REVISTA DE
ARQUITETURA IMED

The use of games and gamification elements in the construction industry

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Revista de Arquitetura IMED, Passo Fundo, vol. 14, n. 1, p. 165-192, janeiro-junho, 2025 - ISSN 2318-1109

DOI: https://doi.org/10.18256/2318-1109.2025.v14i1.5153

Sistema de Avaliação: *Double Blind Review*

Abstract

Gamification and serious games are experiencing a notable increase in application within civil engineering, as they can provide additional value, such as knowledge and entertainment. Therefore, there is interest from academia in studying the use of gamification tools in Civil Construction and Lean Construction. It was then noted that there is a need to develop a systematic literature review on gamification and serious games in the construction industry. This article presents the state of the art through a comprehensive bibliographic search of relevant manuscripts on the topic in question. This study was produced through a systematic literature review conducted with the support of the StArt software, using searches on the Scopus, Web of Science, and Engineering Village platforms. Fifteen manuscripts were selected after excluding those unrelated to the topic or failing to meet the minimum quality criteria. A bibliometric analysis was conducted using the data from these manuscripts to understand the research panorama. Furthermore, an analysis of the groups identified through VOSviewer and a detailed analysis of the 15 selected articles were carried out, which made it possible to identify the particularities of each research and thus answer the research questions. The following research gaps were identified: a) using Gamification elements as a management tool in the construction industry and b) Gamification to bring customers and builders together. Furthermore, it was identified that research has focused much more on using serious games in educational environments than on using Gamification elements on the construction site. Thus, the results presented can serve as a reference and contribute to future research on this topic.

Keywords: Serious Games; Gamification; Management; Civil Engineering; Lean Construction; Bibliometric analysis.

1 Introduction

Games and simulations have been used in society for at least two centuries (Freire *et al.*, 2017). As a persuasive strategy, gamification began in marketing and later aroused interest in education and health (Andrade, 2018; Denden *et al.*, 2018; Dichev and Dicheva, 2017). Gamification is widely used for engagement, i.e., generating user interest in a particular topic. Two examples of gamification for customer loyalty are Starbucks (coffee shop) and Waze (GPS navigation). In the case of Starbucks, customers are encouraged to participate in a loyalty program, accumulate stars, and thus earn benefits and free products in return. Using this technique to build loyalty is also essential in the construction industry, focusing on workers, supervisors, and managers to make the work environment pleasant and exciting. On Waze, users enter information about traffic at their location (for example, slowdowns, accidents, the presence of speed bumps, speed cameras, and potholes). As a reward, users earn avatars and points, which are accumulated to improve their ranking.

Using gamification techniques can add technical, scientific, and intellectual knowledge, providing the player with much more than simple entertainment (Magee, 2006). When it comes to games, various taxonomies have been proposed in the literature seeking to classify the differences between serious games and entertainment games. These include the classifications according to Freire *et al.* (2017) and De Gloria *et al.* (2014):

- Focus / purpose: in serious games, the focus is on training and learning elements, while in entertainment games, the focus is on the fun;
- Simulation / Reality: Varying from the imitation of real and fictitious contexts to prove abstract visualizations; in serious games, necessary assumptions are made for viable simulations, while in entertainment games, the simulation scenarios are simplified;
- Social Involvement / Communication: in serious games, communication should be natural, while in entertainment games, communication is usually perfect; the number of players can vary from single-player games to massively multiplayer games in both situations;
- Activity: ranges from active games, where the player plays roles in a scenario, to passive types, situated in a passive perception, like in a movie.

Gamification also has the potential to gain more ground in the context of Civil Engineering since it can provide additional value, for example, knowledge, beyond entertainment (Schatz; Rüppel, 2015) and provide knowledge about a given subject (Bhatnagar *et al*., 2022). The construction industry is a favorable environment for applying gamification techniques. According to Leite *et al.* (2016), various services involved in construction mean that even today, these services are developed artisanally, unlike the production lines practiced in other industries, causing repetitive and demotivating work for the worker and difficult control for the manager. According to Formoso, Powel, and Santos (2002), workers generally do not know what is expected of them or their performance, which demotivates them.

Several studies have used serious games in the construction industry to train staff, raise awareness, and/or learn. Bhatnagar and Devkar (2022) developed and tested a game about eliminating waste using lean practices. Dawood *et al.* (2014) adopted a cross-pollination approach of serious games and 4D concepts to develop a complete virtual replica that emulates the progression of an accurate construction site over time. Scharpff *et al.* (2020) developed a serious game that simulates road maintenance planning with multiple contractors to study changes in decision-making and the emergence of coordination and competitiveness in the network of companies. Jacobsen, Strange, and Teizer (2021) developed a digital learning platform that teaches the concept of lean construction using an active, hands-on game environment involving multiple players simultaneously in virtual reality.

After important considerations about gamification and serious games in the construction environment, it becomes necessary to define them. Gamification is a persuasion technique that increases users' interest, participation, involvement, and acceptance of tasks/activities that traditionally do not attract attention (Andrade, 2018). It is the application of elements and principles of games (not necessarily a game), such as reward, cooperation, and competition, in contexts not necessarily related to

games, in a set of activities and processes that aims to solve problems more attractively (Deterding *et al.*, 2011; Kapp, 2012; Werbach; Hunter, 2012; Zichermann; Cunningham, 2011). Turning something of professional interest into a game is known as a Serious Game. Serious Game combines game concepts and methods with information technologies in serious applications other than entertainment (Bellotti *et al.*, 2010). Serious games are "games used for training, advertising, simulation or education designed to run on personal computers or video game consoles" (Susi *et al.*, 2007; De Gloria *et al.*, 2014). For Laamarti *et al.* (2014), a serious game is training offered as a game built to meet a group's specific needs. Simulation is another learning technique that allows real-world activities and processes to be trained in a safe environment, not necessarily involving a game (Almeida and Simões, 2019). However, simulation games are among the most widely used in education, as they aim to convey a non-fictional reality close to the natural environment (Deshpande and Huang, 2011).

