



CO-CREATING REQUIREMENTS THROUGH GAMIFICATION: IMPROVING COLLABORATION IN REQUIREMENTS ENGINEERING

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ABSTRACT

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Keywords: systematic literature review, requirements engineering, stakeholder engagement.

This thesis investigates the application of gamification tools to improve the stakeholder's involvement in the requirements engineering process in software development life cycle. A systematic literature review of 10 articles was conducted by using Kitchenham's framework. This study explores the impact of gamification in requirements engineering process in SDLC and the motivations of stakeholders in participating such activities.

Declaration of Artificial Intelligence (AI) usage

I recognize that, ChatGPT assisted me in improving the quality of my thesis writing process. It is important to note that, the final version of the document is completely original and not created by AI.

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Despite my dedication and effort, I acknowledge that this thesis may still contain shortcomings and potential errors. I sincerely welcome feedback from my supervisors to further improve and refine this work.

Koushik Mutsuddi

Helsinki, March 2025.

Acronyms

SLR Systematic Literature Review

ACM Association for Computing Machinery

IEEE Institute of Electrical and Electronics Engineers

ATM Automated Teller Machine

SDLC Software Development Life Cycle

SRS Software Requirements Specifications

RE Requirements Engineering

AI Artificial Intelligence

CCRE Crowd-Centric Requirements Engineering

API Application Programming Interface

PRIUS PRIoritizing User Stories

GREM Gamified Requirements Engineering Model

HTTP Hypertext Transfer Protocol

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1 Introduction

Requirements engineering (RE) is a discipline of developing and managing software requirements in software development life cycle (SDLC). There are many reasons why software project fails. However, incorrect requirements are considered to be one of the main reasons for the failure of software projects (Gul et al., 2021).

Requirements elicitation is considered as a crucial activity of RE process (Gul et al., 2021). It is the process of identifying and specifying user needs for a new application (Saad et al., 2018). Therefore, it needs an effective collaboration between project stakeholders and development team for creating a user-centric solution.

The core problem is that the requirements elicitation process cannot confirm all requirements that will be captured from the stakeholders by simply asking about how the proposed software will behave to fulfill their needs (Ribeiro et al., 2014). There are many challenges in this process such as incomplete understanding of the needs, low user participation, requirements volatility and the engineers lack of knowledge on different elicitation techniques (Geshwaree et al., 2015). This leads to a product that may not effectively meet the user demands. Therefore, effective communication is important, and requirements elicitation tools should facilitate this in order to enable the stakeholders to express their needs clearly (Ribeiro et al., 2014). These tools must support strong collaboration and decision-making, even though the stakeholders are in different place and time zones.

Gamification is a strategy that can significantly help to identify all business needs (Gul et al., 2021). Although gamification is still a relatively fresh technology, it is becoming potentially important in terms of stakeholder engagement. Gamification fosters a great collaboration among project stakeholders and optimizes output (Gloria et al., 2018).

There are several reasons why gamification technique in requirements elicitation process can be beneficial. Users can interact directly with the system through this technique by relating to the realistic scenarios (Dar et al., 2022). The games can be designed to imitate the final product before actual implementation. The technique focuses on the features of the gaming environment that improve certain user behaviors in order to amplify their involvement in requirements gathering activity (Gul et al., 2021). It gives the users a chance to explore and

provide valuable feedback. This helps to adjust the product design by addressing the feedback.

In summary, applying gamification in RE process is a powerful way to bridge the gap between the end-users and technology designers. Designers can gain insightful feedback from users which helps to implement a well-designed product.

1.1 Motivation

As an experienced business analyst with 15 years of experience in IT projects, I have observed several collaboration challenges between the software development team and end-users. My expertise in business analysis, project management and client communications has given me a comprehensive understanding of how crucial user-centric design is in bridging the gap between the stakeholders.

The idea of co-creation in the research topic for engaging the stakeholders directly in the process of requirements discovery has attracted my interest. I am quite motivated by the potential of utilizing interactive gamification tools to simplify complex technological concepts, fostering collaborative dialogue and removing barriers for non-technical users. I aim to explore how games can serve as a medium that helps both the users and designers to co-create, ensuring that the solutions are not only user friendly but also aligned with the needs.

This thesis seeks to change the way how technology solutions are envisioned, developed and implemented by promoting an innovative method in which participatory design is an integral part of the overall technology solutions.

1.2 Objectives

This thesis explores beyond the traditional methods of collecting software requirements, by analyzing the complex interactions between the stakeholders and technology designers in collaborative RE processes. These tools not only facilitate as bridges for understanding complex user requirements but also encourage active participation and removing potential barriers that typically hinder productive collaboration. The study will explore how games

can change the dynamics of requirements co-creation process. Finally, this study seeks to offer a more nuanced view of participatory design practices by highlighting the potential of gamified RE approaches to transform traditional requirements engineering process.

2 Background

This section provides some background information about requirements engineering, requirements co-creation, and the role of gamification in requirements co-creation process.

2.1 Requirements Engineering

Requirements engineering (RE) process involves documenting, systematically organizing, and gathering all the requirements of a system (Alam et al., 2017). It facilitates the transformation of user needs into well-defined system requirements.

Requirements are the foundation of all software products, and their elicitation, management, and understanding are common challenges across all development methodologies (Sillitti et al., 2005). Requirements elicitation is a critical phase of RE process. Requirements elicitation aims to uncover requirements and define system boundaries by engaging with stakeholders, such as clients, developers, and users (Paetsch et al., 2003). System boundary defines the scope of a system by understanding the business requirements, system components, business rules etc. The size of a system influences the clarity of its boundary (University of Cape Town, n.d.), smaller systems tend to have more distinct boundaries. In contrast, larger systems may feature multiple boundaries due to their interactions with various other systems. For example: the complexity of defining system boundaries of an ATM which has different boundaries such as the customer and the ATM machine, the ATM machine and core banking system etc. (University of Cape Town, n.d.).

Requirements elicitation involves different types of methods and techniques for gathering user requirements and then implement the software to satisfy those requirements (Yousuf et al., 2015). There are several elicitation techniques such as interviews, card sorting, JAD workshop, focus groups, brainstorming, prototyping, questionnaire, task observation etc.

However, each of these techniques has both advantages and limitations while collaborating with the project stakeholders (Gul et al., 2021). For instance; while using prototyping as a requirements elicitation technique, the users may become firmly attached to it and they may feel reluctant to consider alternative solutions (Zowghi et al., 2005). Another example is questionnaire which is an effective method of gathering information from the stakeholders but it is limited in the depth of insights it can provide (Zowghi et al. 2005).

2.2 Requirements Co-creation

Co-creation refers to any collaborative creative activity, where two or more individuals contribute to the creative process (Sanders et al., 2008). This is typically achieved through a structured process that begins with expressing experiences, followed by building a shared understanding, and concluding in the joint creation of future concepts. (Lee et al., 2018).

Co-creation approaches involve collaboration among experts from diverse fields to design, develop, and evaluate innovations that address specific needs (Oliveira et al., 2019). This approach emphasizes the active participation of key stakeholders, including domain expert, end-users, designers, and developers. Engaging these stakeholders is crucial for effectively eliciting requirements throughout the process. Moreover, sharing findings with stakeholders during the requirement modelling phase enhances transparency (Hosono et al., 2009).

2.3 Gamification in Requirements Co-creation

Gamification refers to applying of game elements in non-game contexts (Deterding et al., 2011). Gamification plays an important role in promoting specific behaviours and boost motivation and engagement (Alharthi et al., 2017). The primary goal of gamification is to boost user involvement by integrating game-inspired strategies like awarding points, granting badges, and offering feedback (Flatla et al., 2011).

Gamification has become an innovative strategy to enhance user motivation and engagement across a range of domains including requirements co-creation process. Research shows that gamification is evolving as a popular approach for boosting user activity and fostering social interactions (Deterding et al., 2011). Co-creation promotes collaboration, but it may still face

issues such as unstructured requirements, lack of motivation, or poor engagement among stakeholders. Gamification has the capability to significantly improve co-creation practices by addressing issues like insufficient structure, coordination, and participant engagement often found in other game-based methods (Patricio et al., 2020).

3 Research Method

This thesis follows the Systematic Literature Review (SLR) method to discover the complicated dynamics of co-creating requirements and using games to bridge the gap between stakeholders and technology designers. The literature review establishes a solid theoretical foundation by investigating existing research on co-creation and gamification in requirements engineering. It further explores how gamification can facilitate communication, enhance collaboration and bridge the gap between stakeholders and technology designers in requirements engineering.

3.1 Systematic Literature Review

Systematic Literature Review (SLR) encourages a precise and focused study by using clearly defined questions. This study ensures a reliable review by using the SLR approach as defined by (Kitchenham, 2004).

SLR is an organized research approach that targets to locate, assess and compile all relevant data related to well-defined research question (Kitchenham, 2004). It emphasizes on transparency and critical evaluation of included studies in order to minimize bias by using a reproducible protocol.

There are three main stages of SLR method as shown in figure 1. Initially, the researcher will formulate the research questions that will provide direction throughout the review process. As next, a comprehensive review protocol will be established. In this stage, search strategy such as databases, search words etc. should be planned. Finally, the reporting phase where the findings of the review are documented and presented.

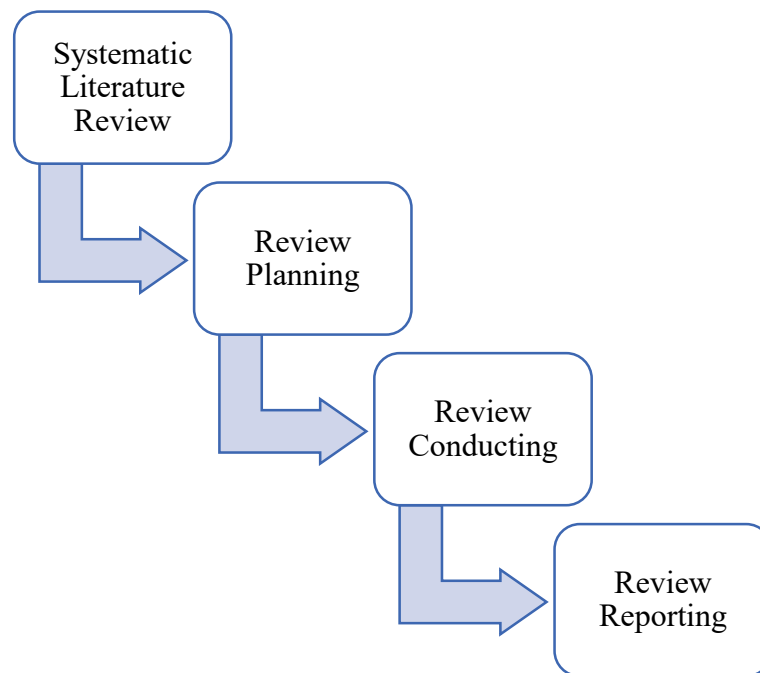


Figure 1: SLR Process (Kitchenham et al. 2007)

3.1.1 Review Planning

According to the guideline provided by Kitchenham (2004), the review planning process is the most critical step of SLR in order to ensure a well-defined review process. This phase includes defining the research questions, developing a review protocol, and establishing inclusion and exclusion criteria.

