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Towards a Framework for Serious Game-Based Learning in Project Management Higher Education: Thematic Insights and Future Directions

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Abstract*– Game-Based Learning (GBL) has emerged as an effective pedagogical approach for enhancing motivation, engagement, and experiential learning within higher education. Nonetheless, the adoption suffers from stagnant rate in Project Management (PM) education, with limited evidence on how research methodology, game design, and learner context collectively shape educational outcomes. This study conducts a thematic synthesis of existing literature on PM-GBL and categorizes them into three dimensions, including research methodology, serious game design, and target audience. The analysis demonstrates that most studies employ short-term, small-scale explorations, predominantly in construction management, while applications in business and software project management are comparatively underexplored. To address this fragmentation, this paper developed a bubble diagram that demonstrates methodological rigor, design diversity, and audience characteristics interaction to influence learning effectiveness. The framework offers a structured overview of the current research landscape and serves as a foundation for advancing the systematic incorporation of GBL in PM higher education. This study contributes to the evolving discourse on experiential learning by clarifying the thematic relationships shaping PM-GBL integration and identifying key areas of imbalance that require scholarly attention.

***Keywords*—Game-Based Learning, Engineering Education, Project Management Education, Educational Technologies**

I. Introduction

In this fast-paced era, the management of projects has become increasingly complex due to the integration of diverse resources, technologies, and stakeholders to achieve a single objective. Accordingly, the increased complexity stressed the need for effective project management (PM) practices capable of considering cost, time, and quality constraints trade-offs, while addressing evolving industry expectations. Project management is the discipline of planning, organizing, and overseeing project resources to achieve a successful completion of specific project goals and objectives [1]. There are several approaches of PM, including the traditional waterfall methodology, Agile PM, and Hybrid PM that combines elements of both. Traditional waterfall approach is a linear PM approach in which each activity begins after the previous one ends, emphasizing a structured and predictable workflow [2]. On the other hand, agile approach enables the team to work on multiple phases of the projects simultaneously [3].

Accordingly, project management is a multi-faceted field, where project managers are expected to be supervising multiple functions and coordinate diverse teams. It is therefore imperative for project managers to be equipped with main skills, including technical skills, organizational skills, and behavioural (i.e., interpersonal) skills [4]. This suggests that effective project managers are developed through experiential learning rather than purely theoretical instructor. Thus, aspiring project managers in academia should develop these skills prior to joining the industry through experiential learning.

This stresses the need for higher education institutions to adapt their teaching methods by incorporating hands-on, experiential learning approaches. Among these, Game-Based Learning (GBL) has emerged as an effective strategy that permits students to actively engage in realistic scenarios and develop essential PM skills [5]. GBL not only facilitates learning through hands-on experience but also enhances students' motivation, engagement, and overall comprehension of complex project dynamics [6] [7]. This indicates that GBL is beneficial to provide students an experiential learning in the academic settings.

Although GBL has earned a positive reputation in higher education, its actual adoption and incorporation into curricula have remained relatively stagnant. This underscored the need for further exploration to identify current practices and develop a comprehensive understanding that can inform future improvements in higher education.

Therefore, this study synthesized several papers that discusses GBL, and the methodologies utilized in each of the papers. Accordingly, Section 2 will discuss the literature review which includes 2.1. Research methodologies of existing literature, 2.2. GBL types, 2.3., Target Audiences of existing literature. Subsequently, Section 3 will discuss the findings and Section 4. Will conclude and provide future work.

II. Literature Review

The stagnation in adopting GBL within PM education has motivated this study. Hence, this study discusses the synthesizes of 49 empirical studies published between 2014 and 2024 [5]. A bibliometric analysis demonstrated a growing interest in this topic, with a notable surge in publications in 2024, as shown in Fig 1. This upward trend suggests that GBL

in PM is gaining momentum, reinforcing the demand for continued research to deepen comprehending and enhance its effective integration into higher education.