The questions to be answered by this study were defined:

1. What are the main purposes of using Gamification and Serious Games in research related to construction management?
2. Which of the two tools, elements of gamification or serious games, is used more for research development?
3. Is there any research using one or more Gamification elements as a construction management method?

Accordingly, the primary objective of this research is to investigate current knowledge, existing methods, and structures for the application of gamification in the construction industry. Moreover, a bibliographic search of manuscripts on this topic was undertaken to discern research perspectives and challenges.

2 Research method

The systematic literature review was conducted in four stages. The first stage consisted of finding manuscripts related to research in gamification and construction in three different databases: Scopus, Web of Science, and Engineering Village. In the second stage, relevant articles from conferences, preprints, books or book chapters, and journals were selected to comprehensively analyze the various types of research that have been and are being carried out on the topic of interest. In the third stage, all the selected manuscripts were analyzed based on the inclusion and exclusion criteria defined in the research protocol and then categorized according to their purpose. In the fourth stage, a bibliometric analysis of the categorized articles and a more detailed analysis of the articles were carried out.

Some of the good practices observed in literature review articles by Freire *et al.* (2017), Wang *et al.* (2018), and Uriarte, Ng, and Moris (2020) were taken as a basis.

A plan for conducting the review was defined and executed, and the results and conclusions are reported in this document.

The review of academic publications presented in this article involved two phases. These are:

1. Bibliometric analysis of the selected articles.
2. Detailed analysis of these articles.

First, a research plan, known as a protocol, was drawn up to organize the criteria for analyzing the articles and the research purpose and define the objectives, description, and research questions. In addition, the PRISMA guidelines were observed (Page *et al.*, 2021b).

Once the results had been obtained, the documents found were extracted and then entered into VOSViewer, a text mining application developed by Van Eck and Waltman (2010), to detect standard terms used in searches that had not previously been considered. In addition, the terms were also applied to the program to detect repeated non-relevant terms and exclude them from the list. As a result, the terms shown in Table 1 were defined for the research development.

Table 1. Search terms

Terms
Gamefication
Gamification
Serious game
Game-base
Construction industry
Lean Construction

Source: the authors (2025).

For the terms presented in Table 1, the search criteria used were as follows: (gamefication OR gamification OR (serious AND gam*) OR game-bas* OR (lean AND gam*)) AND ((construction AND industry) OR (lean AND construction)).

The protocol is the first phase of a systematic literature review, which is essential because it is when the research is planned and structured. A well-defined protocol guides the researcher more precisely when searching for documents in the databases and, above all, when analyzing the documents found.

The protocol is the first phase of a systematic literature review, which is crucial for planning and structuring the research. A well-defined protocol gives the researcher more precise guidance when searching for documents in databases and, most importantly, when analyzing the retrieved documents. The latest version of this study's protocol contains the following information:

Table 2. Protocol for Systematic Literature Review

Description	Mapping studies, current state of knowledge, and future perspectives on using Gamification in the Construction Industry field.
Objective	The objective is to observe the current knowledge, existing methods, and structures for using Gamification as a tool in the Construction Industry field and identify the main research perspectives and current challenges.
Specific objective	1. Map the volume of articles produced that connect the Gamification and Construction Industry; 2. Identify research gaps; 3. Analyze future research perspectives.
Research questions	How has Gamification been applied in the Construction Industry field? What are the existing gaps regarding the gamification technique as a management element in the Construction Industry? What are future perspectives on the use of Gamification in the Construction Industry?
Context	1. Architecture, Engineering, Construction, and Operation (AECO); Business, management and accounting
Intervention	Studies combining the fields of Gamification and the Construction Industry.
Results	1. Quantification of studies addressing Gamification and Construction Industry. 2. Characterization of Gamification's utilization in Construction Industry. 3. Identification of gaps and future research perspectives for the use of Gamification in Construction Industry.
Application	To better understand the use of Gamification as a tool in the Construction Industry and to disseminate the topic to professionals, researchers, and academics interested in the subject.
Key-words	Gamefication; gamification; serious game; game-base; construction industry; lean construction.
Time horizon	No restriction on the publication year
Language	English and Portuguese
Research method	Definir *string* > aplicar na fonte de dados > exportar resultados > importar no StArt[1] > analisar dados
Selection Criteria	Journal articles available electronically and in conference proceedings; availability to export files in BibText or RIS format; not limited to open access; must contain at least 2 of the search strings in the title, and/or abstract, and/or keywords.
Research method	1) Search strings in the databases; 2) Selection of articles using the StArt software; 3) Extraction of relevant articles for full reading and summarization of the papers read; 4) Generation of quantitative data for analysis and preparation of the results report.
Search inclusion criteria	1. Manuscripts that meet the SLR (Systematic Literature Review) requirements; 2. Contain at least two terms from the search strings in the title, and/or abstract, and/or keywords; 3. Manuscripts that align with the objectives of this study; 4. Gamification for training; 5. Gamification and education in the Construction Industry.