The first step of review planning is to define clear and focused research questions. These questions will guide the entire review process such as identification of relevant studies and determine the scope of the review.

A detailed review protocol will serve as a detailed plan for conducting the systematic review. Kitchenham et al. (2007) emphasizes on developing a protocol before the actual review takes place. A detailed search strategy will be designed in order to find related articles. The search items will include the keywords related to gamification, gamification elements and RE. Studies will be selected based on their relation with the research questions. The review protocol will also include data extraction plan to extract the key information from the selected studies, including methodology used, the participants engaged, the context of the study and the results.

3.1.2 Review Conducting

Review conducting process starts with performing the systematic search across selected databases. Studies are then selected based on the inclusion and exclusion criteria as established in planning phase. In this phase, the reviewer critically evaluates the quality of the study to perform data synthesis by using the meta-analysis or thematic analysis to answer the research questions.

3.1.3 Review Reporting

The review reporting is the final step in SLR, where the findings of the review are documented and presented. The results are presented in a structured way by including tables or charts to organize the data extracted from the selected studies.

4 Review Planning

The process of selecting the primary studies for this review is represented in the figure 2. This multi-step process resulted in a final selection of 10 highly relevant papers for the SLR. These papers are included in Appendix 1.

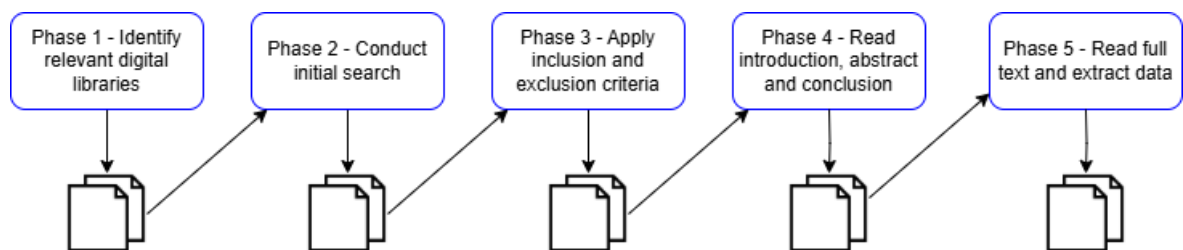


Figure 2: Study selection process using SLR

4.1 Identifying the relevant studies

I conducted a comprehensive search in scientific databases and search engines. Scientific databases include IEEE, Google scholar, Springer, ACM and Science Direct.

4.2 Forming the research questions

This thesis investigates how gamification can improve RE process in the context of SDLC. It will first look at what gamification tools and elements are used in the RE phase of SDLC. Secondly, the study will concentrate on the impact of gamification in terms of fostering effective collaboration.

Table 1 presents three research questions which helped me to explore different types of aspects of how gamification could transform the collaboration between stakeholders involved in RE process.

Table 1: Research Questions

ID	Research Question
RQ01	What current gamification tools are applied in the RE process of the SDLC?
RQ02	What gamification elements are applied in improving collaboration during the RE process of the SDLC?
RQ03	What are the consequences of applying gamification in terms of improving engagement in RE in SDLC?

5 Review Conducting

5.1 Defining Selection Criteria

I have established the following inclusion and exclusion criteria to select the primary papers relevant to my study.

Inclusion criteria

- IC1: Papers must address the gamified RE process. This includes explicitly using gamification-related within the context of stakeholder collaboration in RE. Studies must explore how gamification enhances user engagement, communication, and creativity in defining, refining, or validating system requirements. Additionally, studies proposing frameworks, methodologies, or best practices for integrating gamification into requirements co-creation will be included.

- IC2: Papers must be published within the time frame of 2000 to 2025. Research published outside this range will be excluded to ensure relevance to contemporary advancements in gamification and requirements co-creation.
- IC3: Papers must be from the disciplines of computer science, software engineering, or related engineering fields. This includes studies conducted within the domains of software development, human-computer interaction, and RE. Studies outside these disciplines will be excluded to maintain a focus on software development and engineering practices.
- IC4: Papers must be conference papers, scientific articles, or research studies that are peer-reviewed and published in reputable sources. This includes publications available in online digital libraries including IEEE Xplore, Google Scholar, Springer, ACM Digital Library, and Science Direct.

Exclusion criteria

- EC1: Papers that do not focus on gamification in the RE process within the SDLC will be excluded. This includes studies that discuss gamification in unrelated domains, such as education, marketing, or healthcare, without a direct connection to RE. Research that explores gamification in software development but does not address its role in requirement elicitation, validation, prioritization or co-creation will also be excluded. Additionally, studies that broadly discuss gamification without specific applications to stakeholder involvement in RE will not be considered.
- EC2: Papers that are not available in English will be excluded. This includes studies published in other languages without an official English translation. Only English-language publications will be considered to maintain clarity and comparability across selected studies.
- EC3: Papers that do not have a clear connection to the research questions will be excluded. This includes studies that mention gamification or RE but do not explicitly explore their intersection in the requirements co-creation process. Research that lacks the use of gamification in stakeholder collaboration for requirements gathering will also be excluded.

- EC4: Duplicated papers will be excluded. This includes studies that appear multiple times across different sources, repositories, or conferences under the same title and authorship.
- EC5: Papers that are not accessible will be excluded. This includes studies behind paywalls, or those that are not retrievable from reputable online digital libraries. Research that lacks full-text availability or only provides abstracts without sufficient details for analysis will also be excluded. Only accessible papers will be considered to ensure a comprehensive and thorough review of relevant literature.
- EC6: Short papers with a page count of less than five pages will be excluded. This includes extended abstracts, position papers, and short conference papers that do not provide sufficient depth, methodology, or empirical evidence related to gamification in the requirements co-creation process.

5.2 Selecting Primary Studies

I executed a combined search strings in the aforementioned online digital databases in order to identify the relevant literature. It resulted different outcomes while each database was queried by using the search string below. Some database showed an excessive number of results. However, some databases returned no results for the same search string. I have excluded the databases with no results. The combined search string for the research questions is as below -

(Gamification OR "Gamification methods" OR "Gamification components" OR "Gamification elements") AND ("Requirements Elicitation" OR "Requirements Engineering")

Table 2: Initial search results from online databases

Sources of data	Initial Filter
ACM	201
Google Scholar	3460
IEEE Xplore	51
Springer	183
Science Direct	124

Table 2 displays the chosen databases and their respective results for the search string.

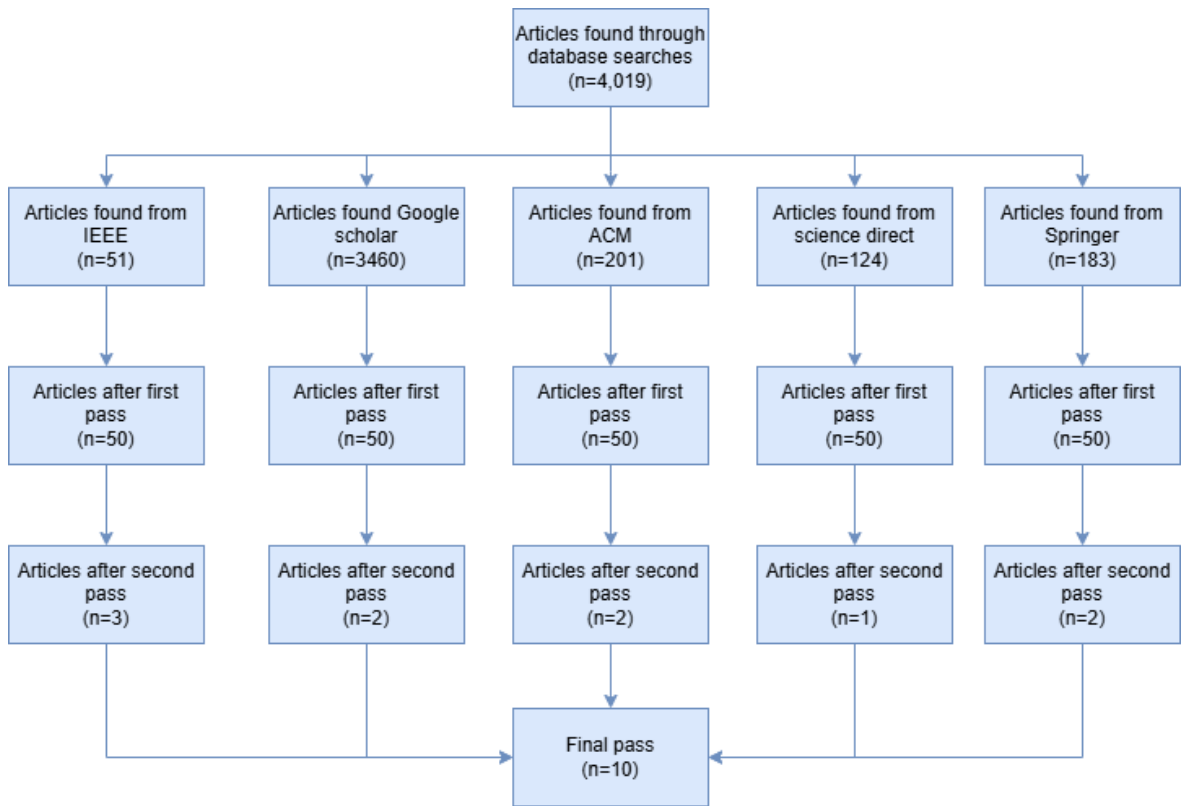


Figure 3: Article selection process

The following procedures were carried out to select the primary studies:

- a. Reviewing the introduction, abstract, and conclusion
- b. Removing duplicate studies.
- c. Ranking research papers based on their relevance to the search terms.

