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Implementation of Scrum in the manufacture of non-invasive blood sugar detection devices using Photoplethysmography signals

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Abstract

This study presents the effective integration of Scrum methodology in the production process of non-invasive blood sugar testing devices using Photoplethysmography (PPG) signals. During three months, a team consisting of a product owner, Scrum master, and developer team successfully utilized Scrum's agile structure to manage the challenges of PPG signal processing, hardware integration, and software development. The repeated sprint cycles enabled swift adjustment to new obstacles and stakeholder input, guaranteeing both effectiveness and agility in the development process. The dynamic approach facilitated both the punctual delivery of complex medical equipment and the cultivation of a culture focused on ongoing enhancement, establishing a model for the future use of agile approaches in healthcare technology. The successful implementation highlights the effectiveness of Scrum in managing the complexities of medical device development. It provides a model for improving non-invasive blood sugar detection devices and establishes agile methodologies as a key driver of innovation in healthcare technology.

Keywords: scrum, ppg, blood sugar, medical, non-invasive

1 Introduction

The healthcare technology industry is currently undergoing a significant transformation, with a growing emphasis on non-invasive methods for monitoring and treating chronic illnesses [1]. In line with this shift, the application of Scrum methodology in the production of medical devices, particularly non-invasive blood sugar testing devices, holds substantial promise [2]. Traditional approaches to product development in

the medical sector have often been rigid and time-consuming, hindering the swift integration of new technologies. Scrum offers a more flexible and iterative approach, allowing for quicker adaptation to evolving requirements and technological advancements. By adopting Scrum, teams can enhance collaboration, streamline processes, and expedite the development of innovative healthcare solutions. This research aims to explore the implementation of Scrum in the development and production process of non-invasive blood sugar testing devices, leveraging its benefits to accelerate progress and deliver effective solutions to patients and healthcare providers [3].

Through the utilization of Scrum in the development process, the technological obstacles associated with incorporating PPG signals could be minimized while guaranteeing an agile and adaptable approach to the ever-changing field of medical device technologies. Scrum is one of the agile practices, its an incremental approach and iterative nature is used to manage complex work, these practices can be applied in development of complex software products with frequently changing business requirements. This is proven in the development of blood sugar detection devices without intrusive methods, the complex nature of developing this product requires a collaborative and adaptable approach that Scrum possess. The framework essential for attaining these objectives is provided by Scrum's cross-functional teams, short development sprints, and regular stakeholder engagements [4]. This research provides a comprehensive background for grasping the pivotal role Scrum methodology plays in shaping the future landscape of healthcare technology, specifically in the realm of developing non-invasive blood sugar testing devices utilizing photoplethysmography (PPG) signals. By elucidating the challenges associated with traditional product development approaches in the medical sector and highlighting the increasing demand for non-intrusive solutions in diabetes care, this study underscores the urgency and relevance of adopting agile methodologies like Scrum. Through detailed analysis and case studies, this research illuminates how Scrum's iterative and collaborative framework empowers teams to efficiently navigate complex development processes, accelerate innovation, and ultimately drive the advancement of cutting-edge healthcare technologies.

2 Material and Methods

In this study, the Scrum methodology is being utilized for the development of our application. Scrum is a nimble framework designed to aid people, companies, or teams in accomplishing their goals by providing flexible solutions to intricate challenges. The explanation of the Scrum framework is described in Fig. 1.

Various methods, approaches, and tactics can be utilized within the framework. Scrum can either include or replace existing approaches. Scrum allows for the evaluation of the comparative effectiveness of current management, environment, and work procedures, hence enabling possibilities for improvements. Scrum is based on the principles of scientific proof and lean thinking. Empiricism asserts that knowledge is obtained by direct experience and the act of making choices according to observed occurrences. Lean thinking eliminates inefficiencies and prioritizes the key features. Scrum utilizes a process that involves repeating and gradually improving methods to increase the ability to forecast outcomes and control potential hazards. Scrum forms teams consisting of persons who have the necessary skills and knowledge to complete the tasks at hand. It also promotes the sharing or acquisition of extra competencies as needed. Scrum includes four organized sessions for examination and adjustment inside a broader event known as the Sprint. The success of these occurrences can be due to their effective

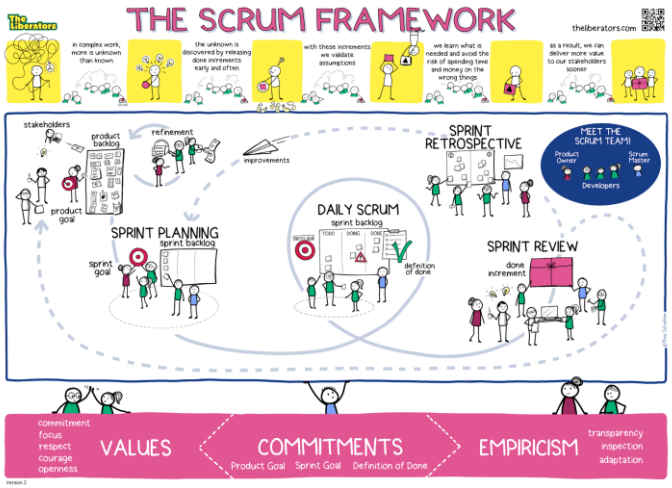

Figure 1. The scrum framework [5].

utilization of the scientific Scrum principles of openness, assessment, and adaptation [9], [10].

