Journal of International Technology and Information Management

Manuscript 1603

ACTIVITIES TAILORING WITHIN AGILE SCRUM ROLES: A CASE OF NIGERIAN HEALTHCARE INFORMATION SYSTEMS DEVELOPMENT

Yazidu Salihu

Julian Bass

Gloria Iyawa

Follow this and additional works at: https://scholarworks.lib.csusb.edu/jitim

 Part of the Business Intelligence Commons, Communication Technology and New Media Commons, Computer and Systems Architecture Commons, Data Storage Systems Commons, Digital Communications and Networking Commons, E-Commerce Commons, Information Literacy Commons, Management Information Systems Commons, Management Sciences and Quantitative Methods Commons, Operational Research Commons, Science and Technology Studies Commons, Social Media Commons, and the Technology and Innovation Commons

ACTIVITIES TAILORING WITHIN AGILE SCRUM ROLES: A CASE OF NIGERIAN HEALTHCARE INFORMATION SYSTEMS DEVELOPMENT

Yazidu B Salihu
Department of Computer Science and Software Engineering,
University of Salford, Manchester, UK
y.b.salihu@edu.salford.ac.uk

Julian M Bass
Department of Computer Science and Software Engineering,
University of Salford, Manchester, UK
j.bass@salford.ac.uk

Gloria E Iyawa
Department of Computer Science and Software Engineering,
University of Salford, Manchester, UK
g.e.iyawa@salford.ac.uk

ABSTRACT

Developing quality agile healthcare information systems requires understanding regulatory compliance and evolving healthcare needs through activities tailored within agile scrum roles. Agile scrum, a widely adopted philosophy, offers significant advantages in managing software development processes. This research explores how activities within the agile scrum roles are tailored to agile healthcare information systems development within the Nigerian context. This study adopted a qualitative case study methodology and interviewed 12 agile practitioners developing healthcare information systems within Nigeria using semi-structured open-ended interview guide questions. The practitioners were selected based on a snowballing process, a sunset of purposive sampling techniques from our network

of experts. In this study, we used the data analysis techniques informed by the grounded theory, which includes open coding constant comparison, memoing, and theoretical saturation to analyse the data. We identified 33 tailored activities performed by the scrum roles comprising product owner, scrum master and self-organising development team. The activities include adherence to medical regulatory standards, clinical quality assurance testing, documentation, and healthcare knowledge sharing, which are specific for developing quality agile healthcare information systems in the Nigerian context. We systematically mapped the practices into four high-level memos that comprise Activities Tailoring for Healthcare Information Systems Development, Tailoring Activities Within the Product Owner's Roles, Tailoring Activities within the Scrum Master's Roles, and Tailoring Activities within the Self-organising Team Role, which are the descriptive theory emerged from the grounded theory conceptual data analysis process. Our primary contribution to this research is a detailed account of 33 tailored activities within Scrum roles and the memos presented, which are necessary for developing quality agile healthcare information systems software. Agile practitioners need more tailoring skills and adequate resources, local regulatory standards, data security infrastructures, and support from the government to deal with technical debt and issues with nonfunctional requirements.

Keywords: Agile Healthcare Information Systems, Self-organising team, Nonfunctional requirement, Grounded Theory, Agile scrum roles.

INTRODUCTION

The problem in this research is understanding how agile scrum activities are tailored within the agile healthcare information systems. Agile methods present approaches that deliver quality products incrementally to clients (Garcia et al., 2022). Agile practices include scrum, eXtreme Programming (XP), Scaled Agile Framework (SAFe), Feature-Driven Development (FDD), Lean, and Kanban, among others (Abrahamsson et al., 2017). Research shows that Scrum is widely adopted in small-scale and large-scale software organisations (Demissie et al., 2016). The approach is defined by iterative sprint cycles, consistent feedback loops, and adaptive planning to deliver customer value (Dingsoeyr et al., 2019). In contrast, studies have categorised scrum concepts into roles, ceremonies or events,

and artefacts (Bass, 2023; Berntzen et al., 2023; Garcia et al., 2022). The agile scrum roles comprise individual experts, including product owner, scrum master, and self-organising team (Schwaber & Sutherland, 2011). These individuals collaborate to deliver valuable software products to the customers incrementally (Garcia et al., 2022).

Similarly, studies exist addressing issues within small-scale and large-scale software development organisations. For instance, in large-scale software development (Dingsoeyr et al., 2019), inter- team coordination mechanism for large-scale software development (Berntzen et al., 2023), Tailoring of product owners for large-scale software development (Bass & Haxby, 2019; Berntzen et al., 2019) and information flow within inter-team boundaries (Rahy & Bass, 2019). Some studies focus on the activities of the scrum team role (Bass, 2015; Kantola et al., 2022; Noll et al., 2017). There are also studies on agile software quality in information systems development (Ardo et al., 2023; Srivastava et al., 2021) and tension in organisations transforming to agility (D. E. Strode et al., 2022). While agile offers benefits, tailoring standard scrum practices challenges agile healthcare practitioners (López-Martínez et al., 2016). Particularly regulatory compliance in agile healthcare information systems development (Dijkers et al., 2018; Fraser & Blaya, 2010). In this research, we aim to explore how standard scrum activities are tailored to agile healthcare information systems development within the Nigerian context.

Reports show that Nigeria is a software development outsourcing hub despite being among the largest economies in Africa (Statista, 2023). Nigeria is an emerging economy and provides a unique and thriving environment for studying the evolution of agile healthcare information systems. With its growing healthcare software startup company, diverse population, advancements in ICT, and supportive policy environment, it is an ideal model for exploring the effective adoption of agile methods to improve healthcare delivery and outcomes.

The study will empirically investigate the dynamic activities of scrum roles in developing agile healthcare information systems through the following research questions: RQ1: How do Nigerian practitioners describe activities tailoring within agile roles in healthcare information systems development? RQ2: How do practitioners describe tailoring activities of agile scrum roles in the presence of nonfunctional requirements and regulatory constraints in Nigerian healthcare information systems development?

This study delves into the dynamic activities involved in tailoring agile scrum team members to develop healthcare information systems. The study adopted a qualitative case study methodology and interviewed 12 agile practitioners developing healthcare information systems within Nigeria. The practitioners were selected based on a snowballing process from our network of professional experts. In this study, we used the data analysis techniques informed by the Grounded theory- guided data collection and analysis. We identified 33 tailored activities performed by the product owner, scrum master, and self-organising development team. This research contributes to discovering novel activities, including medical regulatory standards, clinical assurance testing, clinical documentation, and healthcare knowledge sharing, specific for developing quality agile healthcare information systems in the Nigerian context. We systematically mapped the practices into four high-level memos that comprise Activities Tailoring for Healthcare Information Systems Development, Tailoring Activities Within the Product Owner's Roles, Tailoring Activities within the Scrum Master's Roles, and Tailoring Activities within the Self-organising Team Role. We discovered that agile skills are still in the prematurity stage, which includes healthcare policies and regulations. We further observed that practitioners find it challenging to address conflicting requirements from diverse stakeholders, including users, healthcare professionals and external regulatory bodies with limited resources. This pressure leads to compromised quality standard issues, accumulating technical debt and nonfunctional requirements issues.

The remaining research sections are structured as follows: 2. A thorough review of the existing literature on agile practices and adapting scrum roles to healthcare information systems development. 3. The study covers the methodology, data collection, analysis, and research site. 4. We Present the findings as memos according to scrum roles, which include product owner, scrum master, and development team. 5. We discussed and presented the study's implications based on the research questions raised earlier. 6. We crafted and presented conclusions, recommendations, and plans for future work.