The preliminary search was conducted in multiple databases which returned around 4,000 relevant papers as shown in Figure 3. However, the review was restricted to fifty papers published by each publisher due to time and resource constraints. A final set of 10 most related studies was selected which are listed in table 3 by publisher. Full details of these papers are available in the Appendix 1.

Table 3: Selected final papers for SLR

Publisher	Number of Articles
IEEE	3
ACM	2
Springer	2
Google Scholar	2
Science Direct	1

The distribution of selected primary studies spans from 2012 to 2024 as shown in Figure 4, covering a period of 12 years. The studies are evenly spread across different years, with no particular year having multiple studies.

However, there is a higher concentration of publications between 2015 and 2024, with 9 out of 10 studies falling within this range. Specifically, more recent publications (2020–2024) account for 5 studies. The distribution suggests a growing interest in gamification for RE, especially in recent years (2023–2024).

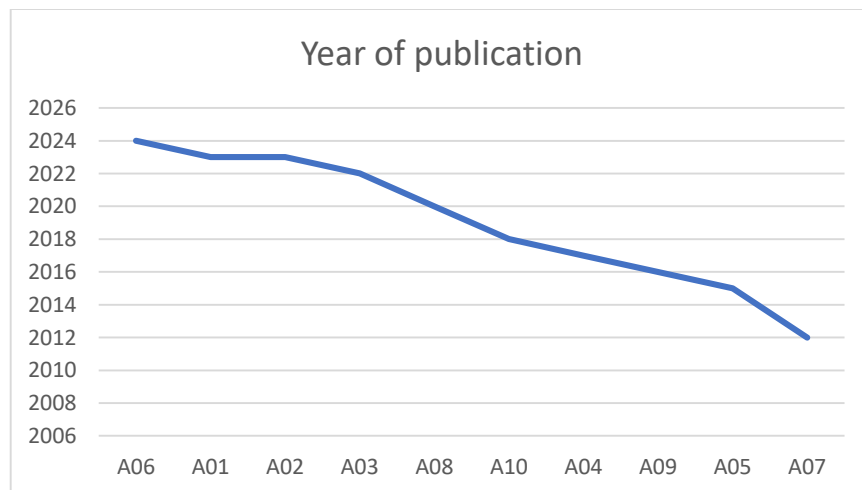


Figure 4: Distribution of studies per year

The oldest study is from 2012, while the most recent one is from 2024, reflecting a broad sequential coverage of research on gamification applied in RE.

The citation count of the selected primary studies varies significantly, ranging from 1 to 238 citations as shown in Table 4. The most cited study is A07 (238 citations), followed by A09

(120 citations) and A05 (117 citations). These papers likely have had a significant impact in their research domain over time.

There is a noticeable concentration of highly cited papers (≥ 50 citations) among studies published before 2020, suggesting that older publications have accumulated more citations. However, more recent studies, such as A01 (1 citation), A02 (1 citation) and A03 (2 citations), have lower citation counts, possibly due to their recent publication and limited time for academic recognition.

Table 4: Number of citations per selected primary study

Article ID	Citation Count
A01	1
A02	1
A03	2
A04	18
A05	117
A06	5
A07	238
A08	52
A09	121
A10	45

Selected primary studies were classified according to Wieringa's classification scheme (Wieringa et al., 2006). Wieringa's classification scheme is a framework used to categorize research papers in software engineering and related fields based on their research type. It was proposed by Roel Wieringa to help systematically classify studies according to their research methodology and contribution. The scheme consists of the following six categories:

- a. Evaluation Research – The studies that evaluates existing techniques, methods, or tools in a real-world setting, such as case studies, experiments, or field studies. The objective of such studies is to analyze the outcomes.
- b. Validation Research – The studies that validates new methods, techniques, or tools in a controlled setting, such as simulations, lab experiments, or proofs of concept before the actual implementation.
- c. Solution Proposal – The studies that introduce a solution of a problem. It focuses on the advantages of the solution accompanied by proof-of-concept implementation or theoretical justification.

- d. Philosophical Papers – The studies that present new theories, conceptual frameworks, or models without empirical validation.
- e. Opinion Papers – The papers that express the author’s personal viewpoint, typically based on experience or theoretical reasoning, without formal validation.
- f. Experience Papers – The papers that describe practical applications and lessons learned from real-world implementations, usually based on industry experience.

Table 5 depicts the mapping of selected papers, categorized by research types. 7 out of 10 primary studies utilized evaluation research methods. Couple of studies proposed new solutions. Most of the studies focus on evaluation research which denotes a solid assessment of the application of gamification in RE.

Table 5: Mapping of selected papers based on research types

	Evaluation Research	Validation Research	Solution Proposal	Total
Gamification applied in RE	A03, A04, A05, A06, A07, A08, A09, A10	A02	A01	
Total	7	1	2	10

6 Data Synthesis

A thematic analysis was conducted to analyze the consequences of applying gamification in RE within the SDLC. A theme highlights a significant aspect of the data in relation to the research question, reflecting a recurring pattern or meaningful response within the dataset (Braun et al., 2006).

I have identified the themes from the data where "data" refers to the results, discussion, findings and conclusion sections of the selected primary studies. I have followed the steps as shown in Figure 5 for identifying the themes by using the principles of thematic coding from qualitative research (Braun et al., 2006).

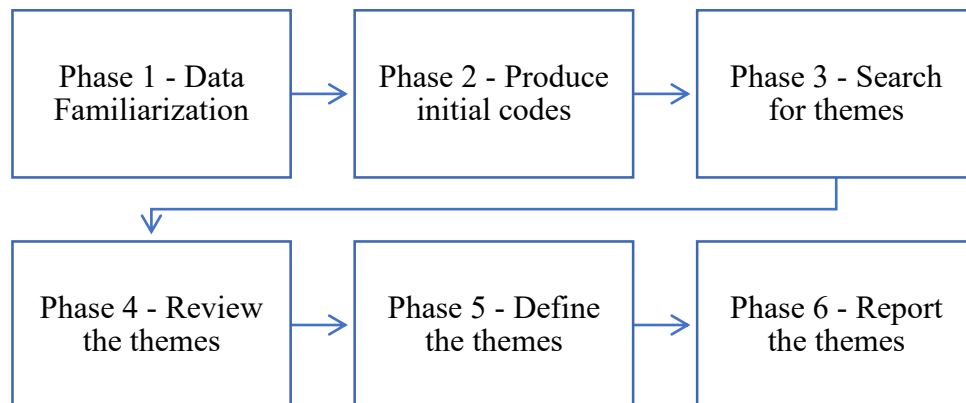


Figure 5 – Thematic analysis process (Braun et al., 2006).

I followed a structured six-step thematic analysis process. At first, I reviewed the results, discussion, findings, and conclusion sections of the selected primary studies repeatedly to familiarize myself with the data. This step enabled me to identify initial ideas based on key insights from the literature. Next, I compiled the key findings and assigned each to a descriptive statement that captured its focus. These descriptive statements were then transformed into conceptual codes, representing the first-order themes (T1) that reflected the primary outcomes observed in the studies.

Following this, I explored connections between these initial codes, integrating related concepts to form broader themes. By identifying patterns across first-order themes, I grouped them into second-order themes (T2) and developed a thematic map to visualize these relationships. Each theme's significance was further analyzed to ensure clear definitions that accurately described its contribution to the research. Finally, I conducted a comprehensive analysis of the themes, linking the insights to my research question and existing literature, and presented the results in a detailed report. This rigorous approach ensured that the identified themes provided meaningful insights into the role of gamification in RE.

My review from the primary studies indicate that gamification has a significant impact on stakeholders in RE such as influencing their engagement, motivation, participation, creativity, and knowledge acquisition. The detailed data synthesis process and how different gamification tools helped to improve engagement are detailed on section 7.3.

7 Results

The studies analyzed in this review provide significant evidence that gamification enhances user engagement and participation in RE process. However, the extent of its effectiveness varies based on the gamification method used and the specific game mechanics incorporated.

7.1 RQ1: What current gamification tools are applied in the RE process of the SDLC??

I have reviewed the final set of 10 papers to analyze the extracted data. All papers that address research question 1 also offer insights into question 2, indicating a potential connection between the two questions. Table 6 shows the mapping between the selected articles and gamification applications which are applied in RE process.

Table 6: Mapping of the studies that apply different gamified requirements applications

Gamification applications	Article ID
Pointagram	A01
REVISE	A02
GAMIFY4REQ	A03
DMGame	A04
REfine	A05
PRIUS	A06
iThink	A07
GARUSO	A08
GREM	A09
RE-PROVO	A10

Several studies have demonstrated that incorporating gamification techniques into the RE process can be highly effective. Pointagram is a gamification tool specifically designed to boost motivation by integrating features like badges and leaderboards. In an experimental setup, this tool was employed to evaluate its impact on enhancing the requirements generation and elicitation process (Masoudi et al., 2023). Similarly, REVISE 2.0 is a collaborative gamified environment developed from a previous shared collaborative prototype (Unkelos-Shpigel et al., 2015). It includes a real-time group chat system that brings together key project stakeholders, such as the system analyst (creator), the reviewer, and the customer. This interactive environment enhances collaboration by providing a

centralized platform where stakeholders can efficiently define and discuss project requirements while benefiting from gamification elements designed to boost motivation and engagement (Unkelos-Shpigel et al., 2023).

Another notable tool, Gamify4Req, is a web-based platform that supports collaborative RE by facilitating interactions between key roles such as the Project Manager, the Requirements Engineer, and the end-user or domain expert (Dar et al., 2022). The system is developed using PHP version 7.4 with a MySQL database and is structured on a three-tier architecture as shown in Figure 6. To actively engage participants, Gamify4Req integrates various gamification APIs, which encourage users to express their needs more clearly and concisely. This gamified approach not only motivates participants but also reduces ambiguity, ultimately improving the quality of the elicited requirements. By blending collaboration features with interactive gamification elements, Gamify4Req demonstrates its potential to enhance engagement and streamline the RE process.

