Software Engineering and Open Innovation: Collaboration between Industry, Academia, and Government

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ABSTRACT

Collaboration between industry, academia, and government (IAC) has proven to be an effective model for promoting innovation, especially through open innovation. However, the integration of these sectors still faces challenges in its implementation, despite the numerous benefits it brings to all involved parties. This research analyzes the perceptions of undergraduate and graduate students involved in open innovation projects, focusing on the development of new products and Minimum Viable Products (MVPs) through Action Research (AR) in real-world projects. The study addresses the use of AR, turnover, and conflicts within software development teams, as well as the collaboration between industry and academia and perceptions of its application. The results show that, although the use of AR presented challenges for students, it led to positive outcomes, including the successful implementation of MVPs.

KEY-WORDS: Software Engineering; Teaching; Industry-academia-government collaboration; Action Research.

REVISTA DE Engenharia e Pesquisa Aplicada

1 INTRODUCTION

Currently, the technology industry is experiencing exponential growth. This rapid advancement, coupled with the increasing need for more efficient methods to manage software development, has driven the pursuit of excellence and continuous improvement in software quality **[22][14]**. One effective way to support this process is through curriculum updates that introduce more industry-relevant contexts into academic environments **[21][6]**, as well as by fostering collaborative processes between industry, academia, and government. This approach significantly impacts the field of Software Engineering, enabling communities to identify mutual needs and develop cooperative strategies to address specific, real-world demands **[9][17]**.

The integration of collaborative projects between industry and academia faces significant challenges, particularly from the industry's perspective. While industry focuses on the development and commercialization of products, academia is primarily driven by the pursuit of new knowledge, academic publishing, and securing research funding **[10][26]**. The application of academic research in industrial settings helps train researchers and encourages companies to adopt more advanced technologies and improve their processes **[9][18]**. Several studies highlight the importance of collaborations between industry, academia, and government in the educational context **[17][08][2][5][28]**.

In collaborative Open Innovation environments—where students work alongside industry professionals—effective management of turnover becomes essential. The diversity of participants within teams enriches the project, but can also increase the complexity of team management, especially in the face of high turnover rates **[15][23]**.

The objective of this research is to replicate case studies focused on the development of various projects (MVPs), aiming to foster collaboration among Industry, Academia, and Government (IAG) by adopting an Open Innovation perspective in real and collaborative contexts. The research involved undergraduate, master's, and doctoral students, private companies, educational institutions, and concrete academic projects. In this context, the study presents the execution of these projects and investigates the participants' perceptions, with an emphasis on analyzing the collaboration between Industry and Academia, turnover, action research, and conflict management within software development teams.

2 THEORETICAL FRAMEWORK

2.1 INDUSTRY ACADEMIA AND GOVERNMENT COLLABORATION AND OPEN INNOVATION

Collaboration practices among Industry, Academia, and Government (IAG) aim to integrate knowledge between the scientific and professional practices of the participants. Several studies provide evidence on industry needs, the solutions developed, and the impact of these collaborative projects across sectors **[9][10][20][22]**. Open Innovation—defined as the process of using both inbound and outbound knowledge flows to drive internal innovation and exploit external market opportunities—has become the preferred model for companies **[2][3]**. This process also applies to academic environments, where the skills and competencies required for implementing Education 4.0 rely on open innovation, promoting the development of multidisciplinary and collaborative abilities that meet the demands of a digital and globalized society **[1][13]**.

The research developed by Marques **[17]**. investigates how collaboration between industry, academia, and government (IAC) can enhance software engineering education through real project development. It focuses on the creation of MVPs involving students (undergraduate to PhD) and professionals in career transition, including low-code and no-code profiles.

The article **[8]** analyzes the "mandacaru.dev" initiative, a software development training program carried out in the rural region of Ceará, Brazil, through a partnership between industry and academia. Results show professional growth and stronger connection to the tech market. The research contributes to academic discussions on talent development in underserved regions. It also highlights the potential of industry-academia collaboration to reduce intellectual and financial capital flight.