A. Scrum Team Composition

The composition of the Scrum Team for this research consists of three essential roles: the Product owner, Scrum master, and developer team as shown in Fig. 2. The product owner is responsible primarily on managing product backlog, establishing priorities, and ensuring that the product meets the expectations of stakeholders. The Scrum master oversees the Scrum process, eliminates obstacles, and guarantees compliance with Scrum principles. The developer teams consist of proficient experts with varied experiences, encompassing biomedical engineering, software development, and quality assurance.

B. Scrum Artifacts

The artifacts in Scrum works as a means to enhance the clarity of information on the development of a product, while also ensuring that the progress of each role can be quantified. Therefore, it strengthens the principles of empiricism and its values for both the team and their stakeholders [7], [11].

The initial component of Scrum is the product backlog. The product backlog is a vital component that comprises of a prioritized inventory for the necessary enhancements

Figure 2. Scrum team composition.

for the product. Therefore, it serves as the origin of the tasks that must be carry out by the Scrum Team [7]. The product owner is responsible for establishing and overseeing the order in which tasks are completed. During the initial week, the product owner engages in collaboration with stakeholders to create a thorough product backlog. The backlog comprises of user account about PPG signal processing techniques, sensor integration, hardware design, software development, user interface, and regulatory compliance. The process of prioritization relies on input from stakeholders and the assessment of the value it brings to the organization.

The second component of Scrum is the sprint backlog. The sprint backlog is a strategic plan devised by the development team to systematically divide each desired targets into a series of activities, incorporating a design element and employing just-in-time planning to accomplish the necessary objectives. The Sprint Backlog should be consistently updated during the Sprint since it serves to evaluate the progress made during the daily scrum.

The third component of Scrum is referred as the increment. The increment is to a series of definite steps that must be taken to accomplish the product goal, ensuring that the final product is of high quality and has the ability to be shipped[12]. Each increment is an additional amount gained by the team, surpassing the previous increment. Multiple increments can be made during the sprint to ensure the cohesive functioning of all increments [7]. The project timeframe is segmented into six consecutive two-week sprints. During the initial two weeks, the team carries out Sprint 0, which primarily involves establishing the project, determining the Definition of Done (DoD), and enhancing the initial product backlog. The following sprints are allocated to certain features and functionality specified in the prioritized product backlog. Sprint planning meetings are conducted at the start of every sprint to choose tasks and establish sprint objectives.

The increment performs as a formal declaration that defines the criteria for measuring the needed product quality. It aims to foster transparency among team members by synchronizing their shared knowledge of accomplished tasks [7].

C. Scrum Tools

As we embark on the development journey of non-invasive blood sugar testing devices using PPG signals within a challenging three-month timeframe, our team harnesses a variety of methods to optimize task management and collaboration. Two essential tools in our arsenal are Miro board and Notion, each offering unique capabilities to support our Scrum-based development process.

Miro board, available at miro.com, serves as a dynamic digital whiteboard tailored for collaborative work. Its rapid, cost-free, and user-friendly interface provides an expansive surface adaptable to diverse domains, including research, design, planning, teaching, and agile operations management. Through Miro, our team engages in collaborative brainstorming, sprint planning, and visualizing workflow dependencies, fostering efficiency and alignment throughout the development cycle [13].

Complementing Miro, Notion (notion.so) emerges as a cutting-edge platform for team collaboration. Notion's customizable markdowns and diverse templates, such as kanban boards, tasks, wikis, and databases, empower our team to organize information, manage tasks, and track project progress seamlessly. Its versatility extends to note-taking, knowledge organization, and data management, further enhancing our ability to navigate the complexities of device development within tight time constraints.

Aligned with our commitment to delivering high-quality, regulatory-compliant, and user-centric products, we adopt Scrum methodology as the cornerstone of our development approach. Scrum's iterative and collaborative framework ensures timely delivery of our non-invasive blood sugar testing devices while upholding rigorous standards of quality and regulatory compliance. By integrating Scrum with Miro and Notion, our team capitalizes on agile practices and digital tools to drive innovation and achieve our development objectives effectively

3 Results and Discussions

In this research experiment, we followed the Agile Scrum framework to execute all events and create the final product. In addition, we generated documentation and designs that illustrate how we used the Agile Scrum process to develop the application.

A. Results

Following assigning Scrum roles to individuals involved in the product's development, the product owner coordinates with stakeholders to collect and define the product's requirements. These requirements are then converted into product backlog items. These items go through a prioritization procedure before being divided into several sprints for efficient completion.

