Project based on Agile Methodologies by DMAIC

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Abstract: The demand for the inclusion of Agile Methodologies in technology products and services, particularly in software development, has become increasingly recurrent. Its application guarantees frequent deliverables, but not necessarily the desired quality, especially when dealing with the technical challenge of rework and employee behavior. These are known challenges in the management of this methodology. Based on the DMAIC method, a customized software development project for a client was analyzed using Agile Methodologies. The proposed objective fulfilled its role of analyzing the process in the development cycle. This was achieved by diagnosing gaps in the processes involved in the treatment of 61 identified bugs, data collection, feedback from the parties involved, and mapping opportunities for improvement, such as the implementation of FDD, to achieve contour actions.

1 INTRODUCTION

The increased demand for technology systems along with the speed at which business requirements are changing has required software development companies to become more flexible. As decision making occurs during the project; changes, adaptability and agility are expected (Soares, 2004). In addition, the challenges for system development go beyond technical issues. Variables such as project management, methodology, organizational culture and labor are critical in the success or failure of developing systems, especially when customized (Ribeiro & Gusmão, 2008).

For technology teams to be dynamic, the use of Agile Methods has been suggested. This method has gained importance in several segments of the software industry where the principle is to build a system with quality that meets the needs of end users by promoting sustainable development with a constant pace of development and effectiveness (Sbrocco & Macedo, 2012).

The company studied has national operations, of medium size and develops software for sectors of the automobile industry and fleet management, making use of Agile Methods since 2014. Due to increased current demands, it is difficult for decision makers in development projects to deal with concomitant business requirements and provide appropriate attention to the implementation and management of the methodology applied by the project teams. In addition, technical indicators of project quality also have opportunities for improvement. These generate rework and impact on customer satisfaction, so this study aims to propose improvements for greater project efficiency.

The research question was: what opportunities for improvement exist with the agile project management practices of the company? This study has as a general objective of analysing, through a case study, the development processes of a customized software that uses Agile Methodologies as a basis. The analysis tool was the DMAIC method that mapped management and technical operation gaps.

The specific objectives of the work are: (i) to perform a focused group dynamic to map and classify the usability improvements of the site and interface design with the designer and prototyping area; and (ii) to identify opportunities for improvements such as exclusive action plans and not implementing the mapped processes, structured by 5W2H.

The software project chosen as a case study is of high complexity as it involves a site and Backoffice system. The revenue is also considered high if compared to other projects. In addition, the team consists of nine employees and is in an intermediate phase of development. The last phase will be the analysis of improvement alternatives and control, which will suggest actions to reduce bottlenecks and increase team performance, even if it already has efficient results through agile management.

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2 THEORETICAL BACKGROUND

2.1 DMAIC

The steps Define, Measure, Analyze, Improve and Control represent the acronym DMAIC. This method of process improvement is composed of a script that helps companies solve problems (De Mast & Lokkerbol, 2012). For each step of DMAIC, secondary tools have been implemented to help the development of this study in the technical and managerial scope.

The first stage of the DMAIC method, called Define, involves the definition part of the problem: where the problem occurs, which indicator will be used, who will be your project team, which schedule will be established and which database will be used (De Mast & Lokkerbol, 2012). This first phase is fundamental for the mapping and can be defined by the stakeholders involved in the solution - in this case the team.

The second stage of DMAIC is called Measuring. In this step the performance of the processes is evaluated through data collection. The measurement of this data can be performed in a qualitative and/or quantitative way. The qualitative one is applied to the focus of the cause of each problem or process and seeks to discover its cause. The team maps the most detailed information to identify the problem while the quantitative is distinguished by collecting mass data and uses an indicator to analyze behaviours and statistics. However, the objective has the same purpose of identifying the causes of the most important problems selected by the project (De Mast & Lokkerbol, 2012).

The third stage of DMAIC, called Analyze, consists in evaluating the results of the measurements that will allow us to identify what is missing in the processes to obtain a better performance. At this point, it is necessary to analyze the causes of the problem in question, which can be qualitative or quantitative, sometimes from a statistical point of view (Prash, 2014).

The fourth and fifth phases are Improve and Control and have been dealt with together, as they propose to evaluate and test possible actions to implement the necessary changes and/or execute an action plan to improve the process, starting from the development of previous phases of DEMAIC (Prashar, 2014). As the last phase of this work, two tools were chosen as essential for the suggestion of improvements in the software development project that uses Agile Methodologies as a methodology for managing its processes.

