



## DEVELOPMENT OF A GAME WITH ACCESSIBILITY FEATURES FOR TEACHING LEAN HEALTHCARE

DESENVOLVIMENTO DE UM JOGO COM RECURSO DE ACESSIBILIDADE PARA O ENSINO DE LEAN HEALTHCARE

DESARROLLO DE UN JUEGO CON FUNCIONES DE ACCESIBILIDAD PARA ENSEÑAR LEAN HEALTHCARE

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### ABSTRACT

Active methodologies of teaching bring the individual practical situations that encourage reflection and problem solving. Among them is the use of games, which seek to make learning more accessible and attractive. However, as much as this methodology works, it is not always inclusive. The application of games with accessibility features to teaching Lean Healthcare offers an engaging and inclusive approach to training healthcare professionals. This combination promotes the understanding of Lean principles in a practical and dynamic way, encouraging continuous improvement in healthcare service processes. The gamification strategy was then used, as it motivates the individual to learn, bringing better results. Thus, the present article presents a case study about the process of creating a game, entitled "Supply Chain Roulette", which has an accessibility feature, developed so that a person with visual impairment can enjoy it without limitations. The results present the final game and its records as an industrial design and software, in addition to discussing the advantages of gamification in teaching Lean Healthcare.

### RESUMO

Metodologias ativas de ensino trazem ao indivíduo situações práticas que incentivam a reflexão e a solução de problemas. Dentre elas, encontra-se o uso de jogos, que buscam tornar o aprendizado mais acessível e atraente. No entanto, por mais que essa metodologia funcione, ela nem sempre é inclusiva. A aplicação de jogos com recursos de acessibilidade para o ensino de Lean Healthcare oferece uma abordagem envolvente e inclusiva para a formação de profissionais de saúde. Essa combinação promove o

aprendizado dos princípios Lean de maneira prática e dinâmica, encorajando a melhoria contínua nos processos de serviços à saúde. Foi então utilizada a estratégia da gamificação, a qual motiva o indivíduo a aprender, trazendo melhores resultados. Assim, o presente trabalho apresenta um estudo de caso sobre o processo de criação de um jogo, intitulado "Roleta da Cadeia de Suprimentos", o qual possui um recurso de acessibilidade, desenvolvido para que uma pessoa com deficiência visual possa usufruí-lo sem limitações. Os resultados apresentam a versão final do jogo e seus registros como desenho industrial e programa de computador, e ainda, a discussão das vantagens da gamificação no ensino de Lean Healthcare.

### RESUMEN

Las metodologías activas de enseñanza aportan al individuo situaciones prácticas que fomentan la reflexión y la resolución de problemas. Entre ellos se encuentra el uso de juegos, que buscan hacer más accesible y atractivo el aprendizaje. Sin embargo, por mucho que esta metodología funcione, no siempre es inclusiva. La aplicación de juegos con funciones de accesibilidad para la enseñanza de Lean Healthcare ofrece un enfoque atractivo e inclusivo para la formación de profesionales de la salud. Esta combinación promueve la comprensión de los principios Lean de forma práctica y dinámica, fomentando la mejora continua en los procesos de los servicios de salud. Luego se utilizó la estrategia de gamificación, ya que motiva al individuo a aprender, trayendo mejores resultados. Es así que el presente artículo presenta un estudio de caso sobre el proceso de creación de un juego, titulado "Supply Chain Roulette", el cual cuenta con una característica de accesibilidad, desarrollado para que una persona con discapacidad visual pueda disfrutarlo sin limitaciones. Los resultados presentan el juego final y sus registros como diseño industrial y software, además de discutir las ventajas de la gamificación en la enseñanza de Lean Healthcare.

## 1. INTRODUCTION

For many years, traditional teaching methods, which focus on the unidirectional transmission of information from teacher to student and assess students in a uniform manner, have been the subject of debate. These methods are criticized for not considering students' prior knowledge, proactivity, and collaboration during the educational process (Móran, 2015). Paradoxically, professionals in the healthcare field, graduated under this model, are expected to demonstrate an innovative, reflective profile capable of influencing opinions (Farias et al., 2015). To develop the desired profile, it is essential to incorporate active methodologies as a didactic strategy in teaching practice (Móran, 2015).