Fig. 3 depicts the story of user activities within the application, illustrating tasks from user/patient, doctor, and admin. Establishing the product goal early in Scrum events is crucial to ensure that the product achieves significant commercial value. This statement is crucial for properly directing the development process. Fig. 4 depicts the product goal, displaying it as a long-term objective and emphasizing its importance in the area of business strategy.

The relationship between the product goal and the narrative story is essential for ensuring coherence and alignment throughout the development process. The narrative story provides context and specificity to the product goal by illustrating how users interact with the application and the specific tasks and functionalities they engage with to achieve desired outcomes. Conversely, the product goal sets the overarching direction and

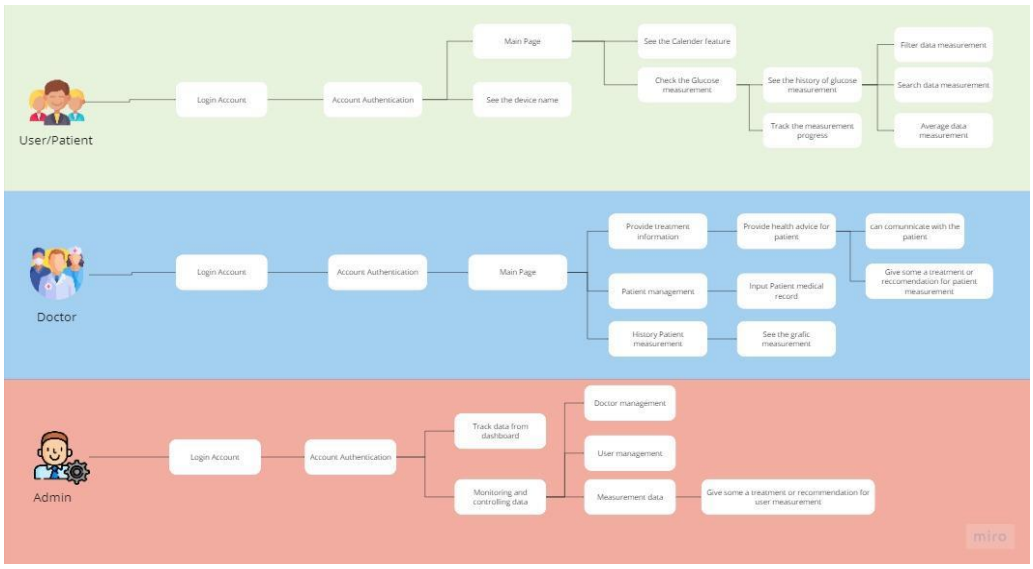

Figure 3. Narratives

purpose for the development effort, guiding the translation of user needs and requirements into actionable tasks and features within the application.

Table 1 illustrates how the narrative stories is transformed into a list of user stories. The table supports the creation of product backlog items based on simplified and summarized user needs. It makes the development team's job easier by allowing them to focus on product tasks within each sprint.

A non-invasive blood sugar detection device using Photoplethysmography (PPG) signals was developed for painless blood sampling, particularly for diabetes patients who are concerned about wound healing time. This device helps with remote blood sugar monitoring, making it easier for medical professionals to monitor patients and enabling specific actions for high or low blood sugar levels.

Figure 4. Product goal

Table 1. List of user Stories

User Story
USER
As a user, I want the application to be able to log in so I can access other features.
As a user, I want the device name and password so that I can log in and access the application.
As a user, I would like to see a "Hello Device Name" display after logging in so that I can see the connected device information.
As a user, I want to see the day and date feature on the main page so I can know what time it is.
As a user, I want to be able to see today's glucose measurement results so I can monitor my blood sugar.
As a user, I want to see a calendar feature to select a date so I can view previous data.
As a user, I want to see the history of glucose measurements in mg/dl so I can track my progress.
As a user, I want a data search feature based on date so that I can search for specific data.

As a user, I want to average glucose measurements over 1 week so I can see short-term trends.
ADMIN
As an admin, I want to log in as admin and do pin authentication so I can access admin data.
As an admin, I want to see the data collected today or on a certain date so I can manage the data.
As an admin, I want to see health suggestions (discovery feature) so that I can provide health recommendations.
DOCTOR
As a doctor, I want to log in as a doctor and do PIN authentication so I can access patient data.
As a doctor, I want to see patient history and collect data on certain dates and times so that I can provide appropriate treatment.
As a doctor, I want to input patient information so that I can complete the patient's medical record.
As a doctor, I want to see the average results of patient glucose measurements in a certain period so that I can carry out a more in-depth analysis.
As a doctor, I want to have access to a graph of the patient's glucose measurement results so that I can better visualize the data.
As a doctor, I want to be able to provide health advice to patients based on the results of their glucose measurements so that I can help them manage their condition.
As a doctor, I want to see overall patient intake data so I can make better decisions in patient care.
As a doctor, I want to see the patient's contact information so I can communicate with them.