3 RESEARCH METHODOLOGY

This study is characterized as an applied research, because it aims to solve a specific problem based on knowledge generated during its development. Regarding the objectives, the research is considered exploratory, qualitative and experimental, because the focus is to propose improvements to the object of study.

The data collection was carried out in a familiar environment with the researcher leading an online focused group held at the end of October (Prodanov & Freitas, 2013). Additional data was collected through technical documents related to the recording systems used by the company.

Table 1: Description of DMAIC application.

	Technical	**Management**
D	Through technical documentation it is possible to characterize the project scope with its forms of management and technical operation.	
	Technical	**Management**
M	The **Pareto Graph** was used to obtain quantitative bugs in the production environment which is updated every 15 days. These bugs are caused by test failures and code break schedule.	The **Checklist** was made to evaluate management gaps involving the profile assigned to the project leader, for skills listed on a sheet, which were verified by the team counting the frequency of their adherence.
A	The **Focus Group** helped to understand the problems faced and the root of the problems in the user's journey through the web. It was established that the exploration of the insights would be done by a script organized in ten attributes specified to the users.	The **Benchmark** obtained the analysis of the causes that impact the management of the team of designers compared to another more efficient team. The user experience and user interface guidelines that lead the user's journey were analyzed against the American e-commerce in terms of usability, communication and design components.
I e C	**Brainstorm** allowed the team to build an action plan with the help of stimulating ideas and creativity. The chosen participants were the project stakeholders grouped into a project leader, a product owner, a scrum master, four full stack software developers, two test analysts and a designer. To score the characteristics of the actions, the **5W2H** tool was used proposing improvements to gain effectiveness of the Agile Methodology used in the project.	

The procedure used was the cross-sectional case study on all the processes of a single analyzed project.

The deliverables were analyzed fortnightly (in Sprints) during the second half of the year 2020. This analysis included the development team.

The main object of this study is the analysis of the software development project, both in the technical and managerial scope of the Agile Methodology using analytical tools organized by the phases of DMAIC - Table 1.

4 RESULTS

4.1 Define

The project team was composed of ten participants, two Jr. Full Stack Developers, one Full Stack Developer (developer members), one Scrum Master, one Product Owner, one Project Leader (management members), one UX/UI Designer, two Testing Analysts and one IT Architect.

The project deliverables took place fortnightly involving the estimated tasks for each Sprint. New features were cut from the backlog and prioritized by the Product Owner, as they are considered fundamental. These features can range from new wireframes, such as a button that will direct to a new page, changing the color of a banner, reducing or increasing the font size, changing components, extracting a spreadsheet, including a field to be filled, placing a QR Code or even developing an online chat box.

Table 2: Schedule and Effectiveness 2nd Semester 2020.

Sprint Deliveries:
Sprint 22 from 27/07 to 07/08: (15.8/ 20 deliveries: 79% done)
Sprint 23 from 10/08 to 21/08: (17.6/20 deliveries: 88% done)
Sprint 24 from 24/08 to 04/09: (17 / 20 deliveries: 85% done)
Sprint 25 from 07/09 to 18/09: (14/ 15 deliveries: 90% done)
Sprint 26 from 21/09 to 02/10: (21/ 21 deliveries: 100% done)
Sprint 27 from 05/10 to 16/10: (16.4 /18 deliveries: 91% done)
Sprint 28 from 19/10 to 30/10: (20.3/ 26 deliveries: 78% done)
Sprint 29 from 02/11 to 13/11: (18/ 18 deliveries: 100% done)
Sprint 30 from 16/11 to 27/11: Future Sprint
Sprint 31 from 30/11 to 11/12 Future Sprint
Sprint 32 from 14/12 to 25/12: Future Sprint

The Sprints occurred every two weeks, totalling two per month, and were planned by this product committee, after the Scrum ceremonies, together with the Full stack IT Developers that estimate the time for the development and the Quality area for the test of each activity. Once this cycle is over, the Product Owner must validate the business rules of each activity developed and approved in the testing environment to later prepare the pull request, known as the source code that is ready to be copied into the customer's production environment window. In this case, the new code was input into the website.

The estimated deliverables had to be 100% delivered, sometimes this meant the detriment of some bugs or that other gaps were not completed as represented in the schedule forsprint most Sprints in the second half of 2020 – Table 2.