The application of active methodologies in professional health education plays a crucial role in promoting meaningful learning. At least three approaches should be considered, used either independently or in combination: Problem-Based Learning (PBL), Team-Based Learning (TBL), and experimentation (Seabra et al., 2023). These methods engage students in practical situations, encouraging reflection, active research, and collaborative resolution of professional challenges. The integration between university, service, and community provides a critical interpretation of reality, stimulating the participation of different actors in the collective construction of knowledge. Valuing autonomy and responsibility, these methodologies promote affective and intellectual skills, fostering critical thinking and accountability for the learning process. The use of games as a means of learning is indispensable, making learning more accessible and appealing. When combined with changes in assessment, prioritizing formative assessment and continuous feedback, these strategies prepare future professionals for complex challenges in clinical practice and healthcare, contributing to a holistic and integrated approach aligned with contemporary demands in professional health practice (Hamada, 2016).

Derived from the Toyota Production System, Lean is a philosophy that seeks to streamline the production process through the use of specific tools. These tools can also be applied in the healthcare field, known as Lean Healthcare (LH). In this context, where operational efficiency is crucial, Lean tools can significantly enhance the management of people, processes, and resources, contributing to the improvement of service quality and promoting more positive outcomes (Holweg, 2007). However, even though various studies highlight the effectiveness of active methodology (Luiz et al., 2022), there are not many reports on the use of games for teaching Lean Healthcare specifically.

Accessible ludic games play a fundamental role in education by offering inclusive learning opportunities for a wide range of participants. Accessibility in educational games involves creating experiences that are easily understandable and participatory for all students, regardless of their individual abilities. This not only eliminates barriers to participation, but also promotes a more welcoming and diverse learning ambience. By incorporating elements such as clear instructions, varied formats and adaptive materials, accessible playful games in education enrich the learning experience for all students, contributing to a more inclusive and equitable educational ambience. This approach not only favors academic development, but

also strengthens values of respect for diversity and equality from an early age, preparing students for a more inclusive society in the future (Vale de Sousa, 2016).

Parallel to this, there is still a gap today regarding the inclusion of people with disabilities in the education scenario (Manzini, 2005). Silveira & Sá (2019) emphasize that playful education aligns with the predominant aspects of inclusive education by enabling a shift in teaching perspective, where the focus is not only on content but also involves the enjoyment and challenging aspect that engaging in the activity can evoke.

Thus, aiming to promote the teaching of Lean tools and seeking to answer the following question: “How can accessible gamification contribute to the teaching and learning process of Lean Healthcare in health units?”, the objective of this work is to present the development of a game with accessibility features as a facilitating means for the learning process of Lean tools in healthcare units and the inclusion of people with disabilities in accessing engineering.

## 2. THEORETICAL REFERENCES

### 2.1 Lean Healthcare

Immediately after World War II, the devastated Japan faced severe resource shortages, forcing the Japanese to find alternative ways to thrive in such circumstances. This led to the development of Lean Manufacturing philosophy, aimed at reducing waste and optimizing processes in the industry by providing the necessary tools. Over the years, this philosophy has been adapted for various other sectors, including healthcare, known as Lean Healthcare. Its goal is to ensure the quality and efficiency of patient care. It is an integrated system of principles, practices, tools and techniques focused on reductions of waste, synchronization of the workflows and management of their variability (D’Andreamatteo et al., 2015).

In a literature review, Zepeda-Lugo et al. (2020) indicated that with the implementation of LH, healthcare professionals increased their capacity, improving the patient flow to meet demands and contributing to the resolution of more complex problems. This is contingent upon the organization providing the necessary support. Fernandes et al. (2020) also highlights, in their bibliographic review, positive impacts such as waste reduction, increased productivity, financial return, improvement in the indicators’ performance, in addition to the clear improvement in the quality of service.

The National Curriculum Guidelines Commission (DCNs) for healthcare courses stipulates that the education process in this field should provide for student participation and autonomy through collaborative and participatory learning. Additionally, it considers the expanded concept of health, encompassing the individual in its entirety (n.d.).

Luiz et al. (2022), in conducting a bibliographic study on active teaching and learning methodologies in the training of health students, found positive results regarding the application of simulation, flipped classroom, and team-based learning as the main teaching strategies used in the healthcare field. This reinforces the need to implement such approaches in the education of graduates to promote changes in the training of these professionals.

