APPLICABILITY OF SERIOUS GAMES TO PROJECT'S MANAGER COMPETENCIES ASSESSMENT – LITERATURE REVIEW

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Purpose: Assessing project manager competencies is a complex but essential factor in ensuring project success. Traditional assessment methods may not adequately address project management's dynamic and multifaceted nature. Serious games have shown promise in education and training, providing a realistic, interactive, and risk-free environment to develop and assess skills. However, their application to project manager competency assessment needs to be explored. The research aimed to investigate the current state of serious games used in project management, particularly their role in assessing project manager competencies.

Design/methodology/approach: The authors use systematic and classical literature reviews and analyze the current research areas of simulation games adoption for project management, learning goals and skills, and assessment models. The literature review findings are compared to the competence model of the IPMA and analyzed for similarities and differences.

Findings: The findings of this research confirm that serious games could be used not only to train but also to assess (certify) the competencies of project managers formally, understood as an assessment of a project manager's ability to apply knowledge, skills, and abilities in practical situations.

Research limitations/implications: The study relies on articles published between 2000 and 2023 and available in English, which may exclude relevant works in other languages or older foundational studies. The selection was limited by the accessibility of articles in specific databases, potentially omitting key contributions from less accessible or alternative sources. The analysis was conducted on only two serious games, which may not represent the full range of serious games available for project management competency assessment.

Practical implications: The research suggests that serious game developers should expand the scope of competencies assessed, including behavioral and contextual dimensions, to offer a more holistic evaluation.

Social implications: By aligning serious games with international competency models like IPMA, the research supports the development of globally recognized standards for project management skill assessment.

Originality/value: The study innovatively uses the IPMA Level C certification process as a benchmark to evaluate the potential of serious games in formal competency assessment. This approach bridges the gap between gamification in learning and formal professional certification standards.

Keywords: serious games, project manager, competencies assessment, complexity.

Category of the paper: Literature review.

1. Introduction

Project management is an increasingly important specialty nowadays. Currently, more than 20% of global economic activity takes place as projects (de Rezende, 2019; Gemunden, 2013), and in some emerging economies, it exceeds 30% (Bredillet C. N., 2010). Moreover, the 'projectification' of organizational work is today observed in almost every industry (Kuura, 2020; Bakker, 2010; Sydow, 2004), and organizations increasingly use projects to achieve their strategic objectives (Morris, 2004).

Effective project management helps organizations improve efficiency and reduce waste, which results in cost savings and improved profitability (Kaufmann, 2022). Organizations skilled in project management can develop a competitive advantage by delivering projects more efficiently and effectively than their competitors (Milosevic, 2003).

With the increasing complexity of projects in various industries (de Rezende, 2019), project management has become a critical skill set for organizations (Maylor, 2017) to successfully complete projects on time, within budget, and with the desired level of quality. There are numerous reasons why project management has become an important profession. In industries such as construction, engineering, IT, and healthcare, there is a need for professionals who can manage these projects effectively. Project management professionals should be trained to plan, organize, and execute projects in a way that ensures their success (Herath, 2021). They should be skilled in identifying and managing risks (Rumeser, 2019), project design, human resource management, communicating with stakeholders, and ensuring project management efficiency. Moreover, they should be skilled in identifying and understanding customer needs and translating those needs into project requirements to ensure that projects meet customer expectations and result in satisfied customers (Chipulu, 2013).

Therefore, assessing project manager competencies is a complex and challenging task; conversely, it is a critical project success factor. Project manager competencies can be assessed through various methods, i.e., performance reviews, behavioral interviews, 360-degree feedback, certifications, or serious games. Serious games are typically created to teach or develop specific skills, knowledge, or behaviors. They can be used in various contexts, including education, training, personal development, and competency assessment. Assessment through serious games can be done in multiple ways, such as scoring a player's performance, evaluating their decision-making skills, measuring their ability to work collaboratively, or testing their ability to solve complex problems. Serious games can also provide a more comprehensive and realistic assessment of competencies than traditional assessment methods, such as exams or written assignments. This is because they allow learners to apply their knowledge and skills in a simulated environment resembling real-life situations (Kriz, 2022).

Nowadays, serious games are a promising new teaching and learning method that has recently emerged in project management (Rumeser, 2018). A considerable body of literature illustrates the benefits of games and gamification for competency assessment purposes (Chin, 2009), but the term "project management competency assessment serious game" is surprisingly rare. This paper aims to review existing project management serious games that assess project manager competencies. The research question of this paper is: are there any serious games that formally assess project manager competencies? The structure of the paper is as follows. Section 2 presents the project manager competency models and their formal certification procedures. Section 3, methodology of the research. In Section 4, a classical literature review on serious games and competency assessment is introduced. Section 5 presents conclusions and future work based on the findings obtained.

2. Formal assessment of project manager competencies

The need for project manager competence assessment is well documented (Soroka-Potrzebna, 2021; Kaklauskas, 2010). The project manager's competence is a factor in the successful delivery of projects (Patanakul, 2009; Stevenson, 2010). Competency frameworks and standards are developed for one specific reason: to assess, develop, and reassess the competencies of project managers. This process should be continuous, and project managers should embrace it to improve their competencies (Marnewick, 2016). Over the past years, several project manager competency models have been developed to define, and some of them formally assess, the knowledge, skills, and abilities required for success in project management (Taket, 2015; Chen, 2008).