The sprint backlog consists of user stories structured as product backlog items as illustrated in Fig. 5. Each sprint is focused on a specific goal aligned with the ongoing item under development. Each sprint has a duration of one week, and addresses an equal amount of items. This approach ensures a systematic and balanced progression of tasks over time.

Figure 5. Product backlog items and sprints

Then, the user stories are transformed into a functional ToDo list. This conversion is accomplished utilizing a website application called Notion. The ToDo list emonstrates a practical method for transforming abstract user stories into tasks that can be managedeffectively. It useful for organizing and tracking the progress of product development. Furthermore, it also enhances transparency by clearly outlining the tasks given to each member of the development team, simplifying the handling of individual contributions and overall project development. Figure 6 depicts the transformation of user stories into a functional ToDo list.

Analyzing Fig. 6 in detail, we can observe the arrangement of tasks within the sprint backlog for the first sprint. These tasks are divided into three stages: “to do”, “doing”, and “done”. The tasks include authentication features, profile features, and PPG system. Each of these tasks requires specific work to be completed by the development team. The items already completed are sign-in and sign-up. The current priority is on finalizing the authentication process. The remaining tasks to be completed are the development of log-out and profile features.

Fig. 7 illustrates The Definition of Done in Scrum, which explains the criteria used to determine whether the product improvements are ready for release. This definition functions as a checklist of conditions that must be fulfilled for every task to be considered

finished within the Scrum framework. For example, declaration of an increment as complete will fulfil the “Done” condition. All members of the development team need to understand the criteria to maintain uniformity of understanding in the “Done” condition.

The sprint, as an integral component of Scrum, demonstrates to be an effective framework for facilitating collaboration within a team especially when supported by suitable guidance and a well-structured timetable. A sprint calendar is required for arranging various Scrum events including sprint planning, daily meetings, sprint reviews,

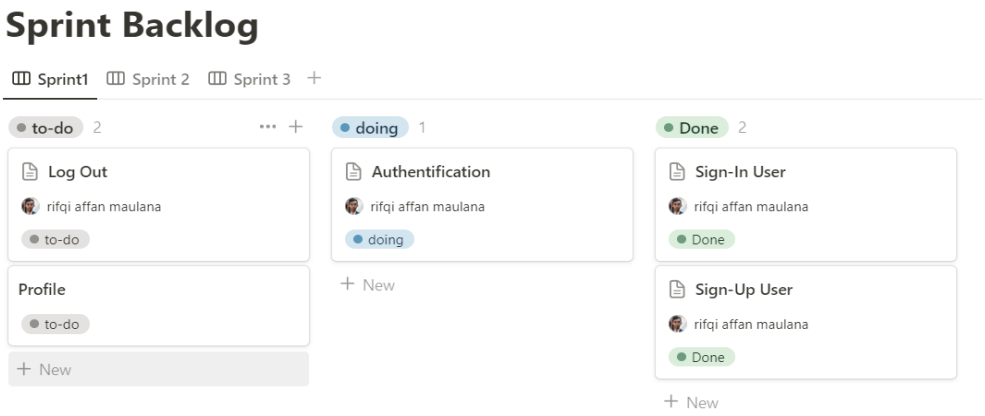

Figure 6. Product backlog on notion

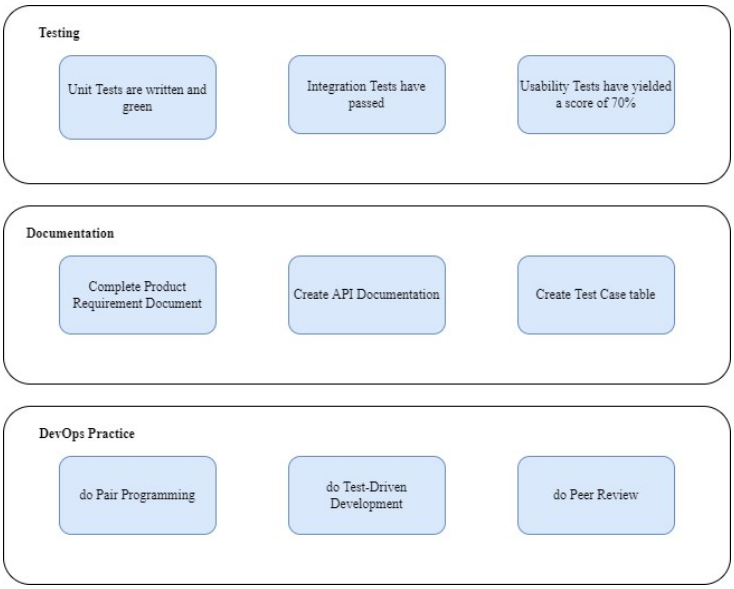

Figure 7. Definition of done (DoD)

and sprint retrospectives. The primary purpose of implementing a sprint calendar is to keep the team on track and to be used as a reminder for important Scrum activities. It also helps to prevent time waste during sprint planning and development by providing a clear and organized overview of the activities to be completed.

