Silver Bullet - Software Project Management Process Support Tool

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ABSTRACT

Software engineering is essential to modern software development, encompassing methodologies, tools, and practices to ensure quality, maintainability, and adherence to deadlines and budgets. However, many software projects still fail due to poor or absent management practices. According to the Project Management Institute (PMI), organizations with a strong project management culture achieve a 71% success rate and significantly fewer financial losses. In response to the need for better training in software management, the Silver Bullet tool. was created in 2018 to support teaching and learning aligned with PMI's PMBOK®. Initially developed for the Problem Solving VI course in a Software Engineering program, the tool aimed to improve both project outcomes and management practices. Since then, it has evolved beyond academia, contributing to professional training and addressing challenges in software project success. The ongoing development of Silver Bullet reflects advancements in educational tools and the broader effort to strengthen the software engineering field. License: Subscription License (SaaS).
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KEYWORDS

Project Management, PMBOK®, Software Tool, PMST.

1 Introduction

Software engineering is a fundamental pillar of modern technological development, supporting the design, implementation, and maintenance of systems across different domains. Within this discipline, the practice of project management emerges as a critical competence to ensure that software is developed within expected time, cost, scope, and quality constraints. Despite the availability of methodologies and tools, the failure rate of software projects remains alarmingly high, largely due to the absence or inadequate adoption of project management practices.

According to [11], around two-thirds of software projects fail due to poor or nonexistent project management. Similarly, the Project Management Institute (PMI) emphasizes that organizations with a solid project management culture exhibit a 71% success rate in project execution and suffer 13 times fewer financial losses than those that do not prioritize such practices [8].

This critical context highlights the urgent need to train future professionals not only in software development techniques but also in the principles and practices of project management. In response to this challenge, the *Silver Bullet* tool was created in 2018 with the purpose of supporting teaching and learning in software project management, originally within the scope of the Problem Solving VI (SP VI) course of the Software Engineering undergraduate program at the Federal University of Pampa (Unipampa). Built upon the guidelines of the PMBOK® Guide (Project Management Body of Knowledge), the tool was designed to simulate a project environment aligned with best practices, including documentation, communication, task management, and evaluation features.

Over the years, *Silver Bullet* evolved into a central pedagogical resource in the SP VI course, becoming widely adopted across different offerings and contexts. However, its initial architecture and feature set were strongly based on the 6th edition of the PMBOK® [8], which follows a predictive and process-oriented approach, organized into ten knowledge areas and five process groups.

While valuable in structured and low-variability scenarios, this approach does not fully address the dynamic and complex reality of modern software projects, where adaptability and continuous delivery are crucial. In 2021, PMI released the 7th edition of the PMBOK® [10], introducing a principle- and performance-domain-based structure, with a stronger emphasis on agile, adaptive, and hybrid methodologies.

Motivated by this paradigm shift, the *Silver Bullet* project underwent a substantial transformation starting in 2022, aiming to refactor and extend the tool to support both the 6th and 7th editions of the PMBOK®, thus embracing a hybrid approach. This evolution encompassed architectural improvements, technology migration, interface redesign, and the incorporation of features such as rich-text editing, collaborative document editing, and enhanced integration among project artifacts. These changes were driven by the results of previous user evaluations and surveys, which identified key limitations in the earlier version of the tool,

such as dependency on external tools, redundant data entry, poor collaboration support, and lack of intelligent assistance.

The new version of *Silver Bullet* aims to address these challenges by providing a modern, responsive, and student-centered platform, integrating pedagogical support and practical functionality. To evaluate the impact of these changes, a case study was conducted with students enrolled in the SP VI course in 2024, evaluating the perceptions of students and professors through questionnaires and feedback. The updated version demonstrated significant improvements in efficiency and effectiveness, such as reduced rework and increased flexibility. However, challenges related to usability and navigation remain.

