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Knowledge Management and Gamification: Driving effective Employee Reskilling

A Systematic Literature Review on the Integration of Knowledge Management and Gamification in Employee Reskilling Strategies

Pedro Miguel Rodrigues de Sousa

Master Thesis

presented as partial requirement for obtaining a Master's Degree in Information Management

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Instituto Superior de Estatística e Gestão de Informação
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by

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Master Thesis presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in Information Systems Management

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STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism, any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

[Lisbon, 15 July of 2025]

Pedro Sousa

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ABSTRACT

Traditional knowledge management systems (KMS) contribute significantly to supporting organizational learning and employee development. However, these systems often face challenges in sustaining motivation and participation over time. Gamification has demonstrated strong potential to enhance engagement and learning outcomes in domains such as education and general training, yet its application within KMS for reskilling initiatives remains underexplored. This research investigates how gamification can be integrated into KMS to promote effective employee reskilling and knowledge sharing. Employing the PRISMA methodology, a systematic literature review (SLR) was conducted to identify and analyse studies addressing the intersection of gamification, knowledge management, and reskilling. The thesis provides a structured synthesis of current evidence and research gaps. The expected outcomes include insights into how gamification can enhance learning engagement and knowledge transfer in organizational contexts, as well as guidance for designing more effective, motivating, and sustainable reskilling strategies supported by knowledge-based systems.

KEYWORDS

Gamification; Knowledge Management; Employee Reskilling; Motivation in Learning

Sustainable Development Goals (SDG):

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

AI	**Artificial Intelligence** - The simulation of human intelligence processes by machines, especially computer systems.
CLT	**Cognitive Load Theory** - A learning theory focused on the amount of working memory used when processing new information and how instructional design can reduce cognitive overload.
DT	**Digital Transformation** - The integration of digital technologies into all areas of business, fundamentally changing how organizations operate and deliver value.
HR	**Human Resources** - The department within an organization responsible for managing employee-related functions such as recruitment, training, development, and organizational culture.
KM	**Knowledge Management** - The systematic process of managing and sharing knowledge within an organization.
KMS	**Knowledge Management System** - A digital platform or framework designed to capture, organize, share, and facilitate the use of organizational knowledge for improved decision-making and learning
L&D	**Learning and Development** - A strategic function focused on enhancing employee skills, knowledge, and capabilities through training, reskilling, and continuous learning initiatives.
PRISMA	**Preferred Reporting Items for Systematic Reviews and Meta-Analyses** - A set of guidelines and a flowchart used to ensure transparency and completeness in reporting systematic reviews.
RQ	**Research Question** - A clearly defined question that guides the focus and objectives of a research study, helping to structure data collection and analysis.
ROI	**Return on Investment** - A performance metric used to evaluate the efficiency or profitability of an investment, commonly applied to assess the effectiveness of training or reskilling programs.
TAM	**Technology Acceptance Model** - A theoretical model that explains how users come to accept and use a technology based on perceived usefulness and ease of use.
TTF	**Task-Technology Fit** - A theory suggesting that technology is more likely to have a positive impact on performance when it fits the tasks it supports.

SDT	**Self-Determination Theory** - A theory of motivation that emphasizes individuals' intrinsic drive and the need for autonomy, competence, and relatedness.
SLR	**Systematic Literature Review** - A structured method for identifying, evaluating, and synthesizing all relevant research on a specific topic.
VR	**Virtual Reality** - A simulated, immersive environment that allows users to interact with digital scenarios, often used in training to replicate real-world experiences and enhance skill acquisition.

1. INTRODUCTION

Employee reskilling has become increasingly important as technological and digital transformations reshape organizational work and demand new skills (Spanellis et al., 2020). Traditional training and knowledge-sharing methods often fail to keep pace with these changes, leading organizations to adopt digital solutions. Knowledge management systems (KMS) enable capturing, organizing, and disseminating institutional knowledge (Donate & de Pablo, 2015), however their effectiveness is frequently limited by low user engagement and participation, which reduces their impact on learning and reskilling initiatives (Nazififard et al., 2019).

Gamification has been used by companies like Microsoft, Cisco, and Google to make learning and participation more engaging (Vanduhe et al., 2020). Despite its potential, the long-term impact of gamification is not well established, and its effectiveness depends on organizational context, workforce characteristics, and the specific design of game elements (Mohanty & Christopher, 2024).

This study follows a systematic literature review (SLR) methodology, using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) framework to synthesize evidence and identify conditions under which gamification affects motivation, learning outcomes, and knowledge sharing in reskilling initiatives. The research is guided by three questions: How does gamification influence learner motivation and participation in reskilling and training? Which game elements most effectively enhance learning outcomes and knowledge retention? How does implementing gamified KM systems affect overall organizational reskilling and knowledge-sharing success?

The study is expected to contribute both theoretically and practically. Theoretically, it clarifies the mechanisms linking gamification, engagement, and learning outcomes in knowledge management (KM) based reskilling. Practically, it provides guidance for designing gamified programs that enhance participation, knowledge retention, and application.

The thesis is structured as follows: Chapter 1 introduces the research context, problem, objectives, and research questions. Chapter 2 reviews relevant literature and identifies research gaps. Chapter 3 presents the SLR methodology and analysis procedures. Chapter 4 reports and discusses findings in relation to the research questions. Chapter 5 concludes by summarizing results, discussing implications, and suggesting directions for future research.

2. LITERATURE REVIEW

2.1. THEORETICAL BACKGROUND

2.1.1. THE NEED FOR RESKILLING IN THE DIGITAL ECONOMY

The rapid acceleration of digital technologies is transforming the structure of labour markets, compelling organizations to rethink how they prepare their workforce. As automation, artificial intelligence (AI), and remote work redefine operational landscapes, new skillsets are required across nearly all sectors. This shift places reskilling at the forefront of strategic workforce planning.

Digital transformation (DT) has reshaped how learning is accessed and delivered. As Fauzi et al. (2025) note, the development of online tools and platforms has made learning more flexible and accessible, enabling employees to access training resources regardless of time or location. However, this accessibility also comes with new pressure: employees must continuously adapt, acquire new competencies, and keep up with the fast pace of technological change.

Traditional training models, such as classroom-based instruction, are often insufficient in the context of rapidly evolving digital workplaces that demand continuous and scalable learning solutions. As a result, organizations are turning to scalable digital learning strategies that align with evolving business needs (Vanduhe et al., 2020). Effective reskilling goes beyond technical knowledge, requiring the cultivation of behavioural and cognitive adaptability among employees (Friedrich et al., 2020).

Contemporary work environments require employees not only to learn new tools but also to incorporate them effectively into daily operations, intensifying the psychopedagogical demands faced by the employees (Vanduhe et al., 2020). As lifelong learning becomes an organizational imperative, the need for reskilling extends beyond technical fields. Employees across industries are now expected to demonstrate digital literacy, adaptability, and the capacity to transfer knowledge across roles and functions.