Crawford (Crawford, 2005) proposes three project manager classifications: input competencies, which refer to the knowledge and skills that a project manager brings to a job; personal competencies, which are the core attributes underlying a project manager's capability to execute a job; and output competencies that relate to the 'demonstrable' performance that a project manager exhibits within the work environment. Rose (Rose, 2007) gathered project management competencies in a particular company using semi-structured interviews with project managers to analyze the required competencies in project situations. The study identified seven competencies: technical, process, time, client, business, personal, and uncertainty management. Project manager competencies could be deployed into knowledge, skills, and abilities (Ahsan, 2013). Bredin (Bredin, 2013) outlines two archetypes of project manager career models: the competence strategy model and the talent management model. Those are only a few examples of numerous efforts in creating the project manager competency classification model, which did not evolve into the formalized competency assessment process. This gap is filled by professional associations or other professional

organizations that gather experience from the best specialists. Based on their basis, methods of conduct and training for future project managers are developed. There are many specialized project management methodologies, such as PMBoK® Guide, PRINCE2®, PCM, TenStep, HERMES, and others described in the literature (Trocki, 213, 2017; Svejvig, 2015; Morris, 2013) but only a few of them include project manager competency models (Eskerod, 2013). Similarly to Bredillet (Bredillet, 2015), in this research, we have selected three standards that have been published by long-established bodies or/and account for a large number of credentialed project managers - Global Alliance for Project Performance Standards (GAPPS), Project Management Institute (PMI) and International Project Management Association (IPMA).

The Competency Baseline for Project, Program, and Portfolio Management (CBP) is a standard developed by the GAPPS that outlines the competencies required for successful project, program, and portfolio management (Global Alliance for Project Performance Standards. A Framework for Performance Based Competency Standards for Global Level 1 and 2 Project Managers, 2007). The CBP identifies 46 competencies across three levels of management: project management, program management, and portfolio management. These competencies are grouped into five Units of Competency focused on project processes, i.e., management of relationships with stakeholders, development of the plan for the project, or project progress management. Unlike IPMA or PMI, the GAPPS is a volunteer organization working to create such frameworks and standards by providing a forum for stakeholders from differing systems, backgrounds, and operating contexts to work together to address the needs of the global project management community. Therefore, CBP can be freely used by businesses, academic institutions, training providers, professional associations, and government standards and qualifications bodies globally. Still, they are not formalized as an official assessment (certification) standard.

The PMI's Talent Triangle was recently updated (PMBOK Guide - Seventh Edition, 2021) but remains a framework that outlines the three key areas of competencies required for success in project management: ways of working (formerly - technical project management), power skills (formerly – leadership), and business acumen (formerly- strategic and business management). The detailed framework for defining, assessing, and developing project manager competence is described in Project Manager Competency Development (PMCD) Framework (Project manager competency…, 2017) that is consistent with the Talent Triangle. The PMCD Framework structure represents a typical competency standard. It identifies:

- Units of Competence. Each Unit of Competency in this Chapter of the PMCD Framework corresponds to one of the five Project Management Process Groups: Initiating, Planning, Executing, Controlling, and Closing.
- Elements of Competence. Each Unit of Competence consists of several Elements that reflect the activities in which project managers are expected to be experienced.

- Performance Criteria. Each Element is described by Performance Criteria, which specify the outcomes to be achieved to demonstrate competent performance.
- Types of Evidence are associated with each of the Performance Criteria. These form the basis upon which competence can be self-assessed.

PMCD framework describes competence as consisting of three separate dimensions:

- project management knowledge competence—what the project manager knows about project management,
- project management performance competence—what the project manager is able to do or accomplish while applying project management knowledge,
- personal competency—how the project manager behaves when performing the project or activity.

Even though PMI's project manager certification system is one of the most reputable and recognized worldwide, it is important to highlight that it is not based on PMCD Framework but on PMBoK® Guide mastery. Furthermore, the certification requires a defined length of professional experience, depending on the applicant's academic credentials. Therefore, the PMCD Framework is used by PMI as a reference guide for project managers in their professional development, not as a formalized project manager competency assessment standard.

The IPMA Competence Baseline (ICB) does not discuss competencies in terms of specific roles (e.g., project manager) but rather in terms of the domain (e.g., individuals working in project management). The rationale is that roles and role titles vary greatly by language, industry, and focus. Therefore, the ICB presents important project management, program management, and portfolio management competencies. Each domain may contain roles and titles that fit into the overall competence domain. ICB is organized into three areas: technical competencies, behavioral competencies, and contextual competencies (IPMA Individual Competence Baseline. Ver. 4.0.1, 2015).

Figure 1. IPMA's Eye of Competence.

Source: (IPMA Individual Competence Baseline. Ver. 4.0.1, 2015).

According to ICB, people competencies are personal and interpersonal competencies required to successfully participate in or lead a project, program, or portfolio. Practice competencies are the specific methods, tools, and techniques used in projects, programs, and portfolios to realize their success. Perspective competencies are methods, tools, and techniques through which individuals interact with the environment and the rationale that leads people, organizations, and societies to start and support projects, programs, and portfolios. Within each competence area, there are generic competence elements (CE) that apply to all domains. CEs contain lists of the pieces of knowledge and skills required to master the CE. Key competence indicators (KCI) provide the definitive indicators of successful project, program, and portfolio management for two or all three domains. Measures exist that describe highly detailed performance points in each KCI.

Competence in the project domain is broken into 28 CE with one to many KCI each.

Table 1.
IPMA project KCIs (IPMA Individual Competence Baseline. Ver. 4.0.1, 2015)

Area No.	CE No. & Description
4.3 Perspective	4.3.1. Strategy
	4.3.2. Governance, structures and processes
	4.3.3. Compliance, standards and regulations
	4.3.4. Power and interest
	4.3.5. Culture and values
4.4 People	4.4.1. Self-reflection and self-management
	4.4.2. Personal integrity and reliability
	4.4.3. Personal communication
	4.4.4. Relationships and engagement
	4.4.5. Leadership
	4.4.6. Teamwork
	4.4.7. Conflict and crisis
	4.4.8. Resourcefulness
	4.4.9. Negotiation
	4.4.10. Result orientation
4.5 Practice	4.5.1. Project design
	4.5.2. Requirements and objectives
	4.5.3. Scope
	4.5.4. Time
	4.5.5. Organization and information
	4.5.6. Quality
	4.5.7. Finance
	4.5.8. Resources
	4.5.9. Procurement
	4.5.10. Plan and control
	4.5.11. Risk and opportunity
	4.5.12. Stakeholders
	4.5.13. Change and transformation

To assess the project manager's competency, IPMA developed the IPMA Four Level Certification (IPMA 4-L-C), where a candidate's competence level is evaluated by assessors trained in the IPMA certification assessment process. The project manager assessment process may vary depending on the certification level and National Certification Body regulations.