2.2 TURNOVER AND CONFLICT MANAGEMENT IN SOFTWARE TEAMS

Employee turnover is a critical factor to consider when planning and managing a project, as the replacement of team members can have adverse effects on productivity. Constant staff changes can lead to several issues, such as increased costs, difficulties in managing teams, decreased workplace harmony, negative impact on project success, delays in timelines, and disruptions to project scope, among others **[23]**.

In Software Engineering, high turnover rates are attributed to factors such as lack of managerial support, inadequate compensation plans, and dissatisfaction with the work environment. Professionals often seek new opportunities in organizations that offer better salaries and benefits, making talent retention a significant challenge. These challenges are compounded in dynamic project environments, where adaptability and domain-specific knowledge are essential for progress. In response, many IT organizations implement policies and strategies aimed at mitigating turnover, recognizing the importance of such measures for the company’s sustainable growth and performance **[27][7]**. Some common retention strategies include professional development programs, clear career progression pathways, employee recognition initiatives, and flexible work arrangements **[11]**.

Conflict Management is related to the interactions among team members and other stakeholders, such as users and roles involved in software development **[16]**. Resolving these types of conflicts involves articulating differences and negotiating alternatives, with the goal of reaching a reasonable compromise, agreement, or shared understanding **[29]**. Promoting open communication channels, clear role definitions, and early conflict detection mechanisms are essential to fostering a constructive project environment.

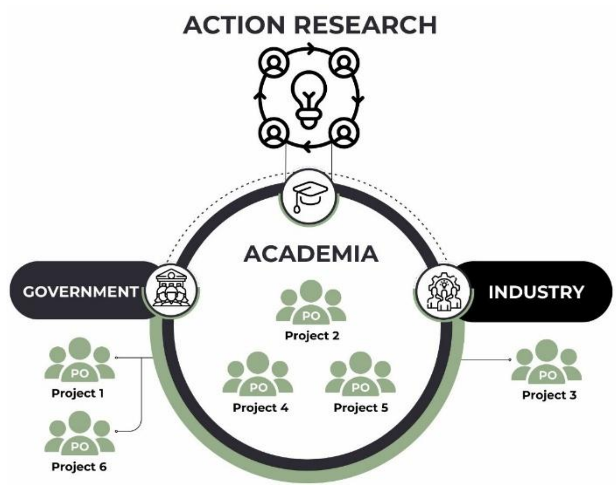
3 METHODOLOGY

This research adopts a qualitative approach, based on the replication of a case study following the guidelines proposed by **[24]**. Building on the study by **[2]** and **[17]**, this work analyzes the perspectives of professionals and undergraduate, master's, and doctoral students involved in real-world projects that apply Action Research to foster Open Innovation.

Research by **[2]** is related to the implementation of collaborative projects, conducted through three case studies across distinct projects. The aim was to assess the perceptions of graduate students in PA, involving the participation of seven students/professionals. In turn, the replicated study by **[17]** focused on the development of MVPs within the PA framework, aiming to analyze the perceptions of both undergraduate and graduate students. In total, 38 students and professionals from the IT field and those in career transition participated, and seven projects were developed.

The study was conducted within the undergraduate and graduate (Master’s and Ph.D.) programs in Computer Engineering at the University of Pernambuco (UPE/POLI). Unlike the studies used as references for replication, the teams in this research consisted of both undergraduate and graduate students, totaling 26 undergraduate and 15 graduate participants. These students were divided into six groups, each working on different problems and projects, as illustrated in Figure 1. The students in each group had multidisciplinary profiles. One of the main goals of this initiative was to provide students with direct exposure to real challenges faced by the software industry, while simultaneously equipping them to design and implement effective actions to address these real-world problems.

Figure 1 - Interaction between developed projects and real clients.



Fonte: Os Autores.

To develop the projects, agile practices such as Scrum or Kanban were adopted, dividing activities into smaller blocks and assigning specific roles to participants **[4]**. One of the main roles implemented was that of the Product Owner (PO),

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represented by the client of each project. A graduate student was assigned as the project leader, responsible for planning the necessary activities to address the proposed problem, selecting the technologies to be used, and aligning the skill levels of the team members.