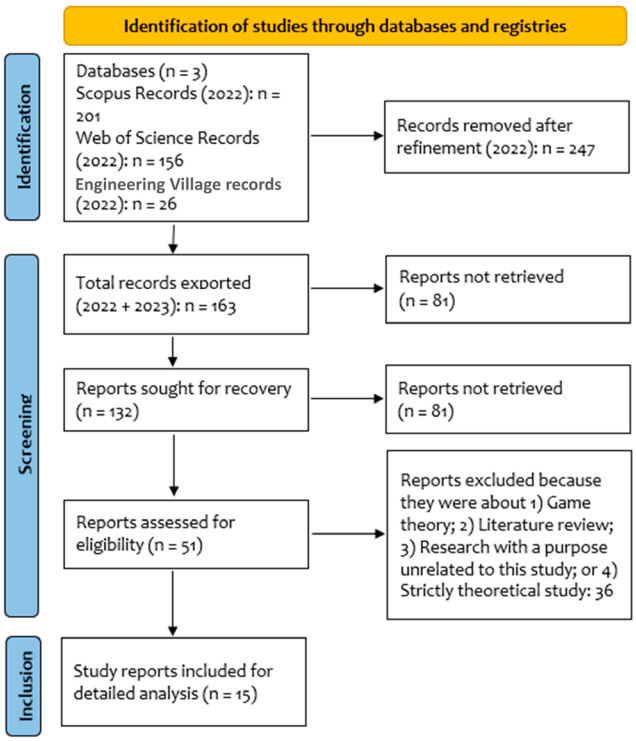
Description	Mapping studies, current state of knowledge, and future perspectives on using Gamification in the Construction Industry field.
Search exclusion criteria	1. Redundant or incomplete manuscripts, irrelevant to the subject, or failing to meet SLR (Systematic Literature Review) requirements; 2. Articles not related to Gamification or gaming within Civil Construction; 3. Articles, literature reviews, and conference papers that do not integrate Gamification with Civil Construction; 4. Articles that do not feature an application of gamification or a game; 5. Articles that do not fall within the scope of Civil Construction (e.g., other engineering disciplines); 6. Studies originating from the computer science field.
Evaluation of study quality	To evaluate the quality of the studies, we looked for the presence of well-delineated research methods in the manuscripts.
Database	Scopus, Web of Science, Engineering Village
Definition of study types	Articles published in Scientific Journals and Conferences.

Source: the authors (2025).

With the search terms mentioned above, 383 documents were obtained in the search carried out on 25/05/2022. For better refinement, the following method was applied to the Scopus database: Selecting area: 1) Engineering (AECO); and 2) Business and management and accounting; Selecting type: 1) Conference paper; and 2) article. This resulted in 73 manuscripts. In the case of the Web of Science database, the following method was applied: Selecting category: civil engineering, construction building technology; Selecting type: conference paper and article. This resulted in 38 manuscripts. With the refinement applied to Engineering Village (EI Compendex database), 25 manuscripts were found. Thus, the search on 25/05/2022 returned 136 articles. The search was updated on 10/05/2023 to identify more articles from 2022 to May 2023 that could serve as a basis for this literature review. The search on 10/05/2023 then returned 27 articles.

Figure 1 shows the quantitative results of the articles retrieved from the research carried out in 2022 and updated in 2023 using the PRISMA 2020 flow diagram.

Figure 1. PRISMA 2020 flow chart



Source: Page (2021a) adapted by the authors (2025).

The results found were exported in ".ris" format and inserted into VOSviewer.

The years of publication were not limited, so the period of publication of the manuscripts found is from 2012 to 2023. The data (such as bibliographic and citation information, abstracts, and keywords) extracted from the databases in RIS-type files was imported into the StArt application (FABBRI *et al.*, 2016). A manual screening process was then started to ensure that all the publications were related to the objective of this study. In this screening process called selection, duplicate articles were first identified (31 documents), and by reading the title and keywords of the articles, a total of 51 publications were selected for the second phase of the analysis, called extraction, in which we sought to select the manuscripts by observing whether the development of the research relates to the objective of this study through a more careful reading of the abstracts.

In the extraction phase, the abstract of each document was read, and literature reviews and non-relevant articles were disregarded. The manuscripts were categorized according to their research focus into the following themes: safety, planning, management, cost, design, emergency exit, training, and student education. A total of 15 documents on gamification in construction were selected.

3 Results and Discussion

3.1 Analysis of interrelationships between databases

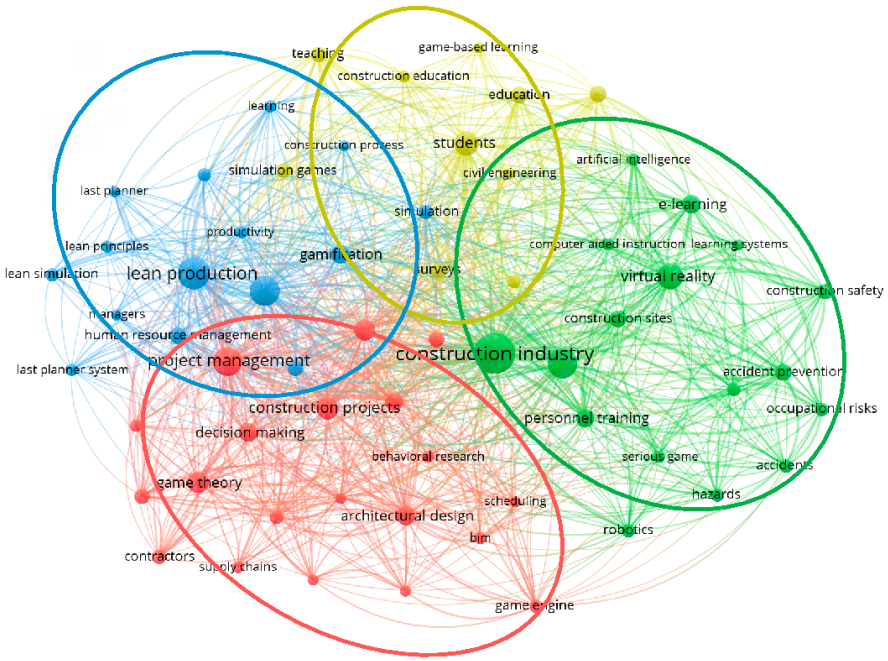
The main groups and their bibliometric networks are shown in Figure 2, Figure 3, and Figure 4 and were used to identify the interconnections and groups of keywords most used in the exported articles. Table 3 shows the data used to create the Keyword Group Map for each database used in the VOSviewer software.