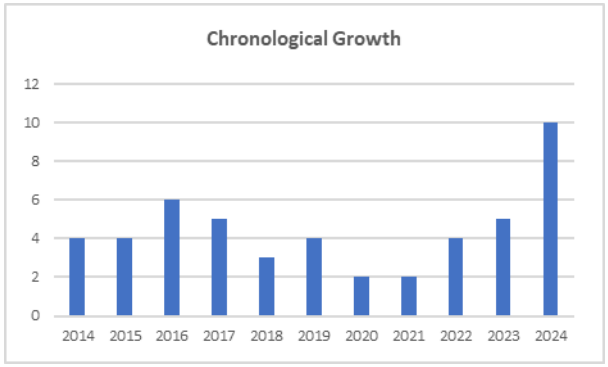

Fig 1 - Chronological Growth of studies investigating GBL in PM education

The literature review is categorized into three main sections based on the previous studies, including the research methodologies, game design approaches, and target audiences.

A. Research Methodology

This section demonstrates the primary objectives, data collection, and experimental setups utilized in PM-GBL empirical research.

Existing studies in literature have investigate GBL in PM in higher education and have utilized various methodological approaches to investigate how games affect students' learning, behaviour, and engagement. Accordingly, several studies evaluated GBL learning outcomes by investigating students' reflection or survey responses after gameplay to capture learners' behavioural patterns and cognitive gains [8],[9]. Despite that these objectives demonstrate useful insights into engagement and motivation; most assessments remain short-term and focus mainly on self-reported measured rather than observable performance improvement.

In terms of experimental setups, some studies primarily relied on classroom-based case studies and pilot implementations [10], [11]. These designs permit close observation of the way students interact with serious games (SGs) and on the way instructors incorporate them into coursework. Other studies have extended this approach through multi-game comparisons or traditional-versus-GBL experiments, revealing how gameplay can enhance collaboration and conceptual understanding [12], [13]. Moreover, there are few studies that have innovatively explored student-made games, in which learners design or adjust the games themselves to reinforce PM concepts [14].

According to data-collection methods, the literature reveals an increasing methodological diversity. Quantitative studies utilize pre-tests and post-tests or structured questionnaires to measure knowledge gains and motivation [11]. On the other hand, qualitative research relies on interviews, focus groups, and reflective journals to capture experiential perspectives [15]. Besides, mixed-methods frameworks combine both to provide a comprehensive evaluation [13]. Although there is a diversity in the studies, most research remain exploratory, with few longitudinal studies evaluating the sustained development of PM competencies through GBL.

Overall, existing studies have revealed insightful inputs into the integration of GBL in PM education, yet the field remains methodologically fragmented with a lack of evidence on the longe-term development of PM competencies. Short-term studies and self-reported measured offer initial signals of engagement and motivation; however, there is limited capture of whether experiential learning translated into durable skills relevant for real-world PM practices. Therefore, it is imperative that future research to develop more robust experimental designs, performance-based assessments, and longitudinal evaluations that trace sustained behavioural and cognitive outcomes. Delving into this direction will contribute to a profound understanding of GBL's transformative potential within higher education PM curricula. However, the subsequent subsection will explore the different types of GBL applications in PM and present a clear categorization of approaches under this broad instructional umbrella.

B. Serious Game Design

Building on how these studies were methodologically executed, it is also crucial to understand how serious games are designed to support PM competencies. SGs fall under the umbrella of GBL and are defined as an experiential learning practice that engage learners in hands-on experience and experimentation through simulation of systems or processes in a simplified manner [16]. According to [5], SGs are used interchangeably with some keywords, such as educational games, simulation games, and gamified learning. Similarly, there are two categories presented in the literature for SGs, including interface and interaction. Interface refers to the platform connected plays to the game world, and interaction refers to the interaction between players [17],[18].