LITERATURE REVIEW

This section thoroughly reviews the existing literature on agile scrum practice and a detailed review of product owner, scrum master, and development team adaptation in healthcare information systems development. It also provides an

overview of current research on agile studies in the Nigerian context. The goal of consolidating the existing literature is to provide a strong justification for the study.

Overview of Agile Practice

The agile manifesto was formulated in 2001 by software practitioners seeking alternative methods to plan-driven approaches. The agile core principle underscores the values of individuals and interactions over processes and tools, customer collaboration over contract negotiation, responding to change over following a plan, and delivering working software over comprehensive documentation (Beck et al., 2001). The agile scrum framework provides a structured yet flexible approach for iterative software development, emphasising incremental delivery and frequent inspection. Conventionally, the agile philosophy encompasses a range of practices that include scrum, eXtreme Programming (XP), Scaled Agile Framework (SAFe), Feature-Driven Development (FDD), Lean, and Kanban, among others (Abrahamsson et al., 2017). Agile Scrum is the most widely adopted for small-scale and large-scale software development software project development (Demissie et al., 2016). The agile scrum philosophy featured roles, ceremonies, and artefacts as effective development mechanisms (Bass, 2023; Berntzen et al., 2023). The research conducted by Fowler & Highsmith agile scrum roles delivers quality software solutions to the customer earlier incrementally and iteratively (Fowler & Highsmith, 2001). The unified team of professionals encompasses the product owner, scrum master, and self-organising team committed to achieving the product goal and objective at a time (Schwaber & Sutherland, 2021). Understating the activities of the standard agile roles is significant despite the challenges in healthcare software development.

Agile Scrum Roles Activities

The scrum agile approach defines three distinct roles: the product owner, the scrum master, and the development team, known as a self-organising team (Moe et al., 2010). An agile scrum team emphasises collaboration as a highly efficient strategy for achieving success in various project types (Schwaber & Sutherland, 2021; D. Strode et al., 2022). Product owners are crucial in agile scrum teams' stakeholder engagement, especially when developing sophisticated systems like healthcare Information Systems. The product owner optimises the product's value through effective communication and collaboration between stakeholders (Matturro et al., 2018) and knowledge-sharing with cross-functional team members (Kuusinen et al., 2017).

Generally, the product owner articulates the product vision and creates a roadmap that outlines the strategic direction of the product based on risk (Cohn, 2010). This necessitates understanding market needs and managing core activities, such as prioritising tasks by value, making the product backlog visible, accessible, and understandable to stakeholders, aligning them with the product strategy and integrating them into the product development process. In the research study conducted by Bass et al., 2018, the product owner is responsible for 8 generic activities that include backlog grooming, prioritisation, communication, and product releasing (Bass et al., 2018). The backlog prioritisation must be based on value, risk, and dependencies (Kantola et al., 2022). However, the product must comply with healthcare regulations and standards in healthcare software development.

Similarly, the scrum master is the central intermediary between the product owner and the software development team (Noll et al., 2017). The scrum master's role is to facilitate development and ensure the team adheres to all relevant agile values, practices, and standards (Shastri et al., 2021). This includes facilitating daily coordination meetings and resolving any obstacles that the team meets (Schwaber & Sutherland, 2021). Sprint planning, daily stand-up meetings, and retrospective reviews provide a fundamental framework for maintaining transparency and tailoring within the team. The ceremonies According to Rubin, 2012, the core activities of the scrum master are identifying and removing impediments arising from technical and organisational perspectives that prevent the team from progressing (Rubin, 2012). The Scrum master coaches the team and ensures that the team align with the agile software development principle (Hoda et al., 2013). These practices promote transparency, collaboration, and adaptability, enabling teams to respond swiftly to changing requirements and stakeholder feedback (Larman & Vodde, 2016). Despite tailoring scrum activities, balancing multiple activities such as facilitating, coaching, and mediating in healthcare software development proved challenging. There is an issue with team collaboration and resistance to change (Hoda et al., 2013; Moe et al., 2010). Especially when work culture, personality, and professional background are different (Gregory et al., 2022).

In an agile scrum framework, individuals on the development team are responsible for delivering potentially shippable product increments during each iteration. Software developers, testers, and other technical specialists collaborate to implement user stories and meet the acceptance criteria. This entails developing, testing, and integrating features that satisfy the predetermined acceptance criteria.

The development team collaborates closely to deconstruct product backlog items into tasks, estimate effort, and designate responsibilities (Cohn, 2010). This collaboration is crucial for guaranteeing that all team members comprehend the specifications and can make meaningful contributions (Schwaber & Sutherland, 2021). During sprint planning meetings, the development team collaborates with the product owner to identify the priority items from the sprint product inventory (Bass et al., 2018). The team devises a strategy for delivering these items by breaking them into manageable tasks.

In general, the development team members and scrum master participate in daily stand-up meetings, which are brief, time-limited sessions during which they disclose their accomplishments from the previous day, their objectives for the current day, and any obstacles they are encountering (Noll et al., 2017). These meetings contribute to the preservation of coordination and transparency. At the end of each sprint, the development team conducts a sprint review to present the completed work to stakeholders and solicit feedback. Additionally, they participate in a sprint retrospective to deliberate on process enhancements (Schwaber & Sutherland, 2021). The team ensures the product adheres to healthcare regulations and meets quality standards. This encompasses the coordination of automated tests, the execution of code reviews, and the execution of routine assessments (Bass, 2016). Although the development team's autonomy and self-organisation are fundamental principles of agile scrum, obstacles may arise due to the team's communication barriers, resource constraints, and talent gaps. In healthcare, software development must balance regulatory requirements, data security, and user needs. This study explores how standard activities within scrum roles are tailored to healthcare information systems development within the Nigerian context. The dynamic of healthcare software and the rapid evolution of technology and regulatory frameworks necessitates agile and tailoring approaches.

Agile Tailoring in Healthcare Information System Development

The current computing organisations are experiencing an unprecedented increase in the need for high-quality software solutions, leading to significant transformation approaches in software development strategies. Agile scrum practices offer numerous benefits for developing software systems, including flexibility, stakeholder collaboration, early delivery (Berntzen et al., 2023), and risk mitigation through corresponding ceremonies (Bass, 2016). The advantages offered by Agile methodologies have captivated numerous professionals across various industries globally (Dingsoeyr et al., 2019). This is especially evident among agile healthcare information systems practitioners in the developed world

(McCaffery et al., 2016). However, such evidence suffers serious setbacks in the emerging economy(Fraser & Blaya, 2010).

Even though agile practices have been gaining traction in emerging economy countries (Ardo et al., 2023; Mohallel & Bass, 2019; Rahy & Bass, 2020). Software practitioners are adopting an agile approach to improve their software development processes (Rahy & Bass, 2020). However, the related agile core values may not align well with healthcare processes, especially when traceability is crucial for regulatory compliance (Kokol, 2022). An empirical study in Nigeria shows a lack of established government policies and standards to regulate quality software development (Ardo et al., 2023). A gap between developers and end users leads to issues in software quality and failures resulting from an inefficient tailoring process (Akinnuwesi et al., 2013). There are constraints on skilled personnel and a lack of an effective working culture for agile scrum teams (Ardo et al., 2023; D. E. Strode et al., 2022).

