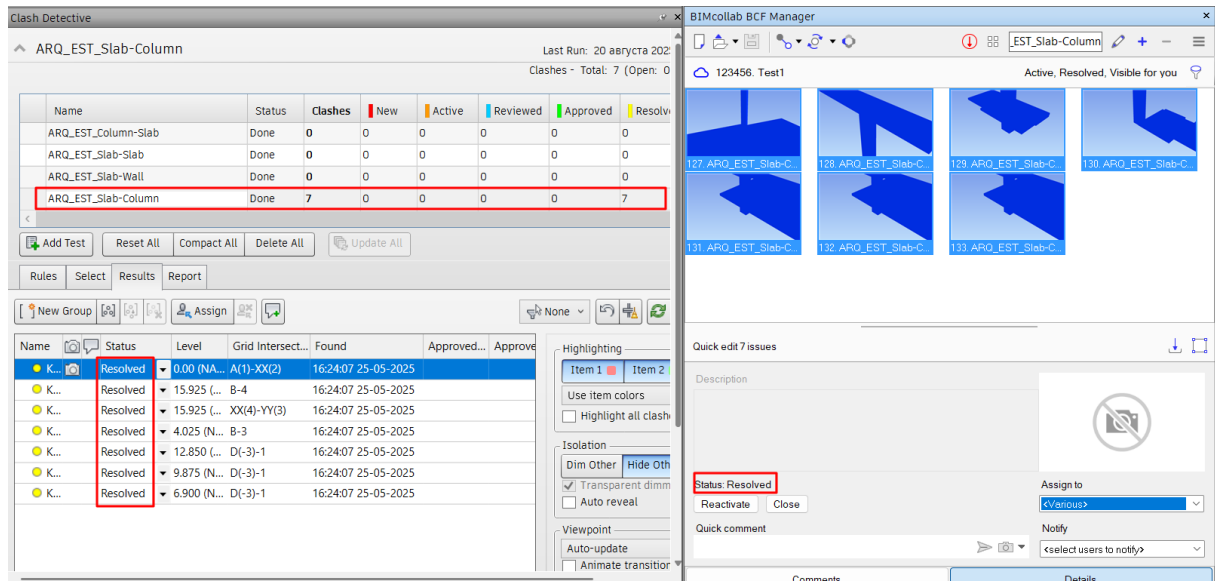


Figure 35 – 7 clashes after automatic verification and designers’ corrections

The validation workflow typically involves:

1. Setting the clash status to Approved.
2. Exporting the updated set of issues to the BIMCollab Join project.
3. Selecting the set of checks to be updated.

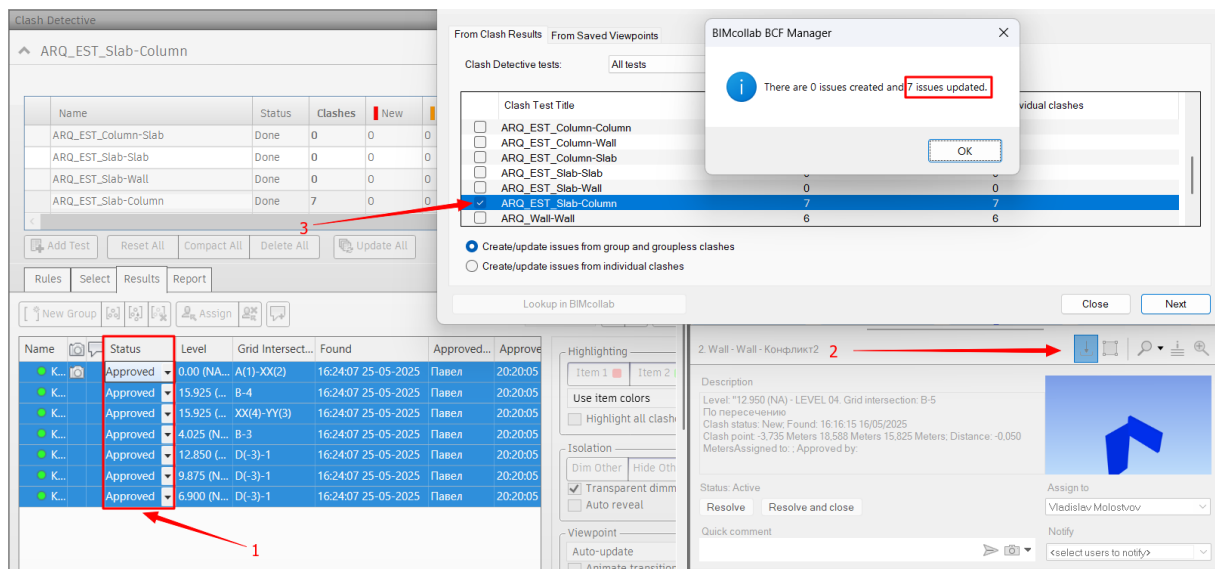


Figure 36 – Updating the issues

The result of this cycle is that the seven clashes previously corrected in Revit are now officially marked as closed. The coordinator then generates a final BCF file including all validated issues, converts it to CSV, and stores it on the project server.

4.1.5. Formation of the Dataset for the Dashboard

At this stage, the project server contains two synchronized datasets:

- Resolved files (C1_Issues_Resolved_By), representing designers' declared resolutions;
- Closed files (C1_Issues_Closed_For), representing coordinator-validated closures.

Together, these datasets capture both the individual contributions of designers and the validation layer introduced by the coordinator. This dual-record structure not only ensures reliability of the data but also provides the foundation for gamification, since points are awarded only for issues that are both resolved by designers and confirmed as closed by the coordinator.

The prepared CSV files are subsequently uploaded into Power BI, where the gamification mechanics – scoring, leaderboards, badges, and performance metrics – become active automatically. This completes the full cycle from clash detection to visualization in the C1_BIM Clash Gamification Dashboard.

4.2. Tracking Clash Resolution Metrics in the Dashboard

At this point, attention may be shifted to the tracking of the seven corrected clashes within the developed dashboard. The subsequent analysis will consolidate the relevant metrics by comparing the datasets prior to their update (when the clashes and associated performance points had not yet been recalculated) with the refreshed datasets containing the validated results. This will provide an opportunity to examine in detail how the resolution of clashes is registered, how performance indicators are updated, and what insights can be drawn from the dashboard regarding both individual and team contributions.

The work of the design team is modeled without the involvement of external participants. In this example, the team consists of three members, each assigned a unique email address, which also serves as their login credential for accessing and managing clash detection tasks. The table below provides an explanation of the roles and corresponding participants.

Table 10 – Simulated Process Participants

User	Email Address in the Dashboard
Participant A	vlad-molostvov@yandex.ru
Participant B	johnsmitt@outlook.com
Participant C	billcheck@gmail.com

4.2.1. Recorded Results Before Update

As initial input for the dashboard, a set of pre-recorded data has been provided in order to illustrate the process. These records correspond to the project results dated 28 May 2025 and 9 July 2025. Over the entire observation period, a total of 203 clashes were identified. Of these, designers marked 113 clashes as resolved, while the BIM Coordinator closed 145 clashes. The higher number of closures reflects the fact that certain elements passed automated checks indirectly – for example, when the resolution of one clash simultaneously removed other associated conflicts. Such automatically cleared clashes are not credited to any participant in the scoring system.

The number of clashes that directly influenced the allocation of points amounted to 72. These represent clashes that were explicitly corrected by designers (status Resolved in the dataset) and subsequently validated by the coordinator (status Closed in the corresponding dataset).

The records also indicate that three designers were actively involved in the process; however, particular attention should be directed to Participant A, as this participant was responsible for correcting the seven clashes analyzed in the previous chapter.