The interface refers to the platform through the game which the game is accessed, and the interface differs whether the game is digital, physical, or hybrid [19]. Accordingly, [19] reported that digital games are accessed through computers, mobile phones, or Virtual Reality (VR) headsets, and tabletop games (i.e., physical element) are accessed in physical space utilizing boards, cards, papers-and-pencils, other tangible suppliers, or no supplies at all. Lastly, Computer-assisted games (hybrid) are games that combines the elements of digital games and tabletop games [20]. This classification of interfaces in SGs underscores the importance of aligning game platforms with learners' context and technological accessibility, particularly in higher education settings where diversity formats, such as digital, physical, and hybrid games, can significantly impact engagement and learning outcomes in PM training.

Alternatively, interaction refer to how players interact with each other and is also divided into three groups, including single-player games, cooperative multiplayer games, and competitive multiplayer games. The single player approach in GBL is known to support individual learning, while multiplayer is known to support social learning [21]. As per the two studies [22] and [23], cooperative multiplayer games enhance students' social skills, such as teamwork or leadership, as well as it enhances students' motivation and engagement in learning. On the other hand, competitive multiplayer permit player to compete with each other which is frequently considered to motivate students, and it promotes a better learning experience [24]. However, according to [25], the findings indicates that students in the study favoured cooperative gameplay over competitive gameplay, suggesting the importance of considering student preference when integrating games into higher education environments.

Nonetheless, although there are several game design choices in the analysis of the PM-GBL, literature demonstrated distinct trend and gaps. The most researched area of SGs are digital single-player games and tabletop cooperative games [5]. Thus, there is a lack of exploration in some design spaces, such as hybrid games and competitive games in the existing literature, with limited studies experimenting these types. Besides, the authors in [5] revealed that it is crucial in the early-stage game development in education to ensure game's objective align with the learning goals. Similarly, there are important design criteria, including ease of use and accessibility, motivational impact, clarity of educational content, and simplicity in the gameplay. Therefore, it is crucial to gather feedback from students, educators, and industry professionals to align game objectives with learning goals to continuously develop SGs, emphasizing the achievement of high-quality user experience and educational value. Finally, it is imperative that game developers to design games that are modular, customizable, and expandable to accelerate widespread adoption.

The classification of SGs based on interface and interaction reveals valuable insights on comprehending and designing games and optimize the integration of PM-GBL in the curricula. Nonetheless, although the availability of diverse configurations, such as hybrid formats and competitive multiplayer structures, the literature reveals limitation in the exploration of design possibilities in these subsets. Most research conducted in literature is on single-player and tabletop cooperative games in the context of PM education, narrowing the understanding of alternative approaches and their impact on teamwork, decision-making, or real-world PM skill development. Moreover, one of the most critical challenges is aligning between game mechanics and instructional objectives, especially when balancing engagement, usability, and educational rigors. These insights indicate that there is a need for more experimental breadth and design refinement in future SG development to harness their potential holistically as transformative learning tools in PM education. Subsequently, the next subsection will illustrate the target audience of PM-GBL studies, underscoring who is currently benefiting from these interventions and identifying segments that remain underrepresented.

C. Target Audience

Beyond methodological design factors, learner characteristics significantly impact how SGs are adopted and evaluated in PM education. SGs are an experiential learning approach that offers flexibility, allowing to cater various target audiences within PM education. According to existing literature, the target audience is divided into two main categories, including academic demographics and distribution by discipline.

As reported by [5], academic demographics include students enrolled in higher education, such undergraduate students who are pursuing bachelor's degrees and graduate students who are working toward master's or doctoral degrees. This suggests that GBL is being considered across all educational levels in higher education. Moreover, existing literature has investigated PM-GBL across several categories, including business PM, construction management, and software PM [5].