Similar challenges are envisaged in a study conducted with Egyptian software practitioners (Mohallel & Bass, 2019). The findings of a Lebanese study show that software practitioners lack knowledge of agile concepts, including roles, ceremonies, and artefacts (Rahy & Bass, 2020). Effective team communication remains essential even in medical information systems development, where agile implementation is still challenging (D. Strode et al., 2022). Software development in healthcare is characterised by regulatory complexities, diverse stakeholders, and rapidly evolving technologies (Moyón et al., 2020; Srivastava et al., 2021). It is necessary to address their weaknesses in healthcare software development by tailoring the activities of the agile scrum role. This includes regulatory compliance and data security early and throughout the information systems (Ardo et al., 2023). In this research, we aim to explore how standard scrum activities are tailored to agile healthcare information systems development within the Nigerian context. Reports show that Nigeria is a software development outsourcing hub despite being among the largest economies in Africa (Statista, 2023). Nigeria is an emerging economy with over 200 million people, and many start-up companies offer a diverse environment to test agile healthcare systems.

METHODOLOGY

This study adopted a qualitative case study methodology to examine the research inquiries. The case study offers a chance to thoroughly explore a phenomenon in its authentic setting (Yin, 2003). The study employed data analysis techniques informed by the grounded theory. This grounded theory analysis is appropriate for software engineering research to generate innovative ideas from the collected data (Hoda et al., 2012). We collected data from 12 experienced agile professionals from various companies using semi-structured, open-ended interviews and a snowballing process, a subset of purposive sampling techniques. The participants include product owners, scrum masters, a self-organising development team, and other technical experts developing agile healthcare information systems in Nigeria. We interviewed them, ensuring their anonymity and strict confidentiality. This research is part of my PhD, in which we collect and analyse data and publish the results. The initial stage was an exploratory pilot study to enhance the quality of questions, make any required modifications, and become acquainted with the research methodology. We conducted a deductive synthesis for each interview to streamline the analysis.

Research Sites

The research sites are shown in Error! Reference source not found. We collected the data from the 12 software participants. The participants were drawn from various companies developing healthcare information systems solutions in Nigeria. Nigeria is an emerging economy and is among the top five African countries with a high economic index and over 200 million people, offering a diverse environment to test agile healthcare systems. Despite having a history of software outsourcing record, it is also the hub for agile software development startups. The practitioners were carefully chosen based on their years of experience and evidence in healthcare tools developed for government and non-governmental organisations within Nigeria and beyond. Similarly, Nigerian software practitioners have numerous development milestones within the healthcare industry. We selected the practitioners using a snowball, a subset of purposive sampling techniques from the network of professionals within and outside the academic cycle. Each participant represents a company and is coded from H1 to H12. The practitioners' variety and expertise provide credibility and quality to the data.

Table 1. Description of Participants of the study

MIS: Medical Information Systems
HIS: Healthcare Information Systems

Company	Participants	Years	Project	Agile Process
H1	Senior Engineer	10	HIS	Extended Scrum
H2	Tester	12	HIS	Extended Scrum
H3	Developer	8	MIS	Hybrid Agile
H4	Business Analyst	12	MIS	Hybrid Agile
H5	Tester	8	HIS	Hybrid Agile
H6	Project Manager	16	MIS	Scrum
H7	Medical Scrum Master	5	MIS	Scrum
H8	Product Leader	20	MIS	Extended Scrum
H9	Data Manager	18	MIS	Hybrid Agile
H10	Product Manager	13	MIS	Hybrid Agile
H11	Lead Developer	6	MIS	Extended Scrum
H12	Product Owner	9	HIS	Extended Scrum

Data Collection

We gathered data through interviews with 12 experienced software practitioners from Nigeria who specialise in developing independent healthcare information systems. **Table 1** comprehensively depicts the geographic locations, roles, and corresponding duties. We gathered data using semi- structured, open-ended interviews conducted in English via virtual and in-person interactions. We used a snowball sunset of purposive sampling techniques from our network of professionals. We sought explicit written agreement from each participant before conducting the interviews. Likewise, we were cautious about seeking participants' consent before recording the interview. The time of each interview varied between 50 and 70 minutes. We transcribed the interviews using the word processing application version 16.76. developed by Microsoft. The proposed method ensures an accurate transcript and prompts interviewers to consider psychological and emotional factors that may influence the interview process (Vaivio, 2012). Researchers have found that transcribing data from interviews is the most efficient approach for optimising the quality of the obtained data. The study utilised subjective guided questions, enabling the participants to openly and plainly explain their thoughts without interruptions. The data collection is ongoing as the research data is part of the PhD journey. We collected, analysed, refined, and collected more data on a particular phenomenon and published the results.

Data Analysis

In this study, we used data analysis techniques informed by grounded theory. The data analysis techniques are relevant and appropriate to software development research (Hoda et al., 2012). **Figure 1** illustrates the conceptual development of systematic data analysis in grounded theory.

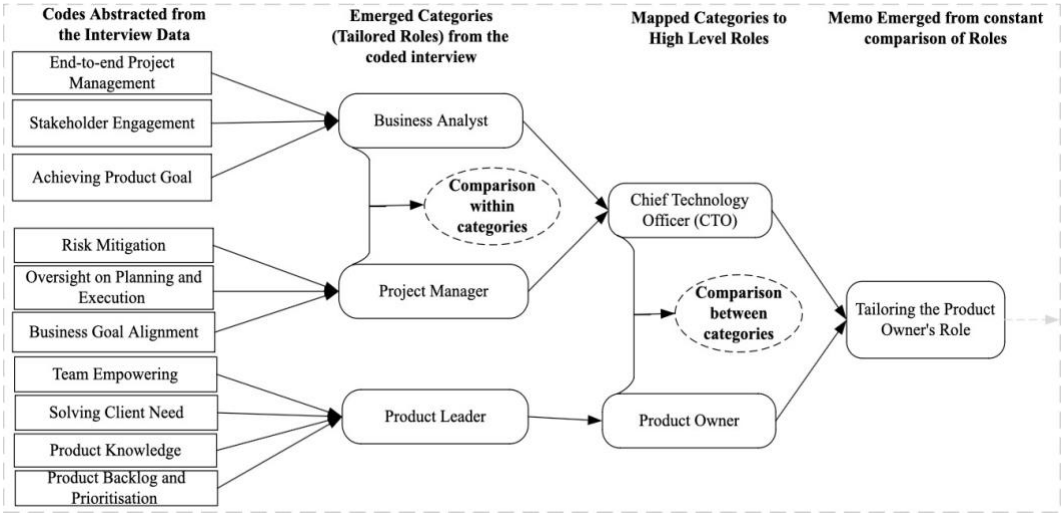

Figure 1. Graphical Description of Grounded Theory Analysis

The analysis began by iteratively examining each interview record to ensure accurate verbatim transcription and minimise any possible distortion of meaning. The transcribed data was entered into NVivo version 12, a qualitative data analysis software. The grounded theory analysis techniques include open coding, constant comparison, memoing, and theoretical saturation. The open-coding process entailed meticulously examining each line to identify and categorise issues, discovering 86 distinct codes. The transcript codes underwent examination, comparison, refinement, and categorisation with each new interview. This ensured the recognition and consideration of every subject. We use the constant comparison technique to examine the categories and compare participants' responses. After classifying the topics, we proceeded to write each memo separately. We made numerous adjustments to enhance the formality of each memo. We selected the subject topics and categorised each memo according to the roles involved: product owner, scrum master and self-organising team. The research is part of my PhD, and data collection and analysis are still ongoing. Our goal is to reach a state of theoretical saturation where no new categories are emerging with additional data collection or no further insights from the data conceptualisation (Corbin & Strauss, 1990).