In addition, it is observed that only two design disciplines participated in the checks – Architecture and Structure. The dashboard also incorporates a range of other visual elements that enable detailed monitoring of project progress, including weekly leaderboards, distribution of clashes by priority, and comparative indicators of team performance.

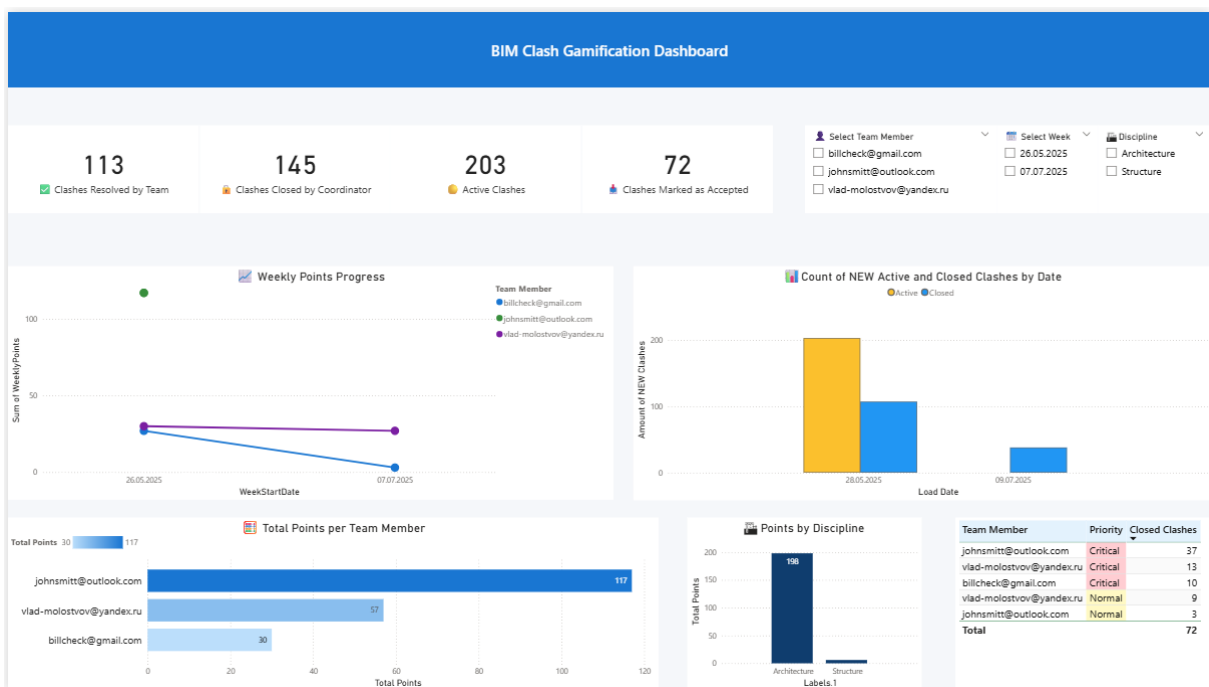


Figure 37 – Recorded results before update: clashes

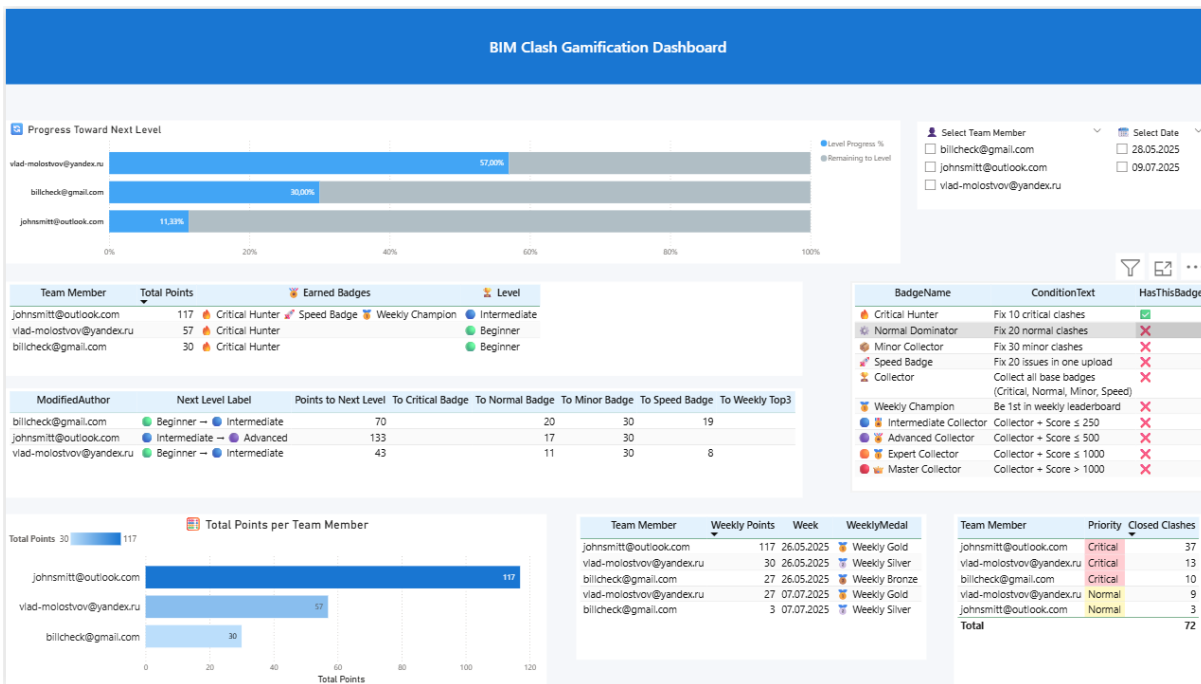


Figure 38 – Recorded results before update: team progress

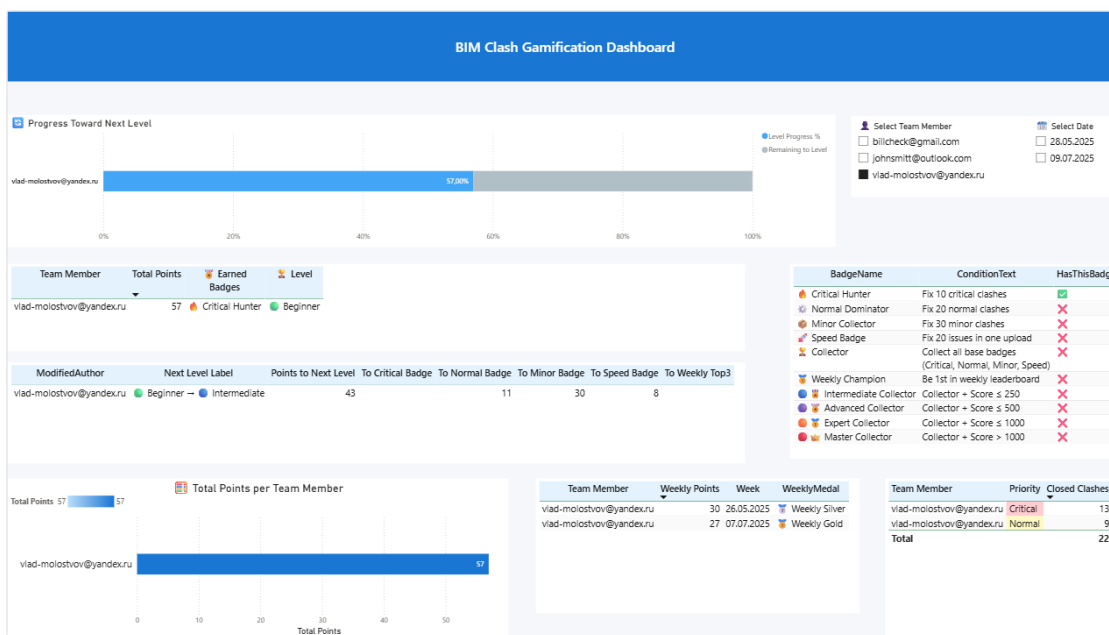


Figure 39 – Recorded results before update: individual progress

Furthermore, both on the team dashboard and on the individual dashboard, it is visible that the user of interest has completed 57% of the Beginner level, requiring an additional 43 points to reach the Intermediate level. The user has already earned a badge for resolving critical clashes, and the dashboard also allows for tracking the number of points accumulated toward the achievement of other badges.