Therefore, this paper aims to present the motivation, development process, and evaluation of the current version *Silver Bullet* tool. Specifically, it seeks to (i) describe the problems that motivated its evolution, (ii) explain the engineering process and new features aligned with the PMBOK® 7th edition, and (iii) discuss the results obtained from the case study and feedback from students. By addressing current gaps in PM education through a flexible platform, *Silver Bullet* contributes not only to academic training but also to bridging the gap between theory and practice, thus equipping future professionals with the skills needed to reduce the high failure rate of software projects and promote sustainable software engineering practices.

2 Potential Users

The *Silver Bullet* tool is currently positioned as a comprehensive project management solution, catering for different user profiles in both academic and professional environments.

2.1 Academic vs. Professional Ecosystem

As mentioned above, one of the principles of the tool is to make PM teaching solidly based on the principles of the PMBOK® so in the academic setting the tool effectively serves teaching institutions, lecturers and students. It provides an ideal environment for learning PM and simulates situations that occur in real projects, which facilitates learning by effectively combining theory and practice.

At the same time, *Silver Bullet* understands that it has value in the professional environment, being able to serve industries and professionals in training with the aim of implementing structured PM methodologies. Proof of this is the evolution of the tool to the 7th Edition of the PMBOK® which is suitable for the agile approach, which is extremely important in today's market.

2.2 Simultaneous Collaboration Feature

Taking into account the feedback acquired during all versions of the tool, functionalities have been added that allow project managers and the members of each project to have autonomy during the life cycle of each project. The feedback received has become one of the significant differentiators of the tool, which today has a simultaneous collaboration tool, this function, which today uses a *Websocket* server that has a *Yjs framework*, very similar to Google Workspace, which allows a visual representation and the iteration of multiple users in a single document.

This feature increases *Silver Bullet's* robustness since simultaneous collaboration is ideal for both large teams and start-ups, allowing multiple people to work and see changes in real time within the tool's documents. This functionality reduces rework and makes it easier for multi-functional teams to work together.

3 Software Engineering

3.1 Software Requirements

First and foremost, it is worth to emphasize that this project is being developed collaboratively, where each part depends on the contribution of others for the advancement of the tool's development. With this in mind, one of the team assumed the responsibility of documenting and specifying the application requirements. We divided this task into three interdependent parts: (1) analysis and specification of requirements, (2) screen prototyping for the documentation, and (3) detailed documentation of the functionalities.

Accordingly, a list of the tool's functionalities was compiled and specified using user stories. Additionally, the non-functional requirements of the project were also identified. Both sets of information are available in the Zenodo (Section Artifact Availability). Furthermore, screenshots and a brief demonstration of the current version of the tool are also provided.

3.2 Componentization

Componentization, also known as software modularization, plays a fundamental role in Software Engineering by offering multiple benefits to system development. This practice breaks down complex systems into smaller modules—independent, reusable, and interchangeable units of code [5].

Developers design these modules to achieve high internal cohesion and low coupling, which simplifies maintenance, increases scalability, and promotes code reuse [13]. Following this approach, we present the main components developed to address the issues identified in the current version of the tool.

3.3 Technologies

When developing a software project, selecting the right tools plays a crucial role in ensuring the efficiency, quality, and robustness of the final product. The chosen tools actively support multiple stages of the development lifecycle, from design and planning to implementation, testing, and maintenance [14]. With this in mind, Table 1 presents the technology stack selected for the development of the new version of *Silver Bullet*, including frameworks and libraries.

3.4 RichEditor & Collaboration

One of the most frequent complaints about the current tool is the lack of a robust text editor, which can become inconvenient for users when writing longer texts. To avoid this potential discomfort, we developed a RichEditor—a WYSIWYG (*What You See Is What You Get*) editor. For this, we chose a headless library, meaning that all styling and customization of the editor falls under the developer's responsibility. The selected library is TipTap, a fully customizable framework built on ProseMirror, another WYSIWYG editor.

Although the editor provides basic functionality and includes some pre-installed plugins, it offers nothing more than a plain text box by default. As a result, the entire concept, styling, and state management logic of the editor had to be designed and implemented

Table 1: List of main technologies selected for development.