Studies focusing on business PM have investigated how GBL can improve learners' comprehension of essential managerial processes, such as time, cost, and lifecycle control. For instance, a study in [26] collaborated with a game company to develop a digital simulation designed to enhance earned value analysis, while [27] utilized the commercial serious game SimulTrain to expose students to real-time project lifecycle management. Other studies have explored wider managerial skill sets, including stakeholder engagement and organizational decision-making, utilizing hybrid or traditional classroom approaches complemented by reflective assessment methods [28],[29]. Recent experimental studies have provided preliminary support for the effectiveness of GBL in improving students' conceptual understanding relative to traditional teaching methods [27]. Nonetheless, the application of GBL in business PM remains comparatively underexplored when compared to construct-related context, suggesting promising potential for further innovation and adoption in this field.

Accordingly, construction management within the context of PM-GBL has received greater attention compared to the other two domains. This substantial portion of PM-GBL exploration done through game-based simulations that consider planning, scheduling, and resource coordination challenges. For instance, Castronovo et al. in [29] have developed a digital game focused on improving problem-solving skills in construction operations, while Elenany and Ahmed in [9] proposed a real-time resource management game tailored to linear construction processes. Other studies have examined lean methodologies and sustainability practices, utilizing LEGO-based simulations to enhance process optimization capabilities and employing digital tools

to teach students about environmentally conscious decision-making [30], [31]. More sophisticated types of educational games have emerged, such as hybrid formats and VR applications, which enable students to identify and analyse design mistakes and experience how construction project unfold [10],[13]. Among these initiatives, findings constantly demonstrate that games support the development of practical skills that are core to construction project success, such as risk mitigation, cost-time trade-off analysis, and effective teamwork.

On the other hand, studies examining software PM within the PM-GBL context have focused on enhancing agile methodologies, fostering team collaboration, and building competencies in global software delivery. Fatime et al. in [32] utilized a digital game environment to teach agile PM techniques through iterative decision-making, while authors in [33] proposed a customizable digital simulation to engage students with distributed project scenarios. Other studies incorporate Scrum (i.e., agile PM framework) and design-thinking (i.e., a creative problem-solving method) principles through organized role assignments and collaborative problem-solving utilizing LEGO materials [11]. Games have also been developed to address additional aspects of software projects, such as human resource management and psychological dimensions, ranging from balancing productivity and morale to promoting perseverance and organizational mindfulness through reflective gameplay strategies [15], [34].

Overall, these findings reveal that while SGs provide flexibility to compromise for alternative learner profiles and disciplinary needs, their adoption in PM education remains unequal. Construction management dominates the research landscape, benefiting from well-established gameplay models that align naturally with real-world tasks, such as coordinating teams, scheduling work, handling materials and budgets, and managing construction sites. Conversely, business and software PM applications are emerging but remain relatively scarce, often limited to small-scale studies, such as trials conducted within a single university, and typically involving a limited number of participants, which makes it difficult to generalize the findings or demonstrate broad effectiveness. This disciplinary imbalance indicates that the full potential of GBL, particularly in enhancing strategic decision-making, distributed teamwork, and human-centred leadership, has yet to be fully explored across the broader PM curriculum. Additionally, most studies tend to focus on short-term learning outcomes, such as how well students perform immediately after gameplay rather than long-term competency development or authentic workplace alignment. Thus, it is vital for future research to expand efforts across underrepresented aspects of PM and to further explore diverse learner profiles and performance-based assessment strategies, aiming to establish a scalable and equitable incorporation of SGs within higher education.

III. Discussion & proposed framework

To sum up the findings, the bubble diagram in Fig 2 summarizes the thematic findings presented in this section through a two-tier bubble structure. The central bubble reflects the research methodologies discussed in the literature, positioned at the core due to its predominant emphasis across PM-GBL studies. Surrounding this, the secondary bubbles illustrate SG design and target audience considerations, capturing the main contextual dimensions explored in the literature. The relative size of each bubble indicates the extent of research attention dedicated to that dimensions, suggesting which aspects have been more extensively explored. This visual structure offers a concise overview of the current research landscape in PM-GBL and justifies how the thematic elements relate to one another.