4.2.2. Recorded Results After Update

After the dataset was updated, all indicators were recalculated, allowing for an assessment of their completeness and accuracy. The dashboards presented below reflect the post-update results. In the following sections, each of the key indicators will be examined in detail.

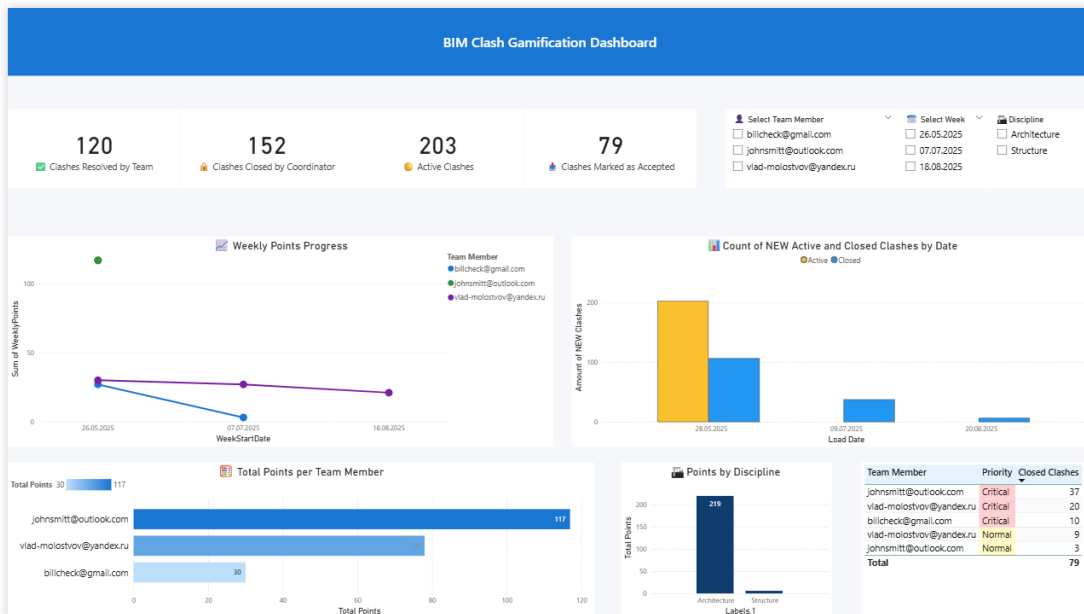


Figure 40 – Updated results: clashes

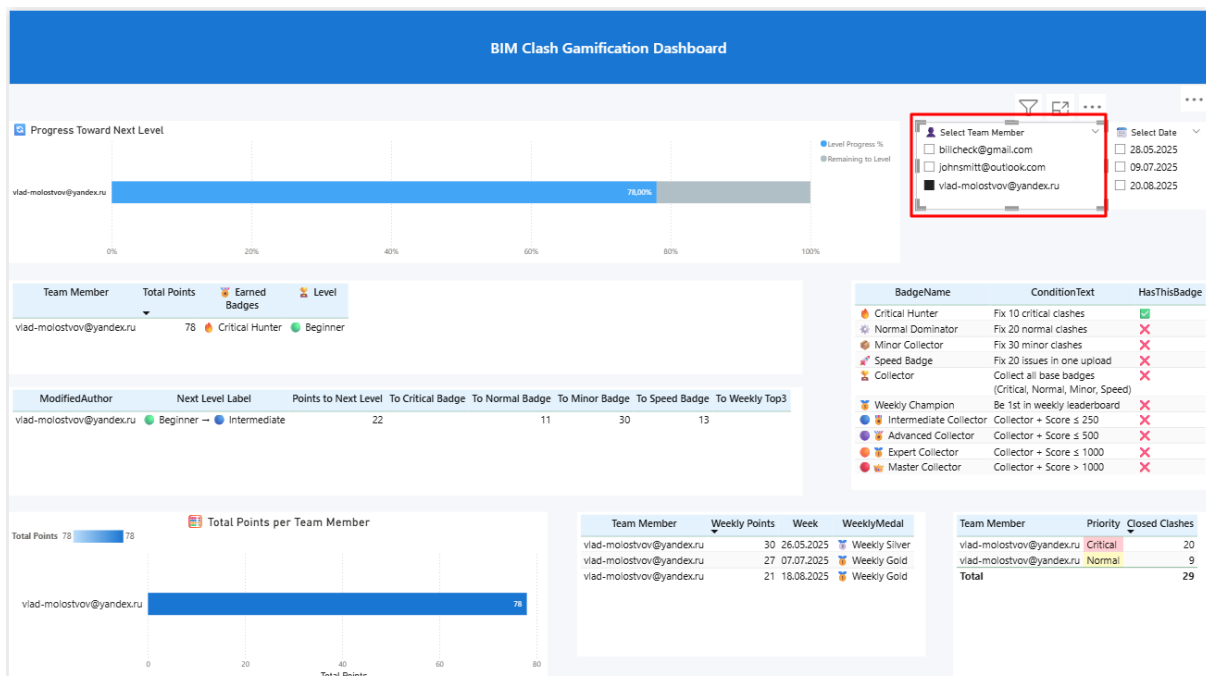


Figure 41 – Updated results: individual progress

After the data update, three out of the four indicators displayed on the KPI cards increased, reflecting the number of clashes that were resolved and subsequently validated. The number of active clashes, however, remained unchanged, as this metric represents the total count of all active clashes ever

identified within the project. This is an important characteristic of the dashboard: while corrective actions directly influence progress-related KPIs (such as Clashes Resolved by Team or Clashes Closed by Coordinator), the cumulative number of active clashes functions as a historical reference point. It does not decrease automatically when individual issues are resolved but instead preserves the overall scope of coordination challenges encountered throughout the project lifecycle. Consequently, the updated KPI cards provide a dual perspective – on the one hand, they demonstrate measurable improvements achieved through the resolution and validation of clashes, and on the other hand, they retain a record of the project’s complexity and the scale of detected conflicts.

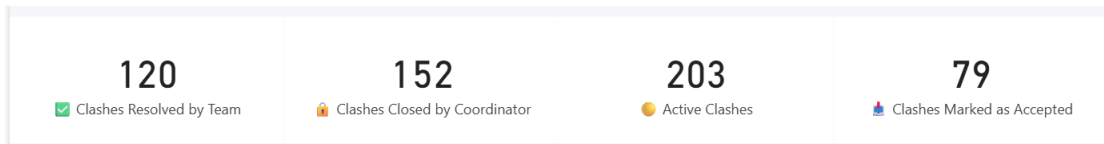


Figure 42 – Updated KPI cards

With the latest update, the filter panel now includes the option to select the week of 18 August 2025, which corresponds to the most recent dataset refresh. This functionality ensures that users can focus their analysis on the specific reporting period in which the updated data was incorporated. Should new participants or disciplines be introduced into the project in the future, the filter panel would automatically expand to accommodate these additional categories, thereby maintaining flexibility and scalability of the analytical model.

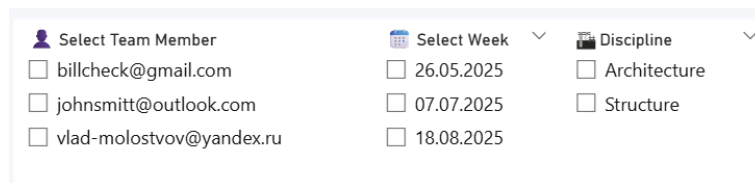


Figure 43 – Updated filters: option to select a new week in the weekly ranking

The updated statistics on newly active and newly closed clashes indicate that, as of the date of the refreshed dataset upload, seven clashes were resolved, while no new clashes were detected.

