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JOHANNESBURG

THE ENHANCEMENT OF THE SOFTWARE DEVELOPMENT LIFECYCLE UTILISED IN THE DELIVERY OF DIGITAL HEALTHCARE PRODUCTS

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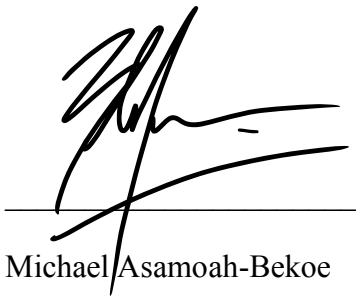
March 2024

SCHOOL OF MECHANICAL, INDUSTRIAL & AERONAUTICAL ENGINEERING

PLAGIARISM DECLARATION

I declare that this project report is my own, unaided work, except where otherwise acknowledged. It is being submitted for the degree of Master of Science in Engineering at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university.

Signed on the **1st August 2023**



Michael Asamoah-Bekoe

ABSTRACT

The digital healthcare industry has experienced significant growth in recent years, resulting in increased competition among companies operating in this market. Company X, a competitor in this industry, utilises a mixed set of methodologies across their teams, where some methodologies may be outdated. With the emergence of new software development lifecycle methodologies (SDLC), it is crucial for Company X to adapt their current approach to remain competitive. As part of a research study, 24 participants from various teams in Company X were interviewed to gain insights into the industry, the current methodology being used, and how management could ensure a smooth transition to a new SDLC methodology. According to the study results, 21% of participants from Team A-D were unwilling to change their current methodology, while 37% were willing to make a switch. The remaining 42% were indifferent, with their decision depending on the reason for the transition. Based on the literature review and the findings from the study, a conceptual framework was developed to guide the process of transitioning to a new SDLC methodology.

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LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation / Acronym	Full name

SDLC	Software Development Life Cycle
DEV	Developer
BA	Business Analyst
TA	Test Analyst
TDD	Test Driven Development
SLA	Service-Level Agreement
PR	Pull Request
BAT	Business Acceptance Testing
UAT	User Acceptance Testing
QA	Quality Assurance
RAD	Rapid Application Development
CRS	Customer Requirements Specification
PRS	Product Requirements Specification

1. CHAPTER ONE – INTRODUCTION

1.1. Research Background and Context

The software development industry has evolved significantly in recent years due to the advancement of technologies as part of the fourth industrial revolution (Gunal, 2019). This has led to the growth of numerous software companies in the market as well as the advancement of companies that traditionally operate in non-digital markets to now provide an enhanced digital product offering to their clients (Varadarajan, et al., 2022). Such markets include healthcare, education, and manufacturing. With the growth of these digital products, managing software development projects has become an essential task for many project managers and digital product owners, as it determines whether the software product will meet the project objectives (Ebert & Brinkkemper, 2014). As the development of software products goes through many phases and tasks that various stakeholders handle throughout the project's lifecycle, a project management framework needs to be put in place to ensure the successful delivery of the product (Todorović, et al., 2015).

Many software development teams utilise the software development lifecycle (SDLC). This framework allows the team to minimise project risks by controlling the software development process across its various stages (Sahu, et al., 2014). The SDLC's main stages are requirements analysis, design, implementation/development, testing, deployment, and maintenance. This systematic framework is essential to ensure that high-quality software is produced using a cost-effective and time-efficient process (Pooja & Lekh, 2015).

The type of SDLC methodology to be used often depends on the type of company, team composition, and technology available at the company's disposal (Jafari & Dinarvand, 2021). The software development project team utilising the SDLC methodology usually comprises business/systems analysts, software developers, test analysts, and project managers. These stakeholders within the software development team are responsible for ensuring that their allocated tasks in the SDLC are implemented and executed effectively so that the project can be delivered successfully (Ulaş & Güler, 2021). Different companies use various SDLC methodologies to deliver these products; a few of these methodologies include traditional waterfall, incremental, agile, spiral, and rapid development (Ulaş & Güler, 2021).

As the global digital landscape continues to grow, companies also need to enhance their chosen SDLC methodologies to ensure that their software deliverables remain produced within scope and budget while meeting/exceeding customers' expectations (Jafari & Dinarvand, 2021). The failure of companies to enhance their way of working often leads to them being left behind in the digital age, as technology now also plays a vital role in the daily operational processes and product delivery for the company.

This research study focuses on the software development company "Company X," which specialises in delivering digital healthcare products to a wide range of customers in the medical industry. Company X comprises various software development teams, each utilising a different methodology. While other teams utilise an agile approach, Team A of Company X is believed to follow a traditional waterfall methodology.

1.2. Problem Statement

The digital healthcare products developed by Company X are designed to assist healthcare providers in monitoring and managing the chronic health conditions of their patients, as well as storing patients' clinical health metrics in the form of electronic health records (EHRs) (Hermes, et al., 2020). Therefore, these products must be delivered with minimal to no defects, as any incorrect reading/s or results displayed to the end user (healthcare providers) can affect the manner in which patients are treated for their chronic conditions (Hyman, 2018). In some cases, this may be a matter of life and death.