This research used Polish rules and procedures (IPMA Polska Certyfikacja, 2023). At level D, designed for individuals new to project management or with limited experience, the certification process involves completing a written exam and a self-assessment, which evaluates the individual's project management knowledge and skills. Level C is designed for project managers with several years of project management experience, and the certification process involves completing a written exam and assessment center (or individual interview). Level B is designed for senior project managers who have significant project management experience and have managed complex projects. The certification process involves completing a written exam, report, and an assessment center (or individual interview). Level A is designed for individuals with extensive experience managing multiple projects or programs. The certification process involves the presentation of recommendation letters, a written report summarizing project management experience, and an assessment center.

As discussed above, among three selected competency standards, IPMA ICB is the only competency standard that was formalized and operates as an actual project manager assessment (certification) body worldwide. Therefore, further research will use the IPMA Level C certification process as a competency assessment model to seek its utilization in project management serious games design, development, and actual embracement.

3. Methodology

The initial research was based on a systematic literature review methodology (Okoli, Schabram, 2010). Three key phrases were selected: project manager, competencies assessment, and serious games. They were searched for in the most recognized databases, including EBSCO, ScienceDirect, Scopus, Web of Science, and SAGE journals – in the time frame of 2000-2023. The initial search revealed 16.064 articles. After the initial title and abstract screening, 51 articles were selected for further investigation. Articles were chosen based on exclusion criteria. The first exclusion criterion was the lack of one of the adopted keywords (project manager, competency assessment, and serious games) because it pointed to the lack of relevance for the subject and indicated other areas of research (e.g., higher education, pedagogy, 21st-century skills, children's education). Also, metaphorical (or random) uses of keywords were excluded – for instance, "project-oriented", "competent manager", and "Game Theory". Articles were expected to have been published no earlier than 2000 because the number of serious games in the literature increased exponentially then. Repeated game cases described in other articles were excluded as well. The last exclusion criterion was unspecified or non-assessment embeddedness of the game. The next phase consisted of full screening and selection based on inclusion criteria. Only the articles that indirectly referred to the project manager competency model were supposed to be considered. It was important to find cases explicitly

addressing project manager assessment considering their characteristics. It was supposed to be verified by checking the goals of the games. Only the cases contributing to the project manager assessment or its derivatives would be considered. Finally, the research would not include games if there was insufficient information about game design. None of the reviewed articles fulfilled the selected criteria.

Due to the failure of the systematic literature review methodology, the classical literature review methodology was adopted. Firstly, serious games and areas of their applicability were reviewed. Based on the review findings, the education and training simulation games category was selected for further research from the perspective of project management competency development. Then, serious gaming and its competency assessment aspect were explored, focusing on adopting the project manager competency model. Finally, examples of project management serious games were presented as a basis for conclusions and findings.

4. Serious games and competency assessment – literature review

4.1. Serious games applicability

The serious game term was defined in 1970 (Abt, 1970). However, it referred to board games rather than video games. Since then, numerous authors have investigated the serious games concept (e.g. Connolly, 2012; Djaouti, 2011; Michael, 2005; Wouters, 2013; Zyda, 2005). Zyda's definition of a serious game as "a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives" (Zyda, 2005), was extended by Michael and Chen (Michael, 2005) who added that serious games "do not have entertainment, enjoyment, or fun as their primary purpose" to emphasize that serious games are designed for purposes beyond entertainment. However, for the project management environment simulation, an interesting perspective is the usage of game artifacts (form) to simulate (function) the system processes of a complex (real) system (Duke, 1974; Klabbers, 2009). Kriz et al. (Kriz, 2022, p. 4) define a serious game as "a reconstruct of important aspects of the reference system; therefore it is an abstract model of reality with less complexity and fewer details". The major challenge of project management is its complexity and decision-making in a rapidly changing environment. Therefore, the simulation of a simplified reality model lays solid grounds for various applications of serious gaming in project management.

Serious games are typically created to teach or develop specific skills, knowledge, or behaviors and can be used in various contexts, including education, training, and personal development. According to (Kriz, 2017), gaming simulations can be categorized taking into consideration the following perspectives:

- an analytical science perspective leads to the usage of games and simulations as scenarios to empirically test, justify, and develop theories in specific domains,
- the design perspective emphasizes the usability of simulation games and their objective to promote and evaluate their development and use in a practical context.

Serious games can take many forms, including board games, behavior-oriented role plays, with or without computer-assisted simulation elements, and, more recently, digital and non-digital educational games, game-based learning, and web-based simulation games. According to Kriz et al. (Kriz, 2022), the application of serious games can be categorized as follows:

- education and training simulation games, where they promote knowledge acquisition of the development of skills, competencies, attitudes, and values, and the understanding of complex relationships,
- simulation and game-based policy interventions, where they support the testing and evaluation of alternative strategies and courses of action,
- gaming simulation as a core method for designing complex sociotechnical systems, where gaming applications may facilitate the (re)design of organizational rules, structures and performance, workflow processes, and human factors.

From the project manager competency assessment perspective, education and training applicability are most promising, as learning can significantly influence personal competencies. Moreover, facilitating the understanding of complex relationships is of key importance for the project management area.