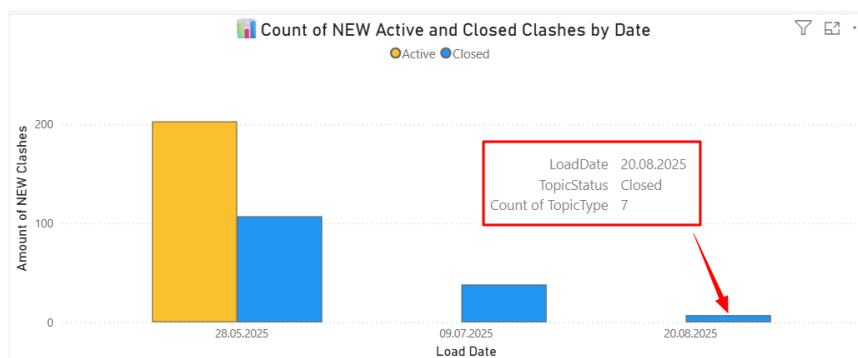


Figure 44 – Updated statistics of new and closed clashes: 0 new, 7 closed

In the weekly progress chart, it can be observed that only Participant A engaged in resolving clashes during the reporting week, for which a total of 21 points were awarded. This score corresponds to the resolution of seven critical clashes, with each critical clash valued at 3 points, thereby producing the

total of 21. At the same time, the user's performance shows a slight decline compared to previous periods, and the fact that they were the sole contributor in this week does not render the outcome exceptional: one of the other users, during an earlier reporting week, achieved a cumulative result exceeding the combined scores of several colleagues across the entire observation period.

This pattern illustrates a dual perspective on performance assessment. On the one hand, the user demonstrated consistent engagement by addressing a series of high-priority issues, which directly contributed to project stability. On the other hand, the relative decline in efficiency and the comparison with past peak achievements highlight the importance of evaluating not only absolute performance but also contextual benchmarks. Such comparisons reinforce the gamification framework by motivating participants to sustain or surpass their earlier results, while also providing coordinators with insights into fluctuations in workload distribution and team dynamics.

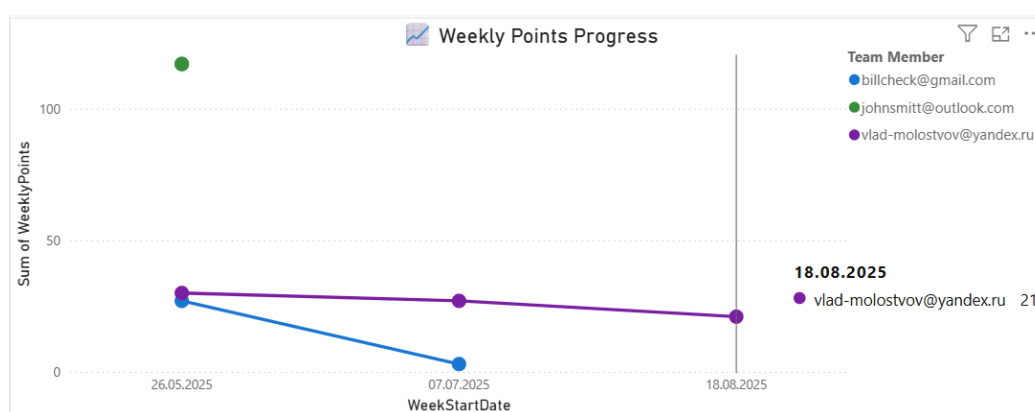


Figure 45 – Points for the new week in the weekly progress chart

In the overall cumulative ranking, it is evident that the user's recent activity did not substantially alter their long-term progress. Nevertheless, the contribution, albeit modest, had a measurable effect both on the individual score and on the performance of the Architecture team, since both the resolved clashes and the user in question were associated with this discipline.

While the direct impact on the user's personal advancement appears relatively minor, the aggregated effect within the architectural discipline demonstrates how the gamification framework integrates micro-level contributions into a broader picture of team accountability. Such integration ensures that incremental progress is recognized and that participants remain aware of the interconnected nature of interdisciplinary collaboration.

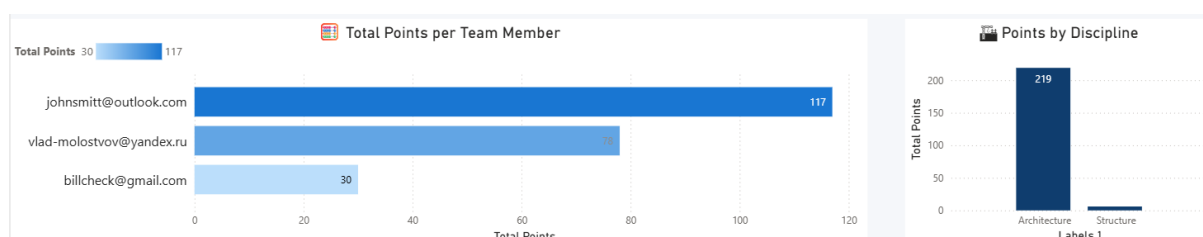


Figure 46 – Updated individual and team leaderboard

The two tables show that by resolving seven clashes, the user entered the weekly leaderboard and was awarded the “Weekly Gold” medal. At the same time, the first table indicates that the user, ranked

fifth overall, did not surpass their two previous records, which reflects a decline in overall productivity. The second table confirms that the seven resolved clashes were classified as critical, and their effect is reflected in the updated project total of 79 closed clashes.

Team Member	Weekly Points	Week	Weekly Medal
johnsmitt@outlook.com	117	26.05.2025	Weekly Gold
vlad-molostvov@yandex.ru	30	26.05.2025	Weekly Silver
billcheck@gmail.com	27	26.05.2025	Weekly Bronze
vlad-molostvov@yandex.ru	27	07.07.2025	Weekly Gold
vlad-molostvov@yandex.ru	21	18.08.2025	Weekly Gold
billcheck@gmail.com	3	07.07.2025	Weekly Silver

Team Member	Priority	Closed Clashes
johnsmitt@outlook.com	Critical	37
vlad-molostvov@yandex.ru	Critical	20
billcheck@gmail.com	Critical	10
vlad-molostvov@yandex.ru	Normal	9
johnsmitt@outlook.com	Normal	3
Total		79

Figure 47 – Leadership achieved in the new week; updated number of closed clashes by priority

The following elements present the participant’s results in the individual progress view. The progress toward achieving the next level increased from 57% to 78%, and all indicators related to badge acquisition were updated accordingly. The fields To Critical Badge and To Weekly Top 3 remain empty, since the user had already earned a badge for resolving critical clashes and had previously occupied leading positions in the weekly rankings. The values in To Normal Badge and To Minor Badge did not change, as progress in these categories requires the resolution of clashes corresponding to their respective priorities.

The dashboard also updated the information on how many points remain to reach the next level, as well as how many points were missing to obtain the badge for speed of clash resolution. Specifically, the requirement for this badge was the resolution of 20 clashes, and the panel indicated that the user was short by 13 clashes.

Thus, by showing not only achievements already obtained but also the precise distance to future milestones, the interface reinforces user motivation and encourages continuous participation. Importantly, the explicit tracking of remaining points and badge conditions makes the scoring system transparent: participants can clearly see how their actions translate into quantifiable progress. Such visibility reduces ambiguity, builds trust in the fairness of the system, and supports self-regulation, as users can independently assess which categories require further effort.