Library	Version	Description
TypeScript	5.8.3	TypeScript is a strongly typed programming language based on JavaScript, offering more advanced tooling at any scale.
React	18.2.0	A JavaScript library for building reactive user interfaces. It also supports integration with TypeScript.
TailwindCSS	3.4.17	TailwindCSS is an open-source design framework that allows flexible customization of user interfaces using utility classes in CSS. It also facilitates the creation of responsive interfaces.
React Aria	3.37.0	React Aria is a library that provides accessible React hooks and components to support the development of user interfaces that comply with web accessibility guidelines.
Framer Motion	11.18.2	Framer Motion is an animation library for React that simplifies the creation of declarative and responsive UI animations.
HeroUI	2.7.8	HeroUI is a comprehensive UI library for React, built on top of TailwindCSS, Framer Motion, and React Aria.
I18next	23.16.8	I18next is a JavaScript library for internationalization, allowing easy and efficient translation of content in a web application into multiple languages.

from scratch. To avoid creating an overly complex interface, we based the editor's design on common models from existing editors: a toolbar at the top and a text input area below. Figure 1 presents the structure of the component: **(1)** Component label linked to the input field; **(2)** Tooltip with additional information on the expected user action; **(3)** Toolbar for text formatting; **(4)** Text input area; **(5)** Real-time conversion of the current text for use in Overleaf; **(6)** Button to hide the fixed toolbar; **(7)** Character count; **(8)** Word count; **(9)** Collaboration server connection status.

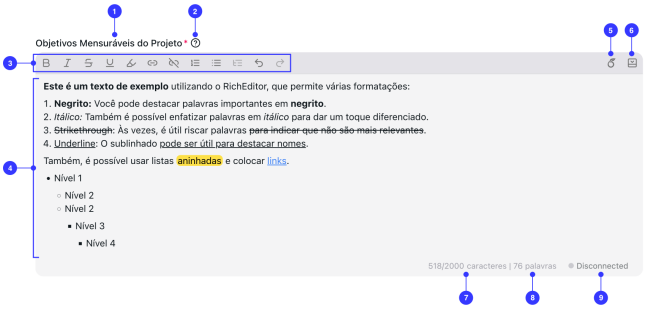

Figure 1: Component RichEditor

In addition, we identified another issue: the lack of real-time collaboration within documents. This type of collaboration refers to the ability of individuals or groups to work simultaneously on the same project, viewing and editing content instantly [7].

To address this problem and enhance collaboration efficiency among team members, we implemented a service that allows users to work on documents in real time (Figure 2). This service relies on a WebSocket server configured to handle documents in the editor's specific format. It is built using Yjs, a framework that enables efficient, conflict-free data sharing and automatically distributes changes across users.

3.5 Tags

During the tool's development, we noticed the absence of a generic multi-select component capable of handling scenarios involving relationships among multiple items within documents.

To meet this need, we developed a tag component that supports single and multiple selection, includes an item search field, offers

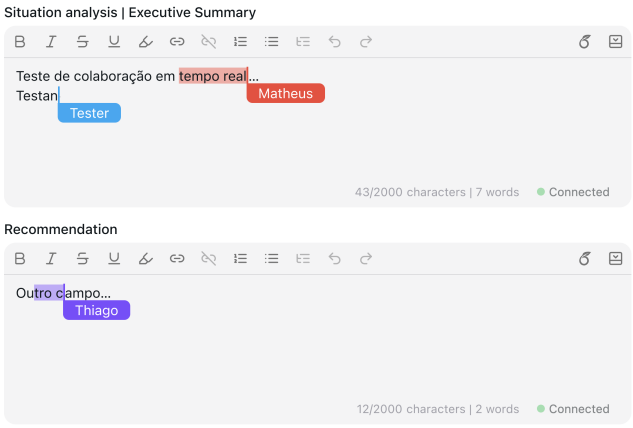

Figure 2: Simultaneous Collaborative Editing

high customizability, and allows users to add new items if the desired one is not available. Figure 3 presents the component designed to address this issue.