Table 3. Method and data used to create clusters of keywords with VOSviewer

Item	Scopus	Web of Science	Engineering Village
Counting Method	Full counting	Full counting	Full counting
Minimum number of occurrences of a keyword	5	3	3
Number of keywords selected	62 of 1307	21 of 250	12 of 84

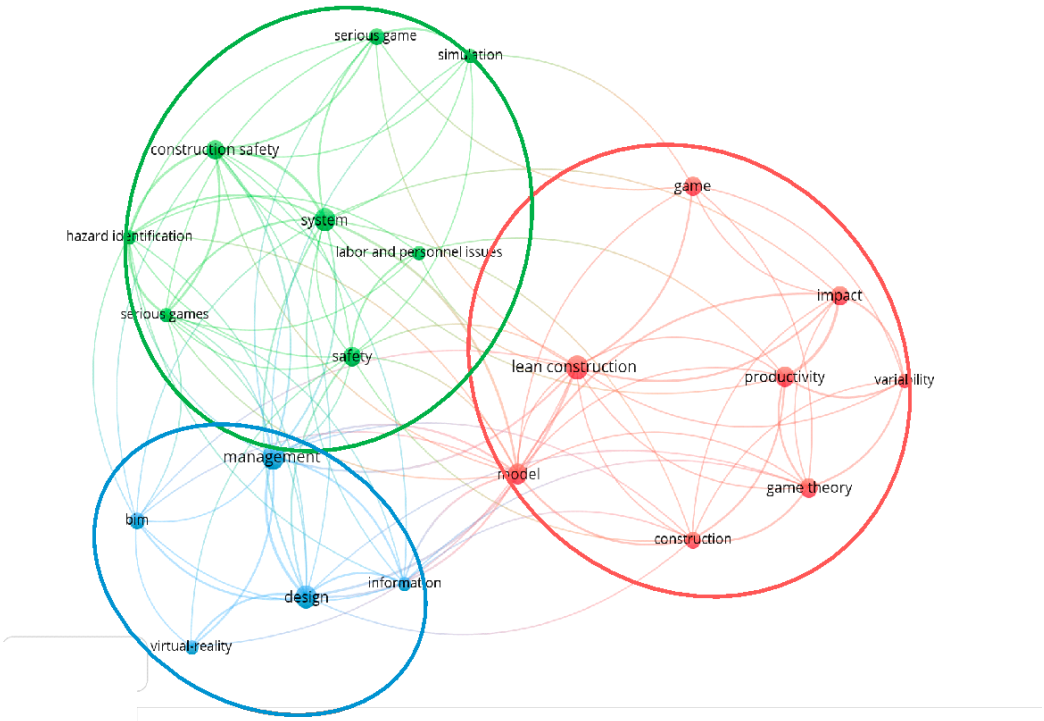
Source: the authors (2025)

Figure 2. Map of groups obtained from a search of the Scopus database using the VOSviewer software



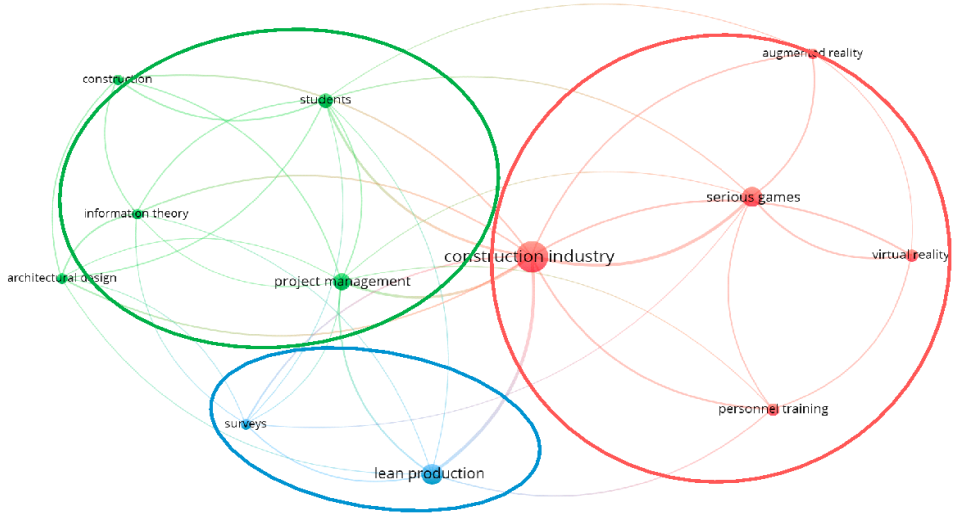
Source: the authors (2025).

Figure 3. Map of groups obtained by searching the Web of Science database using the VOSviewer software



Source: the authors (2025).

Figure 4. Map of groups obtained by searching the Engineering Village (EI Compedex database) using the VOSviewer software



Source: the authors (2025).

Table 4 shows the number of clusters generated by VOSviewer, the keywords that make up each cluster, and the principal observations made based on the data obtained.

Table 4. Analysis of the clusters created

Database	Scopus	Web of Science WOS	Engineering Village EV
Number of clusters	**4**	**3**	**3**
Main observations	- Cluster 1 is related to construction design, focusing on planning through decisions - Cluster 2 concerns virtual reality and safety in construction - Cluster 3 concerns lean construction and its principles - Cluster 4 is about teaching in construction, focusing on students in general.	- Cluster 1 indicates the relationship between productivity and lean construction - Cluster 2 indicates safety in construction with serious games - Cluster 3 indicates design and planning	- Cluster 1 presents the connection between serious games in the construction industry - Cluster 2 shows the connection between project management with a focus on students - Cluster 3 indicates the connection between lean production and research

Source: the authors (2025).

By analyzing the interconnection between the clusters, it was possible to see that there are research gaps in gamification, combining essential themes for the construction industry. Among the main ones found is the combination of Construction safety or Accident prevention with Lean Construction or Project Management.

3.2 Bibliometric analysis

The articles selected in the extraction phase were considered for the bibliometric analysis. This analysis aims to observe which publishers in this research publish the most on this study, the history of publications over the years, which keywords are most used, and which authors carry out the most relevant research in the area. In addition, this section shows the percentage share of each area of interest concerning the total number of manuscripts and which publication media have the highest concentration of manuscripts in the scientific environment.

3.2.1 Publishers

Table 5 shows the number of publications per publisher.