As a result, reskilling has emerged as a key pillar of strategic workforce planning in the digital age. Hao et al. (2023) notes that companies who prioritize these capabilities tend to exhibit stronger performance during periods of disruption.

2.1.2. RESKILLING FOR THE FUTURE DEMANDS

Reskilling initiatives must address not only technical competencies but also soft skills such as communication, adaptability, and collaboration. Skills that are increasingly critical in digitally mediated work environments. These programs benefit significantly from engaging delivery methods that foster motivation and long-term retention.

Gamification has the potential to meaningfully transform workforce development practices. Basit et al. (2021) highlighted that gamified platforms significantly improved employee engagement and performance, reinforcing their potential in workplace learning environments. These mechanisms leverage competition, real-time feedback, and goal setting to make learning more interactive, especially for younger or digitally native employees.

Ultimately, reskilling should be viewed not as a reactive measure but as a proactive strategy for long-term organizational adaptability. Future-ready enterprises embed continuous learning into their operational culture, supported by scalable systems and reinforced by leadership commitment and individual initiative.

2.1.3. KNOWLEDGE MANAGEMENT AND LEARNING IN ORGANIZATIONS

Knowledge Management (KM) plays a crucial role in facilitating organizational learning, particularly within fast-paced and innovation-driven environments. KM refers to the processes and systems that enable organizations to capture, organize, disseminate, and apply both explicit and tacit knowledge to enhance decision-making, adaptability, and long-term performance.

A central component of KM resides in the conversion of tacit knowledge (personal, experience-based insights) into explicit knowledge that can be shared and reused across the organization. KM strategies not only preserve institutional knowledge but also promote its development and dissemination through collaborative networks. As mentioned by Spanellis et al. (2020), by converting tacit insights into explicit, organizations can enhance their learning capacity and build specialized capabilities over time.

However, organizations often face significant barriers to fostering active knowledge sharing, including a lack of incentives, psychological safety, and a supportive culture. These factors can increase the likelihood of KMS failure.

To overcome these challenges, effective incentive design becomes essential. According to Friedrich et al. (2020), combining extrinsic rewards (e.g., recognition, visibility, and gamified elements) with intrinsic motivators (e.g., autonomy and a sense of meaningful contribution) can significantly enhance participation in KM systems. Additionally, promoting an environment of openness and encouraging the sharing of both successful practices and failed attempts can improve collective learning outcomes.

Organizational structure also plays a critical role in enabling effective knowledge flow, beyond the implementation of technological tools. Capatina et al. (2024) emphasize the value of structured collaboration environments and dedicated KM leadership. Their study found that appointing KM facilitators or community managers during collaborative initiatives led to significantly higher rates of knowledge exchange.

Ultimately, KM should be viewed as a dynamic capability that enables strategic adaptation. When embedded within a culture of trust, experimentation, and shared purpose, KM systems can help transform organizations into agile, learning-oriented entities. This transformation depends not only on tools but on carefully designed incentives, leadership commitment, and cultural alignment.

2.1.4. GAMIFICATION CONCEPTS AND KEY ELEMENTS

Gamification is commonly defined as the application of game design principles in non-game contexts to increase user engagement, motivation, and participation (Bitrián et al., 2024). In the context of learning and organizational development environments, it serves as a tool to enhance the effectiveness of knowledge-sharing platforms and training systems. Gamified systems seek to address the limitations of traditional training methods by making learning experiences more interactive, goal-oriented, and personalized.

In professional environments, gamification has emerged as a valuable approach for promoting participation KMS and reskilling initiatives. Vanduhe et al. (2020) emphasize that the integration of game elements improves both the user experience and learning outcomes by aligning system features with motivational theories such as the Technology Acceptance Model (TAM) and Task-Technology Fit (TTF).

Motivation plays a critical role in the effectiveness of gamified systems, particularly within the context of KM employee reskilling. Two primary motivational mechanisms are recognized: intrinsic motivation, which stems from internal satisfaction and engagement with the learning process itself, and extrinsic motivation, which is driven by external rewards or recognition mechanisms.

Gamification enhances intrinsic motivation by incorporating elements that foster curiosity, a sense of achievement, and personal relevance. Features that encouraged learners to invest effort and attention voluntarily (Li et al., 2024). At the same time, extrinsic motivation provides immediate, visible acknowledgment of effort and achievement, contributing to higher participation in reskilling and training initiatives (Basit et al., 2021).

Nevertheless, an overreliance on extrinsic rewards can limit long-term engagement if not balanced properly with meaningful learning experiences. While extrinsic motivators are effective at initiating participation, sustained motivation in KM and reskilling contexts often depends on the learner's intrinsic connection to the material and the perceived relevance of the task. (Friedrich et al., 2020)

A well-balanced gamification strategy for reskilling, should activate both intrinsic and extrinsic motivation, supporting not only, short-term engagement but also promoting deeper learning and sustained knowledge-sharing behaviour over time.

2.1.5. IDENTIFIED CHALLENGES AND RESEARCH GAPS

While gamification has shown potential in enhancing KM and reskilling efforts, its implementation is often challenged by conceptual, organizational, and design-related limitations. A major concern is the lack of alignment between gamification design and the specific learning or knowledge-sharing goals. Attia et al. (2024) notes that some implementations may emphasize superficial engagement over long-term knowledge retention, especially when game elements are not integrated within a coherent instructional framework.

Another common challenge involves over-reliance on extrinsic motivators. Friedrich et al. (2020) argue that users primarily driven by external rewards are less likely to contribute authentic or high-value content to KM systems, thereby limiting the effectiveness of gamified platforms in promoting genuine learning or collaboration.

Cultural resistance and perceptions of triviality can impede adoption. Friedrich et al. (2020) observe that employees may associate gamification with entertainment rather than professional development, especially when initiatives are hierarchically imposed without employee involvement or contextual relevance. Trust and autonomy are critical in KM environments, and gamification must be designed in ways that enhance these values.

Measurement inconsistencies across studies also present a research gap. Bashokuoh et al. (2024) emphasizes the need for more robust and long-term evaluation methods. Many studies rely on short-term metrics such as participation rates or user satisfaction, often neglecting deeper learning outcomes or knowledge transfer effectiveness.

Finally, a lack of standardized frameworks for gamification design and evaluation limits broader applicability. Spanellis et al. (2020) highlight the variation in how gamification is conceptualized and applied across different contexts, making it difficult to replicate results or establish best practices. The heterogeneity of game elements, delivery platforms, and organizational goals suggests a pressing need for more structured models and evidence-based design principles.