4.2. Serious games and learning

Definitions of learning differ enormously in psychology, neuroscience, behavioral ecology, evolutionary theory, and computer science, as well as in many other disciplines, and new definitions continue to be proposed (Barron, 2015). As it comes to the discussion of learning in games, most frequently Kolb's model of Experiential Learning Cycle (ELC) appears (Kolb, 1984), where learning optimally is a cyclic, four-step process of Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation (Kolb, 1984). In serious games gaming, participants are offered an environment close to reality, where they can experience situations and make decisions without risking trouble in real life (Kriz, 2022). In Kolb's model, the learning subject should reflect on and "work with" his/her experience. The typical structure of serious games reinforces specific experiences and the realization of other ELC steps. Breaks for observation and conceptualization before continuing with experimentation are advised. The very important debriefing is represented in the ELC (Reflective Observation and Abstract Conceptualization) (Schwagele, 2014). Research has shown that serious games can be an effective tool for learning, as they engage learners in active and experiential learning (Dekanter, 2005; Karney, 2007), which can enhance knowledge retention and transfer. Unlike passive knowledge transfer, learners are drawn into an active,

experience-based learning environment (Leigh, 2005). Gaming simulation can be characterized as prime examples of cooperative, experience-oriented (Kolb, 1984; Jones, 1997), problem-based, and primarily self-organized (Kriz, 2010, 2014) methods of learning and education. Serious games can also create a safe and controlled environment where learners can practice and apply new skills without fear of failure or negative consequences (Kriz, 2022). Therefore, it is not a surprise that there is a continuous number of areas where serious games are used as a mechanism to teach or improve skills, such as in language teaching (Patino, 2014), sex education (Kwan, 2015), or enhancing doctor or nurse communication (Zielke, 2015). This trend can also be observed in the project management discipline, where an increasing number of project management games have been proposed since their introduction in 1974 (Estes, 1974). According to (Rumeser, 2018) the number of project management serious games suggested in the literature has increased exponentially in the last two decades (from a couple per year in the 70s of the 20th century to 80 in 2018). The authors have identified the following three types of simulated projects in the games: games with no specific project type (general), games that simulate Information Technology (IT/software) projects, and games simulating Engineering, Procurement, and Construction (EPC) projects. Most project management games (43%) simulate EPC projects, 35% of games are played in an IT/software project context, and 23% have no project context. Project management games are predominantly played in a single project setting (86%), in one of or a combination of the three project phases (planning, execution, and control), the majority of them (64%) are single-player games and in most cases are digital-based or computer-based (87%).

4.3. Serious games as an assessment tool

As serious games are designed to simulate real-life scenarios, they can be used to assess competencies (Kriz, 2022). There are numerous definitions of the term "competence" (e.g. Boyatzis, 2008; Hoffman, 1999), and it has not been clearly defined in the literature (Robotham, 1996). In this research project, individual competence is the application of knowledge, skills, and abilities to achieve the desired results (IPMA Individual Competence Baseline. Ver. 4.0.1, 2015). Consequently, competency assessment is understood as an assessment of the learner's ability to do so in practical situations. Therefore, as mentioned earlier, a safe and controlled environment allows practicing and applying professional skills, which is another positive aspect of serious games' applicability to project manager competency assessment.

Assessment through serious games can be done in various ways, such as scoring a player's performance, evaluating their decision-making skills, measuring their ability to work collaboratively, or testing their ability to solve complex problems. Serious games can also provide a more comprehensive and realistic assessment of competencies than traditional assessment methods, such as exams or written assignments. This is because they allow learners to apply their knowledge and skills in a simulated environment resembling real-life situations

(Kriz, 2022). Furthermore, serious games can provide immediate feedback to learners, allowing them to understand their mistakes and correct them in real time, enhancing their learning and performance (Kriz, 2022). Considering that an assessment center is an inherent component of the IPMA 4-L-C system based on immediate feedback from project management senior experts, this quality of serious games can be seen as a significant asset.

Serious games often use various competency models to design and evaluate learning outcomes. Using a competency model as a guide, serious game designers can ensure that the game content and scenarios align with the specific competencies that learners need to develop. This can help to make the game more effective at achieving its learning objectives. Competency models in serious games can vary widely depending on the specific game and its intended purpose. Therefore, there are numerous competency models used in serious games across different domains, and a single game may include several competency models. For example, one of the most popular Microsoft games, Flight Simulator (Flight Simulator, 2023), is, on the one hand, based on the Dreyfus Model of Skill Acquisition (Dreyfus, 1980) and, at the same time, incorporates International Air Transport Association (IATA) pilots competencies model and assessment framework (Competency Assessment…, 2023). Another worldwide recognized serious game, World Climate Simulation, includes several theoretical models, including competency ones, such as Hersey and Blanchard's Situational Leadership Model (Hersey, 1969), Collaborative Leadership (Gumus, 2018), interest-based negotiation model developed by Fisher and Ury (Fisher, 1981) and their numerous followers as well as the collaborative problem-solving model initiated by Dewey (Dewey, 1933) and then refined by several scholars and practitioners over several decades.

Serious games can also be used to assess competencies based on the same competency model that was used to design the game. For example, a game designed to develop leadership competencies might use a competency model that includes skills such as communication, decision-making, and team building. The game could then assess the player's performance in these areas to provide feedback and track their progress. Using a competency model in serious game design and assessment can help to ensure that the game is focused on the most relevant and important skills and knowledge for a given role or situation. It can also help to provide a clear and consistent framework for measuring and evaluating competency development. A growing number of serious games are used to certify competencies in various fields formally. Flight simulators are used to train and certify pilots in a safe, controlled environment. These simulators can replicate various conditions and emergencies that pilots may encounter in the real world, allowing them to demonstrate their knowledge and skills in a controlled setting. Boeing 737-full flight (Boeing 737 MAX full-flight simulator, 2023), Airbus A-320 (Full Flight Simulators, 2023) or Cessna172 (Full Flight Simulators, 2023) are only a few examples of simulators that are often used as part of comprehensive training and certification program for pilots. Medical simulators are used to train and certify healthcare professionals in various skills and procedures, such as surgical techniques, diagnostic imaging, and emergency medicine.

These simulators can provide a realistic and immersive learning experience, allowing learners to practice their skills in a safe and controlled environment. For example, Lap Sim (LapSim, 2023) is used for laparoscopic surgery training and assessment, da Vinci Surgical System (Da Vinci, 2023) for robotic-assisted surgery training and assessment or VirtaMed ArthroS™ (Medical training simulators, 2023) for arthroscopic surgery training and assessment.