FINDINGS

The findings in this research draw from a constant comparison and contrast process, which led to the identification of overarching categories. We then organised categories into four high-level memos: Tailoring for agile roles in Healthcare Information Systems Development, Tailoring Activities Within the Product Owner's Roles, Tailoring Activities within the Scrum Master's Roles, and Tailoring Activities within the Self-organising Team Role. The activities tailored within the agile scrum roles emerged as descriptive theory from the conceptual evolution of the grounded theory data analysis process.

Tailoring for Agile Roles in Healthcare Information Systems Development

This study shows that an agile team includes experienced individuals, including the product owner, scrum master, and development team, who work collaboratively and deliver value incrementally to customers. In healthcare software development, these roles are tailored to manage challenging activities, including various regulatory requirements, diverse stakeholder needs, and their working culture. The practitioners H6, Product manager, H1, Senior Engineer, H4, Business analyst highlighted*, "We have an experienced and dynamic team who ensures quality standard is achieved in developing healthcare software".* This is the view of most practitioners, though emphasising the challenges in balancing diverse stakeholder needs and a clear working culture is particularly important to the team and organisation.

The composition of agile development teams in healthcare information systems development typically comprises cross-functional members, including software developers, healthcare professionals, quality assurance experts, and user experience designers. This multidisciplinary composition fosters a holistic approach to healthcare information systems development, ensuring that solutions are technologically robust, clinically relevant, and user-friendly. These individuals have the philosophical understanding to carry out their tasks more quickly than in the regular plan- based development process. During the interview, a senior practitioner using an extended scrum agile process for developing healthcare information systems platforms, including medical record systems, highlights, *"In our company, we tailored activities of agile product owner, that includes management of product backlogs, stakeholder, engagement and ensuring regulatory compliance etc., ...especially during medical record system developments"* (H8, Product Leader). Most practitioners are product owners,

scrum masters, and development teams engaged in domain- specific extra activities. Through the agile process, tailoring activities guarantees selecting and adjusting agile practices to meet the project's unique requirements, enhancing their relevance and effectiveness and maximising value. Another medical information systems project practitioner further revealed, *"…I ensure the product meets the quality assurance …carefully complied healthcare regulatory standard"* (H11, Product Owner). The tailored activities are integral to the agile healthcare information systems team developing high-quality software solutions and maximising value.

Through the practitioners' interviews, we learned that tailoring activities of the scrum role allows teams to focus on delivering the highest value to the customer and navigating the complexity of agile healthcare information system development.

The agile practices healthcare software development process with complex clinical communication protocols processes. This communication process requires clear understanding from the team members' perspective to ensure adequate confidentiality, integrity, and availability of information. According to the senior software developer involved in developing the electronic medical systems highlighted during the interview, "*We have a stringent set of procedures and characteristics that facilitate the provision of healthcare services, known as clinical workflow. …this process is a series of communications between patients and staff members. It happens across various departments and units"* (H1, Senior Engineer). The practitioner responsible for gathering and analysing software requirements collaboratively with the developers and product owner in understanding the needs of the customers and translating the requirement to user stories reveals, "*It is important to note developing medical software is like developing marketing software. …even the developers' most extended understanding of the dynamics of healthcare processes"* (H4, Business Analyst).

Similarly, a practitioner accountable for the entire project, team and resources management, including the success and failure of the project, revealed, "*…we have individual experts within the team with experience and knowledge in managing nonfunctional requirements, including data security and safety"* (H6, Project Manager). Another software development practitioner, support in formulating user stories, prioritising tasks, and collaborating with the development team, highlighted to us during an interview, "*You know, we have an existing data manager who ensures the implementation of data security. … even though the*

Nigerian general data protection regulation is still fully mature to protect medical data" (H10 Product Manager). The experienced practitioner who collaborates with the product owner to acquire and assess user requirements highlighted, "*…he always ensures that customer requirements are followed one hundred per cent % during the software process"* (H3, UI/UX Designer). The practitioners from the table above who collaborate with the team members to clarify acceptance criteria and user stories defined and execute test cases for both functional and non-functional requirements highlighted, *"We also have a special quality assurance activity commonly known as a clinical feature which domain expert manages along with the product owner"* (H2, Software Tester).

Tailoring Activities within the Product Owner's Role

The finding of this study shows that product owners performed crucial activities in ensuring the success of agile scrum teams, especially in complicated and regulated settings like healthcare. According to the interview transcript, the product owner is responsible for defining the product vision, effective communication and collaboration, empowerment and authority managing the product backlog, actively involving stakeholders, and ensuring adherence to regulatory requirements and updated knowledge. For instance, we discovered exciting activities within the product owner, including the product leader, Project manager, product manager, and chief technical officer, who are responsible for the whole project, team, and resources management, ensuring the requirements are followed as defined and accounted for success or project failure.

According to the practitioner, supporting the user stories, prioritising tasks, and collaborating with the product owner, highlighted to us during an interview, *"the product owner is in charge. …within the organisation, he is responsible for articulating product vision and outline strategic direction"* (H4, Business Analyst). Another experienced software practitioner responsible for assessing user requirements in collaboration with a self-organising team highlighted, *"We have a brilliant product manager who is conscious about data security and ensures standards are followed"* (H3, UI/UX Designer*).* The product owner is responsible for the end-to-end product development standard, prioritisation, and acceptance of completion. According to the practitioner responsible for testing clinical test cases and hotkeys features, *"Our product owner is a powerful person who always ensures customer requirements are followed and implemented. He doesn't let go of products until all requirements are met"* (H5, Clinical Tester). All practitioners highlighted ensuring project goals and requirements are followed as defined by the customer. Most practitioners inform us that in agile healthcare information systems

development, the product owner performs all the responsibilities in standard agile practice and ensures regulatory and data security compliance from the beginning and through the development process.

Tailoring Activities within the Scrum Master's Role

Our interview with practitioners of this study indicated that a scrum master performs indispensable activities for the success of agile scrum teams, especially in complex and regulated healthcare information systems software development. They oversee Scrum events, such as daily standups, sprint planning, spring reviews, and retrospectives; resolve obstacles, coach and mentor the team; and ensure compliance with agile principles. As highlighted by the senior engineer in charge of an agile software team who conducts code reviews to guarantee cleanliness, *"We have a professional scrum master who assumed servant leadership responsibility. …he is also equipped with an understanding of facilitating scrum event"* (H1, Senior Engineer). The majority of the practitioners highlighted to us that the action of the scrum master in facilitating daily standups, sprint planning, sprint reviews and retrospectives is commendable. Despite challenges, the event helped maintain transparency within the team. Another practitioner responsible for secure data management and analysis reveals, *"…he is always given us support regarding any challenges. …he organised coaching training on agile implementation…"* (H9, Data Manager). We learned from the interview transcript that the scrum master focuses on mitigating challenges hindering the team from progressing and ensuring team collaboration and continued protection. According to the practitioners involved, the medical records project reveals. *"…our scrum master is our agile coach. …he organised agile training for the team and ensured mitigating any challenges drawing the task completion"* (H3, UI/UX Designer). According to the practitioner, accountable conduct code reviews to guarantee cleanliness, efficiency, quality, and standards during the software development cycle, including testing and debugging, *"Imperatively, our scrum master performed additional responsibility to lead strategic communication between the team, external regulatory, and security expert"* (H1, Senior Engineer). Another practitioner revealed, *"We have an active scrum master who fosters the effective culture of continued improvement by encouraging the team to self-organise and make decisions"* (H2, Tester). Most practitioners of this study (H6, Project Manager) and (H1, Senior Engineer) reveal that they have functional agile coaches who work round the clock and remove any impediment through active engagement at sprint events.