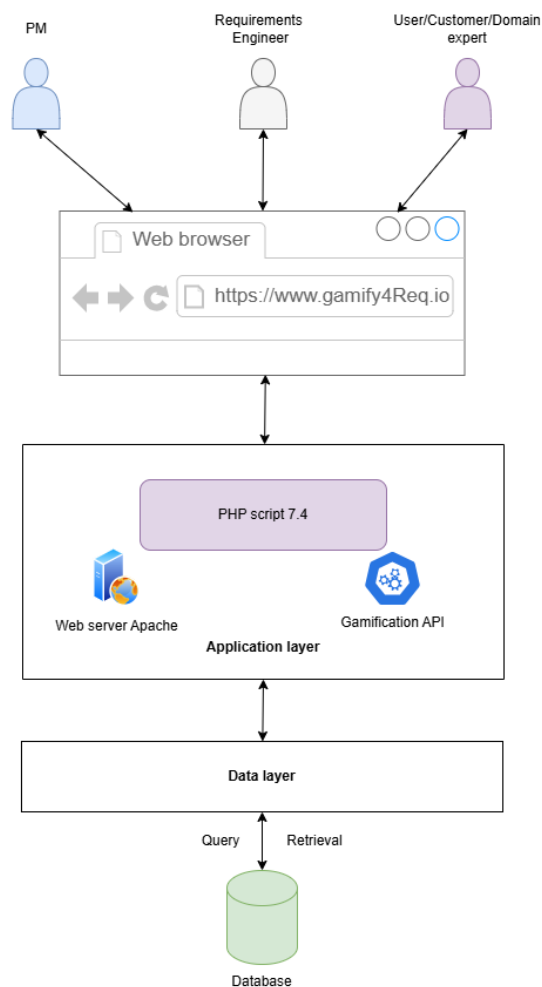


Figure 6: Architecture diagram of Gamify4Req tool (Dar et al., 2022).

DMGame is a collaborative tool designed to facilitate stakeholder engagement in the RE process by enabling participants to actively create, engage in, and oversee discussions aimed at determining the relative importance of a defined set of requirements, ultimately reaching a consensus-based conclusion (Kifetew et al., 2017). The process involves three key roles: the supervisor, the opinion provider, and the negotiator as shown in Figure 7. Initially, all necessary information including requirements, evaluation criteria, stakeholder roles, and user feedback is gathered. The supervisor then utilizes this information to configure and initiate the game. Following this, the opinion providers are given a specific timeframe during which they actively participate by expressing their preferences.

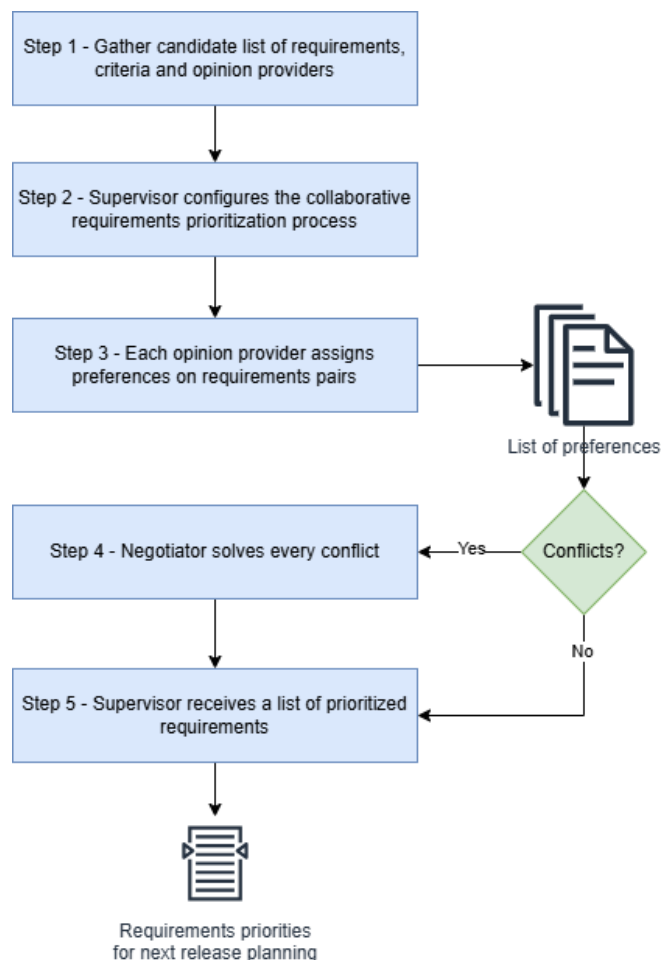


Figure 7: Steps involved in DMGame for collaborative requirements prioritization process (Kifetew et al., 2017)

REfine is an interactive gamified online platform developed to facilitate requirements elicitation and refinement which involves a wide range of stakeholders (Snijders et al., 2015). As part of the Crowd-Centric Requirements Engineering (CCRE) method, REfine enables software product companies to effectively integrate crowdsourcing principles throughout the RE process (Snijders et al., 2014). The CCRE method emphasizes comprehensive analysis at each stage of RE to identify areas where crowdsourcing and gamification can enhance value (Snijders et al., 2014).

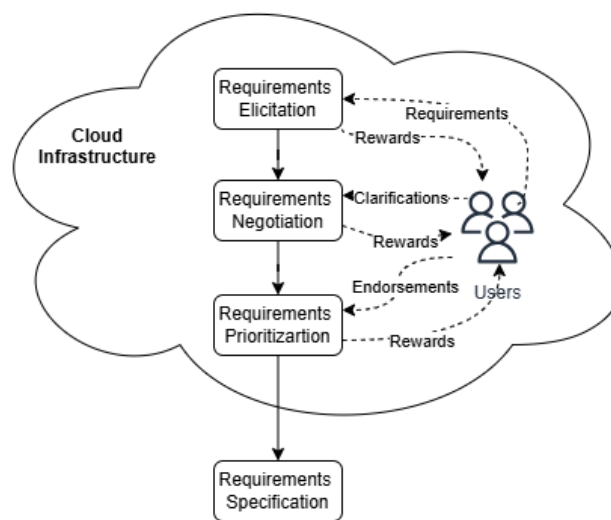


Figure 8: CCRE method (Snijders et al., 2014).

CCRE extends beyond elicitation by facilitating co-creation and co-design process (Snijders et al., 2014). Points and badges are awarded to the users for actively participating in developing and validating requirements continuously as shown in Figure 8. The infrastructure of the platform is cloud-based, allowing seamless interaction between the user crowd and the software company during activities like proposing and clarifying requirements (Snijders et al., 2014). REfine is built using HTML, JavaScript, CSS, and PHP, with MySQL as the backend database (Snijders et al., 2015). The user interface was developed using the Bootstrap framework, and the PlayBasis API was integrated to implement gamification features. This combination of interactive features and technical flexibility makes REfine a powerful tool for enhancing engagement and collaboration in the RE process.

PRIUS is a gamified platform designed to enhance user story prioritization in agile projects by integrating gamification elements into the prioritization process (Lencastre et al., 2024). The system was employed during experimentation and hypothesis testing to assess its

effectiveness in improving user engagement and prioritization outcomes. The platform's web interface module was developed using the Ember.js3 framework as shown in Figure 9 (Lencastre et al., 2024). The Prioritization Module contains the system's JavaScript logic, which determines the priority of each user story based on input from participants with diverse roles. Meanwhile, the Game Module leverages the Bootstrap library to manage and present gamification elements such as points, badges, and interactive features. This module handles all game-related interactions, tracks user actions, and manages the storage of collected data to ensure a seamless and engaging experience.

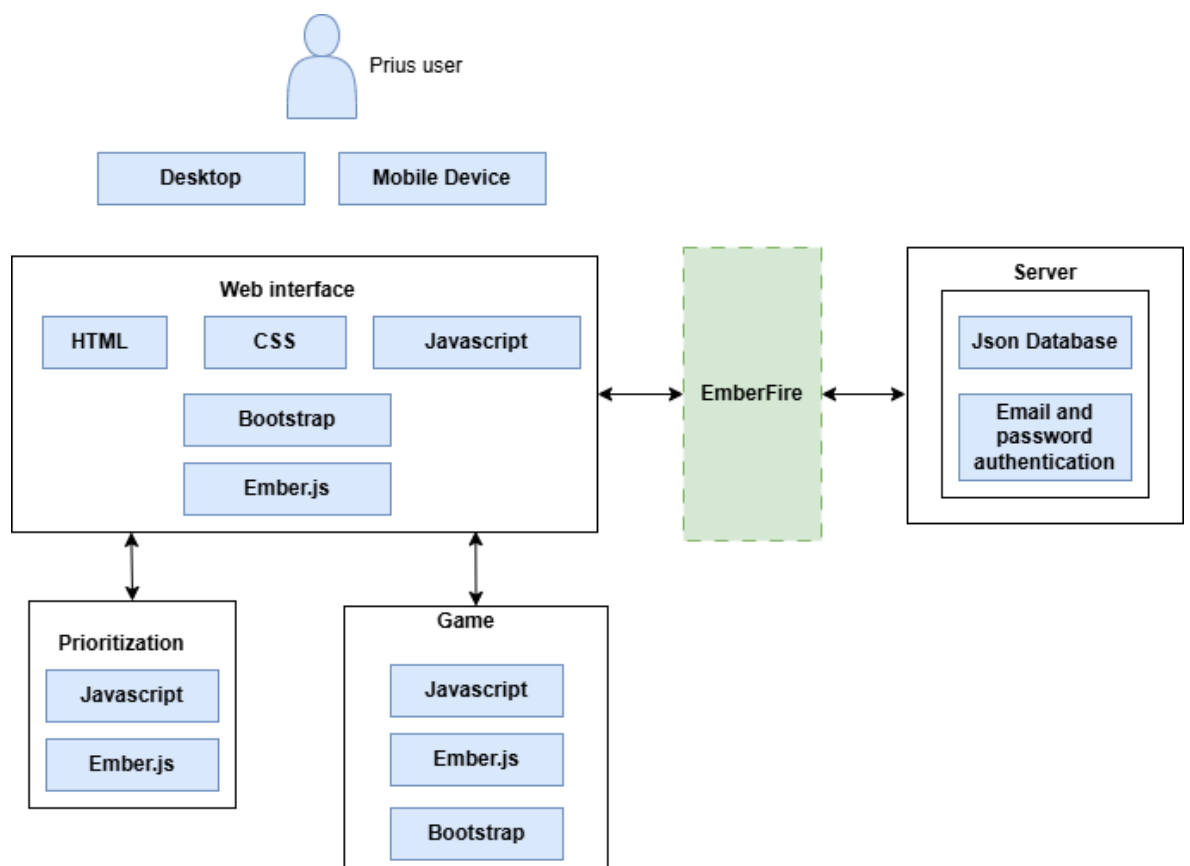


Figure 9: Architecture diagram of PRIUS (Lencastre et al., 2024).