A sprint calendar shown in Fig. 8 illustrates the scheduling and execution of Scrum events by the team. Over numerous sprints, the development team has successfully met the timelines. As an example, on October 2, 2023, the team initiated the sprint with a sprint planning session. The following day was dedicated to routine daily scrum meetings, which were held to ensure constant communication, monitor the development progress of the application, and handle any challenges faced by the team during the development of a non-invasive blood sugar detection device using Photoplethysmography (PPG) signals. This daily interaction is crucial for keeping the entire team aligned and informed. Following this routine, on October 9, 2023, the team conducted a sprint review and a sprint retrospective. Then on October 10, 2023, the team evaluated on the finished sprint and planned improvements. Then the team continues the tasks as presented on the sprint calendar provided as shown in Fig. 8.

Sprint planning is a pivotal meeting in the Scrum framework where the team deliberates on the sprint objective, the production timetable, and tasks allocated to the team for the duration of the sprint. All Scrum team members are required to attend this crucial Scrum event. The Scrum Master's responsibility extends beyond assuring attendance; they are also accountable for ensuring that each team member comprehends their designated duties and tasks.

Fig. 9 depicts the unique duties allocated to each scrum roles particularly during the sprint planning phase. The product owner has the responsibility of showcasing the product backlog, providing detailed explanations of backlog items, responding to inquiries, resolving issues, defining acceptance criteria, and prioritizing backlog items. Scrum

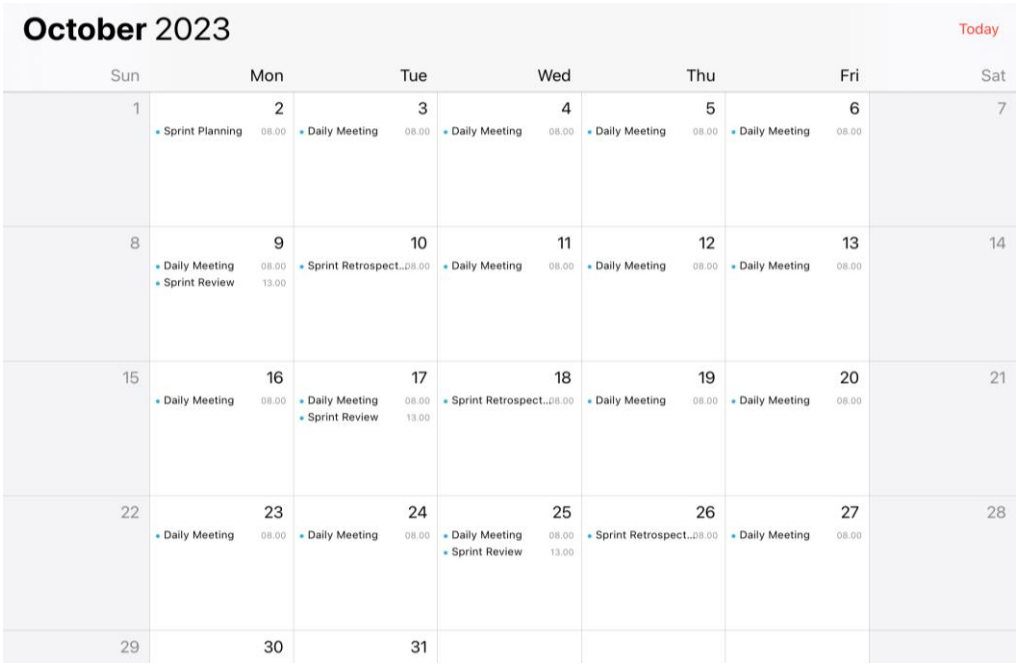

Figure 8. Sprint calendar

master include overseeing meetings, leading team discussions, resolving obstacles, managing time, and assisting the product owner. Meanwhile, the development team is tasked with evaluating the amount of work required, breaking down the items in the backlog, resolving any dependencies, choosing which items to work on during the sprint, and making a commitment to achieving the sprint goals.

The development of a non-invasive blood sugar detection device employing Photoplethysmography (PPG) signals incorporates Scrum as the software development framework, with specific Scrum roles tailored for the device's purpose. The Scrum framework encompasses several key roles, namely the product owner, scrum master, development team, and two stakeholders, as depicted in Fig. 10. Mrs. Hesti and Mrs. Arna are individuals who have a vested interest in the application. The stakeholders are

Figure 9. Sprint planning

collaborating with Erita, who is the product owner of the application. Erita will engage with the team to oversee the advancement of the development and manage the product backlog. Additionally, she represents the desires of stakeholders in relation to the product backlog. Subsequently, Izza ought to assume the role of the scrum master. Izza is responsible for overseeing the functioning of the scrum team and ensuring that the team remains free from disagreements or barriers. She is not involved in product development. The last aspect to consider is the development team. The composition of our development team consists of Rifqi, who serves as both the UI/UX designer and developer, and Rafly, who fulfills the roles of a backend engineer and DevOps engineer. They possess a high level of expertise.