Tailoring Activities within the Self-Organising Team Role

The development team, also known as a self-organising team, is the agile scrum engine responsible for developing potentially shippable bits of the product during each sprint and continue improving their processes. Software developers, testers, and other technical specialists comprise the chief technical officer, business analyst, and data manager, who collaborate in analysing and decomposing user stories and meeting acceptance criteria for developing agile healthcare information systems. The practitioner says, *"Our team is responsible for planning, coding, testing, and refining backlog items while maintaining close collaboration and communication. ...we have a product leader who's some lead in the product development process"* (H4, Business Analyst). This has been the thought of the practitioners H1, H2, H5, and H9). Most practitioners also highlighted, *"We have an active senior engineer who served as a role model in the team and assisted in ensuring team collaboration while breaking down product backlogs. ...he also assigned responsibility and ensure effort estimation"* (H2, Tester). The interviews showed that despite autonomy, ranking still exists among self-organising team members developing agile healthcare information systems. Even though there is trust and choices for the best working procedure. For example, the senior is the head of the development team. A practitioner involved in the medical records project highlighted that *"Our in charge is a senior engineer who conducts code reviews quality, and standards during the software development cycle, including testing and debugging"* (H3, UI/UX Designer). According to the practitioner responsible for testing clinical test cases and hotkeys features, *"The senior engineer is involved in conducting code reviews, quality, and standards during the software development cycle, including testing and debugging" (H5, Clinical Tester).* Even though teams possess the significance of collectively determining their working methods, analysing backlogs and breaking user stories collaboratively, senior engineers and chief technical officers sometimes assume a higher authority level. A practitioner responsible for secure data management and analysis highlighted, "*The team worked together to analyse requirements and decomposed to them workable chunk"* (H9, Data, Manager). This critical collaboration effort is essential for ensuring all team members understand the requirements and can contribute effectively.

The interviews showed challenges from regulatory bodies like GDPR and HIPAA and data security affecting agile healthcare information system development practitioners. However, the specialised role of "Data Manager," with the support of a product owner and scrum master, ensures balancing the speed and managing quality issues like nonfunctional requirements earlier and through the development

lifecycle. Even though most practitioners are concerned about balancing the speed in meeting a scarce resource, which sometimes leads to technical debt accumulation. A practitioner accountable for the entire project, team and resources management, including the success and failure of the project, highlights, "*…we have individual experts within the team with experience and knowledge in managing nonfunctional requirements, including data security and safety"* (H6, Project Manager). Another practitioner involved in formulating user stories and collaborating with the development team highlighted to us during an interview, "*You know, we have a team of expert who ensures the implementation of data security. … even though the Nigerian general data protection regulation is still fully mature to protect medical data" (H12 Product owner*). Another practitioner revealed, *"Throughout, the chunk of the job from the backlog analysis and embedding work items to sprints is done collaboratively by development team members"* (H4, Business Analyst). The interview data shows development team members are accountable for overseeing their work processes, and they engage in collaborative efforts to attain optimal outcomes. Though there are few interdependencies, the agile self-organised development team's roles collaboratively drive work forward and decide their next focus.

DISCUSSION

This study aims to understand how scrum activities are tailored within agile roles in developing healthcare information systems in Nigeria. The study delves into 12 Nigerian agile healthcare information systems developers and identifies 33 activities conducted by agile scrum teams that encompass the product owner, scrum master, and self-organising team. The activities include adherence to medical regulatory standards, clinical quality assurance testing, documentation, and healthcare knowledge sharing, which are specific activities for developing quality agile healthcare information systems in the Nigerian context. We mapped the practices into four high-level memos: Activities Tailoring for Healthcare Information Systems Development, Tailoring Activities Within the Product Owner's Roles, Tailoring Activities within the Scrum Master's Roles, and Tailoring Activities within the Self-organising Team Role. To the best of our knowledge, this is the first study investigating such phenomena within a Nigerian context.

RQ1: Tailoring activities of agile roles in healthcare information systems development

To address the research question, "How do Nigerian practitioners describe activities tailoring within agile roles in healthcare information systems development?" This research identified 33 tailored activities of the agile scrum team roles during agile healthcare software development. The roles include product owner, scrum master and self-organising team. We mapped the practices into four high-level memos: Activities Tailoring for agile roles in Healthcare Information Systems Development, Tailoring Activities Within the Product Owner's Roles, Tailoring Activities within the Scrum Master's Roles, and Tailoring Activities within the Self-organising Team Role. The memos presented in this study are the descriptive theory emanating from the grounded theory conceptual evolution analysis (Gregor, 2006). The findings show that of the 33 practices, the product owner is responsible for 9 activities, including defining and prioritising the clinical backlog, stakeholder engagement, medical regulatory compliance, release, planning, user story refinement, acceptance test criteria, customer feedback integration, and software risk management. However, the activities that involve adherence to medical regulatory standards, clinical quality assurance testing, documentation, and healthcare knowledge sharing are unique activities for agile healthcare information systems development in the Nigerian context. The findings of this study correspond with the findings of the study (Bass et al., 2018). The Bass et al. study identified eight practices: backlog prioritisation, release mastering, and intermediary activities specific to the product owner function (Bass et al., 2018). Our results also corresponded with the findings of the research conducted (Berntzen et al., 2019; Matturro et al., 2018). Studies emphasise teamwork, coordination, communication and customer service. However, ensuring regulatory compliance is a unique activity discovered for the healthcare information system development product owner. We observed that the product owner struggles to manage conflicting requirements from stakeholders, such as users' regulatory bodies, such as the HIPAA Health Insurance Portability and Accountability Act (HIPAA) and General Data Protection Regulation (GDPR).

We further discovered that 9 of the 33 tailored practices are specifically related to the scrum master activities developing healthcare information systems. These activities include facilitating scrum events, removing impediments, coaching the team, ensuring compliance, fostering communication, ensuring quality assurance, supporting team collaboration and promoting continuous improvement during retrospectives. This finding corresponds with the findings of the study conducted

by the (Bass, 2014). Bass's study reveals six practices, including impediment removal, sprint planning, and standup meetings, among others, for which the scrum master is responsible. Our study presents unique activities like quality assurance, facilitated by the scrum master's in healthcare software development in Nigeria. This requires the scrum master to collaborate with the quality assurance team to integrate quality assurance processes into the development cycle. This includes supporting automated testing, code reviews, and compliance audits to ensure the product meets high-quality standards. Scrum masters struggle to handle communication pressure from diverse stakeholders, especially team, regulatory and security experts.

Our finding reveals that self-organising is an autonomous team responsible for 15 out of 33 activities identified in this study. Sprint planning and task allocation, collaborative design and architecture, code peer reviews and pair programming, sprint review and demonstration backlog refinement adhering to regulatory standards, quality assurance and testing, user-centric development documentation and knowledge sharing risk management. These practices, especially adherence to medical regulatory standards, quality assurance testing, documentation, and knowledge sharing, are unique to healthcare information systems development in the Nigerian context. Our findings corresponded with the study conducted by Berntzen et al. 2023 that identified various test cases and quality assurance mechanisms for developing health healthcare software (Berntzen et al., 2023). We observed some challenges affecting the development team, especially the issue of balancing the speed of software development and ensuring quality standards. We also observed that addressing technical debt is an issue, mainly when pressure is exerted on the development to deliver product increment. This finding corresponded with the study (Gregory et al., 2022).