4.2 Measure

The click up tool was used to extract the competent data to bugs produced during two weeks of development (Sprint) reflected in the number of bugs collected in the customer's environment both on the site and Backoffice - Figure 1.

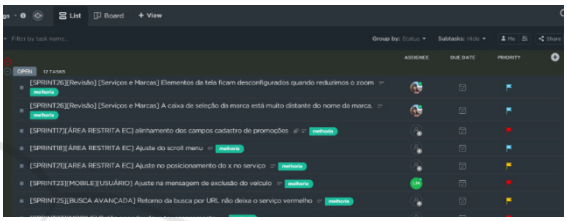
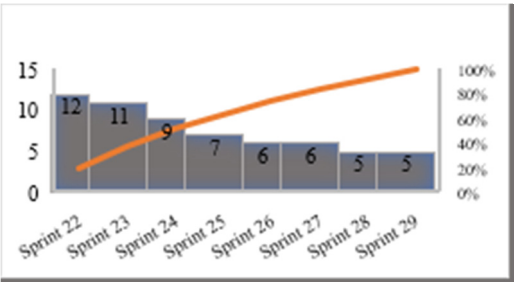


Figure 1: Click Up Tool - register of bugs.

System quality tests on both the site and Backoffice were performed manually by two test analysts for each Sprint. On the last day of closing tasks performed during the Sprint, the quality area conducted a second test, known as unit or regressive test.

The role of the test analyst was to detect flaws that do not contemplate the business requirements documented by the Product Owner, as well as non-compliances of prototyped components on the screens performed by the Designers. The test should compare the visual aspect and check if they conform with the prototype. However, due to the large number of bugs remaining in the last two days of the Sprint, it became unfeasible to manually test all the points of each task and track their respective bugs. In addition, the IT full stack developers did not perform unit testing on the developed code.

As a measurement of the delivery quality, a Pareto Graph was plotted (Figure 2) which shows the number of bugs detected per Sprint at the end of the development cycle and consequently on the client-side.



Total	Bugs not removed	Visual	Functional	User Experience
Sprint 22	12	3	6	3
Sprint 23	11	5	1	5
Sprint 24	9	5	2	4
Sprint 25	7	5	0	2
Sprint 26	6	2	3	1
Sprint 27	6	5	1	0
Sprint 28	5	3	0	2
Sprint 29	5	1	3	2
Sprint 30	Future			
Sprint 31	Future			
Sprint 32	Future			
Total:	61	29 (45%)	16 (25%)	19 (30%)

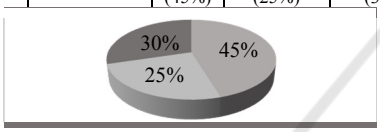


Figure 2: Pareto Graph.

Besides the Pareto Graph, that represents the total number of bugs found in the system and on the website in the customer's production environment for each Sprint, a secondary data collection was also performed to register the category assigned to each bug. In software and technology development, a bug is interpreted as anything that does not conform or is outside the standard business requirements documented in the activity (card), therefore it does not fulfill its functionality or does not represent the behavior of the component prototyped by designers. The questions related to the user experience are interpreted as improvement, because they meet the requirements and do not break the flow. However, they could have a better development, functionality and form. In general, improvements do not bring new rules, so they are within the quality cycle.

Applied the Checklist as a measurement tool for the managerial scope to verify which assignments would have greater relevance to the current Leader of agile management, through the employees' point of view. Therefore, eight team members were chosen, including: Full stack Junior, Full Developers, Test Analysts, designers, Scrum Master and Product Owner. The most critical attributions were decision making, responsibility, communication, organization and transparency as points of extreme importance, followed by adaptability, empathy, commitment, engagement, democracy and trust. Finally, the least critical points identified relate to impulsiveness, authoritarianism and management of resources and changes.

The application of this tool aimed to map the skills needed for the agile project leaders to achieve effective team management, including changes in scope and prioritization which require fast delivery of high performance.

The outcome of the checklist was analyzed against the management gaps of the project and the main failure identified was internal communication. The role of this company's Agile Project Leader is to manage the employees in a dynamic way, ensuring that the process remains regular and fluid. Nevertheless, the relationship with the client is fundamental for the success of the project, as the Leader is responsible for the negotiation of deadlines and deliverables, feedback and management of the project as a whole. The extra bugs identified are directly proportional to the management gaps of the leadership, since they are associated with failed deliverables in the development cycle, tests and also in the product area.