Table 5. Number of documents published per publisher

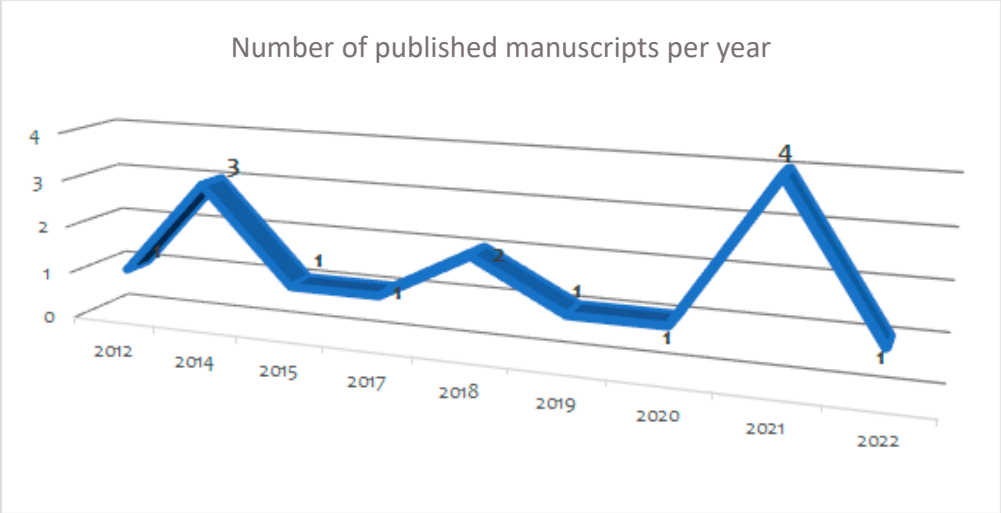
Publisher	Papers
International Group for Lean Construction	10
Journal of Management in Engineering	2
Journal of Professional Issues in Engineering Education and Practice	1
Computing in Civil and Building Engineering	1
Teknik Dergi	1

Source: the authors (2025).

3.2.2 Publication history over the years

As presented in the Research Method section, documents were found from 2012 onwards.

Figure 5. Publication history over the years



Source: the authors (2025).

It is important to note that the survey was carried out in May 2023.

3.2.3 Countries

To define the country of publication, the country of origin of the educational institution where the primary author was based during the period in which the

research was carried out was considered. A total of 18 countries with publications on the subject were identified, but Table 1 shows the countries. The United States has led many publications on using gamification in construction.

Table 6. Countries that publish the most

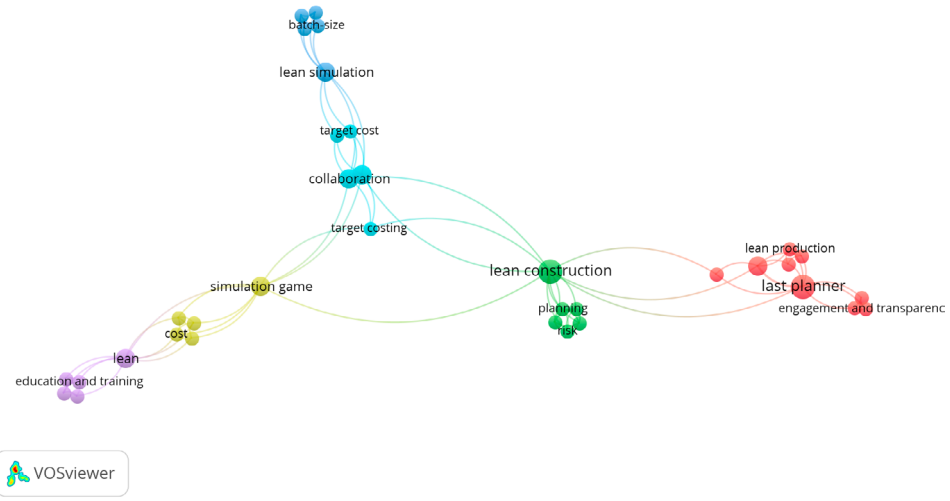
Countries	Search Number
United States	3
Brazil	2
Canada	2
India	2
United Kingdom	2
Germany	1
Denmark	1
Hong Kong	1
Turkey	1

Source: the authors (2025).

3.2.4 Keywords

For this analysis, the number of manuscripts in which the term is used in their keywords was identified. The data from the 15 selected articles was entered into VOSViewer to identify the groups and their bibliometric networks, considering the terms used in keywords used in two or more articles.

Figure 6. Bibliometric networks of the selected articles using VOSviewer software



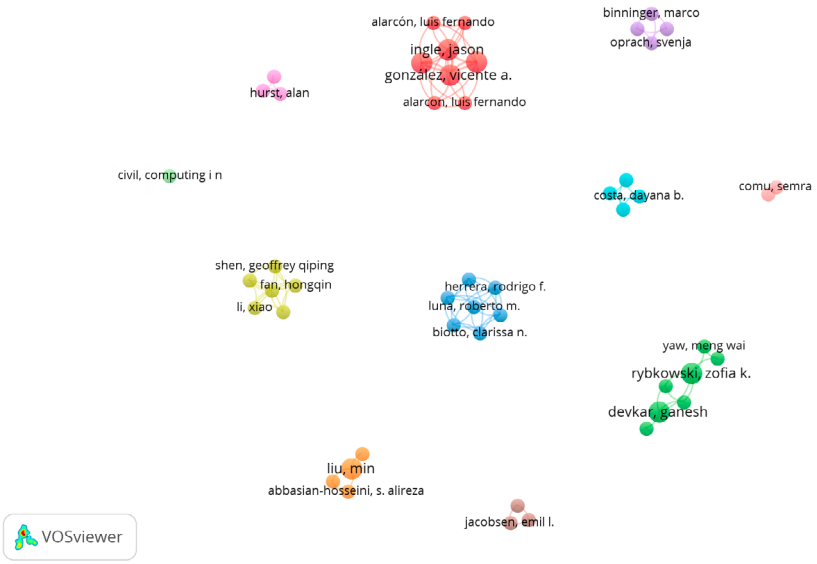
Source: the authors (2025).

Almost all the clusters contain the word “lean”, which indicates that almost all the studies have used lean production principles adapted to the construction industry, whether for training, simulation, planning, or production.