RQ2: Tailoring activities of agile scrum roles in the presence of nonfunctional requirements and regulatory constraints in Nigerian healthcare information systems development.

To address the research question, "How do practitioners describe tailoring activities of agile scrum roles in the presence of nonfunctional requirements and regulatory constraints in Nigerian healthcare information systems development?" This study identified and detailed various activities tailored to developing the healthcare information system. We discovered that the product owner, scrum master, and self-organising development team collaboratively plan sprints and break down user stories into manageable tasks. They collaborate to tailor these

specific activities, which include adherence to regulatory standards, quality assurance testing, documentation, and knowledge sharing during healthcare information systems development in the Nigerian. Sharing knowledge in software development is crucial to the team (Kuusinen et al., 2017). Collaboration through facilitating scrum events is essential in fostering trust and mitigating software issues (Berntzen et al., 2023). The self-organising team collectively decides who will work on each task based on skills, interests, and availability. We discovered the team dealt with nonfunctional requirements through Engagement with stakeholders, including healthcare professionals, regulatory bodies, and end-users, to gather requirements and ensure the product aligns with their needs and stakeholders' expectations. We discovered that the development team ensured the product complied with healthcare regulations and standards such as HIPAA, GDPR, and other relevant local and international regulations. This is achieved by informing the product owner about regulatory changes and ensuring compliance is integrated into the product development process by updating the backlog into the workflow. Our findings correspond with the study conducted by Ardo et al. The study emphasised that nonfunctional requirements like security and legislation should be integrated early and throughout the software development (Ardo et al., 2023). Regular communication and collaboration with stakeholders are crucial for understanding the domain- specific needs of healthcare software development.

Developing healthcare information systems is challenging because of the frequent changes in requirements. We observed that Nigeria's agile healthcare information system practitioners experienced challenges of not having local regulations, which forced them to partially comply with GDPR and HIPAA regulations set by internal regulatory bodies. Agile implementation among software practitioners is still under pressure. Defining local regulations and implementable data security standards will help develop quality agile healthcare information systems within Nigeria (Ardo et al., 2023). We also observed that the organisational working culture, team pressure and prioritisation under resource constraints and conflicting requirements from various stakeholders within and outside the organisation presented a bottleneck to the development team. Our findings, especially those on organisational working culture, IT infrastructural constraints, and governance, corresponded with some of the studies' conclusions (Gregory et al., 2016). This led to the accumulation of technical debt and non-functional requirements. This study will help the agile practitioners understand in detail the activities within each role, know and minimise misconceptions and improve team cohesion.

Research Implication

This research's empirical contribution spans the development of the agile healthcare information system in Nigeria. The study identified and presented 33 practices performed by the agile roles of product owner, scrum master and self-organising development team. However, these activities comprise medical regulatory standards, clinical quality assurance testing, documentation, and knowledge sharing, which are specific for developing quality agile healthcare information systems in the Nigerian context. The study suggests that more agile tailoring skills and local regulations are necessary for software practitioners to develop quality agile healthcare information systems in Nigeria.

CONCLUSION

Tailoring activities within agile Scrum roles signifies a paradigm shift in how practitioners approach software development to manage complexities like regulation and data security in developing healthcare information systems. This research explores how activities within agile roles are tailored to healthcare information systems development within Nigeria. This study adopted a qualitative case study methodology and interviewed 12 agile practitioners developing healthcare information systems within Nigeria using semi-structured open-ended interview guide questions. The practitioners were selected based on a snowballing process from our network of experts. In this study, we used data analysis techniques informed by grounded theory, including open coding, constant comparison, memoing, and theoretical saturation, to analyse the data.

We identified 33 tailored activities performed by the Scrum roles comprising the product owner, Scrum Master, and self-organising development team. The activities that included adherence to medical regulatory standards, clinical quality assurance testing, documentation, and knowledge sharing are specific activities for developing quality healthcare information systems in Nigeria. We systematically mapped the practices into four high-level memos comprising Activities Tailoring for Healthcare Information Systems Development, Tailoring Activities Within the Product Owner's Roles, Tailoring Activities within the Scrum Master's Roles, and Tailoring Activities within the Self-organising Team Role.

Our main contribution in this research is a detailed account of 33 tailored activities within Scrum roles and the memos presented, which are necessary for agile activities tailoring in developing quality healthcare information systems. Our

findings show that agile healthcare information development practice skills are still in the prematurity stage for Nigerians. We observed a lack of defined regulatory standards, and data security policies are yet to be established locally. We further observed that practitioners find it challenging to address conflicting requirements from diverse stakeholders, including users, healthcare professionals, and external regulatory bodies with limited resources. This pressure leads to compromised quality standards, accumulating technical debt, and nonfunctional requirements issues.

To achieve quality and effective agile healthcare information systems development, we recommend that agile practitioners acquire more skills, adequate resources, local regulatory standards, developed data security infrastructure, and support from the government.

Declaration of Originality

I hereby declare that the research work presented in this thesis titled "**Activities Tailoring within Agile Scrum Roles: A Case of Nigerian Healthcare Information Systems Development**" is my original work, and it has not been submitted previously in its entirety or in part for obtaining any other academic publication. All sources of information, ideas, and data used in this work have been appropriately acknowledged. I confirm that this work complies with academic integrity and honesty standards, and I take full responsibility for any inaccuracies or errors.

REFERENCES

Abrahamsson, P., Salo, O., Ronkainen, J., & Warsta, J. (2017). Agile software development methods: Review and analysis.

Akinnuwesi, B. A., Uzoka, F.-M., Olabiyisi, S. O., Omidiora, E. O., & Fiddi, P. (2013). An Empirical Analysis of End-User Participation in Software Development Projects in a Developing Country Context. The Electronic Journal of Information Systems in Developing Countries, 58(1), 1-25. https://doi.org/https://doi.org/10.1002/j.1681- 4835.2013.tb00413.x

Ardo, A. A., Bass, J. M., & Gaber, T. (2023). Implications of regulatory policy for building secure agile software in Nigeria: A grounded theory. The Electronic Journal of Information Systems in Developing Countries, e12285.

Bass, J., Beecham, S., Razzak, M. A., Canna, C. N., & Noll, J. (2018, 2018). Poster: An Empirical Study of the Product Owner Role in Scrum.

Bass, J. M. (2014, 18-21 Aug. 2014). Scrum Master Activities: Process Tailoring in Large Enterprise Projects. 2014 IEEE 9th International Conference on Global Software Engineering,

Bass, J. M. (2015). How product owner teams scale agile methods to large distributed enterprises. Empirical Software Engineering, 20(6), 1525-1557. https://doi.org/10.1007/s10664-014- 9322-z

Bass, J. M. (2016). Artefacts and agile method tailoring in large-scale offshore software development programmes. Information and Software Technology, 75, 1-16. https://doi.org/https://doi.org/10.1016/j.infsof.2016.03.001

Bass, J. M. (2023). Agile Software Engineering Skills. Springer International Publishing AG. https://doi.org/10.1007/978-3-031-05469-3

Bass, J. M., & Haxby, A. (2019). Tailoring Product Ownership in Large-Scale Agile Projects: Managing Scale, Distance, and Governance. IEEE Software, 36(2), 58-63. https://doi.org/10.1109/ms.2018.2885524

Berntzen, M., Hoda, R., Moe, N. B., & Stray, V. (2023). A Taxonomy of Inter-Team Coordination Mechanisms in Large-Scale Agile. IEEE Transactions on Software Engineering, 49(2), 699-718. https://doi.org/10.1109/TSE.2022.3160873

Berntzen, M., Moe, N. B., & Stray, V. (2019, 2019//). The Product Owner in Large-Scale Agile: An Empirical Study Through the Lens of Relational Coordination Theory. Agile Processes in Software Engineering and Extreme Programming, Cham.