3.1 OPEN INNOVATION PROJECTS

The teams' projects were defined through brainstorming sessions and collaboration with companies. Due to the limitations of the academic semester, the scopes were kept narrow, focusing on delivering a Minimum Viable Product (MVP). After discussions and analysis, the following projects were defined:

- Project 1 – BemEstar Pro: A platform designed to monitor and assess employee well-being within companies. Based on the collected data, companies can adjust their processes and reinforce initiatives aimed at employee wellness. The final solution was transferred to a higher education institution.
- Project 2 – Educational Chatbot: An intelligent platform to support students in learning programming and assisting in the correction of their practice exercises through artificial intelligence. The platform offers four main features: Programming Instruction; Programming Challenges; Command Explanations; and Source Code Correction. The solution integrates the OpenAI platform in its operation.
- Project 3 – Medical CoPilot: An AI-powered tool designed to support physicians in generating medical reports and aiding in diagnostics. The tool includes a plugin to facilitate integration with various platforms. The solution also uses the OpenAI platform.
- Project 4 – Open Innovation Projects Observatory: a platform that serves as an observatory for innovation projects with the aim of promoting transparency and dissemination of university-developed projects, including broad outreach and providing contact information for the developers.
- Project 5 – EditalView: Evolutionary maintenance of an existing platform that centralizes innovation funding calls published by government agencies and Science and Technology Institutions (STIs), such as CAPES, CNPq, and FINEP. This project is part of an ongoing Ph.D. research initiative at a higher education institution.
- Project 6 – ZapDados: An online platform designed to assist community managers using WhatsApp. The solution provides dashboards to support the management of these communities. At the end of the project, the technology was transferred to a government organization.

3.2 CURRICULUM ELEMENTS

The program follows the academic curriculum but includes practical activities and guest lectures from professionals in the field of software engineering. These activities were carefully integrated to ensure alignment between theoretical learning and real-world application. The combination of theoretical instruction with industry engagement ensured a hybrid approach, connecting academic knowledge with professional experience. This dual focus enabled students to both consolidate academic concepts and observe how they are applied in practical settings.

Among the key topics covered were: Evidence-Based Software Engineering, Software Configuration and Management, Software Testing Applications, Technical Debt, Software Project Management, Artificial Intelligence in Software Engineering, Modern Software Engineering, and the Application of Agile Methodologies in Industry.

In addition to the topics presented by guest speakers, the course also covered content directly related to the academic curriculum, including: Software Engineering, Requirements Engineering, Software Quality and Testing, Traditional and Agile Methodologies, Software Analysis and Design, Design Patterns, Software Architecture, Software Management, and Software Simplicity.

For project development, weekly development and validation sprints were organized, totaling eight development sprints. The course instructors conducted two sprint retrospectives per week: the first focused on people management, including team communication, collaboration, and role clarity; and the second on evaluating activity progress, identifying bottlenecks, and defining new features to be developed, ensuring continuous improvement in project delivery.

3.3 DATA COLLECTION

For data collection, an online questionnaire was applied through the Google Forms platform. Twenty completed questionnaires were obtained. To measure the intensity of the participants responses, a series of graduated response options were used, based on the Likert scale **[12]**, in this way the responses were organized in a sequence that indicated a degree of agreement or disagreement in relation to a given statement.

Table 1: Questionnaire Structure.

Section 1: Participant Profile	RQ01 - RQ07
Section 2: Team Size and Project Duration	RQ08 - RQ09
Section 3: Challenges in Applying Action Research	RQ10 - RQ14
Section 4: Challenges and Benefits for Industry and Academia from the Application of Action Research	RQ15 - RQ20
Section 5: Perceptions of Satisfaction and Learning	RQ21 - RQ25
Section 6: Conflicts, Alignment, and Team Collaboration	RQ26 - RQ33
Section 7: Team Turnover	RQ34 - RQ40

Fonte: Os Autores.