4.4. Project management, serious games, and competencies assessment

The main purpose of the research was to review the literature, investigate the application of serious games in project management, and analyze their utilization for the project manager competency assessment. The research question was: are there any serious games that formally assess project manager competencies? The identification and selection of games were the subject of several stages. From January 2023 to May 2023, intensive research was systematically performed using multiple sources, i.e., research papers, international gaming awards, and contacts with experts, to identify the project management games available. This investigation led to the identification of over thirty serious games that were relevant to the scope of research, i.e., Construction Project Management Game (Hassan, 2021), GRAPM (Miler, 2016), SiMSE (Navarro, 2004), DELIVER! (von Wangenheim, 2012), PMQUIZ (Petri, 2016) and others. However, a selection was required to select the games that were suitable for the scope of the research. The following criteria were followed to undertake this selection:

- the game should be available and used for project management training,
- adequate and publicly accessible documentation should be available to evaluate the game's applicability to the competency assessment process,
- the serious game scoring system should assess the player in as many CEs as possible using IPMA's project manager competency assessment model.

As a result, two games were selected. The first is SimulTrain (SimulTrain, 2023), developed by STS Sauter Training & Simulation SA (STS). SimulTrain is a project management simulation that allows participants to manage a virtual project from start to finish. Its general objective is to train in three fundamental areas, divided into various learning points. The first one is project leadership, where participants learn to lead a project in its entirety, which includes dealing with the project's stakeholders, the project's functions complexity, and priorities management. The second one is project management, where participants learn to manage a project on a day-to-day basis by making decisions which being a project manager requires updating, planning, checking progress, managing quality, and organizing project reviews. They also learn how to make decisions as a team. They have to make decisions requiring them to negotiate cost, deadline, quality, and motivation goals, as well as manage conflict within the team and consider each participant's views. The last one is resource management, designed to teach how to plan the involvement of resources for maximum efficiency. There are eleven simulated project manager functions, such as project planning, budgeting, risk management, decision-making, or project controlling.
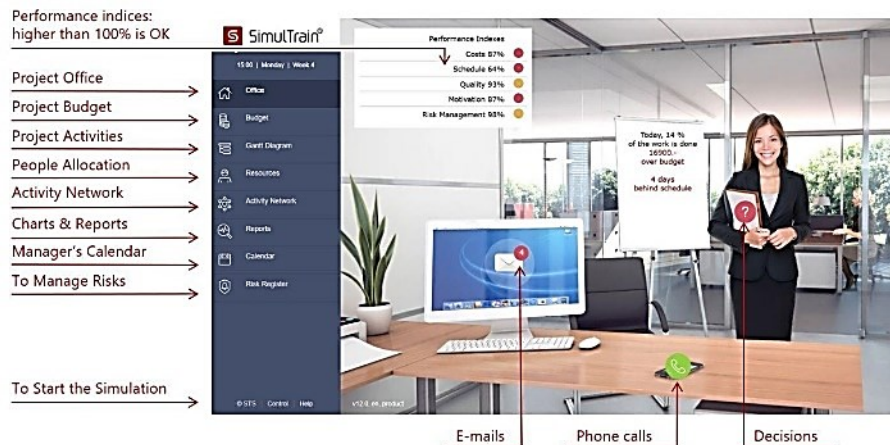
Figure 2. SimulTrain users dashboard.

Source: SimulTrain, 2023.

SimulTrain is primarily used in combination with classroom activities but can also be played completely online. Training is conducted with teams of four participants where learners play the role of the project manager. The teams must plan and execute a typical mid-sized project in two or three sessions of 3-4 hours each. The teams are confronted with many situations requiring quick decisions while considering all project parameters (cost, deadlines, quality, and human factors). The teams are scored against five parameters: cost, schedule, quality, motivation, and risk. The trainer can adjust the weight of each parameter to accomplish various learning objectives, i.e., focus of players on project cost management. The SimulTrain is used in trainings for project managers, project participants, top management, managers and their reports, and students of business schools and technical universities. The game is available in more than 22 languages, and there are up to 10 scenarios, reflecting project simulations in different areas. According to STS, the simulator is used in more than 51 countries and has contributed to the training of more than 200.000 project managers (About STS, 2023).

The second one is "Project Management" (PM), developed by REVAS (Games, 2023). Similarly to SimulTrain, it is a simulation that allows participants to manage a virtual project from start to finish the game and its main objective is to train in three fundamental areas of project leadership, operational management, and resource management. Players can play individually or in small (three to four people) teams. The game scenario starts with the endeavor orientation session, where project objectives and stakeholders are identified, and the company's organizational structure, budgets, and resources are reviewed. In the second part, players are expected to develop the project plan, including the project's schedule, budget, resource allocation, and risk management plan. The third phase focuses on project execution with several rounds, each representing one calendar month. To simulate real-life project challenges, unexpected events are introduced, such as late materials delivery, conflict with stakeholders, or project team members getting sick. During the game, players score against eight key competence areas presented in Figure 3.
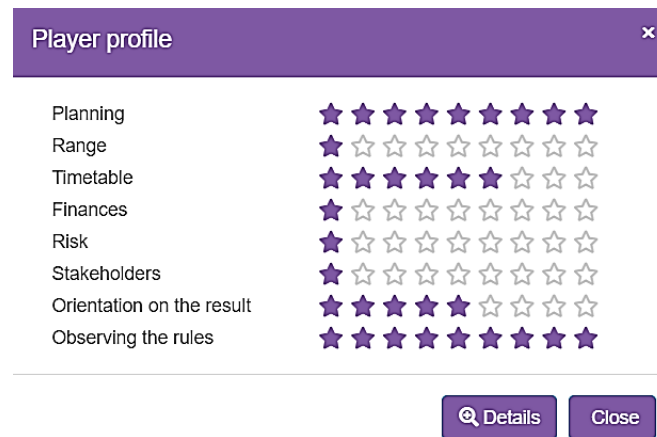
Figure 3. "Project Management" player's profile.

Source: Games, 2023.

The PM game is available in three languages (Polish, English, and Ukrainian). It has four scenarios: new product introduction, research lab launching, training course organization, and implementation of the project management approach in the organization. REVAS game is used primarily to train business audiences and students at higher levels of education in Poland.