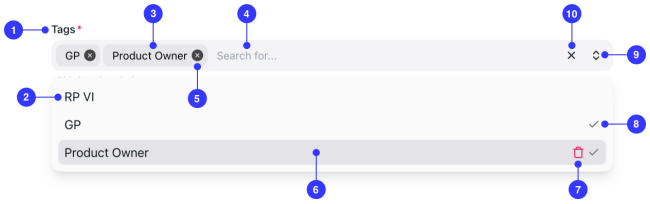

Figure 3: Tag Component (*Tags*)

As shown in Figure 3, we divided the tag component into several parts: **(1)** label linked to the input field; **(2)** listed item; **(3)** selected item; **(4)** item filter input; **(5)** button to deselect a specific item; **(6)** button to select an item; **(7)** delete button to remove an item from the list; **(8)** indicator showing the selection state of an item; **(9)** toggle button to open or close the item list; and **(10)** button to remove all selected items.

Additionally, we implemented features to enhance accessibility, allowing users to perform common actions using the keyboard.

3.6 Dashboard Menu

In the previous version, the dashboard menu aimed to facilitate navigation across application pages by functioning as a direct link to each document. However, the layout's block arrangement created visual gaps, and the lack of a search function made it harder for users to find specific information, resulting in a less efficient navigation experience.

To improve usability and streamline navigation, we redesigned the main dashboard. Instead of using a static page for navigation, we turned the dashboard into a global modal, allowing users to access it from anywhere in the application.

As shown in Figure 4, the new dashboard includes several modular sections: (i) search field for application phases; (ii) current view mode of the modal, which can be "Areas", "Phases", or "Recent Documents"; (iii) list of available items; (iv) button to list all

Figure 4: New Menu

phases; (v) button to view recent documents; (vi) current workspace; (vii) current project; (viii) button to close the modal.

Users can access the modal in four ways: (i) by clicking the name of a project on the project listing page; (ii) by clicking a project's action button and then selecting "Open"; (iii) by clicking the global button in the application header (only available after entering a project); or (iv) by using the shortcut `CTRL + M` on Windows and Linux or `Meta + K` on macOS (same condition as above applies).

3.7 Software Architecture

We developed an architectural diagram of the tool (Figure 5) using the Icepanel tool[1], following the C4 model standard [15]. The diagram illustrates the main modules of *Silver Bullet*, their relationships with key actors (Project Manager, Professor, Developers, etc.), and the system's external integrations. In *Silver Bullet*, users with the Project Manager role can create projects and manage the entire set of PMBOK knowledge areas, which are developed by Developer users and evaluated by Professor users.

The *Silver Bullet* system is composed of three main components: the Web Application, Hocuspocus, and the Backend. The Web Application serves as the frontend interface for users using React, Typescript and Vite.js technologies . Hocuspocus is a real-time collaboration server using Node, WebSocket and Typescript. The Backend is a REST API server that handles application logic and communication between components using Typescript, Node and Prisma. Data generated within the *Silver Bullet* core is persisted in a PostgreSQL database and Supabase Backend-as-a-Service (BaaS) [6]. Additionally, Hocuspocus stores collaboration data in a separate PostgreSQL database using Supabase BaaS.

Authentication for the application is handled via integration with the external Google Auth system.

4 Case Study

Context: We developed *Silver Bullet* to support the teaching of software project management and has been employed in the Problem Solving VI (PS VI) course within the Software Engineering program at the Federal University of Pampa (Unipampa). SP VI adopts an active learning approach based on the Problem-Based

[1]Icepanel: https://icepanel.io/c4-model

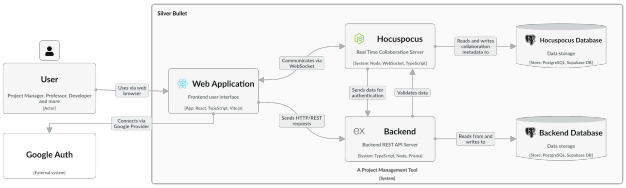

Figure 5: Architectural Diagram based on C4 Model

Learning (PBL) model [4], in which students are organized into groups responsible for managing a project while simultaneously acting as developers for another group.