The lack of encouragement for education causes many individuals to feel unmotivated to learn something new, especially when the learning is not interactive, becoming dull and tiresome. Thus, the use of gamification becomes ideal, wherein game elements are applied in contexts, products, and/or services that are not necessarily game-focused but intend to promote individual motivation and behavior (Bussarelo et al., 2014). It is then noted that this is an effective teaching method, in which individuals remain active and motivated throughout, consequently retaining the covered content. This strategy considers the concepts of Freire (1970), who proposes a liberating, problematizing, dialogical, and reflective education, positioning students as active subjects in their learning processes and protagonists in the creation of their knowledge. The use of this type of active methodology is a practice that adds to team training, especially in the application of the Lean philosophy, which comes from the manufacturing industries and has been used in the most diverse types of sectors, including the area focused on medical care (de Araujo et al., 2023).

## 2.2 Accessibility and Inclusion

The Brazilian Association of Technical Standards (ABNT, 2004), defines accessibility as the possibility and condition of reaching, perceiving, and understanding for safe and autonomous use of spaces in everyday life. Despite the norm focusing on the use of these spaces, it also emphasizes that the term ‘accessible’ implies both physical and communication accessibility. The United Nations (UN), sets goals called Sustainable Development Goals (SDGs), so that by 2030 all people can enjoy peace and prosperity. The SDG 4 seeks to ensure access to inclusive, quality and equitable education, promoting learning opportunities for all (Objetivos de Desenvolvimento Sustentável, n.d.).

Nevertheless, Freitas (2023) emphasizes that the word ‘inclusion’ is not self-explanatory, and access and inclusion do not imply the same, as the later depends on various other factors. Accessibility is, therefore, the achievement of access, and inclusion is the consequence of that; it is the coexistence of a person with a disability in the same space as any other person. Therefore, as Manzini (2005) shows, social inclusion should be seen, measured, and interpreted with the social environment itself as a reference, not solely based on accessibility conditions. In this sense, accessibility can be understood as the path to inclusion.

Knowing that education is a universal right, it is essential to consider accessibility aspects when creating games and technologies for this ambience (Torrente et al., 2014). That pointed, several researchers are already studying the universal design format, such as Alves et al (2014), who, when developing and evaluating a game from this perspective, shows that this is still a challenge, as it involves numerous factors and areas of knowledge that are necessary for its conclusion, further highlighting that the aim of the game is not to develop something for people with disabilities, but rather to allow them to enjoy the same resources as others.

Oliveira et al. (2021) also identified in their research on usability and accessibility of an educational game for people with visual impairments, that one of the main problems faced by people with this type of disability is the lack of audio description, reiterating that auditory feedback for these people is necessary in all interactions.

### 2.3 Education and Gamification

Gamification is defined by Araujo et al. (2023) as the use of game mechanisms and systems with the aim of solving problems, increasing motivation and engagement of an audience for certain information. They also emphasize that the method enhances the ability to retain the knowledge transmitted and capacitates professionals. In this way, gamification contributes to the development of social and professional skills, directly influencing more assertive decision-making and more precise action plans.

In this sense, there is an increasing need for a new teaching profile, given the progressive changes in contemporary society. This new stance can then be found in active teaching methodologies, which place the student as the protagonist of the learning process (Luiz et al., 2022) and the teacher as the activator of this knowledge, serving as a mediator in this regime (Fioravante & Bonilha Guarnica, 2019).

Fioravante and Bonilha Guarnica (2019) also show the importance of expanding the teacher-student-knowledge triad to obtain more fluid and meaningful learning, in which the student's well-being is a fundamental part of the dynamic. Gamification must therefore be enhanced in Lean teaching, seeking to break the theoretical with the practical, thus contributing experiences to deal with problems that arise every day, enriching the professional knowledge.

### 3. METHODOLOGY

The present study is characterized as an action research with a qualitative approach, based on the development of a card game aimed at teaching Lean Healthcare. The choice of this method is suitable, because, as Bunder and Barros (2019) shows, this process is conducted in a cycle of action and reflection, which begins by defining the solution that will be tested for a specific problem, in which the researcher makes use of their theoretical-scientific knowledge and the participants use their practical knowledge.