The team of developers engages in a daily scrum meeting lasting 15 minutes [7]. In this study, there were two development teams consisting of Rifqi, who served as the UI/UX designer and developer, and Rafly, who fulfilled the roles of a backend engineer

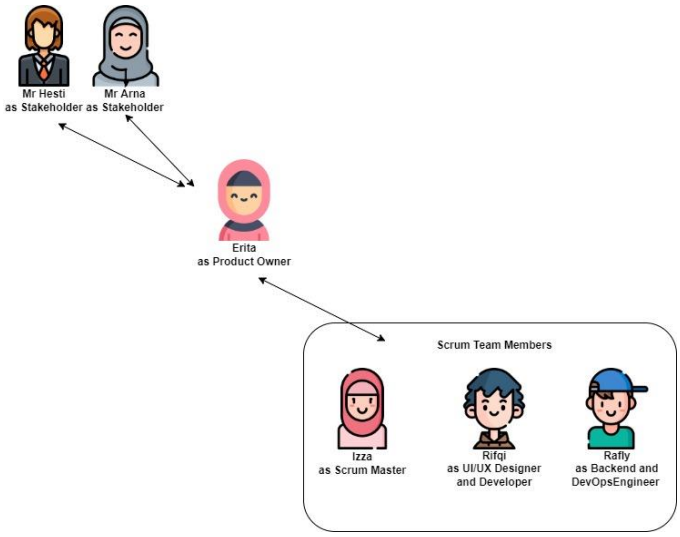

Figure 10. Scrum roles

and DevOps engineer. The four development teams provided updates on their activities from the previous day, identified any obstacles hindering their progress, and outlined their current tasks.

Fig. 11 illustrates a daily meeting that took place on December 4th, 2023. This figure serves as documentation since it presents a comprehensive breakdown of the reports discussed at the meeting. Rifqi informed that she successfully finalized the design of the registration page, and accomplished the implementation of One-Time Password (OTP) and Short Message Service (SMS) connectivity. Rafly developed a service specifically for new users and also established an Application Programming Interface (API) for new users in the "What did you work on yesterday?" report section. After seeing the report section titled "What issues are impeding progress?", the four members of the developer team did not face any difficulties during their daily meetings. The upcoming tasks for today, as mentioned in the last report titled "What are you working on today?", are as follows: Rifqi will be responsible for designing the profile page and integrating the API and SMS provider. On the other hand, Rafly will focus on creating a sign-up page view. Additionally, Rifqi will also handle the integration of the API and SMS provider. The daily scrum activities provide insights into the performance of the developer team and the achievement of the project's sprint goals. During the sprint review, the scrum team showcases their work to stakeholders and engages in discussions regarding the progress

made towards achieving the product goal [7]. If the duration of the sprint is one month, the maximum duration for the sprint review is four hours.

Fig. 12 illustrates the sprint review actions that took place during sprint 1. A Scrum team is showcasing the system design of an application that utilizes Photoplethysmography (PPG) signals to detect blood sugar levels in a non-invasive manner. Our team conducts sprint reviews remotely using the Zoom platform.