Accordingly, the thematic findings of this study underscore that the integration of GBL in PM education remains fragmented across methodological, design, and audience aspects. Despite that SGs have demonstrated significant value in supporting experiential learning and enhancing motivation and engagement, the literature reveals a heavy reliance on short-term assessments, small-scale case studies, and discipline-specific integration, especially within construction-focused contexts. These limitations hinder the ability to generalize findings and broaden adoption into more interdisciplinary PM domains.

To address these fragmentation obstacles, this study develop a structured framework as demonstrated in the bubble diagram in Fig 2 that incorporates three critical dimensions, including research methodology, SG design, and target audience contemplation. By situating methodological choices at the core of the framework, the model ensures that the quality of assessment directly impact the credibility of learning outcomes and the scalability of GBL adoption. Subsequently, design-related decisions are also incorporated into the framework, including interface format (i.e., digital games, tabletop games, and hybrid games) and interaction mode (i.e., single player, cooperative multiplayer, and competitive multiplayer games), shaping how effectively PM processes are simulated and how learners engage with the content. Finally, the framework emphasizes that identifying appropriate learner profiles, such as discipline, academic level, prior experience, is crucial to align gameplay mechanics with educational needs and industry expectations.

The proposed framework can be used as structured decision-support guide by organizing key design and research dimensions into an integrated process. While the framework does not prescribe fixed solutions, it supports informed decision-making by linking audience, characteristics, game design choices, and methodological approaches. Specifically, the framework can be applied by first identifying the target

audience and disciplinary context, followed by selecting appropriate game design features (e.g., interaction mode and interface type), which subsequently inform the choice of research methodology, including experimental setup and evaluation methods. For instance, interactive and collaborative game designs may require mixed-method evaluation approaches to capture both performance and teamwork dynamics, whereas simulation-based designs may rely more on quantitative performance measures. Furthermore, the framework can be applied in domain-specific contexts. For example in software PM contexts, the framework suggests prioritizing the interaction dimension, particularly collaborative and multiplayer designs, due to the emphasis on teamwork and agile practices. In contrast, for construction PM, the framework indicates a stronger emphasis on simulation-oriented designs that reflect structured workflows and task sequencing, thereby reducing the relative importance of interaction complexity.

To further illustrate the applicability of the proposed framework, selected studies from the reviewed literature can be mapped onto its dimensions. For instance, studies in construction PM predominantly employ simulation-based game designs with structured task sequencing, often evaluated using quantitative performance measures such as scheduling accuracy and resource allocation efficiency. In contrast, studies in software PM tend to emphasize interactive and collaborative game formats, incorporating multiplayer dynamics and communication-based tasks, which are frequently assessed using mixed-method approaches that capture both performance and teamwork outcomes. This mapping demonstrates how variation in audience, disciplinary context, and design choices influence methodological decisions and evaluation strategies, thereby supporting the framework's role as a decision-guiding tool rather than a purely descriptive visualization.

To translate the proposed framework into actionable guidance, several practical implications can be derived from the findings to guide researchers and educators in designing and implementing serious GBL in PM education. First, in terms of evaluation measures, future studies should move beyond reliance on self-reported outcomes and incorporate performance-based assessment approaches. These may involve task completion accuracy, decision-making effectiveness, and teamwork performance, particularly for multiplayer and collaborative game environments. Such measures provide a more robust indication of learning outcomes and skill development. Second, regarding study design, it is imperative for future research to adopt minimal yet rigorous experimental setups. This may involve combining controlled pilot studies with follow-up assessments to evaluate both immediate engagement and longer-term knowledge retention. Mixed approaches can also be beneficial to capture both quantitative performance outcomes and qualitative learning experiences. Third, scalability and practical implementation should be considered during the design phase. This includes evaluating the cost of game development, the required technological infrastructure, and the level of instructor training needed to effectively integrate GBL into curricula. Hybrid or modular game formats may offer a balance between innovation and feasibility, enabling a broader adoption across different educational contexts. Overall, these guidelines support the transition from small-scale experimental studies toward more sustainable and scalable applications of GBL in PM education.