3. METHODOLOGY

3.1. SYSTEMATIC LITERATURE REVIEW METHODOLOGY

A Systematic Literature Review (SLR) was adopted as the methodological approach in this thesis due to the limited empirical implementation of gamification within KMS specifically aimed at employee reskilling. While gamification has seen broader applications in areas such as education and general corporate training, its integration in reskilling-focused KMS remains fragmented, conceptually diverse, and in early stages of adoption (Hamari et al., 2014). The limited availability of mature real-world implementations and longitudinal studies in this area constrains the feasibility of conducting direct empirical research, such as case studies or surveys.

The SLR provides a rigorous, transparent, and reproducible method for synthesizing and evaluating existing literature across relevant domains, including gamification, information systems, learning technologies, and organizational behaviour. The review supports the development of a comprehensive understanding of how gamification strategies influence knowledge sharing, user engagement, and learning outcomes in organizational contexts.

This study followed best practices for systematic reviews and adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. PRISMA provides a structured approach to the review process, reducing bias and enhancing transparency through clearly defined phases of identification, screening, eligibility, and inclusion.

To ensure methodological consistency and transparency, the review protocol included:

- A **precise definition of research questions**, focused on how gamification affects motivation and participation in KM based reskilling programs (RQ1), which game elements are most effective (RQ2), and the broader organizational impacts of gamified KM systems (RQ3).
- **Inclusion and exclusion criteria**, such as, articles written in English, published between 2014 and 2025, with an explicit focus on gamification in professional or organizational learning contexts.
- **Database selection**, limited to high-quality academic sources: IEEE Xplore, Scopus, Web of Science, ScienceDirect and Google Scholar.
- A **multi-step filtering process**, including title and abstract screening, full-text review, and eligibility confirmation based on the alignment with one or more research questions.

3.2. SEARCH STRATEGY AND DATABASES

To ensure a comprehensive and replicable review of the research topic, a structured search strategy was developed. The objective was to identify academic studies that explore the intersections between KM, and employee reskilling, particularly within organizational contexts. To ensure coverage of high-quality and relevant studies, the search was conducted across five reputed academic databases: IEEE Xplore, Scopus, Web of Science, Science Direct and Google Scholar.

In each database, the following Boolean search query (adapted to syntax limitations) was employed:

("**gamification**" OR "**game elements**" OR "**serious games**") AND ("**knowledge management**" OR "**KM systems**") AND ("**reskilling**" OR "**employee training**") AND ("**motivation**" OR "**knowledge retention**")

Figure 1 Query used for SLR

Searches were conducted between **January 15 and February 16, 2025**, and results were screened based on predefined inclusion and exclusion criteria.

3.3. INCLUSION AND EXCLUSION CRITERIA

To ensure methodological rigor and thematic relevance, the review applied **inclusion and exclusion criteria** throughout the screening process. The **inclusion criteria** focused on:

- **Empirical or theoretical studies** published in reputable databases.
- Studies published between **2014 and 2025**, written in **English**.
- Research explicitly addressing **gamification** in the context of **KM** and **employee reskilling**.
- Studies examining outcomes related to **employee motivation**, **participation**, **learning outcomes**, or **knowledge retention**.
- Research referencing **game mechanics** (e.g., points, badges, leaderboards), **knowledge sharing**, or **organizational training and development** strategies.
- Studies conducted in **organizational settings**, including corporate, public sector, or industrial learning environments.

The **exclusion criteria** ruled out:

- Studies focused exclusively on **primary or secondary education.**

- Research centred solely on **entertainment gaming**, **game design theory**, or **gamification tools** without organizational application.
- Informal or non-academic content.
- Articles not available in **full text.**
- Studies not published in English.

These criteria were consistently applied during both the title and abstract screening and full-text review stages. Only studies offering substantive insights into how gamification influences KM based reskilling practices in organizational contexts were retained for synthesis.

3.4. SCREENING AND SELECTION PROCESS (PRISMA DIAGRAM)

The selection of studies followed a rigorous and transparent process guided by the PRISMA framework. The selection process involved four distinct phases: identification, screening, eligibility, and inclusion.

3.4.1. IDENTIFICATION PHASE

The identification phase marks the initial step of the systematic literature review, aimed to retrieve all potentially relevant studies aligned with the predefined search strategy. A total of 3562 records were collected from all five databases: Web of Science (n = 747), Scopus (n = 448), IEEE Xplore (n = 673), ScienceDirect (n = 737), and Google Scholar (n = 957). This broad search approach was designed to ensure comprehensive coverage of empirical and theoretical studies related to gamification in knowledge management and reskilling contexts.

3.4.2. SCREENING PHASE

The screening phase involved a preliminary evaluation of all records retrieved during the identification stage to remove irrelevant, duplicate, and inaccessible entries. This process began with the **elimination of 473 duplicate records** across databases.

After removing duplicates, **3089 records** remained for title and abstract screening. During this phase, studies were excluded if they clearly did not meet the inclusion criteria, defined in section 3.3 Inclusion and exclusion criteria.

Table 1 Screening phase

Stage	Number of Records
Records identified (all databases)	3,562
Duplicates removed	473
Records after duplicates removed	3,089
Records excluded during title/abstract screening	2,857
Records moved to eligibility phase	232

As a result, **232 records** moved to eligibility phase.

3.4.3. ELIGIBILITY PHASE

In the eligibility phase, the remaining **232 full-text articles** were assessed in detail to determine their suitability for inclusion in the final synthesis. This review focused on three key aspects:

- The presence of gamification mechanisms.
- Explicit relation to knowledge management or reskilling.
- Application in real-world organizational or workplace contexts.

Following this evaluation, **170 articles were excluded**, primarily due to one or more of the following reasons:

- Lack of direct relevance to KM or workforce reskilling.
- Incomplete methodological details.
- Absence of empirical or theoretical contributions.

3.4.4. INCLUSION PHASE

Ultimately, **62 studies** satisfied all inclusion criteria and were retained for qualitative synthesis. These studies represent a diverse yet coherent body of work addressing one or more of the core research questions related to **gamification**, **KM**, and **employee reskilling**.

The complete selection process is illustrated in the **PRISMA diagram** (Figure 2), and a detailed list of the included studies is provided in **Appendix A**.