In addition, PRIUS features a Server Module responsible for user authentication, which verifies email addresses and passwords using a JSON database (Lencastre et al., 2024). The system also utilizes the Firebase platform to leverage ready-to-use functionalities and resources, enhancing the platform's scalability and reliability. By combining these technical components with gamification strategies, PRIUS effectively promotes engagement and improves the user story prioritization process in agile project environments.

iThink is a web-based platform that leverages game-like elements to facilitate collaborative requirement elicitation among stakeholders (Fernandes et al., 2012). The platform gamifies the requirements elicitation process by rewarding users not only for generating new requirements but also for analyzing existing ones from different perspectives. To achieve this, iThink integrates De Bono's six thinking hats method into its game mechanics, where each hat corresponds to a specific elicitation activity (Fernandes et al., 2012). By blending structured thinking techniques with gamification, iThink enhances engagement and encourages diverse contributions during the requirements elicitation process.

GARUSO is a social media platform designed to foster collaborative participation from external stakeholders in requirements elicitation and prioritization activities. The platform allows visitors to sign up securely through a two-factor authentication system, enhancing security and mitigating the risk of malicious users (Kolpondinos et al., 2020). Upon successful registration, users gain access to the platform's RE engine, where they can submit their wishes for system improvements, describe the benefits of implementing these wishes, and categorize the benefits accordingly. Users can also upload images to further clarify their ideas. To enhance engagement, GARUSO employs a gamification engine that combines two distinct rule sets: a points system that integrates with requirement features, and a reward system that builds upon the point system.

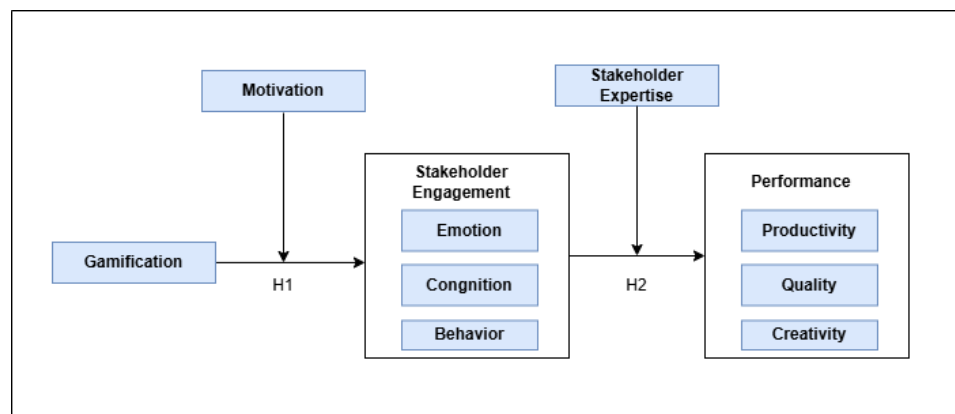


Figure 10: Gamified Requirements Engineering Model (Lombriser et al., 2016).

The GREM model combines gamification principles with engagement theories to enhance performance in RE (Lombriser et al., 2016). The conceptual model, depicted in Figure 10, illustrates the relationships between gamification, stakeholder engagement, and performance within the RE context. In this model, gamification is identified as the independent variable, while stakeholder engagement and performance serve as dependent variables. To address

potential threats to internal validity, the model includes two control variables: motivation and stakeholder expertise. Stakeholder engagement is further divided into three dimensions: emotions, cognition, and behaviour (Lombriser et al., 2016). Similarly, performance is categorized into productivity, quality, and creativity, reflecting essential outcomes of effective requirements elicitation (Lombriser et al., 2016). Based on the GREM model, an online gamified platform was developed using WordPress, designed to facilitate requirement elicitation through user stories and acceptance tests. This platform integrates GREM's structured approach, ensuring enhanced stakeholder participation, improved collaboration, and better RE outcomes.

RE-PROVO is a tool designed to support RE activities, named by combining "provo," meaning "test," with "RE," referencing both RE and the concept of repetition in the process (Alexandrova et al., 2018). The tool was implemented on Jira, a widely used project management platform for issue tracking. The design of RE-PROVO was influenced by the non-domain-specific Triadic Game Design framework, which played a vital role in guiding the game's development process (Alexandrova et al., 2018). An initial mapping was created based on Triadic Game Design principles to connect game elements with RE concepts and organizational goals, ensuring a structured and effective approach to enhancing collaboration and engagement in the RE process.

7.2 RQ2: What gamification elements are applied in improving collaboration during the RE process of the SDLC?

This research question seeks to identify and explore specific gamification elements that can effectively improve the collaboration in the RE process within the SDLC. Game elements play a significant role in gamified systems for requirements elicitation, as they are designed to enhance user engagement with the system (Cursino et al., 2018). By understanding these elements, we can investigate how gamification can enhance engagement, and overall effectiveness during the critical stage of defining software requirements.

Table 7: mapping of primary studies that used gamification elements

Gamification elements	Article ID
Points/Scores	A01, A02, A03, A04, A05, A06, A07, A08, A09, A10
Badges	A01, A02, A03, A09, A10
Leaderboard	A01, A03, A05
Rewards	A02, A09
Progress	A04, A06, A09
Time pressure	A04
Roles	A10
Feedback	A06
Avatar	A06
Ratings	A06

Table 7 provides a detailed breakdown of which studies employed each specific gamification element. The mapping of primary studies reveals distinct trends in the use of gamification elements within the RE process. Points/Scores were the most widely adopted element, appearing in all primary studies, emphasizing their effectiveness in motivating participation through instant recognition. Badges and leaderboards were also commonly used, fostering achievement and competition to boost engagement. Rewards and progress indicators were used selectively. Conversely, time pressure was used in only one study, reflecting potential concerns about its impact on stakeholder performance. Additionally, elements like roles, feedback, avatars, and ratings were incorporated less frequently but play crucial roles in enhancing collaboration, personalizing experiences, and ensuring constructive communication.

Figure 11 illustrates the distribution of research studies focused on specific game elements that encourage stakeholder's engagement. The data reveals a diverse range of gaming elements were applied in the primary studies selected in this review. The x-axis lists the individual game elements while y-axis represents the number of studies dedicated to a

particular game element. The data exhibits the inclusion of diverse gamification elements like Points/Scores, Badges, Rewards, Progress, and Time Pressure across selected primary studies.

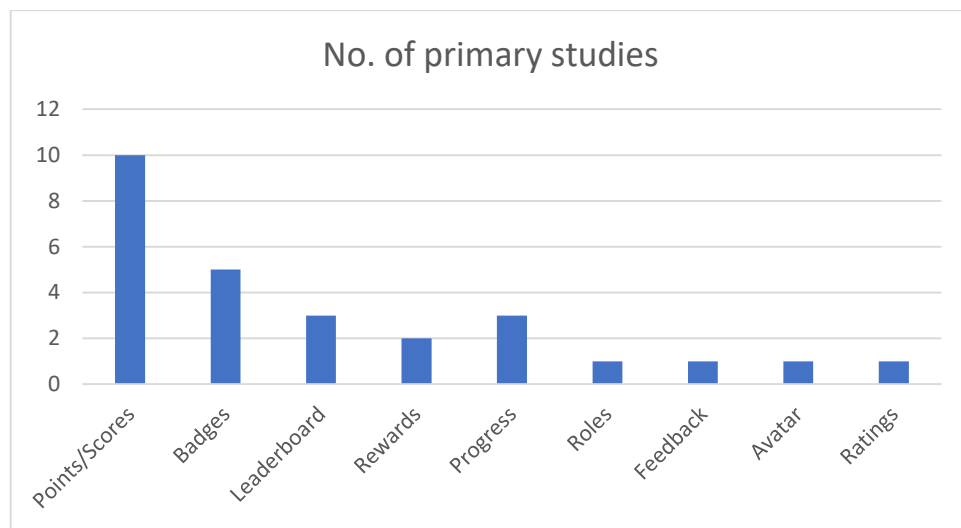


Figure 11: Distribution of primary studies by game elements

All selected primary studies mentioned about using points as a gamification element in the respective gamification process or tools. In the Pointagram environment, requirements-related questions are presented as quests, with distinct sets for mission requirements and system requirements (Masoudi et al., 2023). User earns a specific number of points upon completing a quest. However, the paper A01 does not indicate whether points have any impact on stakeholder collaboration.

In the REVISE 2.0 environment, points are awarded to participants for commenting on requirements, with additional points granted for comments that enhance the quality of a requirement description (Unkelos-Shpigel, et al., 2023). These awarded points motivate the stakeholders to engage actively. The additional initial score for reviewers and points for authors for receiving comments can foster a sense of recognition, reward, and healthy competition, which can drive collaboration. This gamification element taps into intrinsic and extrinsic motivations, promoting more interaction and involvement among stakeholders in the RE process.

In the CCRE method, members of the user crowd are rewarded through a points system for actively participating in the requirements process (Snijders et al., 2014). These points are

awarded for proposing new requirements, commenting on existing requirements and polling on requirements.

Gamify4Req is designed to reward each user by applying achievement-based rules (Dar et al., 2023). If the requirements engineer, user, customer, or domain expert submits new requirements in level 1 then they are awarded points for each requirement. They also receive points for updating each requirement in the second level. If the user, customer or domain expert confirm requirements in the second level then points are awarded for providing validated requirements. If the requirements engineer verifies requirements in the second level, then he achieves points for verified requirements. Finally, if requirements engineer, user, customer or domain expert verifies the requirements document then points are awarded. A user feedback survey indicates that points are the most valuable gamification element in Gamify4Req (Dar et al., 2023). Therefore, points play a vital role in Gamify4Req in terms of engaging the stakeholders.

The Pointsification mechanism in DMGame is designed to provide an incentive for performing voting task quickly and accurately (Kifetew et al., 2017). Therefore, it encourages user participation by providing incentives for both speed and accuracy in voting. In REfine, participants can earn points when requirements are added, commented or voted (Snijders et al., 2015). Table 8 illustrates the distribution of points for different actions in REfine process.

Table 8: Allocation of points on Refine. Adapted from (Snijders et al., 2015).