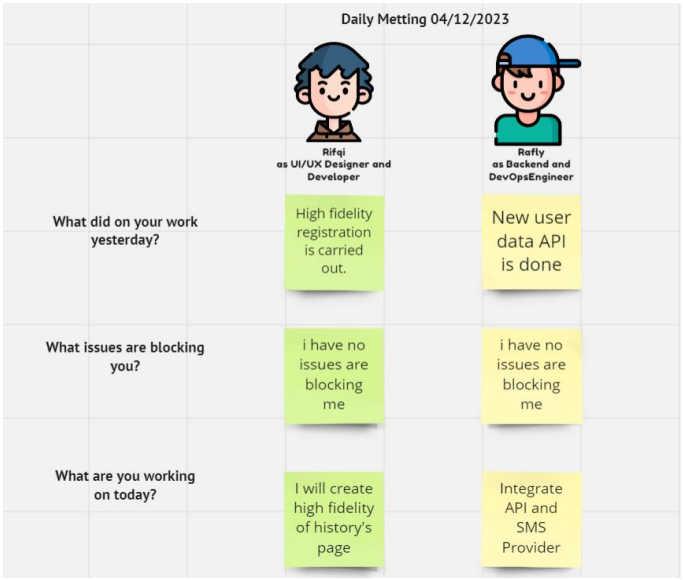

Figure 11. Sample of daily meeting activity by development team

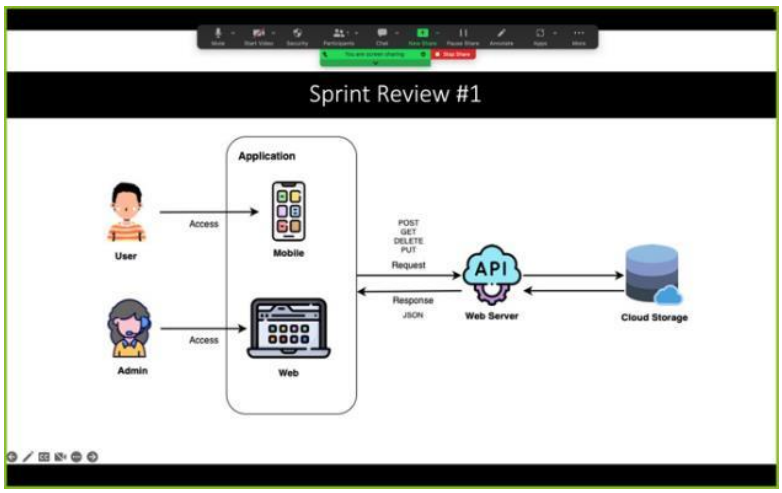

Figure 12. Development team's exemplary sprint review activity

The sprint retrospective involves analyzing the performance of a certain sprint, identifying any encountered problems, and devising solutions to address those problems [8] The objective of the sprint retrospective is to gain insights from the performance of the previous sprint and utilize that knowledge in the subsequent sprint. The length of the retrospective sprint is governed by the length of the sprint itself. For instance, if a sprint lasts for one month, the maximum duration of the retrospective sprint is three hours.

Fig. 13 illustrates the retrospective sprint employed in this investigation. Every member of the development team reviews the sprints that have been finished. Rifqi expressed a positive assessment of the successful sprint. In contrast to Rifqi, Rafly demonstrated the ability to discern between personal problems and the task at hand by providing comments.

B. Discussions

Based on the findings, there are several benefits to adopting the Scrum framework for the development of an application for non-invasive blood sugar testing device employing Photoplethysmography (PPG) signals in its current form, as indicated in Table 2.

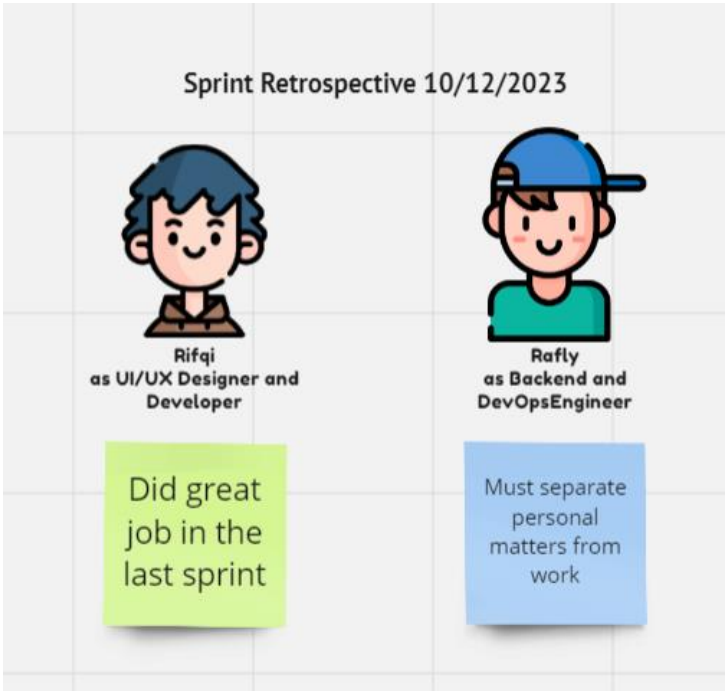

Figure 13. Sample of Sprint Retrospective Activity by Development Team

Table 2. The benefits of implementing agile scrum methodology into the development of the application

Case	Benefit
Estimation of Tasks	The task plan is more detailed for team members during the sprint (1-2 weeks).
Product Monitoring	To effectively track the progress of product execution, we create a "to-do list"
Changes in Business Processes	It is highly adaptable to changes required to support the business side. After the final sprint, the development team receives input in the form of new sprint tasks.
Feedback from Users	The user can contribute to the product's development by testing and providing feedback. Aside from that, the requirements of the users and stakeholders must be aligned during the final sprint discussion.
Transparency in the Project	During the sprint review, each member of the development team shows off their work from the sprint. As a result, they can all learn about the product's development progress.

Comparing the benefits of adopting the Scrum framework with other project management methodologies can provide insights into why Scrum may be the preferred choice for developing a mobile application for a non-invasive blood sugar detection device using PPG signals. Let's compare Scrum with the traditional Waterfall model and the Kanban method:

Task Estimation:

Scrum: In Scrum, task estimation is done collaboratively by the team during sprint planning sessions. The tasks are broken down into smaller, manageable units, allowing for a more detailed plan within short timeframes (1-2 weeks).

Waterfall: In the Waterfall model, task estimation is typically done upfront during the planning phase. However, this estimation may be less detailed and flexible compared to Scrum, as the entire project is planned in advance.