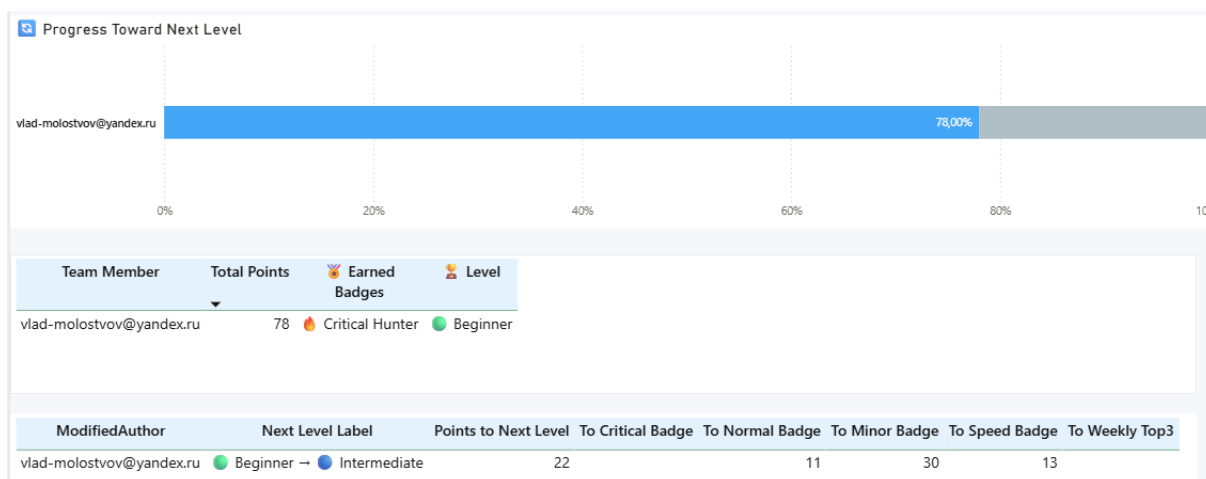


Figure 48 – Updated results in the progress bar; badge updates

For greater clarity, the following table on the dashboard presents all badges ever earned by the user. The list of badges is not limited to rules based solely on the accumulation of a certain number of points, thereby demonstrating that badges may also be awarded through alternative achievement pathways. This highlights the system’s potential for virtually unlimited scalability.

A key principle of any gamified system is the need for continuous renewal in order to sustain user engagement. Without periodic updates, even the most well-designed mechanics risk becoming predictable and losing their motivational impact. The creation of new badges and their inclusion in the comprehensive badge table directly addresses this requirement by introducing fresh goals and recognition opportunities. While this represents the minimum level of system refresh, it plays a crucial role in maintaining long-term interest, ensuring that participants continue to perceive the environment as dynamic, rewarding, and responsive to their efforts.











BadgeName	ConditionText	HasThisBadge
 Critical Hunter	Fix 10 critical clashes	✓
 Normal Dominator	Fix 20 normal clashes	✗
 Minor Collector	Fix 30 minor clashes	✗
 Speed Badge	Fix 20 issues in one upload	✗
 Collector	Collect all base badges (Critical, Normal, Minor, Speed)	✗
 Weekly Champion	Be 1st in weekly leaderboard	✗
 Intermediate Collector	Collector + Score ≤ 250	✗
 Advanced Collector	Collector + Score ≤ 500	✗
 Expert Collector	Collector + Score ≤ 1000	✗
 Master Collector	Collector + Score > 1000	✗

Figure 49 – Badge table after update

4.3. Summary of the Case Study

The presented case study has demonstrated a practical scenario of implementing the C1 BIM Clash Gamification Dashboard, illustrating the full lifecycle of clash management – from detection in Navisworks, through correction in Revit, to final validation and closure by the BIM Coordinator. A specific set of seven clashes was used as a detailed example to trace how the system records individual and team contributions, transforming raw coordination data into transparent and engaging performance metrics.

The process highlighted the dual role of datasets (Resolved by designers and Closed by the coordinator), which together ensure both the accuracy of technical corrections and the fairness of the gamified scoring system. By requiring confirmation from both sides, the model minimizes false positives, reinforces accountability, and builds trust in the recorded results.

The analysis of dashboard elements confirmed the system’s ability to translate technical progress into measurable indicators. KPI cards reflected the immediate impact of corrections, while weekly and cumulative leaderboards provided layered perspectives on productivity. Progress bars and badge

panels further enhanced transparency, allowing participants to track not only achievements already gained but also the precise requirements for future milestones. The badge table underscored the system's scalability, showing that recognition is not limited to point accumulation but can encompass diverse dimensions of performance.

The findings emphasize two essential dimensions of gamification in BIM workflows. On the operational side, gamified dashboards improve visibility of clash management, reduce the likelihood of unresolved issues, and promote timely corrective actions. On the cultural side, they foster engagement, create a sense of ownership, and establish a shared framework of accountability across disciplines. Importantly, the analysis also demonstrated that such systems require continuous renewal—through the introduction of new badges, updated targets, and evolving benchmarks—to sustain long-term motivation and prevent stagnation.

In conclusion, the case study illustrates that the integration of gamification into clash management processes is both technically feasible and organizationally beneficial. By combining automation with structured human oversight, the C1 BIM Clash Gamification Dashboard provides a robust quality-control mechanism that not only enhances project outcomes but also contributes to the development of a transparent, competitive, and quality-oriented design culture.

Moreover, the implementation of such a dashboard – even when accounting for investments in visual enhancement (such as the creation of web and mobile applications with advanced animations), ongoing support by a dedicated specialist, and the regular updating of gamification mechanics – would not require significant resources in the overall scale of project management. The developed concept thus demonstrates the potential to deliver substantial advantages while demanding only minimal financial investment, making it a cost-effective tool for improving both performance and collaboration in BIM-based projects.

5. CONCLUSIONS

In this dissertation, a concept of a gamified environment adapted to modern design methods in the AEC industry using BIM was created and presented. The proposed system is generally aimed at solving the most common problems of design organizations, which go beyond purely technological issues and are mainly related to the human aspects of project management. Among them, the key ones are: compliance with project requirements and standards, maintaining high efficiency of coordination, ensuring a sufficient level of involvement and motivation of designers, as well as overcoming difficulties in communication – both within individual project teams and between different participants in the entire construction process.

The central hypothesis of the study was that the introduction of gamification, embedded directly into BIM processes, can become an effective tool for solving these problems. By strengthening participants' personal responsibility, increasing their level of motivation, and providing transparent feedback mechanisms, gamified systems can complement the technical foundation of BIM, enriching it with organizational and behavioural elements.

The research developed step by step, which made it possible to consistently structure the study from the theoretical foundation to practical illustrations. At the first stage—the stage of writing the literature review—the focus was on studying the principles of gamification and examining the impact of game elements in a non-game context. Particular attention was paid to finding examples of the application of gamification both within the AEC industry and beyond it. The review demonstrated a general consensus among researchers that gamification can bring significant benefits, but its effectiveness largely depends on the context and the environment into which game mechanics are introduced. In the AEC sector, there is a clear lack of research in this area, which causes uncertainty in assessing the long-term advantages of implementation. One of the key questions repeatedly highlighted by authors remains the study of the sustainable effect of gamification with long-term use. Since the practical implementation of such solutions is still limited, this problem remains open for future studies.

It was precisely this gap in research that became the starting point for the present work. The author assumed that the design environment is the most promising for the introduction of such solutions: it is characterized by a high degree of digitalization, widespread use of BIM, and a sufficient level of maturity for the integration of digital game mechanics. Thus, the formation of gamification systems in design can have significant potential to increase the productivity of the entire process.