3.2.5 Authors

No authors with a high concentration of publications in this study area were identified. This analysis was completed with the support of VOSViewer to identify the connection networks of the authors of the 15 articles selected. The image in Figure 7 shows that the authors are connected in specific groups with no broader interconnection, i.e., no consolidated network.

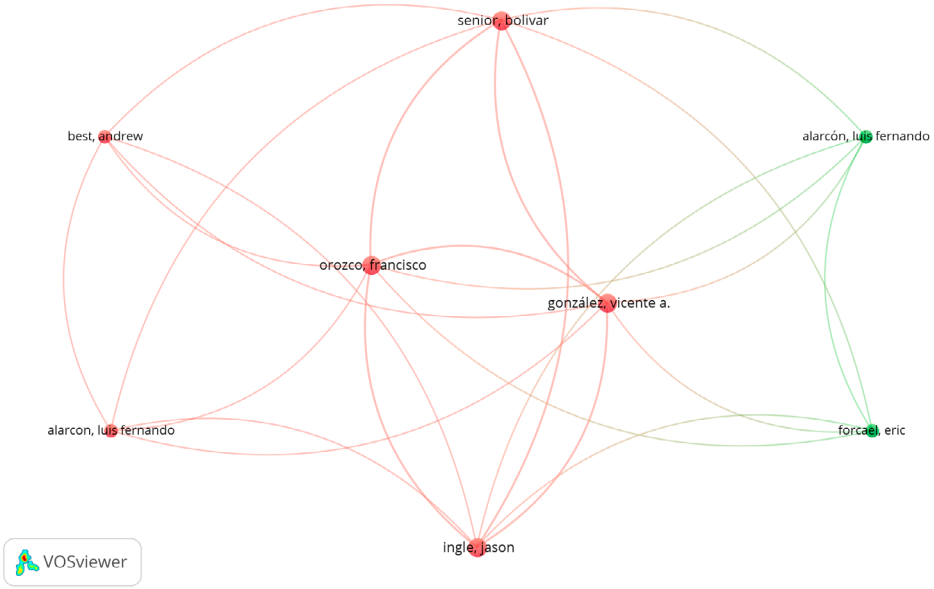
Figure 7. Connection networks between the authors of the 15 selected articles



Source: the authors (2025).

Although the authors are connected in specific groups and there is no consolidated network of the authors of the 15 articles selected, there is a more consolidated group with more publications and connections, as shown in Figure 8.

Figure 8. Connection networks between the authors of the most consolidated group



Source: the authors (2025).

3.2.6 Analysis of selected documents

After analyzing the abstracts of the articles in the extraction phase, 15 articles were selected that met the inclusion criteria set out in the protocol. After selecting these manuscripts, a more detailed analysis was carried out, and the main information was extracted from them: objective, game technique, gamification strategy, and the game's name. Table 7 shows some details of the articles analyzed. This is followed by a summary of the research for each article analyzed.

Table 7. Important data from the articles selected for analysis

Paper	Author	Title	Game technique	Gamification strategy	Name of the game
1	Bhatnagar and Devkar (2021)	Development and Testing of a Simulation Game	Each team must complete the target of constructing eight Lego™ houses within eight minutes to get cash points for defect-free houses. The game is played in three rounds, each showing continuous improvement in the workflow process due to waste reduction by using 5S, Supermarket, Kanban, Heijunka box, and pull planning.	A mapping mechanism of time and flow was used with the help of Gantt charts. Preparing Gantt charts allowed participants to learn the graphical representation of process mapping and will help them switch to more advanced ways of mapping for real-life scenarios. The workflow improvement by understanding VA/NVA activities and waste reduction was expected to save time and cost.	-
2	Jacob *et al.* (2021)	Target Value Design (TVD)_ Development and Testing of a Virtual Simulation	The online TVD simulation developed by this team involved the design, construction, and costing of a tower with height and base width requirements of 26 cm and 12 cm, respectively. Online game templates were prepared for the students to play the simulation. The task of each team was to construct a tower with the help of shapes provided in the game template. A team of 3-4 participants was typically required to play this simulation. Each team member was asked to select and assume the roles of Designer, Contractor, or Owner.	Participatory simulations have been used to help stakeholders comprehend TVD processes before they are implemented on an actual project, enhancing their effectiveness. After the simulation, there is a questionnaire that assesses the understanding.	Online Marshmallow Tower TVD simulation
3	Biotto *et al.* (2021)	Virtual Parade Game for Lean Teaching and Learning in Students from Brazil and Chile	The game is played in two rounds. The game is based on dice probabilities, using cubic dice with six faces. The game requires eight people: one is the facilitator who leads the game, and the other seven are the crew leaders of each activity. The game requires eight people: one is the facilitator who leads the game, and the other seven are the crew leaders of each activity.	The game is played in two rounds to understand the concepts: Production capacity, Production rate, Buffers, and Flowline chart. o (a) draw the flowlines chart according to the productivity executed by the crews every week; (b) interpret and analyze the impact of variability in crews' productivity in successor activities; and (c) discuss the use of buffers to protect the production against variability. The final discussion with the students is essential to achieve the learning objectives proposed by the game.	Parade Game

Paper	Author	Title	Game technique	Gamification strategy	Name of the game
4	Jacobsen *et al.* (2021)	Lean Construction in a Serious Game Using a Multiplayer Virtual Reality Environment	The design includes two scenes: A 'messy' scene, which does not follow lean initiatives, and a 'lean' scene where lean initiatives have been incorporated. Both are similar in layout, and small differences appear when looking closely. Each scene has three workstations and a one-panel area with a board used for instructions.	The novelty is to share rapid feedback with the participants while playing the game. Findings through testing demonstrate they benefit from the run-time data analysis and more effectively understand lean principles to eliminate waste, allow collaboration, and optimize quality in the value-added building chain.	-
5	Yaw, Rybkowski and Jeong (2020)	Reducing Handoffs Between Sequential Trades	To play the game, the following are needed: One facilitator and at least three participants per suit of cards (up to 12 participants per card deck is possible); One deck of playing cards (minimum); writing materials to record the results (e.g., pen, paper). Firstly, the participants are asked to form teams of 3 players each. The facilitator shuffles each set of cards. During each round, a team will receive a set of playing cards of the same suit (A, 2, 3, 4, ..., 9, 10, J, Q, and K), and each player within a team is expected to obtain four to five cards in hand, that are in random order within a particular suit.	This paper discusses the development of a lean simulation that explores the advantages of reducing the number of handoffs on a construction project while acknowledging the benefits of small batching.	-
6	Musa, Pasquire and Hurst (2019)	Using TVD Simulation to Improve Collaboration	The game uses the same concepts as Peter Skillman and Tom Wujec's "Marshmallow Challenge" but applies TVD processes (Ebbs 2015).	Two rounds of the simulation were done. Round one simulated traditional design-bid-build (DBB) processes, while Round two simulated TVD processes. The simulation required four teams, each comprising three groups: owners, designers, and constructors.	TVD simulation game