RP VI is offered annually during the second academic semester. In the 2024 edition, students were challenged to develop a mobile application capable of transcribing articles and books into audio based on outreach project demand engaging community members. This challenge provided a valuable opportunity to apply the new version of *Silver Bullet* in a real-world educational setting.

To assess the tool's effectiveness in this context, a case study was conducted [16]. SP VI adopted the teaching approach previously published by [1], in which it evaluated previous versions of the tool, thus allowing a comparative analysis between the versions and a more detailed evaluation of the results achieved.

Objectives and Research Questions (RQ): We developed the case study following the protocol proposed by Brereton *et al.* [2], with the following main objectives: to evaluate the effectiveness of *Silver Bullet* in software PM, to verify its compliance with PMBOK® and to analyze the progress provided by the new version of the tool, making a comparison with the previously study [1]. To achieve these objectives, we defined the following RQs:

RQ1. What are the successes, errors and aspects that could be improved in the new version?
RQ2. Has the new version of the tool shown progress in terms of efficiency and effectiveness in PM and its teaching?
RQ3. Does the new version have good usability, satisfy users and encourage its continued use?

Protocol and Data Collection: We structured the protocol in four phases, organized according to the SP VI's milestones, which, in turn, adapting the process groups defined by PMBOK® 6th edition. These phases and milestones of the SP VI correspond, respectively, to the processes of "Initiation" (Phase 1), "Planning" (Phase 2), "Execution, Monitoring and Control" (Phase 3) and "Closure" (Phase 4). In each of the phases, data is collected for later analysis.

We used three different types of questionnaires during these phases. The first is the Profile Assessment (PA) questionnaire of the participants and the Informed Consent Form (ICF), applied only at the beginning of the study. Likewise, to allow a fair comparison, the Functionality Assessment (FA) questionnaire was kept the same as that used in the research by [1].

This questionnaire was applied at the end of all phases and aimed to analyze the students' satisfaction with the tool, identify its positive and negative points, evaluate the students' perception of how much the tool helped them and measure the participants' affection towards the tool, using the circumflex model of [12].

On the other hand, the Usability Assessment (UA) questionnaire followed the TAM model (Technology Acceptance Model) [3]. This questionnaire was an adaptation of the one used by [1], with a new organization and the addition of some questions. It was applied only once, at the end of Phase 3, and contains questions related to *Perceived Ease-of-Use* (PEoU), Perceived Usefulness (PU) and Intention to Use (IU). Due to space constraints, we chose to make the ICF and the list of questions from the questionnaires applied available in an open repository.

Execution: The study began on August 26, 2024, and concluded on December 13, 2024. Seventeen students participated in the research (out of a total of 23 who initially agreed to participate, but only 17 answered a questionnaire in addition to the PA and the ICF). Of the 17 participating students, 65% considered themselves to have high or very high knowledge in software projects and 76% claimed to have average or low knowledge, regarding knowledge in PM. Ten participants stated that they had no knowledge of PMBOK®, while 4 indicated that they were familiar with the 6th edition and 3 declared that they were familiar with both editions. Seven participants claimed to have high or very high knowledge in some of the areas of knowledge; however, considering all areas and all participants, there was a rate of 60% evaluating their knowledge as low or very low. During the execution of the phases, we had the following distribution of participants: 13 (Phase 1), 11 (Phase 2), 12 (Phase 3) and 11 (Phase 4). All data and artifacts used in the research are available in Section Artifact Availability.

Results: Here, we sum up the main results answering each one of the RQs proposed by the study.

> **RQ1.** The main successes include the choice of design and the filling tips with examples. Among the errors highlighted are the presence of some bugs, the lack of information about certain features of the tool, and the lack of a centralized location for general viewing of progress and feedback. Finally, suggestions for improvements include the correction of bugs, greater automation, and the creation of a general dashboard for document management.

We answered **RQ3.** based on usability assessment questionnaire shown in Figure 6. In general, it can be seen that the tool presents good usability and adequately fulfills its role. Almost all participants agreed with the questions related to PU, with the exception of one participant who remained neutral in relation to PU3 and another in relation to PU4.