At the next stage, related to the development of the research methodology, the main focus was on creating gamified mechanisms capable of addressing some important problems of the design industry. These problems included insufficient coordination between project participants, reduced employee motivation, and weak involvement in collective processes. The selection and formulation of the problems were carried out with particular care: the analysis included relationships both within individual project teams and in the interaction between disciplines, with clients, and even with government institutions responsible for issuing construction permits.

For each of the identified problems, a solution was proposed in the form of gamified dashboards developed in the Microsoft Power BI environment. The datasets necessary for the functioning of the game mechanics were determined, interaction scenarios of participants were described, and additions to existing formats of communication were presented. An important feature of the study was that, along with the concept of dashboards, detailed instructions for their use were prepared. These instructions included an explanation of the logic of all game elements, the sequence of working with the dashboard, and the potential benefits of its application. Moreover, two levels of guides were developed: for ordinary users (designers) and for management (primarily BIM coordinators). This structure made it possible to separate the attention of different user groups, focusing their efforts on those aspects of working with the system that are most relevant to their tasks.

The presence of instructions and the use of gamification mechanics that are easy to learn make the implementation of the developed system in real design conditions relatively simple and not requiring significant costs for training or support. Systems of this kind can be integrated into existing processes, minimizing the need for radical restructuring of infrastructure.

Of particular importance in the dissertation is the case study dedicated to the C1 BIM Clash Gamification Dashboard. This dashboard was chosen for practical demonstration because its implementation is already possible today using available tools and software. Within the case study, the process of forming the necessary datasets was examined in detail, the interaction of participants in the clash resolution process was shown, and an example of the practical implementation of game mechanics on existing platforms was provided.

The case study was based on the life cycle of seven specific clashes—from their detection in Autodesk Navisworks, resolution in Autodesk Revit, to verification and final closure by the BIM coordinator. This approach made it possible not only to demonstrate the system’s operation in practice but also to trace how “raw” coordination data gradually transforms into transparent and motivating performance indicators.

Dashboard elements, including KPI cards, ratings, progress bars, and badge panels, confirmed the system’s ability to capture both short-term work results and form long-term user motivation. At the same time, the dashboard demonstrated the scalability of the proposed approach: game mechanics can be adapted to various levels of project complexity and expanded when necessary.

The results of the case study analysis demonstrated a combination of operational advantages and cultural effects. From an operational point of view, the gamified dashboard provides increased process transparency, faster problem resolution, and reduced risk of unresolved clashes. From a cultural point of view, it contributes to the growth of participant engagement, the formation of a sense of personal responsibility, and the consolidation of a culture of accountability among teams.

The importance of the dynamic development of such systems is emphasized separately. Gamified mechanics cannot remain static: they require regular updates, the creation of new rules and incentive models, as well as the introduction of additional elements to maintain participants’ interest and prevent a decline in motivation.

Overall, the case study confirmed that the use of gamification in clash management is not only technically feasible but also organizationally valuable and, most likely, economically justified. Even when additional investments in visual improvements, specialist support, and updating game mechanics are considered, the costs remain insignificant compared to the managerial benefits that the project receives.

Research limitations

Despite the positive results obtained during the study, it is necessary to acknowledge several limitations that affect both the completeness of the conclusions and the possibilities of their generalization. These limitations should be considered when interpreting the results and especially when applying them in practice.

- Lack of long-term observations. Within the framework of the dissertation, it was not possible to conduct a study of the impact of gamification over a long-time horizon. This means that the question remains open as to whether the achieved effect of motivation and involvement is maintained over months or years.
- Lack of user feedback. Systematic work on collecting feedback from end users (designers, coordinators, managers) was not carried out. Thus, the study does not provide a complete picture of the subjective perception of the proposed game mechanics and their convenience.
- Lack of practical validation for aspects other than clashes. The main focus in the practical case study was on clash management. Although this area is key to BIM coordination, it does not cover the full range of processes in which gamification can be useful (for example, document approval, schedule management, or client interaction—for these purposes separate dashboards were also created).
- Timeframe of the research. The limited period of the dissertation did not allow for integration with mobile and web applications, conducting multi-stage pilot testing, and including additional mechanisms (for example, adaptive systems or elements of artificial intelligence).

Thus, the work has several limitations related both to the scope of the research base and to the lack of full-scale practical implementations in real design organizations. These limitations at the same time indicate the boundaries of the reliability of the conclusions made and outline directions for the further development of the topic.

Directions for future research

Considering the identified limitations and the nature of the results obtained, further research in this area appears especially promising. The following directions can contribute both to the expansion of scientific knowledge and to increasing the applied value of the developed concept:

- Large-scale case studies. Conducting research on a larger number of real projects with the participation of several design teams will allow testing the universality of the proposed

approach and identifying differences in the perception of gamification among different disciplines.

- Long-term observations. It is necessary to study the sustainability of the gamification effect over a long period of time. This will make it possible to determine whether the motivational and organizational effect is maintained months and years after implementation, as well as which mechanics require regular updates.
- Systematic collection of user feedback. In the future, it is worth integrating qualitative and quantitative analysis methods (surveys, interviews, observations) into the study to better understand the perception and satisfaction of participants. Such an approach will make it possible to refine the mechanics of scoring, awarding badges, and forming leaderboards in accordance with the real expectations of users.
- Integration with web and mobile platforms. The development of applications with extended visualization capabilities and a user-friendly interface will make the system more accessible and increase its influence on the daily work of designers.
- Use of artificial intelligence. In the future, AI algorithms can be integrated for analysing large volumes of project data, predicting risks, automatically providing recommendations, and adaptively adjusting game mechanics. This will enhance the intellectual component of the system and make it more effective.

Thus, the directions of future work go beyond the narrow case study and set the vector for building a comprehensive research program focused both on theoretical development and on practical application in the AEC industry.

To summarize, it should be noted that the developed concept and the proposed dashboards represent the first step toward the integration of game mechanics into the professional practice of design. These results are valuable both for academic research and for practical application in the AEC sector. In the future, this direction may be developed through more large-scale, long-term, and interdisciplinary research, which will make it possible to finally confirm the effectiveness and sustainability of gamified systems in BIM coordination.