User Action Type	Trigger	Coin Change	Point Allocation
Active engagement	Registering an account	+10	-
	Posting a new need	-3	+5 (<i>Ideator</i>)
	Adding a comment	-1	+1 (<i>Commentor</i>)
	Voting on need	0	+1 (<i>Assessor</i>)
	Branching from a need	-3	+5 (<i>Ideator</i>), +1 (<i>Commentor</i>)
Passive engagement	Having branched need	+1	+3 (<i>Ideator</i>)
	Receiving comment votes	+1	+1 (<i>Commentor</i>)
	Agreement on a need	+1	+1 (<i>Ideator</i>)
	Disagreement on a need	0	-1 (<i>Ideator</i>)

One of the primary goals of the PRIUS gamified approach is to enhance stakeholder participation (Lencastre et al., 2024). Table 9 shows how points are awarded for different activities such as opinion on a user story, add comment to a story, view the acceptance criteria of a story and so on in PRIUS system. For example: the user receives 80 points by providing an opinion on a user story.

Table 9: Point awarded for each performed activity in PRIUS.

Adapted from (Lencastre et al., 2024).

User Activity Type	Description	Score
Log in	Log into the system	+1 point
Content Contribution	Add a comment to the story	+15 points
	Be the first to comment on a story	+5 points
Story Exploration	View the story's acceptance criteria	+10 points
	View the story's wireframes	+10 points
Engagement with Others	Rate another user's comment	+5 points
	Receive positive feedback on a comment	+5 points
	Receive negative feedback on a comment	-5 points

In iThink, points are distributed to encourage participation in various activities during the requirements elicitation process. Providing a new requirement, considered the most critical and challenging task, rewards users with 500 points, making it the highest-scoring activity (Fernandes et al., 2012). User can earn 50 points when a requirement is rated. Similarly, concrete or statistical comments, though less relevant, also grant 50 points due to their relative difficulty. User can earn 100 points for providing feedback positively or negatively. Additionally, users receive a bonus of 100 points for completing the discussion of a requirement using all four available methods. This scoring scheme is designed to prioritize significant contributions while encouraging diverse and active engagement.

The point system is one of the rule sets of gamification engine in GARUSO platform. Rule set 1 links requirement features to the point system by converting the activities of platform users into points (Kolpondinos et al., 2020). Table 10 outlines each activity supported by the requirement features, along with the corresponding points awarded in each point category defined by the system.

Table 10: Points earned per activity in GARUSO.

Adapted from (Kolpondinos et al., 2020).

User Activity	Sharing Points (Active)	Evaluating Points (Active)	Community Points (Passive)
Share a post	+6	-	-
Rate a post	-	+2	Range: [-2, -1, 0, +1, +2]
Vote on a post	-	+2	Range: [-2, 0, +2]
Share a sub-post	+3	-	+3
Vote on a sub-post	-	+2	Range: [-2, 0, +2]

An online platform was created to support Gamified RE Model (GREM) (Lombriser et al., 2016). The platform was designed with the flexibility to easily enable or disable its gamification features and to gather requirements using user stories and acceptance tests. This platform allowed to award points based on user activities on the website. For example, user can earn 30 points by submitting a user story and 10 points for creating an acceptance test for the user story. Users earn points and badges based on their activities in RE-PROVO (Alexandrova et al., 2018). Points are awarded to players for actions such as issuing a challenge, performing requirement morphing, posting comments, creating new requirements, or ranking and voting on any object. In summary, the use of points encourages stakeholders to collaborate more. By implementing achievement rules that reward participants for their actions, the system motivates stakeholders to actively contribute in the RE process.

Badges are visual representations of a player's accomplishments that foster a sense of achievement, motivating stakeholders to actively participate in tasks such as writing user stories, providing feedback, and analyzing requirements (Lombriser et al., 2016). Different gamified RE platforms employ badges in various ways to reward user engagement. In the CCRE method, badges are awarded to stakeholders who provide valuable and constructive feedback, reinforcing positive behavior and improving the overall process (Snijders et al., 2014). In the REVISE 2.0 environment, stakeholders are awarded badges for their personal scores (Unkelos-Shpigel et al., 2023). Similarly, in the Gamify4Req platform, badges are awarded for task completion milestones. For example, submitting at least five new requirements in Level 1 earns a level completion badge, while updating five requirements in Level 2 grants an achievement badge (Dar et al., 2022). The GREM platform assigns badges

for specific user activities such as writing user stories; for instance, users earn a ‘User Story Writer’ badge after drafting three user stories (Lombriser et al., 2016). In the RE-PROVO platform, badges are granted for consistent activities like posting numerous comments or for reaching predefined point thresholds (Alexandrova et al., 2018). In summary, badges serve as an effective tool across various gamified RE platforms to acknowledge stakeholder contributions, promote engagement, and encourage consistent participation.

Leaderboards are a widely used gamification element designed to foster competition and encourage active participation by ranking users based on their performance. In the Pointagram environment, accumulated points, referred to as Requirements Elicitation Points, determine the ranking of a user on the leaderboard (Masoudi et al., 2023). However, the study did not provide evidence on whether these points had a direct impact on stakeholder collaboration. In contrast, the Gamify4Req platform employs a leaderboard maintained at each user level, where participants identified it as the most influential game element in a user involvement survey (Dar et al., 2023). This proves that, leaderboards can perform a positive role in enhancing user engagement by promoting competition and encouraging active contributions. The REfine platform adopts a more diverse approach by implementing three types of leaderboards to both motivate stakeholders and identify participants for focus group invitations regarding selected requirements (Snijders et al., 2015). While participants did not consider leaderboards particularly prominent, they generally agreed that game elements improved their overall experience, indicating that leaderboards can enhance engagement indirectly

Reward is another gamification element which is used as powerful incentives to motivate stakeholder participation and enhance engagement. In the REVISE 2.0 environment, teams are rewarded based on their scores, with incentives ranging from monetary rewards to other forms of recognition, such as breakfast with higher management (Unkelos-Shpigel et al., 2023). Similarly, in the Gamified RE Model (GREM), the leaderboard winner receives a monetary prize, such as a €25 gift card, determined by their accumulated points and likes (Lombriser et al., 2016). In summary, rewards indirectly improve user engagement by motivating participants to actively contribute and achieve predefined goals.

In agile methodologies, prioritization of user stories happens before the start of each sprint (Lencastre et al., 2024). To support this process, the Progress element was incorporated into the PRIUS method. An overview of the remaining stories that need prioritization was

provided to the user, ensuring better planning and time management before a sprint begins. The Progress element in the PRIUS method helps users track how many stories still need to be prioritized before a sprint begins. While this supports efficient backlog management and planning, its connection to stakeholder collaboration is indirect. In DMgame, the Progress element is implemented by reporting each user's completion rate stakeholders (Kifetew et al., 2017). However, this feature focuses on individual tracking rather than facilitating stakeholder collaboration. In GREM, the Progress element is represented by a bar that displays the player's current state within a process (Lombriser et al., 2016). This visualization helps users understand their position and remaining steps in the workflow. However, it serves as an individual tracking tool rather than a mechanism to enhance stakeholder collaboration.

The Roles element ensures that different stakeholders contribute their expertise effectively, enhancing collaboration in the RE process. In the RE-PROVO platform, roles are integrated into gameplay to enhance stakeholder engagement and promote constructive discussions. Players are assigned one of two roles: Heritage Keeper or Innovator, each with distinct responsibilities. Heritage Keepers focus on challenging requirements that deviate significantly from the current operational state or pose excessive risk, ensuring continuity and stability. On the contrary, Innovators critique requirements that closely mirror legacy workflows, advocating for modernized solutions that embrace digital innovation (Alexandrova et al., 2018). This role-based structure encourages diverse perspectives, fostering productive debates over business requirements. By requiring players to express and defend their viewpoints, the Roles element promotes critical thinking, cooperative problem-solving, and balanced decision-making. This structured approach ultimately enhances collaboration, ensuring both stability and innovation are carefully considered throughout the RE process.

Feedback element helps player to understand whether they are on the right track (Lencastre et al., 2024). This element is used in PRIUS gamified approach where the system provides notifications whenever users perform activities that are encouraged within the platform. This immediate response helps maintain engagement and motivation, guiding users toward desired behaviors.

The Avatar element allows users to create and visualize a personal representation which is combined with the leaderboard element in PRIUS gamified approach (Lencastre et al.,

2024). The use of an avatar, along with the visibility of their standing on the leaderboard, keeps users entertained and motivated, making the user story prioritization process not only more enjoyable but also more immersive and fun. This combination helps maintain user engagement throughout the task.

The use of the Rating element combined with the Comments serves as a regulation mechanism within the system in PRIUS gamified approach (Lencastre et al., 2024). The goal is to empower users to act as moderators, by allowing them to highlight the most relevant and highly rated comments. Simultaneously, users who post irrelevant comments or those made solely to earn points are penalized. This system ensures that the quality of user-generated content is maintained, as it encourages meaningful participation while discouraging trivial contributions.

7.3 RQ3: What are the consequences of applying gamification in terms of improving collaboration in RE in SDLC?

To address this specific research question I have conducted the thematic analysis on the results, discussion, findings and conclusion sections of the selected primary studies. Firstly, I have extracted the following key findings which are assigned to a descriptive statement by summarizing its focus. Table 11 depicts the theme description extracted from the relevant primary studies.

Table 11: List of theme descriptions

Theme description	Article ID
Gamification has positive impact on stakeholders engagement in RE.	A01, A02, A03, A05, A06, A07, A08
Gamification helps to generate complete requirements.	A01
Gamification helps to generate greater number of requirements.	A07
Gamification increases motivation for stakeholders.	A02, A05, A06, A07, A08

Gamification can detect ambiguous requirements and minimize ambiguity in requirements.	A03
Gamification helps to improve quality of requirements.	A07
Gamification makes the decision making process effective.	A04
Gamification can enhance innovation.	A05
Applying gamification can increase the number of unique requirements.	A09
Stakeholders can participate remotely in gamified RE process.	A08
Stakeholders can improve their domain knowledge in gamified RE platform.	A08
Gamification can improve creativity among stakeholders.	A09, A10
Participation in gamified RE platform is interesting for stakeholders.	A06, A08

As next, these theme descriptions were converted into conceptual codes which represent the first-order themes (T1). Table 12 shows the list of the first order themes generated from theme description.

Table 12: List of First-order themes (T1)

First order theme (T1)	Theme description
Increased engagement	Gamification has positive impact on stakeholders engagement in RE.
Requirements completeness	Gamification helps to generate complete requirements.
Increased number of requirements	Gamification helps to generate greater number of requirements.