Based upon reviewed documentation, the first research criteria were fulfilled as both games present a similar approach to game design as they create a virtual yet simplified project management reality in various environments and cover the overall project life cycle from its initiation to closure. This characteristic lays solid grounds for numerous competency assessment measures. They are accessible online and used to train professionals or students, making them practical examples of the serious game assessing project manager competencies. The analysis of the available descriptions of player scoring systems in both games brought interesting findings. Out of the twenty-eight IPMA CEs, only five are scored in the case of Simul Train and eight in PM simulation. The scoring systems review results are presented in Table 2.

Table 2.
Coverage of IPMA CEs in selected serious games

Area No.	CE No. & Description	SimulTrain	PM
4.3 Perspective	4.3.1. Strategy		
	4.3.2. Governance, structures and processes		
	4.3.3. Compliance, standards and regulations		▓
	4.3.4. Power and interest		
	4.3.5. Culture and values		
4.4 People	4.4.1. Self-reflection and self-management		
	4.4.2. Personal integrity and reliability		
	4.4.3. Personal communication		
	4.4.4. Relationships and engagement		
	4.4.5. Leadership		
	4.4.6. Teamwork	▓	
	4.4.7. Conflict and crisis		
	4.4.8. Resourcefulness		
	4.4.9. Negotiation		
	4.4.10. Result orientation		▓

Cont. table 2.

4.5 Practice	4.5.1. Project design		
	4.5.2. Requirements and objectives		
	4.5.3. Scope		▓
	4.5.4. Time	▓	▓
	4.5.5. Organization and information		
	4.5.6. Quality	▓	
	4.5.7. Finance	▓	▓
	4.5.8. Resources		
	4.5.9. Procurement		
	4.5.10. Plan and control		▓
	4.5.11. Risk and opportunity	▓	▓
	4.5.12. Stakeholders		▓
	4.5.13. Change and transformation		

5. Conclusions and suggestions

The article suffers from a lot of limitations. The article sample was limited to both period and online availability, search engines, and language (English). The authors are aware that there are significantly more articles and papers published in the area of concern and that the selection is limited due to the methods applied and other constraints. The authors' future efforts will aim to broaden and study the underlying design methodologies, narratives for serious game design, and project management competency assessment methods in more detail. The planned future work aims to extend the classifications of project management serious game usage and look for opportunities to create a model of the project manager competency assessment serious game to improve the project manager education and assessment process.

This research confirms that serious games could be used not only to train but also to assess (certify) formally project managers' competencies, understood as an assessment of a project manager's ability to apply knowledge, skills, and abilities in practical situations. Firstly, they are designed to simulate real-life scenarios. Therefore, assessing competencies is more realistic and comprehensive as project managers apply their knowledge and skills in a simulated environment resembling real-life situations. Secondly, serious games may simplify the major challenge of real-world project management – their complexity, as serious games are an abstract model of reality with less complexity and fewer details. Thirdly, serious games can provide immediate feedback from senior project management experts to project managers, allowing them to understand their mistakes and correct them in real time. At the same time, senior management experts' observations and performance evaluations can also be used to perform the project manager assessment center role. However, the analysis of the two selected project management serious games depicts the current deficiencies of game-based project manager competencies assessment compared to the IPMA Level C assessment process. The first one is that only a few of twenty-eight project manager competencies are assessed, which results in

a very selective assessment of a minority of them. Additionally, as game scenarios focus on project life cycle management, their scoring systems reflect the project operational management mastery level, not the overall project manager competencies assessment. Finally, although the briefing sessions are foreseen in games' scenarios, their ultimate objective is reflection or discussion of activities performed, not a formal assessment of project management competencies in an interview or assessment center. Such a situation creates a research opportunity through the identified research gap in finding the balance between game design, the IPMA competence model, and simulation games as an assessment tool. It also creates the challenge of marring the diverging angles of these competing research areas.

References

1. *Global Alliance for Project Performance Standards. A Framework for Performance Based Competency Standards for Global Level 1 and 2 Project Managers* (2007). Global Alliance for Project Performance Standards.
2. *About STS* (2023.05.07). Retrieved from: https://sts.ch/en/sts/about-sts
3. Abt, C. (1970). *Serious games: The art and science of games that simulate life.* New Yorks Viking.
4. Ahsan, K.H. (2013). Recruiting project managers: a comparative analysis of competencies and recruitment signals from job advertisements. *Project Management Journal, 44*(5), 36-54.
5. Bakker, R. (2010). Taking stock of temporary organisational forms: a systematic review and research agenda. *International Journal of Management Reviews, 12*(4), 466-486. doi: https://doi.org/10.1111/j.1468-2370.2010.00281.
6. Barron, A.H. (2015). Embracing multiple definitions of learning. *Trends in Neurosciences, 38*(7), 405-407.
7. Bloom, B. (1956). *Taxonomy of educational objectives: the classification of educational goals.* New York: Longmans, Green.
8. *Boeing 737 MAX full-flight simulator* (2023.04.16). Retrieved from: https://www.cae.com/news-events/press-releases/cae-deploys-first-boeing-737-max-full-flight-simulator-in-europe
9. Boyatzis, R. (2008). Competencies in the 21st Century. *Journal of Management Development, 27*(1), 5-12. doi:https://doi.org/10.1108/02621710810840730
10. Bredillet, C.N. (2010). *Blowing Hot and Cold on Project Management, 41*, 4-20.
11. Bredillet, C.T. (2015). What is a good project manager? An Aristotelian perspective. *International Journal of Project Management, 33*(2), 254-266.

12. Bredin, K.S. (2013). Project managers and career models: an exploratory comparative study. *International Journal of Project Management, 31*(6), 889-902.

13. Cartwright, C. (2008). Using the Project Management Competency Development Framework to Improve Project Management Capability. *Paper presented at PMI® Global Congress 2008—Asia Pacific, Sydney, New South Wales, Australia.* Newtown Square, PA: Project Management Institute. Retrieved from: https://www.pmi.org/learning/library/ importance-project-manager-competency-development-framework-7169

14. Chen, P.P. (2008). Conceptual determinants of construction project management competence: A Chinese perspective. *International Journal of Project Management*, 655-664.