Table 1 provides an overview of the questionnaire structure. The questions were primarily derived from reference studies, with additional items specifically addressing turnover—whether it occurred and its consequences in terms of team alignment and conflict resolution. The full questionnaire script and results can be accessed at: https://doi.org/10.5281/zenodo.15856590.

4 RESULTS

4.1 PARTICIPANT PROFILE

The study sample consisted of 20 participants. In terms of gender distribution, the majority identified as male (n = 17; 85%), while a smaller proportion identified as female (n = 3; 15%). Participants represented a range of age groups. The largest segment (n = 11; 55%) was composed of individuals aged 25 years or younger. Four participants (20%) were between 26 and 34 years old, and five participants (25%) were over the age of 34.

Regarding professional roles, 14 respondents (70%) identified as students, making them the predominant group in the sample. Other professional roles reported included software developers (n = 4; 20%), higher education professors (n = 3; 15%), and analysts, project managers, or support professionals (n = 5; 25%). It is important to note that participants were permitted to select multiple occupational roles; therefore, the total percentage exceeds 100%. This overlap suggests that some individuals hold hybrid positions, such as professionals who are simultaneously enrolled in graduate studies or academics actively working on industry-related projects. These dual roles contribute to a richer understanding of cross-sector collaboration.

The demographic profile of the participants indicates that the sample is predominantly composed of individuals currently engaged in academic programs, with students representing the majority. This strong student representation highlights the relevance of the dataset for exploring how emerging professionals and academics perceive and engage with collaborative projects between academia and industry. Furthermore, students often bring openness to new methodologies and tools, which can enhance innovation and adaptability within teams.

At the same time, the inclusion of respondents in professional roles, such as software developers, higher education faculty, and project managers, adds diversity and provides insights from individuals with varying degrees of industry involvement. This mixed professional composition enhances the contextual richness of the data, suggesting that some participants may operate across academic and industry settings or transition between them.

4.2 TEAM SIZE AND PROJECT DURATION

This section presents the results concerning students' perceptions of the project format, team composition, and the four-month duration of the initiative, all framed within the Action Research methodology. The data indicate that 60% of participants (12 out of 20) perceived the team size as having a positive influence on the development of the project. In contrast, 35% reported that team size had no significant impact, and a minority (5%) viewed it as a negative factor.

Each team comprised a minimum of seven members, combining four undergraduate and three graduate students, thereby fostering interdisciplinary collaboration and peer learning.

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This composition encouraged the exchange of experiences between students with different academic backgrounds and maturity levels, enriching discussions and problem-solving processes. The mixed academic levels also allowed graduate students to assume informal mentoring roles, which supported the learning curve of undergraduate peers while reinforcing their own leadership and communication skills.

These findings suggest that team diversity and size were generally conducive to achieving the objectives of Action Research, which emphasizes collective inquiry and collaborative problem-solving. Moreover, students frequently reported that working in larger, heterogeneous teams helped distribute workload more evenly, facilitated creativity through multiple perspectives, and increased accountability within the group.

Regarding the temporal structure of the project (RQ09), the majority of participants (80%) reported that the four-month timeframe was adequate for completing the planned activities. Only 10% viewed the timeframe negatively or as having no notable effect. Some students noted that the schedule, though tight, encouraged focus and productivity, preventing long periods of inactivity or scope creep.

The project was structured into eight weekly sprints: the initial two weeks functioned as a "*warm-up*" phase, facilitating team integration, proposal refinement, and foundational knowledge alignment. These early weeks were also crucial for defining roles, understanding client expectations, and clarifying the scope of each deliverable. The remaining six weeks focused on the development of minimum viable products (MVPs), the preparation of solution pitches, and the production of technical documentation.

These results suggest that both the team configuration and the duration of the project were well-aligned with the pedagogical and methodological goals of Action Research. The predominantly positive feedback highlights the effectiveness of combining structured time management with heterogeneous teams in supporting experiential learning and project-based collaboration. However, the small percentage of neutral or negative responses may indicate the need for more flexible pacing or tailored support for teams with varying dynamics and levels of prior experience.