> **RQ2.** It was found that the new version of the tool showed significant advances in relation to its previous version. A total of 70% of the respondents strongly agreed that features used in *Silver Bullet* contributed to productivity (reduction of effort), compared to 26% in the previous version.

In addition, the answers regarding the IU, indicate that the tool has an attractive proposal, and users have shown interest in using it again. However, it is important to pay attention to the perceived ease of use. As pointed out in the open questions, some answers suggest a certain difficulty in learning how to use the tool for certain users, highlighting the need for adjustments to make the experience more intuitive.

Comparing usability with the previous version, there was a significant improvement in the IU: 58% of participants would strongly recommend the tool, compared to 41% in the previous version [1]. Regarding PU, there were notable advances, with the new version presenting superior results in all questions. On the other hand, improvements in PEoU were more modest, *e.g.* in statement PEoU1, 33% of participants strongly agreed that the tool is easy to use, the same percentage as in the previous version. There was only a slight increase from 33% to 50% in the number of participants who agreed with the statement (regardless of the level of agreement).

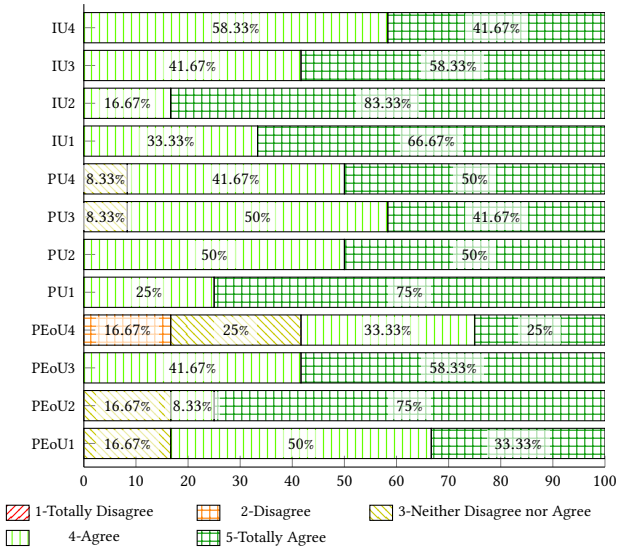

Figure 6: Usability assessment questionnaire results.

> **RQ3.** This version has proven to be quite useful and has the potential to encourage continued use. However, it is necessary to improve aspects related to ease of use and features aimed at teaching PM.

5 Related Tools

To better understand the position of the *Silver Bullet* tool within the landscape of software project management solutions, it is relevant to compare it with other widely adopted platforms, such as **ClickUp**, **Asana**, and **Jira** (Table 2).

These commercial platforms have gained widespread adoption in professional environments due to their comprehensive feature sets designed to enhance team productivity, streamline task coordination, and automate workflow processes. However, despite their sophistication and market penetration, these tools are primarily oriented toward business applications and lack explicit alignment with established pedagogical frameworks or standardized project management methodologies such as the *Project Management Body of Knowledge - PMBOK®*.

In contrast, *Silver Bullet* was specifically developed with educational objectives at its core, serving as a pedagogical instrument to support the teaching and learning of project management principles grounded in PMBOK® standards. The tool's latest iteration demonstrates enhanced flexibility by integrating support for both the 6th and 7th editions of PMBOK®, thereby enabling the implementation of hybrid methodologies that seamlessly combine predictive

Table 2: Comparative Overview of *Silver Bullet*, ClickUp, Asana, and Jira.