15. Chin, J.D. (2009). Assessment in Simulation and Gaming. *Simulation and Gaming, 40*(4), 553-598.

16. Chipulu M.N.J. (2013). A multidimensional analysis of project manager competencies. *IEEE Transactions On Engineering Management*, 506-517.

17. *CodeCombat* (2023.04.16). Retrieved from: https://codecombat.com/home

18. *Competency Assessment and Evaluation for Pilots, Instructors, and Evaluators* (2023). IATA. Retrieved from: https://www.iata.org/contentassets/c0f61fc821dc4f62bb6441d7 abedb076/competency-assessment-and-evaluation-for-pilots-instructors-and-evaluators-gm.pdf

19. Connolly, T.M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education, 59*(2), 661-686.

20. Crawford, L. (2005). Senior management perceptions of project management competence. *International Journal of Project Management, 23*(1), 7-16.

21. *CSTA* (2023.04.16). *CSTA's K-12 standards*. Retrieved from: https://www.csteachers.org/ page/about-csta-s-k-12-nbsp-standards

22. *Da Vinci* (2023.04.16). Retrieved from: https://www.intuitive.com/en-us/products-and-services/da-vinci/software

23. de Rezende, L.B. (2019, Jan.-Apr.). Revisiting project complexity: a new dimension and framework. *Journal of Modern Project Management*, 126-141. doi:10.19255/JMPM01808

24. Dekanter, N. (2005). Gaming redefines interactivity for learning. *TechTrends, 49*(3).

25. Dewey, J. (1933). *How We Think.* Lexington, MA: Heath and Company.

26. Djaouti, D.A. (2011). Classifying serious games: The G/P/S. In: *Handbook of research on improving learning and motivation through education games* (pp. 118-136). Hershey, PA: IGI Global.

27. Dreyfus, S.E. (1980). *A Five-Stage Model of the Mental Activities Involved in Directed Skill Acquisition.* Berkeley: California Univ Berkeley Operations Research Center.

28. Eskerod, P.H. (2013). Sustainable development and project stakeholder management: what standards say. *International Journal of Project Management, 6*(1), 36-50.

29. Estes, C.B. (1974). PAMSIM: a project management simulator. *7th conference on Winter simulation, 2.*

30. Fisher, R.U. (1981). *Getting to Yes* (1 ed.). Houghton Mifflin.

31. *Flight Simulator* (2023.04.16). Retrieved from: https://www.flightsimulator.com/

32. *foldit* (2023.04.16). Retrieved from: https://fold.it/

33. *Full Flight Simulators* (2023.04.16). *Avenger Flight Group.* Retrieved from: https://www.afgsim.com/full-motion-flight-simulators/airbus/

34. *Full Flight Simulators* (2023.04.16). Retrieved from: https://www.frasca.com/full-flight-simulators/

35. *Games* (2023.05.07). Retrieved from: https://www.revas.online/en/simulations/

36. Gemunden, H. (2013). Projectification of society. *Project Management Journal, 44*, 2-4.

37. Gumus, S.B. (2018). A systematic review of studies on leadership models in educational research from 1980 to 2014. *Educational Management Administration & Leadership, 46*(1), 25-48.

38. Hassan, A.H.-R. (2021). Enabling construction project managers through a management game. *Industrial and Commercial Training*, 343-365.

39. Herath, S.C. (2021). Key Components and Critical Success Factors for Project Management Success: A Literature Review. *Operations And Supply Chain Management, 14*(4), 431-443. doi:http://doi.org/10.31387/oscm0470314

40. Hersey, P. (1969). Life cycle theory of leadership. *Training and Development Journal, 32*(5), 26-34.

41. Hoffman, T. (1999). The meanings of competency. *Journal of European Industrial Training, 23*(6), 275-286. doi:https://doi.org/10.1108/03090599910284650

42. *IPMA Individual Competence Baseline. Ver. 4.0.1.* (2015). Zurich: International Project Management Association.

43. *IPMA Polska Certyfikacja* (2023.04.05). Retrieved from: IPMA Polska, https://ipma.pl/certyfikacja/

44. Jaccard, D.B. (2022). How might serious games trigger a transformation in project management education? Lessons learned from 10 Years of experimentation. *Project Leadership and Society, 3*, 1-8.

45. Johnson, G.E. (1907). *Education by plays and games.* Ginn.

46. Jones, K. (1997). *Games and simulations made easy: Practical tips to improve learning through gaming.* Kogan Page.

47. Kaklauskas, A.A. (2010). The life cycle process model for efficient construction manager: Conceptual modeling at the level of personality and at micro, meso, and macro levels. *Construction, Building and Real Estate Research Conference of the Royal Institution of Chartered Surveyors, COBRA 2010.*

48. Karney, J. (2007). *Psychopedagogika pracy. wybrane zagadnienia z psychologii i pedagogiki pracy.* Warszawa: Żak.

49. Kaufmann, C.K. (2022). Does project management matter? The relationship between project management effort, complexity, and profitability. *International Journal of Project Management, 40*(6), 624-633.

50. Kolb, D. (1984). *Experiential Learning. Experience as The Source of Learning and Development.* New Jersey: Prentis Hall.

51. Kolb, D. (1984). *Experiential learning: Experience as the source of learning and development.* Prentice Hall.

52. Kothari, R. (2009). *Research Methodology Methods* (Second ed.). New Delhi: New Age International (P) Limited Publishers.

53. Kriz, W.C. (2010). A systems-oriented constructivism approach to the facilitation and debriefing of simulation and games. *Simulation & Gaming, 41*(5), 663-680.

54. Kriz, W.C. (2014). *The shift from teaching to learning. Individual, collective, and organizational.* W. Bertelsmann Verlag.

55. Kriz W.C. (2022). Gaming as Cultural Commons. Risks, Challenges, and Opportunities. *Translational Systems Sciences, 28*, 4.