Paper	Author	Title	Game technique	Gamification strategy	Name of the game
7	Li *et al.* (2017)	RBL-PHP: Simulation of Lean Construction and Information Technologies for Prefabrication Housing Production	The RBL-PHP simulation game uses two approaches to teach PHP control and planning techniques. The first approach is based on the traditional learning method of a computer-based multi-media presentation. The second approach adopts the RBL-PHP method.	The simulation game can significantly improve the understanding of various knowledge concepts in PHP, such as prefabrication production structure, standardized work, smart construction objects, information sharing and communication, and real-time tracking and visualization when compared with a traditional	RBL-PHP simulation
8	Binninger *et al.* (2017)	Learning Simulation Game for Takt Planning and Takt Control	The training concept is designed as a day seminar for 12-20 participants. The training includes three game rounds. Lean principles are taught through two theoretical and three simulation game lessons.	The development of the simulation game was oriented toward the five levels of reality: the real world, the design phase, the execution of the simulation game, the debriefing, meta-debriefing	Simulation game
9	González *et al.* (2015)	LEBSCO: Lean-Based Simulation Game for Construction Management Classrooms	LEBSCO consists of the assembly of Lego™ pieces to form a schematic house, and it is played by teams meeting in rounds simulating weeks of work. Each team comprises stakeholders, such as a planner, resource suppliers, and trade supervisors, who mirror a typical construction project's planning and control process.	Participants build the Lego houses first using a Traditional management approach and then a Lean-based approach to teaching production control and planning techniques as a part of a graduate course in construction management, in which LEBSCO is used as an instructional or teaching tool. The first approach is based on the Traditional practice of planning and controlling projects. The second approach uses Lean-based planning and control principles to manage a project.	LEBSCO
10	González *et al.* (2014)	Simulating Lean Production Principles in Construction	The simulation game consists of the assembly of Lego™ pieces to form a schematic house, and it is played by teams meeting in rounds to simulate one week of work.	Participants build the Lego houses using a traditional management approach, LPS, and lean principles and procedures.	-

Paper	Author	Title	Game technique	Gamification strategy	Name of the game
11	Morêda Neto (2014)	Visual-Communication-Panels-for-Production	This innovation should generate the membership of workers' planning, drawing their attention to the weekly schedule and inducing a scenario with a healthy "competition" that can improve productivity and engagement in the process as a whole.	This web system proposes the use of visual management principles and gamification techniques. The primary research strategy used in this work was Design Science Research, a constructive methodology to develop, implement, and validate the gamified web system.	-
12	Howell and Liu (2012)	The Oops Game_ How Much Planning Is Enough_	The superintendent handles the cards and moves them as directed. "Project Controls" ensure the rules are followed and keep score. All participants should watch for errors. The simulation aims to complete a nine-card project.	The paper explains the simulation and its application in the classroom and as a platform for research into planning effectiveness, decision-making, and complexity. The Oops simulation raises a fundamental question in project management: how much planning is enough?	Oops Simulation
13	Abbasian-Hosseini, Liu and Howell (2017)	Investigating the Cost-Benefit	This study extended the original version of the Parade Game (also called Parade of Trade or Dice Game) by developing a simulation model that uses PDFs instead of the die to determine the variability level, can obtain different variability levels at different stations, and analyzes the outcome from a cost standpoint (in addition to the production standpoint).	The Parade Game is used as a lean construction educational tool to demonstrate the impact of variability on the performance of construction trades and their successors when they work in a task sequence, and the production output of one trade is a prerequisite to the task of the next trade.	Parade Game
14	Dawood *et al.* (2014)	Combining serious games and 4D modeling for construction	The results demonstrated that combining serious games and 4D approaches can improve users' engagement and affect their abilities to spot H&S hazards.	Approach and then use LPS and lean principles and procedures. This paper also describes the main components of the Toyota Production System as applied by Lean Construction, introduces LPS and describes the simulation rules and setup.	Sandbox virtual training environment for H&S hazard spotting in construction

Paper	Author	Title	Game technique	Gamification strategy	Name of the game
15	Kazar and Comu (2022)	Developing a Virtual Safety Training Tool for Scaffolding and Formwork Activities	V-SAFE.v2 consists of three main modules: i) Training Module, ii) Testing Module 1, and iii) Testing Module 2. These modules are generated firstly to provide safety training for scaffolding and formwork activities and then to evaluate the safety performance of the trainees. The training and testing processes of V-SAFE.v2 are designed for three users, but the number of participants can be increased. Participants are initially asked to select their roles from three options when they start the training session. V-SAFE.v2 uses a third-person perspective to enable a better understanding of the scene.	V-SAFE.v2 was tested with real workers and engineers to evaluate the effectiveness and applicability of the game engine-based safety training tool. To accomplish this goal, fifteen workers who work at a height in the construction sites and ten civil engineers received training in V-SAFE.v2. Since the main target of the case study is to observe the individual performance of participants, only the Training and Testing Module-1 was applied (Figure 6). The test performance of each player was automatically scored via the LMS and provided for each trainee at the end of virtual training.	V-SAFE.v2

Source: the authors (2025).