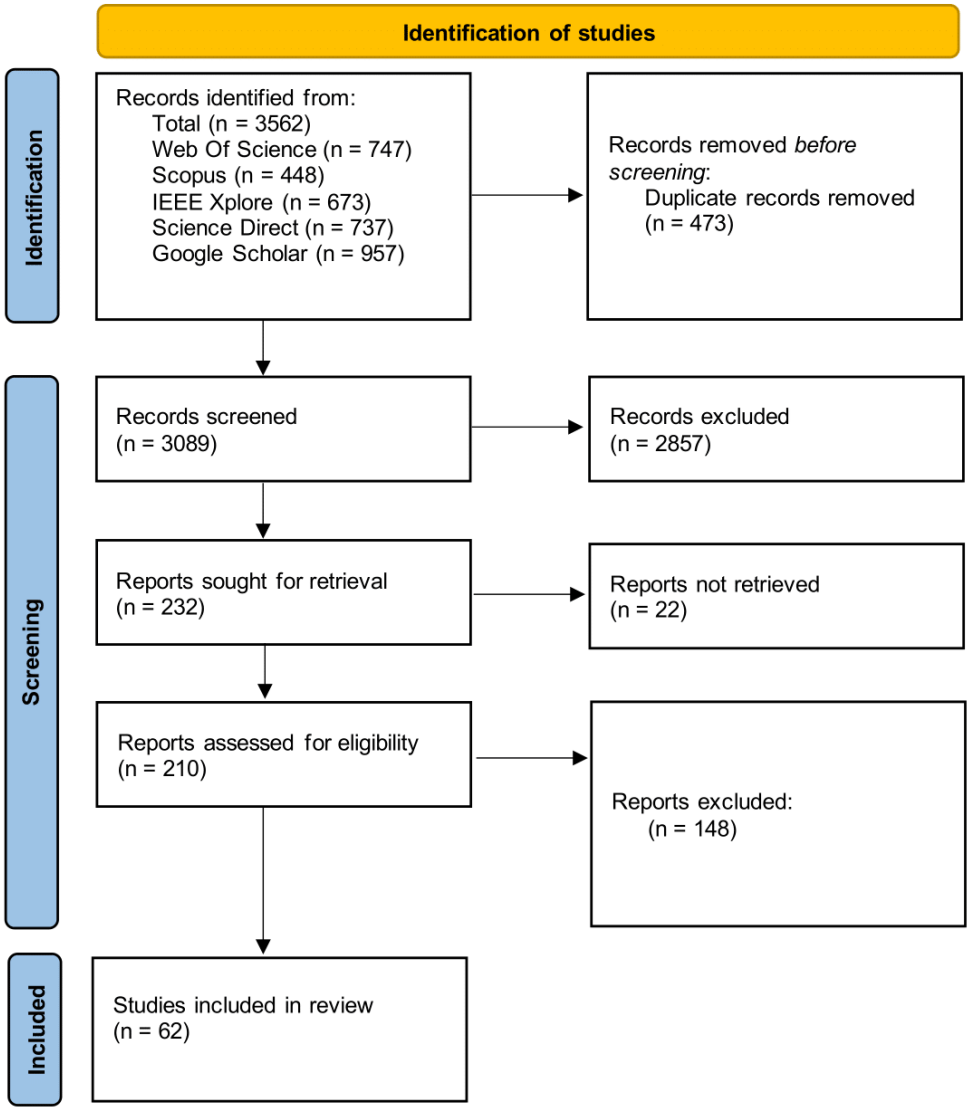

Figure 2 PRISMA flow diagram

3.5. SYNTHESIS APPROACH

To derive meaningful insights from the set of studies included in the review, a structured synthesis approach was adopted. This method allowed the comparison of gamification outcomes across different organizational and methodological contexts, while aligning each finding with one or more of the research questions (RQ1, RQ2, and RQ3).

The synthesis followed a thematic structure. Data from each selected study was analysed for recurring patterns related to employee motivation, game elements, and knowledge management strategies. This mapping supported the development of Table 2, which quantifies the distribution of studies by research question, providing a high-level overview of thematic coverage within the dataset.

Table 2 Articles per RQ

Database	RQ1	RQ2	RQ3
WoS	5	5	5
Scopus	6	6	3
IEEE Xplore	9	12	3
ScienceDirect	7	6	5
GoogleScholar	15	8	15
	42	35	31

4. RESULTS AND DISCUSSION

The integration of gamification into KMS has emerged as a promising approach to enhance employee motivation, participation, and learning outcomes in reskilling and training contexts. This section presents a synthesis of findings from 62 studies, identifying the key gamification elements that influence learner engagement, knowledge retention, and training effectiveness in workplace environments. The discussion is structured around the study's central research questions, providing both thematic analysis and contextual interpretation of the results.

4.1. HOW DOES GAMIFICATION INFLUENCE LEARNER MOTIVATION AND PARTICIPATION IN KNOWLEDGE-BASED RESKILLING AND TRAINING CONTEXTS? (RQ1)

Motivation is a key determinant of reskilling initiative success, and without sufficient motivational support, even the most sophisticated KMS may fail to achieve their intended learning outcomes (Friedrich et al., 2020).

Multiple studies confirm that gamification can significantly enhance intrinsic motivation by supporting the core principles of Self-Determination Theory (SDT), namely autonomy, competence, and relatedness. For instance, Basit et al. (2021) reported that gamification promoted voluntary participation and a stronger sense of ownership over learning tasks. Similarly, was observed that gamified training environments were perceived by employees as more stimulating and rewarding than traditional methods, increasing learner return rates and sustained engagement in corporate training initiatives (Carpatina et al., 2024; Attia et al., 2024).

Cuevas-Martínez et al. (2021) found in a longitudinal study that learners felt more in control of their experience when advancing through structured levels and modules, aligning with principles from goal-setting theory (GST), which emphasizes the importance of clear, measurable objectives in driving motivation. Similarly, Basit et al. (2021) noted that structured milestones enhanced learner persistence in self-paced programs, while Temsirimongkol et al. (2024) showed that unlocking content upon reaching progress thresholds created a positive feedback loop, reinforcing commitment and autonomy.

Gamification offers a mechanism to bridge the gap between static KM platforms and the dynamic motivational needs of users. While KM platforms provide structured repositories of organizational knowledge, they often lack built-in behavioural reinforcement. By embedding gamified mechanics, organizations can foster a culture of continuous learning, peer recognition, and active participation.

These effects are reinforced by theoretical models such as the Technology Acceptance Model (TAM) and Task-Technology Fit (TTF). TAM suggests that gamified elements increase perceived usefulness and ease of use, encouraging system adoption. TTF emphasizes the importance of

alignment between tasks (e.g., knowledge acquisition) and supporting technologies. When gamified features align with job roles and learner preferences, participation improves not just because the system is engaging, but because it integrates smoothly into existing workflows.

Despite its potential, gamification is not universally effective. Its success depends on **contextual fit**, **system design**, and **organizational culture**. Poorly aligned reward structures or overly competitive game mechanics can backfire, causing disengagement or creating perceptions of triviality.

Mohanty and Christopher (2024) warn that competitive gamification without attention to inclusivity may demotivate lower-performing employees or reinforce workplace hierarchies. Similarly, Spanellis et al. (2020) found that gamification was particularly effective among employees without leadership roles, who used it for self-motivation, suggesting that outcomes may vary by role or digital proficiency.