56. Kuura, A. (2020). 25 years of projectification research. *Project Management Development – Practice and Perspectives 9th International Scientific Conference on Project Management in the Baltic Countries* (pp. 20-34). Riga: University of Latvia.

57. Kwan, A.C. (2015). Making smart choices: A serious game for sex education for young adolescents. *International Journal of Game-Based Learning, 5*(1), 18-30.

58. *LapSim* (2023.04.16). Retrieved from: surgicalscience: https://surgicalscience.com/simulators/lapsim/

59. Leigh, E.S. (2005). Congruent facilitation of simulations and games. In: R. Shiratori, K. Arai, F. Kato (Eds.), *Gaming, simulations, and society*, 189-198.

60. Lewis, R. (2007). Virtual Clinical Excursions: Gaming and Simulation for Application and Analysis. *Proceedings of SITE 2007--Society for Information Technology & Teacher Education International Conference* (pp. 1224-1229). San Antonio, Texas: Association for the Advancement of Computing in Education (AACE). Retrieved from: https://www.learntechlib.org/primary/p/24727/

61. Marnewick, C.E. (2016). *Information technology project managers' competencies: An analysis of performance and personal competencies.* Cape Town: AOSIS. doi:0.4102/aosis.2016.itpmc07.01

62. Maylor, H. (2017). Understand, reduce, respond: Project complexity management. *International Journal of Operations & Production Management, 37*(8), 1076-1093.

63. *Medical training simulators* (2023.04.16). Retrieved from: VirtaMed: https://www.virtamed.com/en/medical-training-simulators/arthros/

64. Michael, D.R. (2005). *Serious games: Games that educate, train, and inform.* Boston, MA: Thomson Course Technology.

65. Miler, J.A. (2016). Designing effective educational games-a case study of a project. *Federated Conference on Computer Science and Information Systems, IEEE* (pp. 1657-1661).

66. Milosevic, D. (2003). *Project Management ToolBox Tools and Techniques for the Practicing Project.* John Wiley & Sons, Inc.

67. Morris, P. (2013). *Reconstructing Project Management.* John Wiley & Sons.

68. Morris, P.J. (2004). Moving from corporate strategy to project strategy. *The Wiley Guide to Managing Projects*, 177-205.

69. Navarro, E.V. (2004). SimSE: An interactive simulation game for software engineering education. *Proceedings of the Seventh IASTED International Conference on Computers and Advanced Technology in Education* (pp. 12-17).

70. Patanakul, P. (2009). The effectiveness in managing a group of multiple projects: Factors of influence and measurement criteria. *International Journal of Project Management*, 216-233.

71. Patino, A.R. (2014). Identifying pedagogical uses of serious games for learning English as a second language. In: *Games and learning alliance.* Springer.

72. Petri, G.G. (2016). *MEEGA+: an evolution of a model of educational games.* Tech rep INCoD/GQS.03.2016. E. INCoD/INE/UFSC. Retrieved from: www.incod.ufsc.br

73. *PMBOK Guide - Seventh Edition* (2021). Project Management Institute.

74. *PM-GAME* (2023.04.25). Retrieved from: ALBASIM: https://www.albasim.ch/en/our-serious-games/#

75. *Project manager competency development framework.* (2017). Newton Square: Project Management Institute, Inc.

76. Robotham, D.J. (1996). Competences: measuring the immeasurable. *Management Development Review, 9*.

77. Rose, J.P. (2007). Management competences, not tools, and techniques: a grounded examination of software at WM-data. *Inf. Softw. Technol., 49*(6), 605-624.

78. Rumeser D.E.M. (2018). Project management serious games: identifying gaps, trends, and directions for future research. *Journal of Modern Project Management, 6*(1), 48-59.

79. Rumeser, D.E.M. (2018). Project management serious games and simulation: A comparison of three learning methods. *Journal of Modern Project Management, 5*(3), 62-73.

80. Schwagele, S. (2014). Gaming - an environment for learning and transfer. In: R.K. Duke, *Back to the Future of Gaming* (pp. 242-255). W. Bertelsmann Verlag.

81. *SimulTrain* (2023.05.07). Retrieved from: STS: https://sts.ch/en/products/simulation/simultrain

82. Soroka-Potrzebna, H. (2021). The importance of certification in project management in the labor market. *Procedia Computer Science*, 1934-1943. doi:10.1016/j.procs.2021.08.199

83. Stevenson, D. (2010). PM critical competency index: IT execs prefer soft skills. *International Journal of Project Management, 28*(7), 663-671. doi:10.1016/j.ijproman.2009.11.008

84. Svejvig, P.A. (2015). Rethinking project management: a structured literature review with a critical look at the brave new world. *International Journal of Project Management, 33*(2), 278-290.

85. Sydow, J.L. (2004). Project-Based Organizations, Embeddedness and Repositories of Knowledge: Editorial. *Organization Studies, 25*(9), 1475-1489. doi:https://doi.org/10.1177/0170840604048162

86. Taket, S.C. (2015). Competency mapping in project management: An action research study in an engineering company. *International Journal of Project Management*, 784-796. doi:10.1016/J.IJPROMAN.2014.10.013

87. *Touch Surgery Enterprise* (2023.04.16). Retrieved from: Touch Surgery Simulations: https://www.touchsurgery.com/simulations

88. Trocki, M. (2013). *Nowoczesne zarządzanie projektami.* Warszawa: PWE.

89. Trocki, M. (2017). *Metodyki i standardy zarządzania projektami.* Warszawa: PWE.

90. von Wangenheim, C.S. (2012). DELIVER! – An educational game for teaching Earned Value Management in computing courses. *Information and Software Technology*, 286-298.

91. Wouters, P.V. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology, 105*(2), p. 249.

92. Zielke, M.H. (2015). A serious-game framework to improve physician/nurse communication. *International Conference on Virtual, Augmented and Mixed Reality* (pp. 337-348). Springer.

93. Zyda, M. (2005). From visual simulation to virtual reality to games. *Computer, 38*(9), pp. 25-32.