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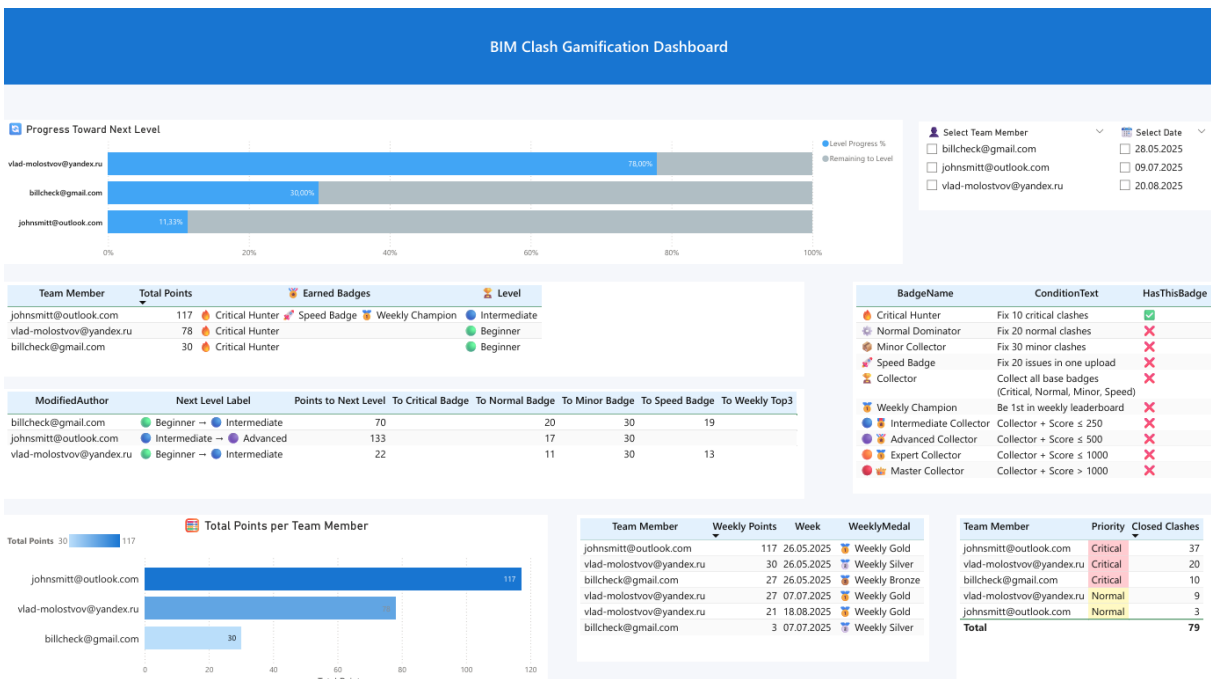
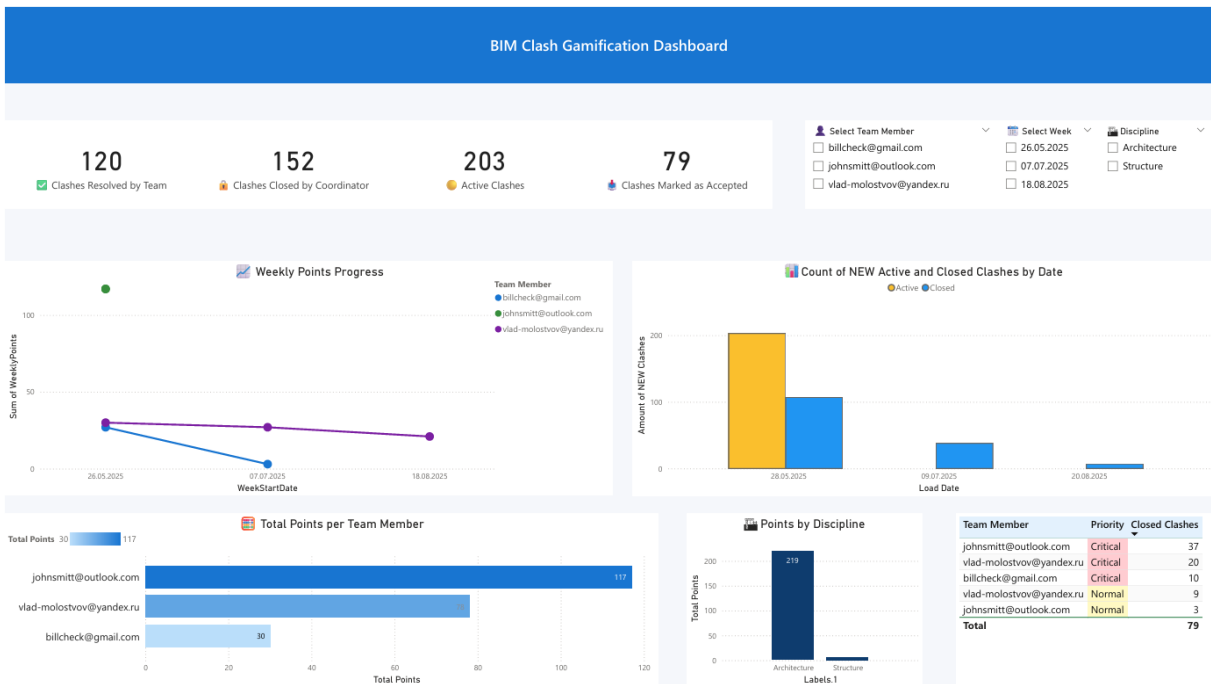
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APPENDICES

APPENDIX 1: FULL GAMIFICATION DASHBOARD



Project Approval Processes

50,00%
% Completed Documents

Total number of approved documents in the project

Comment	Document	Deadline
Load-bearing elements are not justified with calculations based on Eurocode 2 (EN 1992). The report references outdated national standards instead of harmonised European standards. The structural analysis must be recalculated and updated accordingly.	Document 4	29.07.2025
The construction timeline lacks coordination with critical path deliveries and omits safety inspections prior to major milestones. Furthermore, milestone tracking is not linked to quality control documentation, which violates ISO 21500 guidelines. A revised version with integrated QA/QC checkpoints is necessary.	Document 8	29.07.2025
The plan fails to address risks associated with scaffolding and work at height as per Directive 92/57/EEC (Temporary and Mobile Construction Sites). Roles and responsibilities are not clearly assigned, and the risk matrix is missing. A revised H&S plan is required for compliance.	Document 7	29.07.2025
The site layout lacks a verified geospatial reference in accordance with the INSPIRE Directive (Directive 2007/2/EC). Discrepancies were identified between the plan and the cadastral GIS data. A corrected version must be provided using harmonized coordinate systems.	Document 2	29.07.2025

User

- Select all
- Benjamin Ross
- Chloe Adams
- Christopher Reed
- Daniel Hayes
- Emily Carter

55,56%
% Completed Procedures

Total number of approved procedures in the project

Comment	Procedure	Deadline
The Construction Management Plan does not include provisions for temporary access roads or noise and dust mitigation measures, in contradiction with local environmental regulations and Directive 2008/50/EC on ambient air quality. Submission is incomplete and must be amended before approval.	Procedure 9	30.07.2025
The EIA report omits cumulative impact analysis and fails to provide baseline data on local biodiversity, as required by Directive 2011/92/EU (EIA Directive). Public consultation records were also not included. Full environmental compliance documentation must be resubmitted.	Procedure 8	30.07.2025
The fire safety strategy lacks a compliant evacuation plan and fails to demonstrate conformance with EN 1991-1-2 (Actions on structures exposed to fire). There is also no coordination with the local fire brigade, as required by national implementation of Directive 89/106/EEC. The procedure is therefore suspended pending correction.	Procedure 7	30.07.2025
The submitted architectural proposal does not comply with the daylight access requirements defined in EN 17037. Furthermore, the natural ventilation strategy is missing, which is mandatory under Directive (EU) 2010/31 on the energy performance of buildings. The design must be	Procedure 6	30.07.2025

Designer	Count of Document	Approved Documents
James Thornton	2	2
Chloe Adams	1	1
Christopher Reed	1	1
Michael Bennett	1	1
Benjamin Ross	1	0
Emily Carter	1	0
Laura Mitchell	1	0
Olivia Morgan	1	0
Sophie Ellis	1	0
Total	10	5

Designer	Count of Procedure	Approved Procedures
Daniel Hayes	1	1
James Thornton	2	1
Michael Bennett	1	1
Olivia Morgan	1	1
Sophie Ellis	1	1
Benjamin Ross	1	0
Chloe Adams	1	0
Christopher Reed	1	0
Total	9	5

BIM Challenge AI Tests

Completion Date

- 14.06.2025
- 15.06.2025

Topic

- BEP
- EIR
- ISO

Chosen Role

- Architect
- BIM Specialist
- Engineer
- Structural Engineer

20
Total Tests Taken

10
Unique Participants

1,22
Average Score

55,00
Accuracy %

WeekStartDate

09.06.2025

Total Tests by Chosen Role

Total Tests by Topic

Test Volume Over Time

User Name	WeeklyScore	WeekStartDate	WeeklyMedal
Olivia Morgan	36	09.06.2025	Weekly Gold
Christopher Reed	33	09.06.2025	Weekly Silver
James Thornton	30	09.06.2025	Weekly Bronze
Chloe Adams	28	09.06.2025	-
Michael Bennett	24	09.06.2025	-
Daniel Hayes	22	09.06.2025	-
Laura Mitchell	20	09.06.2025	-
Sophie Ellis	20	09.06.2025	-
Emily Carter	16	09.06.2025	-
Benjamin Ross	14	09.06.2025	-