Organizational culture and digital maturity are also preconditions for success. Wang et al. (2020) emphasize the importance of designing KM applications that support intrinsic motivation and integrate knowledge-sharing behaviours into daily practices. When gamification is perceived as superficial or imposed, its motivational value diminishes.

4.2. WHICH GAME ELEMENTS ARE MOST EFFECTIVE IN ENHANCING LEARNING OUTCOMES AND KNOWLEDGE RETENTION IN RESKILLING AND TRAINING INITIATIVES? (RQ2)

4.2.1. IMMEDIATE FEEDBACK AND PROGRESSION MECHANICS

Immediate feedback, delivered through real-time scoring, correction cues, or in-quiz hints is consistently among the most effective gamification features for enhancing learning outcomes. It enables learners to rapidly identify and correct misconceptions, reinforcing accurate knowledge at the moment of learning. This aligns with cognitive reinforcement principles and improves the efficiency of knowledge transfer.

Fauzi et al. (2025) found that immediate, contextual feedback in digital workplace training significantly boosted learner confidence and content retention. Capatina et al. (2024) also emphasized the role of real-time progress updates and feedback mechanisms in maintaining motivation and improving performance outcomes in gamified training. Basit et al. (2021) further noted that immediate validation of progress through feedback loops sustained engagement and motivation.

Progression-based mechanics, such as levels, unlockable modules, and tiered challenges, help structure the learning journey. They support mastery by guiding learners from foundational concepts toward more complex tasks.

Kwok et al. (2023) found that level-based progression in immersive VR training systems increased learner engagement and confidence as participants advanced through stages. Basit et al. (2021) similarly reported that progression aligned with performance metrics boosted self-paced engagement. When paired with immediate feedback, these mechanics create a feedback-rich environment conducive to learning and motivation.

Repetition and spaced retrieval enhance memory retention by leveraging the spacing effect, a well-established cognitive phenomenon where repeated exposure over time leads to deeper encoding and longer-lasting recall. In gamified platforms, these are often implemented through daily streaks, timed reviews, or recurring micro-assessments.

Fauzi et al. (2025) found that platforms incorporating spaced repetition significantly improved learning retention, especially when paired with gamified incentives. Basit et al. (2021) also highlighted the value of recurring micro-tasks, particularly when paired with immediate feedback and trackable progress.

4.2.2. REWARDS, SOCIAL AND NARRATIVE ELEMENTS

Gamification features such as points, badges, and digital rewards typically enhance **extrinsic motivation** by providing visible markers of achievement. When aligned with meaningful milestones, such as, completing skill assessments or applying knowledge in job-relevant tasks, these elements reinforce goal-directed behaviour.

Friedrich et al. (2020) emphasized that rewards tied to learning milestones helped learners track their development and encouraged course completion. However, as cautioned by Basit et al. (2021), rewards are most effective when they complement intrinsic motivation rather than replace it. Overreliance on superficial incentives may undermine long-term engagement, especially if they are not perceived as linked to real-world value or recognition.

Game elements that involve social dynamics, such as, leaderboards, team-based challenges, and peer recognition, tap into **social comparison and cooperation** to reinforce motivation and learning. These features can drive engagement by introducing accountability and shared goals.

Fauzi et al. (2025) demonstrated that collaborative gamification mechanics improved learner satisfaction and performance, particularly in team-based training environments. Basit et al. (2021) observed increased participation when leaderboards were transparent, though they also noted the potential downsides of overly competitive environments, which may discourage some users.

While overlapping with rewards systems, social mechanics uniquely engage **interpersonal motivation** and support **peer-to-peer learning**, a key factor in organizational training contexts.

Narrative-driven game mechanics, such as storylines and mission-based challenges, improve cognitive engagement by embedding learning in meaningful contexts.

Capatina et al. (2024) demonstrated that contextualized narrative-driven gamification, including leaderboards, missions, and role-based challenges, significantly boosted engagement, recall, and skill application in corporate training programs. Likewise, Kwok et al. (2024) showed that story-based immersive VR modules improved learner confidence and procedural knowledge in bioprocess operations. These approaches align with cognitive theories suggesting that learning is enhanced when information is contextualized within coherent narratives, especially in real-world simulations or job-relevant tasks.

4.2.3. Adaptive and Contextualized Learning

Simulations and scenario-based challenges immerse learners in realistic, problem-solving contexts, enabling them to apply theoretical concepts to practical situations. These experiential elements are particularly effective in improving knowledge retention and transfer of skills.

Gjicali et al. (2020) demonstrated that culturally contextualized simulations significantly improved cross-cultural competence and conceptual understanding. Similarly, Kwok et al. (2023) demonstrated that immersive VR simulations enhanced readiness and confidence in technical fields. In cybersecurity training, DeCusatis et al. (2022) found that gamified escape-room scenarios improved real-world protocol recall and behavioural application.

The key contribution of these designs lies in contextualization. Providing a safe but realistic environment to test and refine knowledge.

Adaptive gamification refers to the personalization of content, difficulty, pacing, and feedback based on learner behaviour and performance. This approach enhances learning by aligning training experience with the learner's prior knowledge, performance, and learning speed.

Nazififard et al. (2019) described how personalized gamified features supported learner autonomy and engagement in workplace learning. Shpakova et al. (2017) similarly emphasized that adaptive KM systems improve training relevance by helping learners visualize their growth and adjust at their own pace.

Unlike static systems, adaptive gamification provides **individualized scaffolding**, ensuring learners are neither underchallenged nor overwhelmed, thereby supporting mastery and sustained engagement.

4.2.4. Synthesis of Effective Game Elements

The reviewed evidence indicates that no single game element is universally superior; instead, effectiveness depends on context, learner needs, and design quality. However, certain elements, such as immediate feedback, progression systems, and scenario-based learning consistently show strong impact on learning outcomes and knowledge retention. These elements are effective because they align with core learning principles, including scaffolding,

spaced retrieval, and contextualization. Moreover, their integration into structured, goal-oriented experiences reinforces both motivation and knowledge consolidation.

While features like rewards and leaderboards can boost engagement, their long-term value depends on thoughtful design and relevance to learner objectives. Overall, the most successful gamification strategies combine multiple elements tailored to individual needs, organizational goals, and the learning environment. This integrative approach supports deeper engagement, improved retention, and enhanced transfer of skills, critical outcomes for reskilling initiatives.

4.3. How does the implementation of gamified knowledge systems affect the overall success of organizational reskilling and knowledge-sharing initiatives? (RQ3)

Gamified KMS support organizational reskilling by aligning learning initiatives with strategic goals, key performance indicators (KPIs), and broader human resources (HR) transformations (Kwok et al., 2023; Shpakova et al., 2017). This alignment ensures that learning remains not only engaging but also measurable, goal-driven, and connected to organizational priorities.