Kanban: Kanban also allows for task estimation, but it doesn't follow strict timeboxed iterations like Scrum. Instead, tasks are pulled from a backlog as capacity allows, and estimation may vary based on workflow dynamics.

Product Monitoring:

Scrum: Scrum emphasizes transparency and accountability through sprint planning and daily stand-up meetings. Progress is tracked using a "to-do list" or a Kanban board, providing visibility into the status of tasks.

Waterfall: In the Waterfall model, product monitoring may be less dynamic, as progress is evaluated at predefined stages (e.g., requirements, design, implementation). Changes may be challenging to accommodate once the project is underway.

Kanban: Kanban provides real-time visibility into workflow status, but it may not have the structured sprint planning and review events found in Scrum.

Changes in Business Processes:

Scrum: Scrum is highly adaptable to changes, as new requirements can be accommodated in subsequent sprints. The iterative nature of Scrum allows for flexibility in responding to evolving business needs.

Waterfall: The Waterfall model is less flexible in accommodating changes once the project is underway. Changes may require significant rework and impact project timelines and budgets.

Kanban: Kanban allows for incremental improvements, but major changes may require adjustments to the workflow and may not be as structured as in Scrum.

Feedback from Users:

Scrum: Scrum encourages frequent feedback from users through sprint reviews and demos. User input is integral to the development process, ensuring that the product meets user needs.

Waterfall: User feedback may be limited until the end of the project when the final product is delivered. Changes based on user feedback may be costly and time-consuming to implement.

Kanban: Kanban allows for feedback throughout the development process but may not have dedicated events for user review and feedback like Scrum.

Transparency in the Project:

Scrum: Scrum promotes transparency through its ceremonies, such as sprint planning, daily stand-ups, and sprint reviews. This fosters open communication and collaboration within the team.

Waterfall: Transparency may vary in Waterfall, as progress is evaluated at predefined stages, and there may be less visibility into ongoing work between stages.

Kanban: Kanban provides transparency through its visual board, but it may not have the structured events for team collaboration found in Scrum.

Overall, while each methodology has its strengths, the iterative and collaborative nature of Scrum, along with its emphasis on adaptability and user feedback, may make it more suitable for the dynamic and evolving nature of software development projects, such as creating a mobile application for a non-invasive blood sugar detection device.

Table 2 reveals that implementing agile scrum as a product management approach in this study offers five advantages for handling the software development life cycle with greater efficiency and effectiveness. These benefits include detailed task estimation, user involvement in product development through feedback and reviews, and increased transparency within the development team, which can help minimize miscommunication. In addition, Scrum's timeline and sprint planning facilitate the monitoring of productivity in software development, enabling accurate determination of time costs.

In addition, the developers use daily meeting to share information about their work, ensuring that all team members are informed about the progress of developing the mobile application for the non-invasive blood sugar detection device using Photoplethysmography (PPG) signals. Following the sprint, a sprint retrospective is conducted to assess the performance of individual developers and determine the results of the ongoing product development.

The agile scrum approach can be implemented in the creation of mobile application for the non-invasive blood sugar detection device using Photoplethysmography (PPG) signals. This choice was made based on adherence to the Scrum values, execution of the Scrum events in real-life scenarios, and formation of the team according to the Scrum instructions. The degree of execution of all of the prescribed actions outlined in the guide as a measure of the effective deployment of the Agile Scrum

methodology in the development of software applications. By utilizing thoroughly documented Scrum, we can streamline progress tracking, assume a guiding role in system development, provide a historical record, and evaluate the adoption of Scrum throughout the development process.

C. Application Implementations

The following are the results of the application implementation from login to application results. Fig. 14 is one of the results of the application implementation, namely the results of the user application

Figure 14. The result of the user application

4 Conclusions

In conclusion, the integration of Scrum methodology in the manufacture of non-invasive blood sugar detection devices utilizing PPG signals has yielded significant benefits within the confined three-month timeframe. The iterative and collaborative nature of Scrum allowed our cross-functional team, comprised of the Product Owner, Scrum Master, and Developer Team, to navigate the intricacies of PPG signal processing, hardware integration, and software development with agility. The sprint cycles facilitated quick adaptations, enabling the team to stay responsive to emerging challenges and stakeholder feedback. This dynamic approach not only ensured the timely delivery of a sophisticated medical device but also fostered a culture of continuous improvement, setting a precedent for future endeavors in the realm of healthcare technology.

Looking forward, the successful implementation of Scrum underscores its efficacy in managing the complexities inherent in medical device development. The balance between flexibility and structure afforded by Scrum proved instrumental in not only meeting technological benchmarks but also aligning the final product with the practical needs of healthcare professionals and end-users. The lessons learned from this experience not only contribute to the advancement of non-invasive blood sugar detection devices but also serve as a testament to the adaptability and efficiency that agile methodologies, particularly Scrum, bring to the forefront of innovative medical technology development.

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