4.3 CHALLENGES IN USING ACTION RESEARCH

This section presents the results regarding the challenges faced by the teams during the execution of the project. Action Research is a methodology that aims to integrate academic research with practical application, promoting change and problem-solving in real-world contexts through an iterative cycle of planning, intervention, evaluation, and reflection. A summary of the results from this phase is presented in Table 2.

- **Planning**: This phase was identified as the most challenging by 25% of the participants. The analysis of qualitative responses allowed for the classification of the reported challenges into seven distinct categories: lack of experience or knowledge (20%), difficulty in defining the scope of the project (20%), team turnover (10%), time management issues (5%), low engagement (5%), people management challenges (5%), and communication problems (5%). These findings highlight that a significant portion of the difficulties stem from foundational aspects of project planning and execution, particularly among participants with limited prior exposure to collaborative project work. One respondent remarked, "*Our team initially struggled with planning the goals and the action plan*", illustrating both a knowledge barrier in structuring the project and uncertainty in articulating clear objectives. These insights suggest that early-stage challenges may be mitigated through better onboarding, clearer guidelines, and support mechanisms aimed at developing planning competencies, particularly for less experienced participants.

Table 2: Challenges in the Project Stages.

Stage	Yes, Challenging	No
Planning	25%	75%
Intervention	30%	70%
Evaluation	15%	85%
Reflection	10%	90%

Fonte: Os Autores.

- **Intervention**: The intervention phase was reported as the most challenging by 30% of participants, indicating that the implementation of planned actions frequently encountered resistance or execution difficulties. The qualitative analysis of responses revealed several categories of challenges, with the most prominent being people management (20%), followed by time management (15%), lack of experience or knowledge (15%), and internal team communication problems (5%). These findings suggest that difficulties during this phase were not solely technical but also organizational and interpersonal in nature. One respondent noted, “Scope adaptation based on reduced workforce”, which underscores issues related to limited human resources, low engagement, and the need for flexibility in adapting plans under constrained conditions. Collectively, the data point to a combination of operational and relational barriers that can hinder effective intervention. These results highlight the importance of proactive planning for resource allocation, clearer role distribution, and capacity-building strategies to support teams during the execution phase of collaborative projects.

- **Evaluation**: Only 15% of participants reported challenges during this phase, suggesting that it was generally perceived as less problematic compared to earlier stages. The difficulties that were identified primarily related to a lack of experience or knowledge (5%) and low engagement (5%). These challenges appear to be particularly associated with the task of involving external stakeholders in the evaluation process. One student commented: “*Getting in touch with qualified people to assess our results before presenting them to the professors*”, highlighting both limited access to external expertise and uncertainty about how to effectively validate findings. This indicates a gap in stakeholder engagement and evaluation strategies, especially among less experienced participants. The data suggest that even when fewer challenges are reported, there remain critical issues related to networking, validation, and academic rigor that may impact the quality of outcomes in this phase. Enhancing support structures for stakeholder interaction and offering practical guidance on evaluation methods could help address these gaps.
- **Reflection**: The final stage of the project was reported as challenging by only 10% of participants, with all difficulties attributed specifically to people management. This suggests that, while the overall complexity of this phase was perceived as low, interpersonal dynamics still posed significant obstacles for a minority of participants. One respondent reflected: “*Trying to integrate the different opinions of the team into a single thought*”, highlighting the challenges of achieving consensus and fostering collaborative reflection within diverse teams. This points to the importance of facilitation skills and structured reflection processes to support group alignment during the concluding phase. Although relatively few participants faced difficulties at this stage, the findings emphasize that even in the final moments of a project, unresolved interpersonal tensions can hinder meaningful closure and shared learning.

4.4 CHALLENGES AND BENEFITS FOR INDUSTRY AND ACADEMIA WITH APPLICATION OF ACTION RESEARCH

Questions RQ15 to RQ20 explore the challenges and benefits of using action research in collaborative projects. In RQ15: In your opinion, was the choice of this method representative in strengthening the ties between academia and industry? 70% of the participants stated that action research contributes to strengthening the connections between these two sectors. However, only 10% of the participants believe that the industry is open to applying this research method (RQ16).