Leader´s Profile	Score	% of Score	Check
Communicative	23	95,8%	v
Decision Maker	24	100%	v
Organizer	23	95,8%	v
Empathic	20	83,3%	
Committed	20	83,3%	
Engaged	18	75%	
Resource management	15	62,5%	
Adaptative	21	87,5%	
Responsible	24	100%	v
Democratic	22	91,6%	v
Impulsive	14	58,3%	
Impatient	17	70,8%	
Confident	22	91,6%	v
Authoritarian	14	58,3%	
Transparent	23	95,8%	v

Figure 3: Checklist.

The developers delivered codes without code reviews and automated testing leading to errors that testing analysts ended up not identifying. The delivery of each collaborator is their own responsibility. The execution of processes agile management must achieve a degree of maturity for the team to manage itself. In this study, the Project Leader was the only one interacting with the client and managing the fluidity of internal communications. Depending on the level of maturity

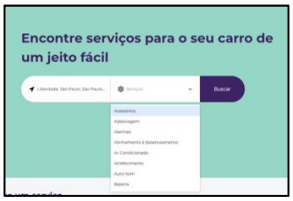
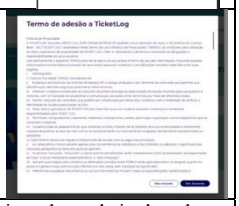
of the team, these tasks can be discarded over time. The Scrum Master in the Agile Methodology also has the role of leading, encouraging, understanding, and pointing out improvements to the development team, although in this project his main role was in technical support. Figure 3 presents the results of the checklist reported by the team considered by the author of this study as above 90% the level of excellence in ability, which means that they are already well developed by the leadership.

4.3 Analyze

For the third phase of DMAIC in the technical field, the Focused Group tool was used to discuss and analyze the usability and the design irregularities on the website's screens - Table 3. The analysis time was three hours and it was conducted by five participants of the project and another three participants of the user experience and design area who were not active in the project.

The analysis focused on three major screens of the website: Homepage – the main page with the start URL which contains the main information, banners, a header with the user access area and a dynamic footer aiming to introduce the user to a menu with the main information of the platform and FAQ; **Advanced search** – a specific page to find and filter information by geolocation/using a map, to later obtain the results; **Page of each service offered** - a page gathering the main information and services of the client's maintenance market partners.

Table 3: Focused Group.

Parts of the system
Search for maintenance services on the Homepage's Desktop Navigation: there is no scroll bar specifying that there are more services in the list. Error: Functional 
Search for maintenance services on the Homepage in Mobile navigation: the dropdown that brings the list of maintenance services is not aligned, it has a font larger than the standard and there is no scrollbar to scroll. Error: Visual 
Advanced Search in Desktop Navigation: in the fields with filters, the selected parameters were below the field followed by an "x" used for exclusion. However, it is not intuitive that such parameter has been selected since the color is similar to the other components. Error: User experience 
Menu in Mobile navigation: absence of the icons representing the restricted area of the Driver and the Workshop. In addition, the Services and Find Shop icons are the same which can confuse the user. Error: Visual 
Adhesion Term for users who had their first access in the restricted area: the "No, I agree" button does not finish the action as the click does not work. Error: Functional 
Footer in Desktop and Mobile Navigation: the website has the option of English translation, but it is not functional.  Error: Functional
Advanced Search Results: only the "Learn More" button directs to the establishment page. This is not very intuitive, as no actions occur when the users click on the photo or the body of  the card. Error: User Experience

The benchmark tool was implemented for the management of the Analyze stage which objective is to observe and understand good practices of a company preferably active in the same field. The chosen company also works within the vehicle maintenance industry but in the United States (U.S.). The website to search and schedule services for mechanical workshops, tire stores and vehicle maintenance repair stores is available only in the U.S. with more than fifty thousand partner establishments. The platform also well known as vehicle parts marketplace and auto parts reseller has been distinguished by its usability and user-friendly interface to schedule services via the internet.

Therefore, we contacted the company via e-mail to understand how the product area creates functionalities, plans the user's journey and new services for the user driver and how they manage backlog. The benchmark was carried out via a phone call of approximately two hours in which the Product Owner, two UX/UI Designers, the Project Leader and the project stakeholders talked to the product area of this maintenance website. The main insight was to understand that the great backlog generator is the conduction of interviews with the users and potential customers of the platform on a recurring basis. The interviews (surveys) focus on truck drivers, outsourced freight drivers from large logistics companies, van drivers, micro van drivers and last but not least, light and passenger vehicle drivers.