User Name	Chosen Role	Total Score Per User	Rank By Score	Medal	Level	Badges
Olivia Morgan	Engineer	36	1	Gold	Beginner	First Try
Christopher Reed	Engineer	33	2	Silver	Beginner	First Try
James Thornton	Architect	30	3	Bronze	Beginner	First Try
Chloe Adams	BIM Specialist	28	4	-	Beginner	First Try
Michael Bennett	Architect	24	5	-	Beginner	First Try
Daniel Hayes	BIM Specialist	22	6	-	Beginner	First Try
Laura Mitchell	Structural Engineer	20	7	-	Beginner	First Try
Sophie Ellis	Architect	20	7	-	Beginner	First Try
Emily Carter	Architect	16	8	-	Beginner	First Try
Benjamin Ross	Structural Engineer	14	9	-	Beginner	First Try

Team Request - Client Response (TRCR Game)

Earliest CreationDate, Earliest ClientResponseDate and Earliest ClientResponseDate by RequestID, RequestName, CurrentStatus and Deadline

RequestID	RequestName	CurrentStatus	Deadline
1001	Approval of floor plan	Closed	3/20/2025
1002	Material samples	Closed	3/22/2025
1003	HVAC layout check	Closed	3/25/2025
1004	Color scheme confirmat...	Closed	3/28/2025
1005	Lighting supplier confir...	Closed	3/30/2025
1006	Confirmation of final zon...	Waiting for Client	6/24/2025
1007	Approval of main circula...	Waiting for Client	6/29/2025
1008	Feedback on proposed fl...	Closed	7/1/2025
1009	Confirmation of main en...	Waiting for Client	6/24/2025
1010	Approval of roof access...	Closed	6/26/2025
1011	Confirmation of staircase...	Closed	6/29/2025
1012	Clarification on require...	Waiting for Client	6/30/2025

RequestName	ProjectStage	CreationDate	Deadline	ClientResponseDate	DelayDays	DelayStatus
HVAC layout check	MEP Design	15.03.2025	25.03.2025	28.06.2025	95	●
Confirmation of final zoning and space allocation	MEP Design	10.06.2025	24.06.2025		65	●
Confirmation of main entrance location and orientation	Design	10.06.2025	24.06.2025		65	●
Approval of mechanical plant room sizes and locations	Interior Design	11.06.2025	25.06.2025		64	●
Request for backup power requirements (UPS/generator)	Design	12.06.2025	26.06.2025		63	●
Review of proposed foundation type and bearing capacity	MEP Design	13.06.2025	27.06.2025		62	●
Approval of electrical main riser and transformer location	MEP Design	15.06.2025	29.06.2025		60	●
Approval of main circulation routes and emergency exits	Procurement	15.06.2025	29.06.2025		60	●
Clarification on requirements for accessible design (ADA compliance)	Design	16.06.2025	30.06.2025		59	●
Confirmation of roof structure and drainage system coordination	Interior Design	17.06.2025	01.07.2025		58	●
Request for data center/server room cooling requirements	Procurement	23.06.2025	07.07.2025		52	●
Confirmation of rainwater collection or reuse requirements	Procurement	28.06.2025	12.07.2025		47	●
Lighting supplier confirmation	Procurement	29.03.2025	30.03.2025	03.04.2025	4	●
Material samples	Procurement	12.03.2025	22.03.2025	25.03.2025	3	●
Approval of floor plan	Design	10.03.2025	20.03.2025	19.03.2025	-1	●
Color scheme confirmation	Interior Design	18.03.2025	28.03.2025	26.03.2025	-2	●
Approval of fire escape routes and pressurized staircases	Procurement	14.06.2025	28.06.2025	24.06.2025	-4	●
Feedback on proposed floor-to-floor heights	Procurement	27.06.2025	11.07.2025	07.07.2025	-4	●
Clarification on noise and vibration limits for equipment	MEP Design	24.06.2025	08.07.2025	02.07.2025	-6	●

14
Overdue Count

60,00%
OnTimePercent

Reliable Responder
Consistent Collaborator

10,42
Average Response Time

Overdue Requests by Project Stage

ProjectStage	Count
Procurement	5
MEP Design	4
Design	3
Interior Design	2

Average Response Time by Period

Period	Average Response Time (Days)
Before Panel	30
After Panel	5

OnTimePercent by Month

Month	OnTimePercent
March	40,00%
June	63,33%

Team Request - Team Response (TRTR Game)

Delays Experienced by Initiating Teams

Team	InitiatorDelayCount
MEP Team	1
BIM Team	1
Facade Team	1
Architecture Team	1
Client	1
Interior Team	1
Operation Team	1
Structural Team	1

TaskName	ResponsibleTeam	PlannedFinish	ActualFinish	Sum of DelayDays	DelayStatus
Equipment selection	Procurement Team	25.03.2025		156	●
Opening request for structural model	MEP Team	27.03.2025		154	●
Clarification of ceiling heights for lighting layout	Lighting Team	31.03.2025		150	●
Confirmation of façade brackets for cable trays	Electrical Team	06.04.2025		144	●
Fire protection coordination in shaft zones	Fire Safety Team	07.04.2025		143	●
MEP clearance validation in basement	MEP Team	10.04.2025		140	●
Structural support details for facade systems	Structural Team	11.04.2025		139	●
Verification of equipment maintenance zones	MEP Team	15.04.2025		135	●
Final model check before IFC export	BIM Team	17.04.2025		133	●
Foundation design	Structural Team	10.03.2025	12.03.2025	2	●
HVAC calculation	MEP Team	15.03.2025	17.03.2025	2	●
Verification of roof loads for HVAC units	Structural Team	30.03.2025	31.03.2025	1	●
Evacuation signage placement coordination	Fire Safety Team	14.04.2025	14.04.2025	0	●
Fire zone boundaries for HVAC zoning	Fire Safety Team	04.04.2025	04.04.2025	0	●
Placement of transformer rooms in floorplan	Electrical Team	10.04.2025	10.04.2025	0	●
Ceiling coordination for MEP routing	Architecture Team	28.03.2025	27.03.2025	-1	●
Confirmation of plumbing shafts with architectural walls	Plumbing Team	13.04.2025	12.04.2025	-1	●
Coordination of drainage points with architecture	Plumbing Team	30.03.2025	29.03.2025	-1	●
Facade detailing	Architecture Team	20.03.2025	19.03.2025	-1	●
Location of risers in architectural core	MEP Team	03.04.2025	02.04.2025	-1	●

4
Walters

5
Delayers

5
Balanced

64,70
Average Delay (Days)

60,00%
OverduePercent

TeamRank	Responsible Team	TotalDelayByTeam	OverdueTasksByTeam	TeamStatusByTotalDelay
9	MEP Team	430	4	●
8	Procurement Team	156	1	●
7	Lighting Team	150	1	●
6	Electrical Team	144	1	●
5	Fire Safety Team	143	1	●
4	Structural Team	142	3	●
3	BIM Team	133	1	●
1	Architecture Team	-2		●
1	Plumbing Team	-2		●

Team	DelayAsExecutor	DelayAsInitiator	Net Impact on Team	Team Impact Status
Procurement Team	156		156	● Delaying Others
Lighting Team	150		150	● Delaying Others
Electrical Team	144		144	● Delaying Others
Fire Safety Team	143		143	● Delaying Others
MEP Team	431	300	131	● Delaying Others
HVAC Team				● Balanced
Plumbing Team				● Balanced
Architecture Team		2	-2	● Balanced
BIM Team	133	142	-9	● Balanced
Structural Team	142	154	-12	● Balanced
Client		133	-133	● Often Waiting
Operation Team		135	-135	● Often Waiting
Interior Team		150	-150	● Often Waiting
Facade Team		283	-283	● Often Waiting