- **Main Benefits and Challenges for Academia**: The main benefits of applying the action research method (RQ17) identified by the participants include knowledge and experience generation (80%), innovation (15%), and networking (10%). These results indicate that most respondents consider collaborative projects to promote mutual empowerment among the participants. However, when asked about the challenges faced (RQ18), 40% of participants pointed out lack of knowledge and experience as a barrier to project success. Additionally, problems such as low stakeholder engagement (30%), time management difficulties (15%), people management challenges (10%), and scope definition issues (5%) were mentioned. One participant highlighted the need for interpersonal skills, proper implementation and evaluation, immersion in practical problems, and methodological rigor, as expressed in the following statement: "Need for interpersonal skills; implementation and evaluation; immersion in practical problems; methodological rigor."

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- **Main Benefits and Challenges for Industry/Government**: In RQ19, participants indicated that the main benefit of collaborative projects is innovation (55%), followed by knowledge and experience generation (30%) and networking (5%). On the other hand, when analyzing the barriers faced in collaborative projects, the main difficulty reported was maintaining participant engagement (20%). Additionally, issues such as the relevance of the results (15%) and time management (15%) were also highlighted as significant challenges. Aspects like networking (10%), innovation (5%), lack of experience and knowledge (5%), and people management (5%) were mentioned to a lesser extent. These data suggest that, while innovation is considered the main benefit of collaborative projects, its implementation can be challenging, especially due to difficulties in mobilizing the participants and ensuring the applicability of the results obtained.

4.5 PERCEPTIONS OF SATISFACTION AND LEARNING

This section addresses questions about satisfaction and experiences with the course, as described in RQ21-RQ25. Of the total number of students, 16/20 (80%) were unfamiliar with the Action Research method, while 4/20 (20%) were familiar with it. Regarding satisfaction with using the method in the course, 8/20 (40%) students were completely satisfied, 6/20 (30%) were very satisfied, 2/20 (10%) were satisfied, and 4/20 (10%) were somewhat or not satisfied at all.

In RQ23, the 360º Evaluation conducted in the course is addressed, aiming to assess the projects through analysis between groups and internal evaluations, assigning grades both within the team members and between different groups. Of the total number of students, 16/20 (80%) considered the evaluation model to be good or excellent, while 4/20 (10%) rated it as "Adequate" or "Average", highlighting that "*Marketing had too much weight in the evaluation, at the expense of the technical challenge and business viability*" (G3, Undergraduate Student).

4.6 CONFLICTS, ALIGNMENT, AND COLLABORATION IN TEAMS

This section addresses the main issues related to recurring conflicts in Software Engineering, focusing on the management and alignment of team members. Research questions were proposed, presented in RQ27 to RQ34. RQ26 and RQ32 diagnose and suggest solutions for conflicts within development teams. The results indicate that 70% (14/20) of the participants reported the absence or presence of misalignment between the team and management, while 30% (6/20) mentioned unawareness or slight misalignment within the teams. Additionally, the data indicate that periodic meetings helped reduce conflict noise, although delays in delivery and development problems were still identified as challenges.

RQ30 aimed to assess interventions in teams that faced conflicts during development. Of the participants, 55% (11/20) considered the management to be good or excellent, 30% (6/20) rated it as neutral, and 10% indicated moderate to severe managerial problems. Team cohesion, weekly meetings, and the departure of conflicting members were highlighted as factors that helped mitigate conflicts. Managerial problems were noted, such as the perception that "there were not enough interventions at certain times" (G16, Undergraduate Student) and the lack of understanding of external project demands. In RQ29, risk management was assessed, with 85% (17/20) of participants reporting no poor management and 15% mentioning minor problems with management.