While traditional KMS focus primarily on storing and retrieving information, gamification enhances these platforms by integrating social and motivational mechanisms. Features such as team challenges, peer recognition, and contribution tracking incentivize participation and foster a culture of active knowledge exchange. Friedrich et al. (2020) emphasize that gamified systems rewarding activities like mentoring, sharing best practices, and engaging in discussion forums promote higher engagement in shared knowledge spaces. These mechanisms foster a collaborative learning culture, break down organizational silos, and encourage cross-functional communication; which increase both the quantity and quality of shared content (Wang et al., 2020; Shpakova et al., 2017).

Gamified KMS generate valuable data that allow organizations to monitor learning effectiveness, track skill development, and optimize training interventions (Basit et al., 2021). This supports evidence-based decision-making for learning and development teams, enabling timely adjustments to content, pacing, and learner support. Additionally, gamified KM platforms enhance operational efficiency and improve learning return on investment (ROI) by delivering scalable, modular, on-demand learning across diverse roles and locations, reducing logistical complexity and accelerating deployment (Miroite & Gardoni, 2023). These systems streamline training delivery, reinforce learner engagement, reduce dropout rates through sustained motivation, and enable real-time intervention via performance tracking dashboards, thereby enhancing organization's ability to respond quickly to evolving workforce needs.

Beyond short-term engagement, gamified systems can drive behavioural change, a key factor in long-term learning adoption. By promoting self-learning, peer mentoring, and ongoing

participation, these systems cultivate a culture of continuous learning through regular interaction, goal setting, and peer recognition (Capatina et al., 2024; Basit et al., 2021; Attia et al., b2024)).

Despite their benefits, gamified KMS face adoption challenges. Cultural resistance may emerge if game mechanics are viewed as trivial, especially in formal or hierarchical work environments (Friedrich et al., 2020; Basit et al., 2021). Overemphasis on competition, poor usability, or lack of relevance to specific job roles may also reduce engagement, particularly among less tech-savvy employees.

To overcome these barriers, research highlights the importance of inclusive and iterative design. Engaging end users in development, conducting pilot programs, and aligning game elements with existing HR frameworks improve acceptance and long-term integration (Friedrich et al., 2020). When gamification is harmonized with organizational values and user needs, it builds trust and supports sustained adoption.

5. CONCLUSIONS AND FUTURE OF WORK

5.1. SUMMARY OF KEY FINDINGS

This thesis explored the intersection of gamification, knowledge management, and employee reskilling through a systematic literature review. Guided by three research questions (RQ1–RQ3), the review synthesized findings concerning motivational impacts, game element effectiveness, and organizational outcomes.

Regarding RQ1, the literature overwhelmingly supports the notion that gamification enhances learner motivation and participation by fostering autonomy, engagement, and goal-orientation in reskilling environments. Features such as immediate feedback, visual progress tracking, and self-paced learning consistently improve intrinsic motivation, aligning with Self-Determination Theory (Basit et al., 2021). These elements contribute to higher training completion rates and sustained user engagement, particularly when gamified systems are aligned with learner's goals and job contexts (Capatina et al., 2024; Attia et al., 2024).

However, the motivational effects of gamification are not universally consistent. The effectiveness of gamification depends on factors such as digital readiness, organizational support, and the relevance of game mechanics to the learner's role. Overly competitive or poorly integrated features may diminish intrinsic motivation or exclude less tech-confident users (Mohanty et al., 2024). When thoughtfully implemented, gamification bridges the gap between static KM platforms and dynamic learner engagement, supporting a culture of continuous participation and development (Mohanty et al., 2024; Wang et al., 2020).

In relation to RQ2, the reviewed literature reveals that **no single game element guarantees universal effectiveness**. However, several consistently contribute to improved learning outcomes and retention when properly designed and integrated.

Table 3 summarizes the main types of game mechanisms, their benefits, drawbacks, and typical use cases based on empirical findings from the reviewed studies.

For example, **immediate feedback** and **repetition mechanics** (e.g., micro-assessments, spaced retrieval) were frequently cited as effective in reinforcing knowledge and supporting long-term memory formation (Fauzi et al., 2025; Basit et al., 2021). **Progression systems and unlockable content** structure the learning journey, supporting learner autonomy and self-paced advancement (Attia et al., 2024).

Simulations and **scenario-based challenges** enhance experiential learning in complex or technical settings by immersing learners in realistic, decision-making environments (Kwok et al., 2023; DeCusatis et al., 2022). In parallel, **narrative elements** increase cognitive engagement and emotional connection, especially when aligned with authentic workplace scenarios (Kwok et al., 2023).

Social features such as **leaderboards** and **collaborative challenges** also show potential in boosting motivation through peer comparison and team-based accountability. However, these elements must be implemented carefully to avoid unintended effects like disengagement among lower performers or negative competition (Fauzi et al., 2025).

Ultimately, the most effective gamification strategies are those that combine multiple elements in alignment with learner needs, task complexity, and organizational learning goals. This integrative approach fosters higher engagement, better retention, and improved knowledge transfer across a wide range of reskilling contexts.

Table 3 Mapping Game Elements to Learning Contributions

TYPE OF GAME MECHANISM	PROS	CONS	USE CASE
POINTS AND REWARD SYSTEMS	Immediate gratification; encourages frequent interaction; visible progress.	Risk of over justification effect, where learners focus more on rewards than content	Entry-level training modules or short-term engagement tasks
LEVELS AND PROGRESSION SYSTEMS	Reinforces mastery; supports goal setting and persistence	May demotivate learners if progress is too slow or difficulty increases too sharply.	Skill development requiring sequential mastery (e.g., technical or compliance training)
LEADERBOARDS AND SOCIAL COMPARISON	Boosts motivation and social engagement; increases repeat participation.	Can demotivate lower-performing participants or foster unhealthy competitiveness.	Sales, customer service, or performance-driven roles
SIMULATIONS AND SCENARIO-BASED CHALLENGES	High retention through experiential learning: contextualizes knowledge	Can be costly to develop; requires high technological readiness.	Technical training, crisis management, or compliance scenarios
NARRATIVES AND STORYLINES	Promotes long-term memory retention increases learner empathy and immersion.	May be less effective for purely factual or compliance-based training.	Change management, customer service, or values-based training
FEEDBACK SYSTEMS	Supports formative learning and adaptive learning loops	Overuse may cause cognitive overload or reduce reflection.	Digital learning platforms and self-paced modules
REPETITION AND SPACED RETRIEVAL	Enhances long-term retention through the spacing effect	May lead to superficial engagement if not meaningfully tied to learning goals.	Language training, soft-skills reinforcement, or compliance refreshers.
ADAPTIVE GAMIFICATION	Reduces frustration; promotes mastery learning	Complex to design and implement; relies on accurate learner data.	Personalized learning paths in digital reskilling platforms

For RQ3, the reviewed literature highlights several positive organizational outcomes associated with the implementation of gamified KM systems. These include increased

employee participation in knowledge-sharing activities and collaborative learning, as well as enhanced alignment between reskilling efforts and organizational goals (Basit et al., 2021; Friedrich et al., 2020). Some studies also reported improvements in training efficiency, such as reduced dropout rates and better onboarding outcomes, due to the self-paced, modular design of gamified learning tools (Attia et al., 2024; Shpakova et al., 2017).