Cohn, M. (2010). Succeeding with agile: software development using Scrum. Pearson Education.

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. Qualitative Sociology, 13(1), 3-21. https://doi.org/10.1007/BF00988593

Demissie, S., Keenan, F., & McCaffery, F. (2016). Investigating the suitability of using agile for medical embedded software development. Communications in Computer and Information Science,

Dijkers, J., Overbeek, S., España, S., Bon, A., de Boer, V., Guéret, C., Diallo, G., & Gordijn, J. (2018). Improving ICT4D projects with Agile software development. Proceedings of the 5th International Symposium" Perspectives on ICT4D"(P-ICT4D 2018) co-located with 10th ACM Web Science Conference (WebSci'18), Amsterdam, the Netherlands, May 27, 2018,

Dingsoeyr, T., Falessi, D., & Power, K. (2019). Agile Development at Scale: The Next Frontier. IEEE Software, 36(2), 30-38. https://doi.org/10.1109/MS.2018.2884884

Fowler, M., & Highsmith, J. (2001). The agile manifesto. Software development, 9(8), 28-35.

Fraser, H. S., & Blaya, J. (2010). Implementing medical information systems in developing countries, what works and what doesn't. AMIA Annu Symp Proc, 2010, 232-236.

Garcia, L. A., OliveiraJr, E., & Morandini, M. (2022). Tailoring the Scrum framework for software development: Literature mapping and feature-based support. Information and Software Technology, 146, 106814. https://doi.org/https://doi.org/10.1016/j.infsof.2021.106814

Gregor, S. (2006). The nature of theory in information systems. MIS quarterly, 611-642.

Gregory, P., Barroca, L., Sharp, H., Deshpande, A., & Taylor, K. (2016). The challenges that challenge: Engaging with agile practitioners' concerns. Information and Software Technology, 77, 92-104. https://doi.org/https://doi.org/10.1016/j.infsof.2016.04.006

Gregory, P., Strode, D. E., Sharp, H., & Barroca, L. (2022). An onboarding model for integrating newcomers into agile project teams. Information and Software Technology, 143, 106792. https://doi.org/https://doi.org/10.1016/j.infsof.2021.106792

Hoda, R., Noble, J., & Marshall, S. (2012). Developing a grounded theory to explain the practices of self-organizing Agile teams. Empirical Software Engineering, 17(6), 609-639. https://doi.org/10.1007/s10664-011-9161-0

Hoda, R., Noble, J., & Marshall, S. (2013). Self-Organizing Roles on Agile Software Development Teams. IEEE Transactions on Software Engineering, 39(3), 422-444. https://doi.org/10.1109/TSE.2012.30

Kantola, K., Vanhanen, J., & Tolvanen, J. (2022). Mind the product owner: An action research project into agile release planning. Information and Software Technology, 147, 106900. https://doi.org/https://doi.org/10.1016/j.infsof.2022.106900

Kokol, P. (2022). Agile Software Development in Healthcare: A Synthetic Scoping Review. Applied Sciences, 12(19), 9462. https://www.mdpi.com/2076-3417/12/19/9462

Kuusinen, K., Gregory, P., Sharp, H., Barroca, L., Taylor, K., & Wood, L. (2017). Knowledge sharing in a large agile organisation: A survey study. Agile Processes in Software Engineering and Extreme Programming: 18th International Conference, XP 2017, Cologne, Germany, May 22-26, 2017, Proceedings 18,

Larman, C., & Vodde, B. (2016). Large-scale scrum: More with LeSS. Addison-Wesley Professional.

López-Martínez, J., Juárez-Ramírez, R., Huertas, C., Jiménez, S., & Guerra-García, C. (2016, 27- 29 April 2016). Problems in the Adoption of Agile-Scrum Methodologies: A Systematic Literature Review. 2016 4th International Conference in Software Engineering Research and Innovation (CONISOFT),

Matturro, G., Cordovés, F., & Solari, M. (2018). Role of product owner from the practitioner's perspective. An exploratory study. Proceedings of the International Conference on Software Engineering Research and Practice (SERP),

McCaffery, F., Trektere, K., & Ozcan-Top, O. (2016, 2016//). Agile – Is it Suitable for Medical Device Software Development? Software Process Improvement and Capability Determination, Cham.

Moe, N. B., Dingsøyr, T., & Dybå, T. (2010). A teamwork model for understanding an agile team: A case study of a Scrum project. Information and Software Technology, 52(5), 480-491. https://doi.org/https://doi.org/10.1016/j.infsof.2009.11.004

Mohallel, A. A., & Bass, J. M. (2019, 2019//). Agile Software Development Practices in Egypt SMEs: A Grounded Theory Investigation. Information and Communication Technologies for Development. Strengthening Southern-Driven Cooperation as a Catalyst for ICT4D, Cham.

Moyón, F., Méndez, D., Beckers, K., & Klepper, S. (2020). How to Integrate Security Compliance Requirements with Agile Software Engineering at Scale? In M. Morisio, M. Torchiano, &

A. Jedlitschka (Eds.), 21st International Conference on Product-Focused Software Process Improvement, PROFES 2020 (Vol. 12562 LNCS, pp. 69-87): Springer Science and Business Media Deutschland GmbH.

Noll, J., Razzak, M. A., Bass, J. M., & Beecham, S. (2017, 2017//). A Study of the Scrum Master's Role. Product-Focused Software Process Improvement, Cham.

Rahy, S., & Bass, J. (2019). Information flows at inter-team boundaries in agile information systems development. Information Systems: 15th European, Mediterranean, and Middle Eastern Conference, EMCIS 2018, Limassol, Cyprus, October 4-5, 2018, Proceedings 15,

Rahy, S., & Bass, J. M. (2020, 2020//). Implementation of Agile Methodology in Developing Countries: Case Study in Lebanon. Information and Communication Technologies for Development, Cham.

Rubin, K. S. (2012). Essential Scrum: A practical guide to the most popular Agile process. Addison-Wesley.

Schwaber, K., & Sutherland, J. (2011). The scrum guide. Scrum Alliance, 21(1), 1-38. Schwaber, K., & Sutherland, J. (2021). The scrum guide. 2020. Accessed April.

Shastri, Y., Hoda, R., & Amor, R. (2021). Spearheading agile: the role of the scrum master in agile projects. Empirical Software Engineering, 26(1), 3. https://doi.org/10.1007/s10664-020- 09899-4

Srivastava, A., Mehrotra, D., Kapur, P. K., & Aggarwal, A. G. (2021, 2021//). A Literature Review of Critical Success Factors in Agile Testing Method of Software Development. Recent Innovations in Computing, Singapore.