The interviews take place every thirty days. Based on the users' feedback, the functionalities are created, such as offering gas filter cleaning for vehicles using CNG which was requested by drivers from the states of Wisconsin, Indiana, Ohio and Illinois. The company focused on hiring partners who made this service available in the Midwest region of the U.S. by promoting the establishments that met this demand on its website.

4.4 Improve and Control

In the last phase of the DMAIC tool, two important instruments were chosen. They suggest improvements to increase the performance of the project, improving the use of Scrum and consequently reducing the bottlenecks studied and identified in the processes.

To reduce the gaps in the Measuring and Analyzing phase at the managerial level, it is suggested to use the brainstorming tool in the grooming meeting to refine the rules added in the user stories. The role of this tool, when applied in a meeting with all members of the project, is to bring people together encouraging discussions and generating ideas to improve behaviors, processes, internal communication and consequently technical deviations over time. As an outcome of this study, it was identified that there is a lack of internal communication between the team which can be solved with the adherence of fortnightly team grooming meetings or even with the inclusion of this tool in the Sprint Retrospective ceremonies.

As a tool to diminish bugs in the system and problems related to usability, interface and user experience, the use of 5W2H tools and also the FDD (Feature Drive Development) is recommended. Table 4 shows the tasks assigned to each project collaborator and their monthly working hours capacity. The calculation of the developers' productivity was based on eight-hour working days. Although for Full Stack Junior Developers during delivery speeds, it was sometimes considered two hours less of productivity due to the level of delivery. Considering this information, it becomes more evident the importance of fulfilling each task in its entirety so that there is no overload. Table 4 presents the number of hours per day involved in the opening, diagnosis, development and correction of bugs by the team.

Table 4: Capacity of hours/day x Tasks.

Team	Tasks	Capacity of hours/ day	Rework - Bug
Leader of Project	Participation in meetings with stakeholders and client; Team management; Presentation of project status report; Performance monitoring.	8h	-
Product Owner	Elaborate Roadmap, documentation of user stories for each activity (card), meeting with project and client stakeholders, co-creation of prototypes with UX/UI Designers, interviews with users, creation of backlog, organization of the Click Up, Gitlab and JIRA tool, prioritization of activities (cards), participation in all Scrum ceremonies and following-up with the teams in charge of activities, testing and validation of deliverables.	8h	1h (12,5%)
Designer UX/UI	Participation in meetings with stakeholders and client, weekly meetings with the Product Owner to understand the business rules, prototyping with wireframes, creation of components and layouts.	8h	20min (4,16%)
Full Stack Jr. Developer	Backend and frontend coding in React and JavaScript, unit test after each activity performed. Participation in all Scrum ceremonies. On average it receives 5 low and medium complexity activities per Sprint.	6h	1h (16,7%)
Full stack Full Developer	Backend and frontend coding in React and JavaScript, unit test after each activity performed. Participation in all Scrum ceremonies. On average it receives 6 medium and high complexity activities per Sprint.	7h	1.5h (21,4%)
Scrum Master	Participation in all Scrum ceremonies. Daily's protagonist, follow-up of the technical development team, technical assistance and IT team management. Technically the Scrum Master leads the technologies approached in the project and makes decisions. To elaborate the pull request with the source code ready to deploy in the client's production environment.	8h	1.5h (18,7%)
IT Architect	To project the architecture of the environments developed with its technologies and dedicates only 30% of his time to the project.	3h	-
Test Analyst	To test all the activities estimated and delivered by the Sprint, perform manual tests in the test approval environment and then a unit and regressive test at the end of the Sprint. They are responsible for opening the bug incidents and for following them up.	7h	6h (85,7%)

Table 5: 5W2H.