Importantly, the success of gamified KM systems at the organizational level is strongly dependent on cultural and contextual alignment. For example, when gamification strategies are designed to reflect internal communication norms and performance objectives, they contribute to sustained engagement and a more resilient learning culture (Mohanty & Christopher, 2024). Furthermore, gamification facilitates the transition from static KM repositories to dynamic, behaviour-driven ecosystems, which improve learning ROI and knowledge flow across departments (Shpakova et al., 2017).

In summary, the evidence confirms that gamification, when thoughtfully integrated into KM based reskilling programs, has the potential to enhance both individual motivation and collective organizational learning. It supports scalable engagement, improves training effectiveness, and contributes to the long-term development of adaptive, knowledge-centric work environments.

5.2. THEORETICAL AND PRACTICAL IMPLICATIONS

This study contributes to both the theoretical and practical understanding of gamified KMS in reskilling. From a theoretical perspective, it extends existing frameworks by introducing a gamified approach to KMS within reskilling initiatives.

On a practical level, the findings provide actionable insights for organizations seeking to modernize reskilling initiatives.

5.3. LIMITATIONS OF THE LITERATURE AND REVIEW PROCESS

While this systematic literature review provides a structured and evidence-based understanding of gamification in KM and employee reskilling, several limitations must be acknowledged, both in terms of the literature base itself and the review methodology.

The reviewed articles differed substantially in methodological approach, ranging from qualitative case studies to exploratory surveys and systematic reviews. While this diversity enriched the thematic analysis, it also limited the ability to generalize findings or apply uniform quality appraisal criteria. For example, few studies conducted longitudinal impact assessments or used control groups to isolate gamification's specific effects on knowledge management or reskilling outcomes.

Another limitation was the heterogeneity of study contexts. The reviewed research spanned diverse sectors, including healthcare, education, information technology, and finance.

Similarly, target populations varied widely, encompassing new employees, mid-level professionals, and human resource practitioners. In terms of methodological design, some studies were based on real-world implementations of gamified knowledge systems, while others relied on controlled simulations or pilot environments. Although this variation enhances the overall generalizability of findings, it simultaneously complicates efforts to draw sector-specific or role-specific conclusions with precision.

A significant number of studies relied on user perceptions or survey-based outcomes rather than objective performance metrics. While valuable for understanding motivation and usability, self-reported data is prone to biases such as social desirability and recall error, limiting the ability to assess actual learning or knowledge-sharing outcomes.

Despite the systematic approach guided by the PRISMA framework, the review may still reflect publication bias. Studies with positive results are more likely to be published and indexed in accessible databases. This could lead to overrepresentation of gamification's benefits and underreporting of failed implementations.

Additionally, even with a clearly defined inclusion protocol, the selection process involved interpretation of scope relevance. Some borderline cases may have been excluded due to ambiguous descriptions or incomplete abstracts.

5.4. RECOMMENDATIONS FOR FUTURE RESEARCH

Considering the limitations identified in the reviewed literature, several future research directions emerge that can deepen understanding and improve the practical implementation of gamified knowledge management systems in reskilling contexts.

Future research should prioritize longitudinal designs that measure the sustained impact of gamified systems on knowledge retention, employee performance, and organizational learning outcomes over time. Controlled studies comparing gamified and non-gamified training across similar cohorts would help clarify causality and address the current reliance on cross-sectional or perception-based data.

Given the contextual variability observed, there is a need for comparative studies that explore how gamification affects different industries and employee groups. Research could, for example, contrast its impact on frontline workers versus knowledge workers, or examine differences between public and private sector organizations. This would enhance the specificity and applicability of design recommendations.

While many studies identify game elements such as points, feedback, and progression as effective, fewer explore *how* and *why* these mechanisms succeed or fail in specific learning contexts. Future research should investigate the interplay between gamification mechanics and learner characteristics, including digital literacy, motivational profiles, and learning

preferences. Additionally, studies should explore how to balance competition, collaboration, and autonomy to optimize engagement.

Further research is also needed on how gamified KM systems interact with existing HR, performance, and cultural frameworks. Questions around compatibility, resistance, and institutionalization deserve more attention, especially in organizations undergoing digital transformation or cultural shifts. Action research or participatory design studies may be especially valuable in capturing stakeholder perspectives during implementation.

The studies reviewed were published in English and originated from a limited set of geographic regions. Future reviews and empirical work should incorporate non-English publications and explore gamification's relevance in different cultural contexts, particularly in Latin America, Africa, and the Middle East, where digital learning adoption is rapidly evolving.

Theoretical models such as Self-Determination Theory (SDT), the Technology Acceptance Model (TAM), and Task-Technology Fit (TTF) appeared in several studies but were not always applied systematically. Future research should test and validate these models empirically in the context of gamified reskilling, offering insights into the psychological, behavioural, and technological enablers of success.

5.5. FINAL REMARKS

This thesis explored how gamification, when embedded within KM systems, can drive more effective and engaging organizational reskilling strategies. Based on a systematic literature review, it demonstrated that gamified approaches have the potential to align training with strategic objectives, improve knowledge sharing, and foster long-term learning cultures, as long as they are well-designed and contextually appropriate.

While individual game mechanics like feedback, progression, and collaboration were shown to enhance motivation and retention, the broader success of gamified KM systems depends on their integration into organizational structures, values, and workflows. As the demand for continuous reskilling grows, gamification offers not just a technological enhancement but a strategic enabler of adaptive learning and sustainable knowledge ecosystems.

In conclusion, this study contributes to both academic understanding and practical application by clarifying when, how, and why gamification can support knowledge-based reskilling. It emphasizes both the opportunities for innovation and the importance of thoughtful implementation tailored to organizational context.