Statista. (2023). African countries with the highest Gross Domestic Product (GDP) in 2022. https://www-statista-com.salford.idm.oclc.org/statistics/1120999/gdp-of-african- countries-by-country/

Strode, D., Dingsøyr, T., & Lindsjorn, Y. (2022). A teamwork effectiveness model for agile software development [Article]. Empirical Software Engineering, 27(2), Article 56. https://doi.org/10.1007/s10664-021-10115-0

Strode, D. E., Sharp, H., Barroca, L., Gregory, P., & Taylor, K. (2022). Tensions in Organizations Transforming to Agility. IEEE Transactions on Engineering Management, 69(6), 3572- 3583. https://doi.org/10.1109/TEM.2022.3160415

Vaivio, J. (2012). Interviews – Learning the Craft of Qualitative Research Interviewing. European Accounting Review, 21(1), 186-189. https://doi.org/10.1080/09638180.2012.675165

Yin, R. K. (2003). Design and methods. Case study research, 3(9.2).

APPENDIX

ROLES	TAILORED ACTIVITIES	DESCRIPTION OF THE ACTIVITIES
Product Owner (PO)	Defining and Prioritizing the Product Backlog	In the healthcare information systems development, the Product Owner (PO) is responsible for creating and maintaining a well-defined product backlog. It defines acceptance criteria, and prioritizing the backlog items based on business value, stakeholders (both internal and external) needs
	Stakeholder Engagement	Engaging with stakeholders, including healthcare professionals like doctors and nurses, external regulatory bodies, and other non-clinical end-users, to gather requirements and ensure the product aligns with their needs and expectations. Regular communication and team working culture with stakeholders are crucial for understanding the domain-specific needs of healthcare software.
	Medical Regulatory Compliance	Ensuring that the software product complies with healthcare regulations and standards such as HIPAA (Health Insurance Portability and Accountability Act), GDPR (General Data Protection Regulation), and other relevant local regulations including Nigeran NDPR. The PO stay informed about regulatory changes and ensure that compliance is integrated into the healthcare software development process by updating the backlog.
	Release Planning	Planning and managing product releases, including deciding on the scope of each release, setting release dates. This also involves ensuring that each release meets the necessary compliance standards
	User Story Refinement	Collaborating with the development team to refine user stories, ensuring they are clear, concise, and actionable. This involves regular backlog grooming sessions to update priorities, clarify requirements, and split larger stories into manageable tasks
	Acceptance Testing	Defining and executing acceptance tests to ensure that the developed features meet the predefined acceptance criteria and are compliant with regulatory standards and user need. The PO may work closely with quality assurance (QA) teams to validate that the product is safe, effective, and user-friendly.
	Customer Feedback Integration	Gathering and analyzing feedback during Clinical (beta) testing from users and stakeholders to continuously improve the product. This feedback is used to adjust the product backlog and ensure that the development team focuses on delivering the highest value features.

	Risk Management	Identifying, assessing, and managing risks associated with the product development process, including regulatory risks, and technical risks. The PO works with the team to develop mitigation strategies and contingency plans
	TAILORED ACTIVITIES	**DESCRIPTION OF THE ACTIVITIES**
Scrum Master	Facilitating Scrum Events	In the healthcare information systems development, scrum master is responsible for organizing and facilitating all Scrum ceremonies, including daily stand-ups, sprint planning, sprint reviews, and sprint retrospectives. Ensuring these meetings are productive and time boxed.
	Removing Impediments	Identifying and removing obstacles that hinder the team's progress. This can involve addressing technical issues, resolving team conflicts, or negotiating with external stakeholders to remove bottlenecks
	Coaching the Team	Coaching team members on Agile principles and Scrum practices to ensure they are understood and effectively implemented. This includes mentoring new team members and providing guidance on how to self-organise
	Ensuring Compliance	Ensuring that the team adheres to healthcare regulations and standards such as HIPAA, GDPR, and other relevant laws. This involves integrating compliance checks into the development process and collaborating with regulatory experts
	Fostering Communication	Promoting open and effective communication within the team and with external stakeholders. This includes facilitating information flow between team members, Product Owners, and stakeholders to ensure everyone is aligned and informed
	Monitoring Progress	Monitoring the team's progress towards sprint goals and overall project objectives. Using burn-down charts and dashboards to track progress and identify potential issues early
	Facilitating Continuous Improvement	Encouraging a culture of continuous improvement by facilitating regular retrospectives and ensuring that actionable improvements are implemented. This includes helping the team reflect on their processes and identify areas for enhancement
	Ensuring Quality Assurance	Collaborating with the QA team to ensure that quality assurance processes are integrated into the development cycle. This includes supporting automated testing, code reviews, and compliance audits to ensure the product meets high-quality standards
	Supporting Team Collaboration Tools	Ensuring the team has the necessary tools and infrastructure for effective collaboration, such as issue tracking systems, continuous integration/continuous deployment (CI/CD) pipelines, and communication platforms

	TAILORED ACTIVITIES	**DESCRIPTION OF THE ACTIVITIES**
Self-organising Team	Sprint Planning and Task Allocation	In health care software development, the self-organising team collaboratively planning sprints and breaking down user stories into manageable tasks. The team collectively decides who will work on each task based on skills, interests, and availability
	Collaborative Design and Architecture	Engaging in group design sessions to create robust and compliant software architectures. Team members contribute their expertise to design solutions that meet healthcare standards and regulatory requirements
	Peer Reviews and Pair Programming	Implementing peer code reviews and pair programming to enhance code quality, share knowledge, and facilitate continuous learning within the team. This happening in managing clinical feature.
	Backlog Refinement	Participating in backlog refinement sessions to clarify and prioritize user stories. The team collaboratively estimates the effort required for each task and adjusts priorities based on business value and feasibility
	Sprint Reviews and Demonstrations	Conducting sprint reviews to demonstrate completed work to stakeholders. The team gathers feedback and discusses potential changes or new requirements, ensuring alignment with user needs
	Retrospectives and Continuous Improvement	Holding sprint retrospectives to reflect on the team's processes and performance. The team identifies successes, challenges, and areas for improvement, and implements actionable changes in subsequent sprints
	Collaborative Problem Solving	Working together to identify and resolve issues quickly. This includes technical challenges, process inefficiencies, and interpersonal conflicts, promoting a supportive and productive work environment
	Cross-Functional Collaboration	Collaborating across different functions, such as development, QA, UX, and operations, to ensure comprehensive solutions. This cross-functional approach helps address the diverse needs of healthcare software development
	Self-Directed Learning and Development	Engaging in continuous learning by attending workshops, training sessions, and industry conferences. Team members take the initiative to enhance their skills and stay updated with the latest technologies and best practices
	Adhering to Regulatory Standards	Ensuring that the software development process complies with healthcare regulations like HIPAA, GDPR, and other relevant standards. The team collectively integrates compliance checks into their workflows
	Quality Assurance and Testing	Conducting thorough testing, including unit tests, integration tests, automated tests, clinical testing to ensure high-quality software. The team collaboratively defines and executes test cases to validate functionality and compliance

	User-Centric Development	Focusing on user needs and feedback to guide development. The team actively engages with end- users and stakeholders to gather insights and ensure the software meets their expectations and requirements
	Documentation and Knowledge Sharing	Creating and maintaining comprehensive documentation, including technical specifications, user manuals, and regulatory compliance documents. The team ensures that knowledge is shared and accessible
	Risk Management and Mitigation	Identifying potential risks early in the development process and collaboratively developing mitigation strategies. This proactive approach helps manage uncertainties and ensures the project stays on track