Increased motivation	Gamification increases motivation in RE process.
Unambiguous Requirements	Gamification can detect ambiguous requirements and minimize ambiguity in requirements.
Quality requirements	Gamification helps to improve quality of requirements.
Effective decision-making	Gamification makes the decision making process effective.
Enhanced Innovation	Gamification can enhance innovation.
Unique requirements	Applying gamification can increase the number of unique requirements.
Remote participation	Stakeholders can participate remotely in gamified RE process.
Gather domain-knowledge	Stakeholders can improve their domain knowledge in gamified RE platform.
Improved Creativity	Gamification can improve creativity among stakeholders.
Increased enjoyment	Participation in gamified RE platform is interesting.

Finally, I have grouped the first-order themes (T1) into second-order themes (T2) based on common patterns. Table 13 shows the relationship between T1 and T2.

Table 13: Relationship between T1 and T2

Second order theme (T2)	First order theme (T1)
Impact on stakeholders	Increased engagement
	Increased motivation
	Increased enjoyment
	Improves creativity
	Remote participation
	Gathers domain knowledge

Impact on RE process	Enhanced innovation
	Effective decision-making
Impact on Requirements	Requirements completeness
	Increased requirements
	Unique requirements
	Unambiguous requirements
	Quality requirements

Several studies highlighted that gamification significantly enhances stakeholder engagement and motivation in RE. Participants in the gamified version of the survey generated an increased number of requirements on average, suggesting an improvement of engagement (Masoudi et al., 2023). The proof of concept conducted in REVISE 2.0 gamified environment demonstrated a greater level of student's participation as well as motivation (Unkelos-Shpigel, et al., 2023).

Interactive game elements make RE process more engaging than traditional methods. Gamify4Req tool successfully integrated effective game elements to enhance user engagement (Dar et al., 2022).

Gamified RE enhances stakeholder engagement while also enriching the overall quality of the RE process. A case study was conducted by using the REfine tool which helped to engage stakeholders by providing incentives (Snijders et al., 2015). Apart from improving the stakeholder engagement, REfine tool helped to improve overall RE process in SDLC.

Another experiment was conducted in PRIUS system which is gamified requirements prioritization tool. The study reveals that the stakeholders who participated in gamified version of PRIUS participated in more requirements prioritization task than the non-gamified version of PRIUS (Lencastre et al., 2024). This finding indicate that the gamified version of PRIUS effectively encourages greater stakeholder participation in requirements prioritization tasks compared to its non-gamified version.

Gamification also increases enjoyment for the stakeholders in RE process. Participants in gamified RE settings found the gamified platform very interesting (Kolpondinos et al.,

2020). Similarly, the gamified version of the PRIUS system significantly enhanced the participants' sense of enjoyment in the requirements prioritization process. All participants in the treatment group (gamified version) reported superior enjoyment, compared to 71% in the non-gamified version who did not experience a meaningful involvement (Lencastre et al., 2024).

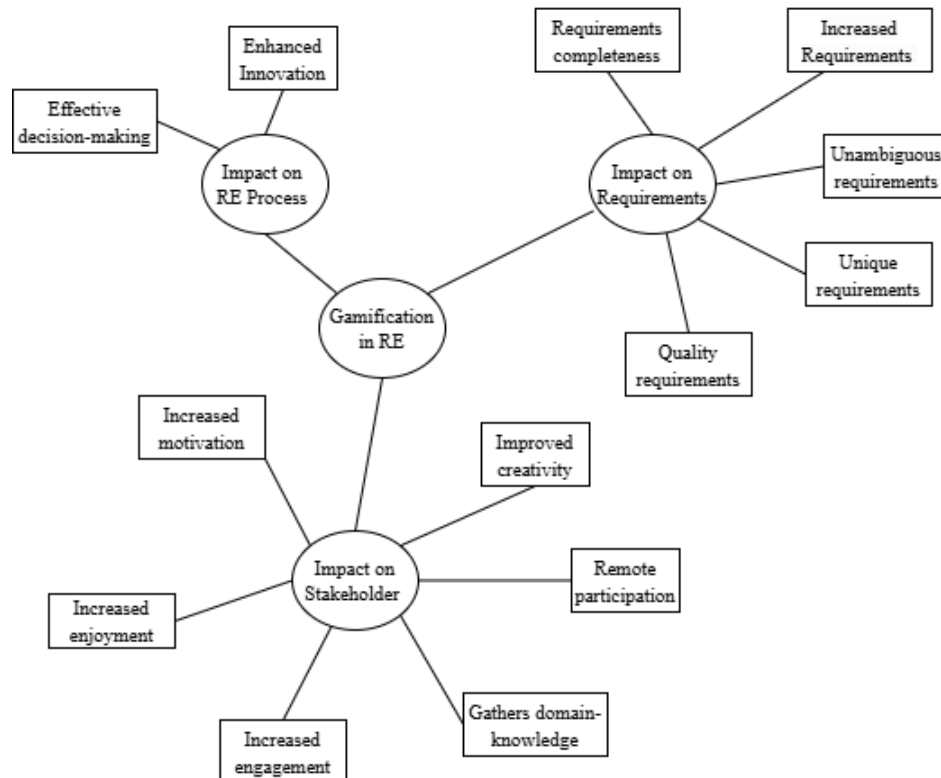


Figure 12: Developed thematic map

Papers A09 and A10 found that gamification encourages creativity in RE. The treatment group not only generated a greater number of user requirements but also demonstrated improved quality and enhanced creativity in their outputs (Lombriser et al., 2016).

Research has shown that participants using gamified platforms demonstrate a significantly higher ability to generate unique requirements compared to those in non-gamified settings. Notably, competition-driven engagement (A09) played a crucial role in boosting the number of unique requirements. Moreover, studies like A08 illustrate that gamification facilitates remote stakeholder engagement, enabling geographically dispersed participants to contribute effectively. Additionally, A08 emphasizes that gamification enhances

stakeholders' domain knowledge, ensuring they are better informed when making contributions to the RE process.

Stakeholder engagement is the key to the success of RE process. It has direct impact on both the quantity and quality of gathered requirements. Several studies have demonstrated how gamification enhances user engagement by incorporating different game mechanics such as points, badges, leaderboards, challenges, and interactive participation. This section presents empirical evidence from multiple case studies and experiments evaluating the effectiveness of gamification in RE.

Table 14: Evaluation of stakeholder engagement in gamified RE environment

Gamification tool applied	Consequences of applying gamification	Impact on stakeholder engagement	Article ID
Pointagram	Enhances participant engagement, resulting in a higher volume of elicited requirements.	Positive	A01
Gamify4Req	Better user participation in requirements elicitation process	Positive	A03
REfine	More difficult, more useful, and more engaging.	Positive	A05
iThink	Motivates to participate in requirements elicitation process	Positive	A07
GREM	Hinders stakeholder communication and collaboration	Negative	A09
REVISE	Improves engagement	Positive	A10

Masoudi et al. (2023) conducted an experiment to assess the effect of gamification on user engagement during requirements elicitation using the Pointagram platform. The study involved two groups: one using a gamified survey (Pointagram) and another using a non-gamified survey (MS Forms). Both surveys were designed with identical questions related to the same project and were conducted online within a one-week timeframe. The study performed a survey which resulted in 186 gathered requirements in gamified environment, whereas the non-gamified survey only yielded 77 requirements. A preliminary quantitative analysis indicated that participants completing the gamified survey produced a higher average number of requirements, demonstrating a positive impact on engagement. This study

highlights the effectiveness of gamification in encouraging active participation and maximizing user input in RE.

Dar et al. (2023) evaluated the Gamify4Req tool in two case studies conducted in IT companies. This evaluation focused on engaging users, minimizing ambiguity in requirements, and improving collaboration. The tool was successfully applied in two case studies. In first case study, 41 requirements were gathered using Gamify4Req where 13 ambiguities were identified within 2 seconds per ambiguity. The traditional RE approach uncovered only 1 ambiguity, which took 20 minutes to identify. The second case study resulted 35 requirements using Gamify4Req where 10 ambiguities were identified, each within 2 seconds. According to a feedback survey, 4 respondents strongly agreed, and 2 agreed that gamification made the system more enjoyable. Users perceived the tool as effective in reducing ambiguity and increasing motivation.

Snijders et al. (2015) analyzed the impact of REfine, a methodology used in the beta release of Qubus 7 (KPMG's compliance auditing platform). The study combined direct observations and questionnaires to assess engagement, ease of use, and effectiveness. The findings indicate that the platform had a positive motivational impact, with 10 respondents rating motivation 4 out of 5. However, clarity of priorities was a concern, as 8 respondents rated it 2, suggesting some unclarity. User consideration received a strong rating, with 11 respondents giving it a 4, indicating that users felt their input was valued. The observed difficulty was high, as most ratings were 4 and 5. Overall, the platform's gamification elements effectively incentivized participation and enhanced engagement.

Fernandes et al. (2012) conducted two case studies by using iThink to evaluate user engagement through prototype-based gamification. In the first case study 10 new requirements were identified. It also generated 6 positive comments, 6 negative comments, and 3 factual comments. In the second case study 17 students participated who contributed 22 new requirements. They generated 48 positive comments, 36 negative comments, and 32 factual comments. The player questionnaire results indicated the tool was user friendly, with an average score of 4.57, and strong motivation for participation, scoring 4.14 on average. Additionally, the platform was perceived as highly useful for elicitation, also scoring 4.57. In contrast, project managers reported moderate motivation, with an average score of 3.16, and found the platform useful, scoring 3.58, though slightly lower than the players'

perception. Users found the tool engaging and enjoyable, though success relied on the quality of generated ideas.

Lombriser et al. (2016) examined the GREM on a gamified online platform to understand how game mechanics can influence user engagement in requirements elicitation. The platform was designed to support requirements elicitation through the use of user stories and acceptance criteria. In addition, a chat feature was integrated to enhance stakeholder collaboration and communication among stakeholders. The gamification elements on the platform can be switched on or off when required. Therefore, it was possible to plan experiments between a control group with disabled gamified environment and treatment group with enabled gamified environment.

The platform was evaluated at MaibornWolff, an IT consultancy company in Munich, using 12 participants split into two equal groups namely treatment group and control group. The result of the experiment showed that the gamification enhanced quality, productivity, and creativity. However, it also hindered stakeholder communication and collaboration. The effectiveness of gamification was largely shaped by the specific game elements incorporated. The study recommended further research to understand the impact of gamification on stakeholder engagement.