One of the expected issues in grouping Postgraduate and Undergraduate students, as well as in the Open Innovation model, relates to knowledge disparities. In RQ33, we investigated the impacts of this practice, where 55% (11/20) of participants reported that there was no educational gap, while 45% indicated the presence of such a gap. As a mitigation strategy, there was leveling (orchestrated by the teams themselves), in addition to proactivity to learn (involving professionals and experienced individuals alongside undergraduates), and negatively as described: “Some students did not have enough (or any) knowledge to overcome technical barriers" (P10, Postgraduate Student).

4.7 TURNOVER IN TEAMS

This section addresses the main issues related to turnover in IT projects, based on the research questions proposed in RQs 34 to 40. RQs 34 and 35 address the consequences of turnover on productivity and delivery deadlines. According to the responses obtained, 45% (9/20) of the participants indicated that there was no turnover in the teams, 25% (5/20) stated that departures did not cause any impact, 15% reported positive impacts, and 15% mentioned negative effects. Regarding delivery deadlines, 40% of participants indicated that turnover did not affect deadlines, while only 15% (3/20) pointed out that there were negative impacts on delivery deadlines.

RQ38 and RQ39 aim to analyze strategies for reducing turnover and the main causes of this issue. Among the reduction strategies, the key ones included recognizing the activities performed, providing continuous feedback, and improving team integration through periodic meetings. As for the main causes pointed out by the participants, personal issues, which led to the departure of team members, and the lack of effective management, ranging from organizational misalignment to health-related problems of the employees, were highlighted.

5 DISCUSSIONS AND RESEARCH LIMITATIONS

This Several aspects can be compared with previous studies and the scientific literature on collaboration between industry and academia. These aspects include:

- **Alignment of schedules between research teams**: As pointed out by **[10]**, **[20]** and **[22]**, one of the main difficulties is aligning schedules and organizing time for meetings and proposals. The current research also faced these challenges, with students reporting difficulties in coordinating and organizing their schedules.
- **Conflicts in Software Engineering**: The conflict diagnosis highlights the importance of managerial interventions and periodic meetings to mitigate misalignment between the team and management. The proactivity of teams and the involvement of experienced professionals were essential for the success of the Open Innovation dynamic.
- **Industry, Academia, and Government Collaboration**: The gap between academia and industry is widely recognized and addressed in several studies **[6][10][19]**. It was observed that students reported difficulties in aligning the team's research schedule with the client's availability. Additionally, it was identified that the Product Owners (POs), who acted as internal members of the teams, contributed positively by interacting with the client.
- **Knowledge Gap**: Just like in **[17]** research, we also observed a strong presence of knowledge gaps within development teams. The encouragement of internal leveling within the teams themselves, along with the grouping of teams (carried out by faculty, focusing on individual skills), was crucial in reducing this issue. Furthermore, a key factor for leveling is the involvement of professionals in the Open Innovation dynamic. These professionals, by being part of the team, contribute with new knowledge while also learning from the participants.

6 CONCLUSIONS

This study aimed to replicate case studies involving the development of diverse software projects—specifically Minimum Viable Products (MVPs)—to foster collaboration among industry, academia, and government (IAG) within a real-world, cooperative setting using the Action Research methodology. In contrast to previous replication studies, this research uniquely focused on examining the impact of team turnover during software development. The initiative engaged participants from multiple levels of education, including undergraduate, master's, and doctoral students, and involved private companies, educational institutions, and authentic academic-industry projects.

Beyond documenting the execution of the projects, the study explored participants' perceptions regarding the process. Several benefits were identified, including the practical application of academic knowledge, the resolution of real-world challenges, enhanced collaboration between academia and industry, knowledge sharing, and the enrichment of academic research through applied experience. Nevertheless, notable challenges were also reported, such as time constraints for MVP development and participants' limited experience with the proposed solutions.

The replication approach not only reinforced previous findings but also underscored the value of establishing structured collaborations among IAG stakeholders to tackle real-life problems and drive technological innovation. Unlike the original studies on which this research was based, the present context experienced the departure of key personnel

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from different groups, which initially hindered productivity. However, this challenge also prompted teams to reorganize and refocus, leading to new collaborative dynamics.

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