As shown in Figure 9, several articles incorporated Lean philosophy into their research (1, 3, 4, 5, 7, 8, 9, 10, 13, 14). Game simulation was another common technique, appearing in articles 2, 5, 6, 7, 8, 12, 14, and 15. Articles 9 and 12 specifically addressed planning. The focus on participant learning and feedback for game improvement was evident in articles 1, 3, and 4. Articles 9 and 10 explored traditional management principles using Lego. Finally, article 11 presented a web system leveraging gamification elements for visual management.

Figure 9. Focuses and Methods in Articles

Source: the authors (2025).

By analyzing the game technique, gamification strategy, and the game's name in each study, it was possible to divide the articles into topics of interest to this study, as shown in Table 8, using the following questions: Is it a game or a gamification element? Was the tool applied in an educational or work environment? Is the tool used to manage work or to teach/train?

4 Considerations

In this review, two analyses of the articles were carried out. The first concerns the analysis of the groups identified using VOSviewer. The second is a detailed analysis of the 15 articles selected. With this analysis, Figure 10 was drawn up, which presents the particularities of each study and thus answers the questions posed at the beginning of this text.

Figure 10. Particularities of each study

Source: the authors (2025).

From the second analysis, it is possible to answer the following questions:

1. What are the main purposes of using gamification and serious games in research related to construction management?

The research focuses on teaching/learning in educational environments using games. Only one use of gamification with a focus on construction management was noted.

2. Which of the two tools, elements of gamification or serious games, is used more for research development?

This vital piece of data was sought to understand which tool has been the focus of researchers and whether there are research gaps in Gamification in Construction. 14 of the 15 articles analyzed, or 93.33%, used games as a tool. Such a difference could give the false impression that there is no interest in researching gamification as a primary use of its elements and that the use of games is in its exhaustion phase. However, the results say that because there is not much research into using gamification as a management tool in the construction industry, much must be developed and implemented.

3. Is there any research that uses one or more Gamification elements as a work management method?

Morêda Neto *et al.* (2014) identified only one study that uses the gamification technique focusing on construction management.

With this, it can be inferred that the use of games focused on teaching/learning in educational environments (12 articles in total) is well disseminated, but there are still many opportunities for study. However, it lacks more significant applications in work environments (4 articles in total) focusing on disseminating knowledge and updating Civil Construction workers, whether workers, supervisors, or engineers. No game was developed to support construction management. Only one research study was identified when dealing with using one or more gamification elements and their application in construction management.

Beyond the article by Morêda Neto *et al.* (2014), no research was identified that deals with the use of gamification on decision-making, productivity, project quality control, costs, schedule, budget, and conflicts, among many other topics related to management in the Construction Industry beyond the school environment or staff training. There are, therefore, research gaps when it comes to using this technique for this purpose.

Furthermore, there is also a gap in the use of gamification aimed at bringing together customers and builders since real estate customers are inexperienced customers, having acquired, at most, only one property in their entire lives.

The use of Gamification as a management element in the Construction Industry presented in the articles analyzed is still very incipient. Although gamification is broader

than serious games, since this tool adds game elements, mechanics, and logic to obtain greater engagement from people, it is not a game itself. Civil construction researchers widely use this technique, with games restricted in educational environments. Examples of broader use of gamification include cashback programs, diet programs through the Weight Watchers program, and likes on social networks. Techniques that can be applied both in educational environments and on construction sites.

Gamification is not necessarily a game but the use of game elements to instigate users' interest. Therefore, there is a lack of research that applies Gamification as a management tool to promote improvements on the construction site. It is possible, for example, to identify the increase in a team's production when using these game elements, identify whether there have been improvements in the organizational environment, checking whether employees' perception has improved after using these elements, such as 1) Phases; 2) rewards; 3) emotional triggers. Gamification elements tend to generate significant engagement because users feel micro pleasures when playing, sometimes without even realizing it, as happens with likes on social networks. No research was identified that encouraged the use of Gamification to provide workers with a pleasant and friendly environment to generate pleasure through performance, and based on this, various analyses were carried out.

As for future perspectives, it can be stated that, through analyzing Figure 5, the number of research has consistently increased. Therefore, it can be inferred that using Gamification in research has attracted the scientific community's attention. Furthermore, gamification in the construction industry is still incipient and restricted to the use of the technique with a focus on learning, which indicates that there is still a lot to be developed on this topic, especially in areas beyond schooling or safety.

5 Conclusion

This study systematically reviews the literature on research dealing with the use of Gamification in the construction industry. A bibliometric analysis identifies the publishers, publication history, the most used terms in keywords, and the most relevant authors in the area. In addition, a more detailed analysis was also carried out on articles that have a purpose following the objective of this study, observing pertinent data from the manuscripts and presenting a summary of the research of each selected manuscript with the following topics: title of the article, objective, game technique, gamification strategy and the name of the game.

In addition to the detailed analysis of the 15 selected articles, an analysis was carried out based on the clusters generated by VOSviewer. These two analyses identified the path that has been followed in research on Gamification in Civil Construction and the research gaps regarding the use of Gamification in Civil Construction. With

this study, it was possible to observe that there is still a lot to be done on this topic by researchers and academics and that it is a topic that generates much interest as it brings a lighter approach to subjects that are not always pleasant to those involved in the activity, such as workers, professionals, clients, and students.

There are, therefore, limitations in this area of research since no uses of gamification were found to foster a better organizational climate on construction sites, to increase the productivity of workers' activities, or to avoid wasting time or materials. Therefore, further studies should be carried out on this subject, including field research and case studies that seek to reinforce and show the possibilities, innovations, and benefits of gamification as a management element in the construction industry.
It is also important to note that few researches in the literature discuss the use of gamification as a management element in the construction industry. These reinforce the need for further research on the subject discussed in this paper.

Finally, this research contributes to the growing body of research on gamification in the construction industry and provides a basis for future studies. In this way, we hope this research results will be a helpful reference for students, researchers, teachers, construction companies, universities, and research centers. They will also contribute to future research into using gamification as a management element in the construction industry.

Acknowledgments

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

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