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APPENDIX A

Table A Relation of article with research questions

Database	Authors	Year	RQ1	RQ2	RQ3	Total
Web of Science	Mohanty, S., & Christopher, B. P.	2024	X			1
Web of Science	Capatina, A., Juarez-Varon, D., Micu, A., & Micu, A. E.	2024		X	X	2
Web of Science	Eger, V. M., Georganta, E., Zuercher, P. D. J., Mueller, F., Bohné, T., & Diefenbach, S.	2024	X			1
Web of Science	Loughrey, K., & O'Broin, D.	2018	X			1
Web of Science	Loughrey, K., & O'Broin, D.	2017		X		1
Web of Science	Gurbuz, S. C., & Celik, M.	2022		X	X	2
Web of Science	Bitrián, P., Buil, I., Catalán, S., & Merli, D.	2024	X	X	X	3
Web of Science	Tay, J., Goh, Y. M., Safiena, S., & Bound, H.	2022		X	X	2
Web of Science	Palmquist, A.	2023			X	1
Web of Science	Sluka, I.	2019	X			1
Scopus	Fauzi, M. A., Saad, Z. A., Aripin, M. A., & Sapuan, N. M.	2025		X		1
Scopus	Palmquist, A., & Jedel, I.	2022	X	X	X	3
Scopus	Ulmer, J., Braun, S., Cheng, C.-T., Dowey, S., & Wollert, J.	2022	X	X	X	3
Scopus	Salvadorinho, J., Ferreira, C., & Teixeira, L.	2025	X	X		2
Scopus	Le, H. N., Cuenen, A., Trinh, T. A., Janssens, D., Wets, G., Khattak, M. W., & Brijs, K.	2025	X	X		2
Scopus	Hao, T., Winn, J. G., & Qiang, Q.	2024	X	X	X	3
Scopus	Deif, A.	2023	X			1
IEEE Xplore	Temsirimongkol, T., Samutkao, D., Suriyachantrathong, P., Kanjina, T., Aunsri, N., & Jakkaew, P.	2024	X	X	X	3
IEEE Xplore	Hamdi, L. F., Hantono, B. S., & Permanasari, A. E.	2022	X	X		2
IEEE Xplore	Choque, P. S. L., Mamani, L. Y., & Navarrete, E.	2024	X	X		2
IEEE Xplore	Bohné, T., Heine, I., Mueller, F., Zuercher, P.-D. J., & Eger, V. M.	2023	X	X		2
IEEE Xplore	Kassenkhan, A. M., Moldagulova, A. N., & Serbin, V. V.	2025		X		1
IEEE Xplore	Vapiwala, F., & Pandita, D.	2024	X	X		2
IEEE Xplore	Kwok, B. W. J., Yeo, A., Wong, A., Loo, B. L. W., & Lee, J. S. A.	2023	X	X		2
IEEE Xplore	Nazififard, S., Jafari, S. M., Matin, H. Z., & Yazdani, H.	2019	X			1
IEEE Xplore	DeCusatis, C., Gormanly, B., Alvarico, E., Dirahoui, O., McDonough, J., & Sprague, B.	2022		X	X	2
IEEE Xplore	Firdaus, M. A., Indah, D. R., Sazaki, Y., Ariefin, E. P., Nuriza, M. F., & Rafly, M.	2023		X		1
IEEE Xplore	Sierra, C. P., Cutipa, E. A., & Wong, L.	2024	X	X	X	3
IEEE Xplore	Cuevas-Martínez, J. C., Yuste-Delgado, A. J., Perez-Lorenzo, J. M., & Triviño-Cabrera, A.	2019		X		1
IEEE Xplore	Lee-Remond, S., & Alavi, S.	2024	X	X		2
ScienceDirect	Cudney, E. A., Murray, S. L., Sprague, C. M., Byrd, L. M., Morris, F. M., Merwin, N., & Warner, D. L.	2016	X		X	2
ScienceDirect	Spanellis, A., Dörfler, V., & MacBryde, J.	2020	X	X	X	3

ScienceDirect	Behl, A., Jayawardena, N., Ishizaka, A., Gupta, M., & Shankar, A.	2022	X			1
ScienceDirect	Friedrich, J., Becker, M., Kramer, F., Wirth, M., & Schneider, M.	2020	X	X	X	3
ScienceDirect	Carvalho, C. R. M. de, Furtado, E. S., & Furtado, V.	2015	X			1
ScienceDirect	Taspinar, B., Schmidt, W., & Schuhbauer, H.	2016		X		1
ScienceDirect	Gjicali, K., Finn, B. M., & Hebert, D.	2020		X		1
ScienceDirect	Hejduk, I., & Tomczyk, P.	2015	X	X	X	3
ScienceDirect	Richter, T., Albers, A., Birk, C., Rapp, M., & Bursac, N.	2018	X	X	X	3
GoogleScholar	Gawali, S.	2020	X	X		2
GoogleScholar	Eger, V. M., Georganta, E., Zuercher, P. D. J., Mueller, F., Bohné, T., & Diefenbach, S.	2024		X	X	2
GoogleScholar	Attia, S., Saad, A., & Mohamed, R.	2024	X	X		2
GoogleScholar	Basit, A., Hassan, Z., Omar, N., & Sethu, S.	2021	X	X	X	3
GoogleScholar	Hamza, I. & Tóvölgyi, S.	2022	X	X		2
GoogleScholar	Miroite, P., & Gardoni, M.	2023	X		X	2
GoogleScholar	Torresan, S., & Hinterhuber, A.	2017	X			1
GoogleScholar	Eger, V. M., Georganta, E., Zuercher, P. D. J., Mueller, F., Bohné, T., & Diefenbach, S.	2024	X		X	2
GoogleScholar	Ďuriník, M.	2014			X	1
GoogleScholar	Suh, A., Cheung, C. M. K., Ahuja, M., & Wagner, C.	2017	X			1
GoogleScholar	Ahmed, A.	2017			X	1
GoogleScholar	Suh, A., & Wagner, C.	2017			X	1
GoogleScholar	Ajirlo, M. B., Arbatan, G. A., & Ebrahimzadeh, M.	2023	X		X	2
GoogleScholar	Marcão, R. P., Pestana, G., & Sousa, M. J.	2020			X	1
GoogleScholar	Ayoup, P., Costa, D. E., & Shihab, E	2022	X	X	X	3
GoogleScholar	Wang, S., Noe, R. A., & Wang, Z. M.	2011	X		X	2
GoogleScholar	Abedi, E., Shamizanjani, M., Moghadam, F. S., & Bazrafshan, S.	2018	X		X	2
GoogleScholar	Shpakova, A., Dörfler, V., & MacBryde, J.	2017			X	1
GoogleScholar	Loch, F., & Federspiel, E.	2024	X		X	2
GoogleScholar	Triantafyllou, S. A., Georgiadis, C., & Sapounidis, T.	2025		X		1
GoogleScholar	Pereira, M., Oliveira, M., Vieira, A., Lima, R. M., & Paes, L.	2018		X		1
GoogleScholar	Vanduhe, V., Nat, M. C., & Al-Delawi, H. F.	2020	X		X	2
GoogleScholar	Abuladze, L.	2023	X			1
			42	35	31	

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