The game developed was applied to employees of a public hospital that is a reference in humanized births, located in the city of Feira de Santana - Bahia, where a high volume of emergency and clinic care is provided. During the study, the existence of three major gaps was noted: the teaching of LH, both for health and production engineering students and professionals, the lack of more practical and functional teaching and learning methodologies and the lack of accessibility for people with visual impairments regarding the use of active teaching methodologies. Seeking to fill them, first, a guiding theme was established which would teach Lean tools, choosing the supply chain of a hospital. Subsequently, the best accessibility feature that would guarantee the inclusion of people with visual impairments during the application of the game was explored and defined. Then, QR code technology was used, which led to a link that provided audio description of the cards, both questions and answers.

Therefore, aiming to facilitate the learning process for individuals unfamiliar with the subject and, furthermore, to promote accessibility for people with visual impairments, the game creation process occurred in 4 stages: model definition, card development, definition and development of the accessibility feature and its registrations as an industrial design and software, which ones will be addressed in the results and discussion section.

#### 4. RESULTS AND DISCUSSION

The objective of the game, named Supply Chain Roulette, is to show how a hospital's supply chain management works. Through it, it is possible to assist in teaching Lean Healthcare tools in healthcare units that already have or are in the process of implementing LH in stock management, and can also be applied to students in the healthcare or Production Engineering area.

In stage 1, the game model was defined. Once the concept was established, the process of building the model began. Questions were then created and divided into easy, intermediary and difficult levels, and separated into 4 areas: pharmacy, satellite pharmacy, warehouse and general knowledge. The proposal is that it be applied in a roulette game format together with cards, and can be played individually or as a team. When spinning the roulette wheel, the player or team must take a card and answer a question corresponding to the area drawn, being able to choose the difficulty level. If the answer is correct, the player will receive the amount of points according to the chosen difficulty level. Otherwise, the turn passes to the next player.

Three questions of each difficulty level were elaborated for each sector, except Satellite Pharmacy, which has only two questions for the difficult level. The general knowledge questions have no difficulty level, being three in total. At the end, was 29 questions in total. Table 1 shows an example of the difference between easy, intermediary and difficult questions for the Pharmacy sector.

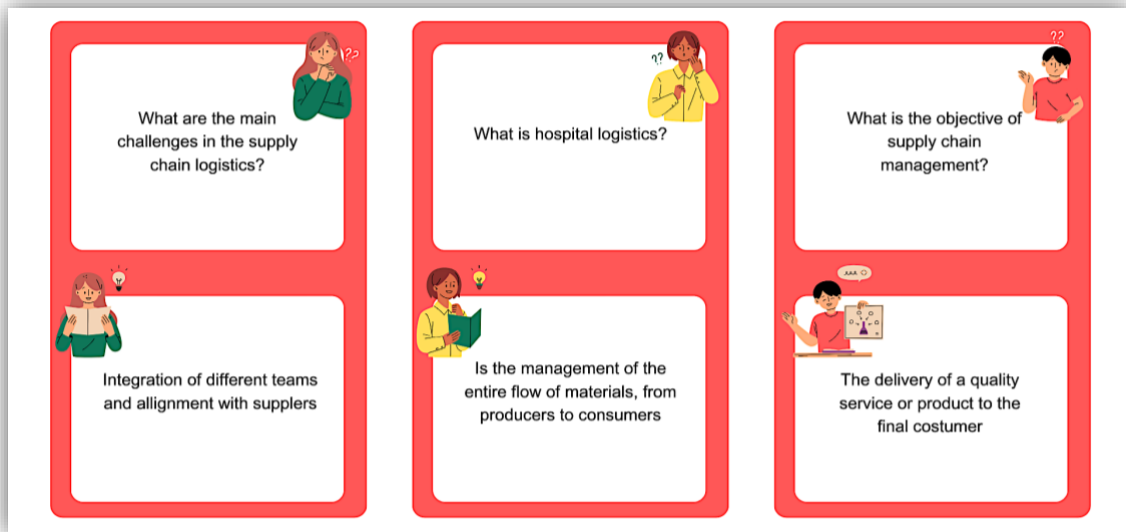
**Table 1.** Difference between the questions by difficulty levels

Level	Question	Answer
<b>Easy</b>	Who are the end consumers of the products (medicines)?	The patients of the hospital
<b>Intermediary</b>	What is the importance of the logistical activities for a hospital pharmacy?	It is important for the administration and supply of essential medicines for good patient care
<b>Difficult</b>	What are the steps in hospital pharmacy purchasing management?	Selection, specification, classification and coding of products

Source: Own authorship.