Unkelos-Shpigel et al. (2023) tested REVISE 2.0, a collaborative gamified RE tool, through a pilot study with 13 software engineering undergraduates. The tool integrates group chats to facilitate stakeholder communication. Participants were highly engaged, with all students actively contributing throughout the entire task. Despite encountering initial technical difficulties, students remained motivated and even requested additional time to continue collaborating. The study demonstrated strong engagement, reinforcing that gamification enhances motivation and participation in RE.

The empirical evidence across multiple studies consistently highlights the positive effect of gamification on user engagement in RE. Key takeaways include:

- Increased input: Gamified tools lead to an increase in gathered requirements than traditional methods (e.g., Pointagram: 186 vs. 77 requirements).
- Reduced Ambiguities: Gamified approaches identify ambiguities faster than traditional methods (e.g., Gamify4Req: 13 vs. 1 ambiguity).

- **Increased Motivation:** Participants find gamified approaches more engaging and enjoyable (e.g., REfine: 10 respondents rated motivation as 4/5).
- **Enhanced Feedback & Collaboration:** Studies show more extensive feedback and participation in gamified environments (e.g., iThink generated over 100 comments across two case studies).
- **Potential Downsides:** While gamification improves engagement, it may also introduce challenges in communication and collaboration (e.g., GREM study).

These findings confirm that gamification enhances engagement in RE, making it a promising approach for improving user participation, requirement quality, and overall project success. However, careful selection of game elements and further research are needed to balance engagement with effective collaboration.

8 Discussion

The study explored the impact of applying gamification methods in enhancing stakeholder engagement in RE process in SDLC. It explored how gamified RE methods influenced user engagement, motivation, and collaboration between stakeholders and technology designers. The research aimed to assess whether integrating game elements could significantly lower the barriers in RE process so that the process becomes more interactive and participatory.

To achieve this, a SLR was conducted by using Kitchenham's framework which resulted 10 primary studies. The study examined various gamification tools and methods applied in RE as well as their effectiveness in improving stakeholder engagement. It also investigated the ability of reducing any potential barriers in stakeholder communication in RE.

The study discovered several important outcomes regarding the influence of gamification applied on the RE process. One of the most significant results was that gamification successfully enhanced stakeholder engagement, leading to increased participation in requirements elicitation. Studies showed that gamified environments encouraged users to contribute more actively, resulting in a greater number of gathered requirements than traditional RE methods.

Another important finding was that gamification helped stakeholders to verify and refine requirements through systematized interactions, which improved clarity and completeness in discovered requirements. The study also found that different game elements played an important role in maintaining user motivation, fostering a sense of achievement, and encouraging continued participation in the RE process.

The increase in active participation and motivation in the gamified environment suggested that game elements played a crucial role in enhancing user involvement. However, while gamification led to more contributions in RE, it did not always guarantee the improvement of requirements quality. Some studies indicated that an excessive focus on game mechanics, particularly competition-driven elements, might have shifted participants' attention away from meaningful requirement discussions.

Lombriser et al. (2016) found that, gamification could have introduced a shift in stakeholder behaviour. The treatment group which were involved in gamified RE process sent less text messages than the control group who were in the non-gamified environment. This indicates that stakeholders in the treatment group became more focused on accruing points rather than engaging in deep collaborations.

These findings suggest that gamification has the potential to effectively enhance stakeholder participation. However, its impact on collaboration depends on how game mechanics are applied in the gamification tools. To maximize the benefits of gamification, RE tools should be designed with a balanced approach, ensuring that elements like competition and time pressure do not override the core objective of achieving clear, well-defined requirements. Further research could explore the sustained impact of gamification on stakeholder behaviour and whether alternative engagement methods, such as cooperative gamification, might mitigate some of these negative effects.

There is a strong indication that, gamification may serve as a beneficial tool for fostering stakeholder engagement in the RE process. By incorporating selective game elements, organizations could potentially increase user participation and motivation, leading to a more interactive and engaging RE process. However, the effectiveness of gamification might vary depending on factors such as stakeholder preferences, project complexity, timeline, budget etc.

These findings may be limited due to variations in gamification implementation across different studies. Factors such as cultural differences, organizational structures, and prior user experience with gamification might influence the effectiveness of game elements in RE. As a result, while gamification has the potential to improve RE processes, its success is not guaranteed across all contexts.

This study contributes to both academia and industry by delivering notable findings into the role of gamification in enhancing stakeholder engagement within the RE process. For academia, the study expands the existing body of knowledge by systematically analyzing the impact of gamification tools and methods on user engagement, motivation, and collaboration. The findings emphasize the possible advantages and limitations associated with the integration of gamification into RE, offering future researchers a foundation for exploring alternative engagement strategies or refining existing gamified models. For industry, this study offers practical guidance for software development teams who are looking for improving stakeholder participation in the RE process. Additionally, the study's emphasis on balancing competition-driven mechanics with meaningful collaboration offers actionable insights for designing effective gamified RE tools that align with project goals and stakeholder needs.

9 Limitations

There are several limitations in this study that may constrain how broadly its results can be applied. First of all, this research is based on a SLR, which means that conclusions were drawn from existing studies rather than direct empirical experiments. While SLR provides a structured and objective method for synthesizing knowledge, the results depend on the quality and scope of the selected studies. Some of the reviewed papers focused on specific industries or user groups, which may limit the applicability of the findings to broader contexts.

Another limitation is that the effectiveness of gamification in RE varies significantly depending on how game elements are implemented. The studies included in the review used different gamification approaches, which makes it challenging to derive universal conclusions about which elements consistently improve collaboration and requirement quality. Some studies showed positive engagement effects, while others reported potential

drawbacks, such as excessive competition or reduced meaningful discussion. This suggests that gamification's impact depends on multiple contextual factors, including stakeholder dynamics, project complexity, and the specific game mechanics used.

Additionally, the study focused on gamification within the RE process in SDLC but did not account for how cultural, organizational, or behavioural differences might influence stakeholder responses to gamified RE environments. User engagement and motivation can be shaped by factors such as company culture, prior exposure to gamification, and personal preferences, which were not consistently addressed in the reviewed studies. This may limit the ability to generalize findings across diverse teams and industries.

The study also faced constraints regarding time and resource availability. Due to the limited timeframe, the literature review was restricted to 10 studies, which may not fully capture the broader research landscape on gamification in RE.

Finally, while the study identified both positive and negative aspects of gamification, it did not measure the sustainable impact of gamification on stakeholder collaboration and requirements quality. Many of the reviewed studies were conducted over short time frames, meaning that the sustainability of gamification's impact remains unclear. Future research could address this gap by exploring whether engagement levels are maintained over extended periods and whether stakeholder behaviour adapts or changes over time.

10 Conclusions

The research explores the complex domain of RE by focusing on the innovative use of gamification to improve engagement. This study investigates how gamified RE approaches can reduce communication barriers and improve stakeholder engagement. By utilizing Kitchenham's methodology, a detailed study was conducted to identify key factors that influence successful collaboration in RE. This research provides insights into effective gamified co-creation strategies, and establish a strong basis for future research in the domain of RE.

Based on the findings of this study, further research should explore the sustainable impact of gamification in RE. Most of the reviewed studies focused on temporary experiments, leaving uncertainty about whether engagement can be sustained over extended periods. Future studies might investigate how stakeholder motivation and participation change over time in gamified RE environments.

Additionally, research should examine how different stakeholder groups, such as developers, product owners, and non-technical users, respond to various gamification techniques. Since some game elements may enhance engagement while others could introduce competition that hinders collaboration, further studies should aim to identify the optimal balance between motivation and teamwork in RE.

Another area of study might involve testing cooperative gamification approaches rather than competitive ones. Since findings suggest that excessive competition could reduce meaningful discussion, researchers should explore gamification models that encourage collaborative problem-solving, rather than ranking-based incentives. Future research could also develop frameworks for adaptive gamification, where game elements are adjusted dynamically based on stakeholder behaviour and feedback.

Furthermore, studies should address the influence of cultural and organizational differences on gamification effectiveness. Since user engagement might depend on industry-specific practices and stakeholder familiarity with gamification, cross-industry comparative studies could provide insights into how RE gamification can be customized for different domains.

Finally, empirical studies should be conducted using real-world software development projects to validate the findings from controlled experiments and literature reviews. This approach might help practitioners understand how gamification affects actual project outcomes, such as requirement completeness, software quality, and team productivity.

Future studies can contribute to a more structured and evidence-based understanding of how gamification can be effectively integrated into the RE process by fulfilling the identified gaps.

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Appendix 1 Selected articles and papers for SLR

Article ID	Title	Authors	Publication year	Database
A01	Requirements Elicitation: Impacts of Gamification on Variety, Novelty, and Completeness	Khade, V., Masoudi, N., Acena, D., Freeman, G., Rai, R., Gorsich, d., Rizzo, d., Castanier, M.	2023	Research Gate
A02	Revise That Again: Are You Motivated?	Unkelos-Shpigel, N., Berencwaig, B., Kas, S.	2023	ACM
A03	Gamification Tool Design for Reducing Requirements Ambiguity during Elicitation	Dar, H S., Imtiaz, S., Lali M I U.	2022	IEEE
A04	DMGame: A Gamified Collaborative Requirements Prioritisation Tool	Kifetew, F., Munante, D., Perini, A., Susi, A., Siena, A., Busetta, P.	2017	IEEE
A05	REfine: A Gamified Platform for Participatory Requirements Engineering	Snijders, R., Dalpiaz, F., and Brinkkemper, S.	2015	IEEE
A06	PRIUS: Applying Gamification to User Stories Prioritization	Lencastre, M., Silva, D., Pimentel, J., Castro, J B.	2024	ACM

A07	iThink : A game-based approach towards improving collaboration and participation in requirement elicitation	Fernandes, J., Duarteb, D., Ribeiroa, C., Farinhab, C., Madeiras ~ Pereira, J., Silvab M.	2012	Science Direct
A08	GARUSO: a gamification approach for involving stakeholders outside organizational reach in requirements engineering	Kolpondinos, M Z., Glinz M.	2020	Springer
A09	Gamified requirements engineering: model and experimentation	Lombriser , P., Dalpiaz, F., Lucassen, G and Brinkkemper, S.	2016	Research Gate
A10	Requirements analysis gamification in legacy system replacement projects	Alexandrova, A., Rapanotti. L	2018	Springer