This integrated view enables researchers and educators to systematically align the what, how, and who of PM-GBL integration. It offers a roadmap for proposing more rigorous empirical studies, innovative hybrid or competitive game formats, and equitable adoption strategies across business PM, software PM, and construction management curricula. Future research guided by this framework may focus on longitudinal studies, bridging the gap between academia and industry, and measuring competency-based performance, ultimately advancing GBL from isolated experiments to a validated and mainstream teaching approach within higher education.

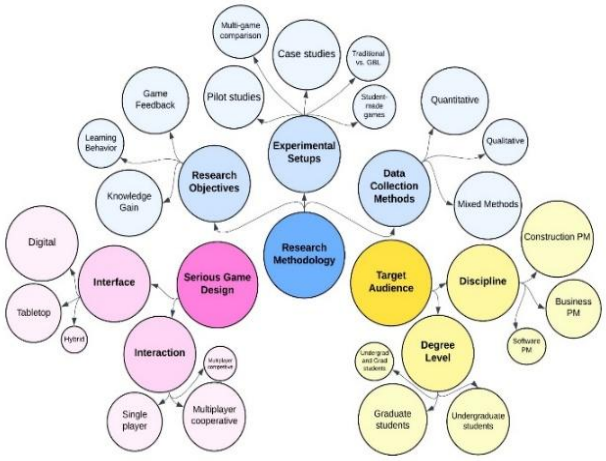

Fig 2 - Conceptual framework of the findings (GBL in PM education)

IV. Conclusion and Future Work

This study synthesized thematic findings of existing literature on GBL in PM education, revealing both its pedagogical value and its current limitations. The findings suggest that despite that SGs have become effective tools for promoting experiential learning, student motivation and engagement, collaboration, yet their application remains fragmented across disciplines and methodologies. Similarly, existing literature reveal that GBL considerations within PM have gained a significant prominence in construction management, particularly within the research landscape, benefitting from well-structured simulations addressing

planning, scheduling, and resource-allocation challenges. Conversely, the research in business and software PM contexts have only recently emerged, exploring digital, hybrid, and reflective game formats. These disciplinary variations underscore that while SGs can simulate authentic PM environments, their potential for advancing managerial, strategic, and human-centred competencies is not yet fully recognized.

To sum up the findings, this paper introduces a two-tier framework presented in Fig 2 that incorporates research methodology, game design, and target audience dimensions. This visualization highlights how methodological rigor forms the foundation of reliable findings, while game design and learner context interact to shape learning outcomes. The framework offers a roadmap for proposing more systematic and transferable approaches to PM-GBL design, implementation, and evaluation. In addition, the findings emphasize the importance of adopting performance-based evaluation measures, context-sensitive game design choices, and scalable implementation strategies, including consideration of cost, technological infrastructure, and instructor training, to support the effective incorporation of GBL in PM education.

Therefore, it is imperative for future research to expand on this model by acknowledging and developing longitudinal and comparative explorations that evaluate learning retention, behavioural alterations, and teamwork performance over time. Scholars are also encouraged to experiment with hybrid, immersive, and competitive game mechanics that better encapsulate real-world PM dynamics. Furthermore, it is crucial for future research to address cost and scalability contemplations, such as technological infrastructure, development time, and instructor training, to emphasize that GBL adoption is sustainable and institutionally feasible. Besides, to further enhance the impact and authenticity of SGs, it is crucial to incorporate industry-aligned outcomes, cross-disciplinary collaboration, and competency-based assessments among educators, game designers, and PM professionals. Therefore, GBL can evolve from novel classroom intervention into a more evidence-driven, cost-effective, and widely adopted experiential leaning strategy by advancing these directions, strengthening PM education across all academic levels.

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