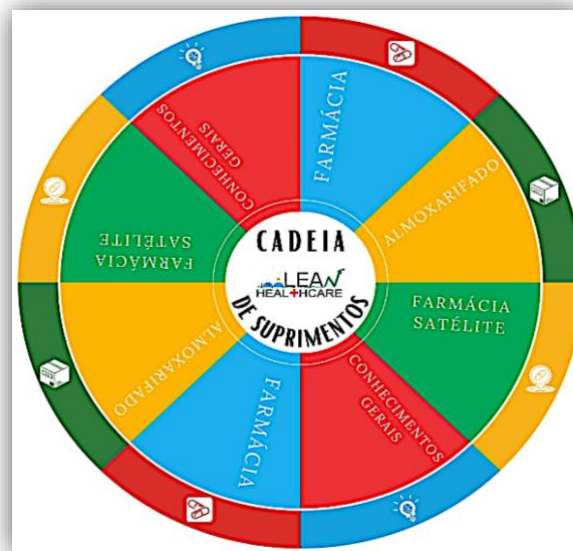
In stage 2, the cards and roulette were developed. With the questions already elaborated, the game's visual identity was created. Using the digital graphic design platform Canva, the color palette was chosen for each area, as well as the figures and font for the text with the question and the respective answer. The colors were chosen based on those present in the project logo. Figures 1 and 2 show the model of cards and roulette developed, respectively.

Figure 1. Game cards template (adapted)



Source: Own authorship.

Figure 2. Game's Roulette



Source: Own authorship.

With the cards model already produced, in stage 3, the accessibility feature for people with visual impairments was developed. This group was chosen because it was noted that it suffers from a large lack of inclusion in relation to ludic games. Besides that, according to the National Health Survey (IBGE, n.d.), it represents 3,4% of the Brazilian population, being the most predominant kind of disability among the others.

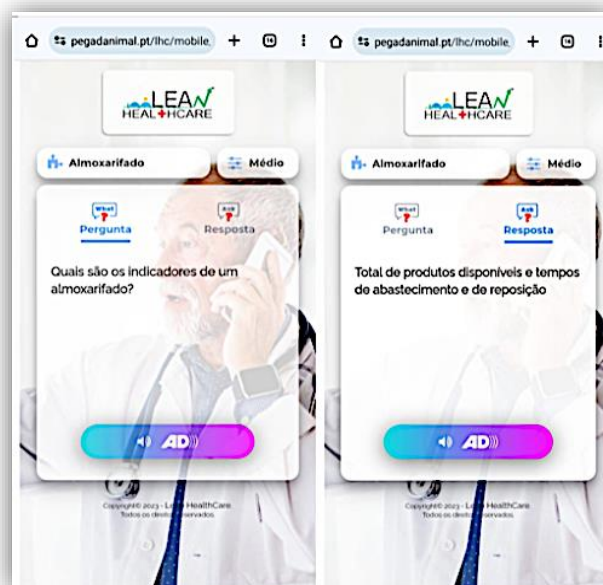
In this way, with the resource model already defined, for its preparation, QR codes were created and placed on the back of the cards, shown in figure 3. These ones, directed to a link that provides audio description, both of the questions and the answers, shown in figure 4. This ensures that with their own cell phone, any player, whether visually impaired or not, can read the codes and participate normally in the game according to the rules previously established.

Figure 3. Card back template (adapted)



Source: Own authorship.

Figure 4. Card's audio description screen



Source: Own authorship.

Finally, with the game finished, in step 4 the cards were registered as Industrial Design and the audio description system as a Computer Program. First, all the necessary documentation was prepared and filled, separately. Subsequently, they were sent to the Creation and Innovation Coordination (CINOVA) of the Federal University of Recôncavo da Bahia (UFRB), which made the requests to the National Institute of Industrial Property (INPI).

In this aspect, as discussed previously in the section 2.3, the use of ludic games contributes in several ways to learning in different areas of application, as pointed by Araujo et al (2023). Torrente et al (2014) reiterate the indispensability when creating games and technologies for the teaching and learning process, as shown in the section 2.2. Vale de Sousa (2016) brought in his insightful work, an analysis of application of ludic games with accessibility in the learning



of children with visual impairments. Playful activities play a fundamental role in the development of children with visual impairments, allowing them to develop imagination, creativity and sensory skills through the exploration of textures, shapes and smells. Furthermore, playing enables the production of knowledge, interaction with other people, including those who can see, and the development of motor, cognitive and social skills in a pleasurable way. Therefore, playful activities are essential to promote the inclusion, learning and active participation of children with visual impairment in social interactions and their overall development.