5W2H	Suggestions
What?	1.Automated testing before code and code review. 2. Inclusion of the Design Review column to check each component of the screen delivered by the Developer, check font size and compare parameters and components with the prototype. 3. Time metrics for the correction of each bug which must start in accordance with the degree of criticality, not by the opening date. 4. Holistic revision of the components of the prototype compared to the developed screen. 5. Include the FDD as a small process within the agile. The development of projects through the application of Feature Driven Development, created by Jeff de Luca and Peter Coad in Singapore (SBROCCO, 2012, p.99) in the years 1997/1998, is considered an option for companies that act in an interactive and incremental way. However, it is necessary to maintain a pre-defined process. The methodology also recommends that a record is kept of every implementation, as follows: organized by functionality and dates, since the creation.
Why?	1. The developer will have a revised code delivery through automated testing. 2. The Designer will be able to do the revision and point out some faults before the test, making it less overloaded and preventing more bugs from opening. 3. Greater control of the completion time of each bug, to decrease their accumulation at the end of Sprint. 4. To have a more reliable check of the components that were previously unnoticed, decreasing bugs in the client. 5. The use of FDD in a project recommends the application of a tool that allows the organization to adopt all the implementations that they want to create, enabling the inclusion and discrimination of all the necessary components for the new features (BARBOSA; 2008, p.10). Therefore, this will facilitate the understanding of the user stories and the business requirements, the inclusion of rule comments in the code and quality process improvements.
Where?	1. In localhost and code development platform. 2. Click up system in the current Sprint development - management and activity control tool. 3. Click up in the Bug area - activity management and control tool. 4. In the test approval area. 5. Along the Sprint and management by the Click Up tool.
When?	1. During coding, the Developer uses the FDD before starting the task and after coding, completing the automated test. 2. This column will be included after each task delivered by the developer and before the quality test. After that, the approved screen will be sent to the test analyst. 3. When a bug is opened, the test analyst should communicate the PO who will determine the degree of priority and estimate the time of completion. 4. At the time of manual testing. 5. At Scrum ceremonies and Sprint development.
Who?	1. Full stack Jr. and Full Developers 2. UX/UI Designer 3. Test Analyst and Product Owner 4. Test Analyst 5. Every project´s workers
How?	1. Automated testing training for Full stack Junior Developers. 2. Including as a new task for the Project Designer. 3. Assigning as a new process of control and management of the opening and correction of bugs. 4. Including as a manual testing activity. 5. Including as a second agile tool, through the verification of macro features and their user stories and inclusion of rules and comments in the code.

At the first level of 5W2H (What), it was suggested the implementation of automated testing by developers and the FDD during the development cycle. The business requirements should be tested and reviewed before starting to code. After the coding is finished, a new test of what has been developed should be conducted.

As a second chosen of improvement, it was suggested the inclusion of a new phase during the Sprint process by the UX/UI Designer who should also validate the tasks that involve frontend. This phase would be initiated after the delivery of the card by the developer and before the testing column. As a third definition of improvement, it was suggested the allocation of time for the solution of each bug, stipulating a goal of hours according to the degree of priority. The degree of priority must be defined not by the opening date of the incident, but by the degree of urgency defined by the Product Owner.

The control phase involves monitoring the improvements over time after their implementation: a review after three months to verify if the objectives were met. The monitoring can be mainly performed by the Project Leader who will gather data on the performance of the team over the eight Sprints along with the number of bugs. To support the monitoring process, it is also suggested fortnightly Specifications meetings. These meetings bring together the development team and the Product Owner whose goal is to refine the business rules of each user stories and understand in depth what should be codified, thus expanding the technical/functional understanding and avoiding rework. In addition, the Discovery Review is to evaluate and annotate the degree of satisfaction of the project's stakeholders including the customers.

5 CONCLUSION

In conclusion, it was possible through the DMAIC method to analyze the gaps presented by the project. The project applied part of the Agile Methodologies as the basis of its processes. To summarize, it can be concluded that the project fulfilled the role of agility and effectiveness but it could have achieved even better results if the performance of each collaborator's role was accomplished. It can be affirmed that the proposed objective has been reached once that the development of the approach brought insights and suggestions for improvements to increase the team's performance. Regarding the specific objectives, it can be understood that they have been also achieved, since the tools were applied in the Define, Measure, Analyze, Improve and Control phases, both in the technical and managerial spheres. For technical gaps, suggestions to reduce the number of bugs in the client's production environment and actions to reduce usability and design failures on the website as well as rework. For the managerial area, suggestions for improvements to strengthen internal communication and the respective demands have been proposed.

In this study, the price attributed to the five points of suggested improvements have not been analyzed. It was considered not feasible to price them at this stage, but it would be recommended to conduct a price analysis in future studies. Furthermore, as a continuation of this study, it is proposed to compare its findings with a second software development project conducted by another team and client, so that the profile of these employees, development cycles and products could be explored.

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