Criterion / Tool	*Silver Bullet*	ClickUp	Asana	Jira
Primary Objective	PMBOK®-based education	Task and productivity management	Collaborative project tracking	Agile project management
Educational Orientation	Yes (academic use)	No	No	No
Support for PMBOK® 6 & 7	Yes (hybrid support)	No	No	No
Real-Time Collaboration	Yes (Yjs + WebSocket)	Yes	Yes	Yes (via Confluence)
Integrated Document Editing	Yes (custom RichEditor)	Limited	Basic	No (via Confluence)
Process Automation	In development	Advanced automations	Rule-based automations	Advanced workflows
Third-Party Integrations	Limited	Extensive (Slack, Google, etc.)	Extensive (Zoom, MS Teams)	Extensive (GitHub, Jenkins, etc.)
UI Usability	Moderate	High	High	Moderate
Target Audience	Students, educators	Business teams	General teams	Dev teams

and agile project management approaches. Beyond its theoretical foundation, *Silver Bullet* incorporates several features specifically tailored for academic environments, including structured guidance through distinct project phases, collaborative document editing capabilities, and interface design optimized for formative learning scenarios. These characteristics distinguish it from conventional project management tools by prioritizing educational value over purely operational efficiency.

This comparison reinforces *Silver Bullet*'s unique value proposition as a pedagogical tool. While it may not yet reach the breadth of commercial integrations and enterprise automation, its alignment with educational objectives and PM standards offers a meaningful contribution to training future software professionals.

5.1 Tool Limitations

As a project management tool, although it has a solid foundation in PMBOK®, we understand that the project management tool market has a large number of competing tools and systems and that these tools already have consolidated customers and users, which could jeopardize the interest in switching to new tools.

For this reason, the tool has been refactored and adapted to meet the needs of different types of project, adapting to the needs and feedback received throughout the time the tool has been developed. These changes are intended to prevent future users from stopping using the tool due to the absence of features such as Kanban, which was previously mentioned, interactive *dashboards* and *RichEditor*, which were added thanks to the feedback received.

6 Final Remarks

This paper presents the evolution of the *Silver Bullet* that was designed to provide a comprehensive project management tool. Now integrating both the 6th and 7th editions of PMBOK® in a hybrid approach, *Silver Bullet* aims to provide comprehensive project management education and high-quality projects.

The improvements that have been described show that by incorporating modern web technologies and real-time collaboration capabilities to enhance not only its pedagogical functionality but also the professional features, is the key to good acceptance in a dense environment with diverse project management tools, it also positioned it better than the last version. The implementation of technologies such as the Yjs framework for conflict-free data sharing, the TipTap-based WYSIWYG editor, and responsive React components enhances the tool's ability to simulate real project environments, leading to improved learning outcomes with 70% of respondents strongly agreeing that *Silver Bullet* features contributed to productivity compared to 26% in the previous version.

As future work, we intend to implement improvements related to usability and user experience, since only 33% of case study participants strongly agreed that the tool is intuitive and easy to use. Therefore, we plan to focus on more accessible navigation options and features that can make the user experience more fluid. Another goal is to integrate the workflow with existing market tools to reduce manual intervention in filling out documents and deadlines. We also aim to conduct additional empirical studies to evaluate the long-term impact of the tool on PM and the effectiveness of its new features. We understand that in order to evolve and continue growing, feedback from both new and existing users is essential.

To support the dissemination of the *Silver Bullet* tool beyond its original academic context, we are currently conducting a new case study with a class of 30 undergraduate students enrolled in the Information Systems program at the Federal University of Rio Grande (FURG). This implementation aims to evaluate the applicability and effectiveness of *Silver Bullet* in a different institutional setting and curricular structure. The ongoing study focuses on observing how the tool supports the teaching of PM practices, aligns with PMBOK® principles, and enhances students' ability to manage software development projects.

Finally, expanding the tool's presence in the professional environments, can generate a vast and diverse amount of feedback, making the tool more useful to a broader audience. Furthermore, the fact that organizations with a solid PM culture achieve success rates of 71% and experience 13 times fewer financial losses [9] further reinforces the importance of taking *Silver Bullet* beyond the academic environment, with the goal of helping companies grow and increase their chances of success in their projects.

ARTIFACT AVAILABILITY

We promote transparency and reproducibility by openly sharing the supporting data of our case study on Zenodo: https://doi.org/10.5281/zenodo.15930785. The Silver Bullet tool is available for experimental use at https://silverbullet.lesse.com.br, and a demonstration video can be accessed at https://doi.org/10.5281/zenodo.16237208.

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