Still in the school context, Fioravante and Bonilha Guarnica (2019) proposed didactic-pedagogical strategies for highlighting the relevance of playfulness in promoting significant experiences and learning in the discipline of Biology. Active practices and methodologies, of a playful nature, significantly amplified the relationship between teacher, student and knowledge. By integrating play into Biology teaching, the activities stimulated student engagement, promoting their protagonist in the learning process and developing critical thinking skills. Besides that, playfulness and active practices strengthened the emotional relationship between teachers and students, creating an ambience of trust and collaboration.

In the health sector, the use of active methodologies and playful learning is also possible. Mitre et al. (2008), presented an article that discusses the importance of active teaching-learning methodologies in professional health training, highlighting their contribution to the integral development of future professionals. Active teaching-learning methodologies play a fundamental role in the integral development of health professionals, by stimulating meaningful learning, integrating theory and practice, developing essential skills and competencies, promoting student autonomy and responsibility, and fostering interdisciplinarity. Through the active participation of students, the resolution of contextualized problems and collaboration between different areas of knowledge, these methodologies prepare future health professionals to face the complex challenges of the work environment, contributing to a more solid and comprehensive training in the area of health.

In an analysis of the application of active methodologies in the health area, Marin (2010) discusses the implementation of this tool in the medical field, emphasizing its importance in professional training in this area. Active learning methodologies are presented as a model more aligned with the principles of current health policy, based on critical pedagogy. This educational approach focuses on the analysis of problems in immediate social reality, the identification of their determining factors and the search for transformative interventions. By adopting active methodologies, health professionals are encouraged to reflect on social contradictions, problematize reality and develop skills to deal with the demands and challenges of the health system, which contributes to a more critical, reflective and committed to the needs of society.

With this, it can be concluded that teaching Lean Healthcare through ludic games with accessibility resources for healthcare professionals represents an innovative and effective approach to training this group in principles and practices related to continuous improvement and efficiency in healthcare services. By using ludic games, healthcare professionals can experience Lean concepts in a practical way, better understanding how to apply them in their work ambience. Additionally, the accessibility of these games ensures that professionals of different skill levels and familiarity with Lean can participate and benefit equally from the learning experience. This promotes a deeper and lasting understanding of Lean Healthcare principles, empowering healthcare professionals to identify and reduce waste, improve processes efficiency and, ultimately, provide higher quality care to patients.

### FINAL CONTRIBUTIONS

The active teaching and learning methodology have been increasingly used by educators in all areas of knowledge, mainly through the use of games. Besides bringing playfulness, it also develops fundamental skills and competencies for the individual's development, both personally and professionally. However, this approach is not always inclusive.

Furthermore, although the Lean methodology is well known in the industrial area, its performance in the health field (Lean Healthcare) is still little disseminated among professionals in the area, whether in health or engineering. In an attempt to reverse this scenario, this work sought the answer to the question: "How can accessible gamification contribute to the teaching and learning process of Lean Healthcare in health units?". In this way, the game created seeks to collaborate during the implementation of Lean in health units, assisting in the management of the supply chain, therefore contributing to the optimization of the flow of materials in stock. Thus, serving as support material both for healthcare professionals who are not familiar with the tools, and for Production Engineering students, who can "learn by teaching". For both, it is a better way to capture the content taught quickly and easily. Furthermore, it allows people with or without visual impairments to enjoy it in the same way, through the developed accessibility feature. Thus, promoting a path for the inclusion of these people in the LH area.

As the main gain, one can note the scientific contribution made to the academy, in the area of innovation, through the registrations with National Institute of Industrial Property. They guaranteed the game's authors the UFRB Inventor Award, granted by the institution itself in 2023 for its creation. Furthermore, the game is applied at various events by project participants, promoting social contributions to the external community and arousing the interest of other students in Production Engineering and Lean Healthcare. Also contributing to the training of healthcare professionals, in the managerial area, who work where Lean is being implemented. However, as a restriction, in order to verify the effectiveness and efficiency of the game in these trainings, it must still be tested and validated by qualified professionals, thus leaving an opportunity for future works.

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