Due to the rapid technological advancements introduced to the healthcare industry, implementing digital healthcare products is expected to be delivered within a short period of time (Richards, et al., 2022). Healthcare Institutions tend to raise new or additional requirements to the initial requirement scope to gain a competitive advantage over rival products in the digital healthcare market (Savage, et al., 2018). These requirements are often raised near the completion of the project's lifecycle, resulting in scope creep and required rework for the software development team (Panyard, et al., 2018). Additionally, unplanned rework often results in the deliverables not being tested thoroughly, resulting in defects being raised once the digital product is released to the market (Hossain, 2018). Any defects customers

discover after the testing phase can harm the company's reputation and negatively impact the user experience (Huijgens, et al., 2017).

As Team A of Company X utilises a traditional waterfall methodology in delivering digital healthcare products, any sudden changes in scope have significant implications from a quality, cost, and time perspective (Sumrell, 2007). This is a result of the traditional waterfall methodology, which does not provide flexibility to allow the project stakeholders to effectively manage unforeseen changes in the product deliverables or within the project's lifecycle (Tanner & Von Willingh, 2014). There have been various attempts to implement a new SDLC methodology in the company's software development operations, which can be used to mitigate the challenges experienced with the current traditional waterfall methodology. However, transitioning into a new SDLC methodology can often be time-consuming and costly for the company (Hossain, 2023). Additionally, if the new software development methodology is not implemented successfully within the project team, the transition may lead to similar or worse challenges being experienced by the company (Niazi, et al., 2016).

Therefore, implementing a suitable software development methodology may allow Company X to improve the quality of their digital healthcare products and mitigate the current challenges experienced with the traditional waterfall methodology.

Further investigation will be needed to determine whether introducing a new or enhanced SDLC methodology is suitable for Company X to implement in its current operations.

1.3. Critical Research Question

The Critical Research Question for this research study is:

- How can Company X introduce a new or enhanced SDLC methodology suitable for optimising the development of digital healthcare products?

1.4. Research Objectives

The overall objective of this research study is to:

- To investigate how Team A of Company X can introduce a software development methodology that will enhance the development of digital healthcare products and mitigate the challenges faced when utilising the current SDLC methodology.

The sub-objectives of this research study are:

1. To evaluate the challenges that are experienced when executing the current SDLC methodology in the delivery of digital healthcare products, as well as the areas in which these challenges arise.

2. To analyse various software development methodologies and compare these methodologies to the current model that Team A of Company X currently utilises.

3. To identify ways management can ensure the successful transition or adoption of the new software development methodology into the team.

1.5. Outline of the Research Methodology

The data of this research study was collected through semi-structured online interviews and transcribed using Microsoft Teams. The generated transcripts were then analysed using thematic analysis, as discussed in Chapter 3. The research study participants are all employed by Company X and work in the digital health department within various software development teams. The interview questions were created using an open-ended approach, as described by Creswell (2007). This approach ensures that the participants' answers enable the researcher to delve deeper into the underlying issues and gain a comprehensive perspective of the SDLC methodology utilised in the company.

The University's Main Ethics Committee (non-medical) granted ethical clearance to conduct interviews as part of this research study. The ethics clearance number is **MIAEC 073/23**.

1.6. Research Limitations

The limitations of this research study have been identified based on the collected research data. These limitations include:

1. Interviews / Participants – The feedback gathered from the interviews is based on the participants' personal experience within the project and their careers. It is important to note that the feedback provided by a participant may contain a certain level of bias, depending on their ability to recall details and articulate their feedback clearly to the researcher. Therefore, the researcher needed to be aware of this while analysing the data to ensure accurate and fair results.

2. Comparative Analysis – Due to the abundance of research papers studying more commonly used software development methodologies, there is a scarcity of papers examining less popular methodologies.

To address the limitations mentioned above, the following actions have been taken into consideration:

- Increase the sample size of participants in the following areas:
    - Job role
    - Level of experience in the software development industry
    - Age, race, and gender.
    - Other participants employed in other departments or teams within Company X
- Conduct follow-up interviews to clarify or confirm points raised by other participants.
- Increase the volume of research papers analysed and research repository sources.

1.7. Report Outline

The research report consists of seven chapters and an appendix. The following outline provides a summary of each chapter covered in this report:

1.7.1. Chapter One – Introduction:

This chapter provides an overview of the research background, problem statement, critical research question, objectives, and limitations of this research study.

1.7.2. Chapter Two – Literature Review:

The literature review chapter of this research study provides an overview of the digital healthcare industry. In addition, this chapter outlines various software development lifecycle (SDLC) methodologies used in previous studies to provide a reference for the comparative study conducted in this report.

1.7.3. Chapter Three – Research Methodology:

This chapter presents an overview of research methodology, including design, instrumentation, sampling, data collection, analysis, research validity, and ethical considerations.

1.7.4. Chapter Four – Research Results and Discussion:

This chapter presents and discusses the results of the research study through qualitative analysis of participants' interview transcripts.

1.7.5. Chapter Five – Enhancement of the SDLC used in digital health (new conceptual framework):

This section presents a conceptual framework developed to address the challenges faced by Company X in the digital healthcare industry.

1.7.6. Chapter Six – Conclusion:

This chapter summarises the key findings and outcomes of the research study.

1.7.7. Chapter Seven – Future Work and Recommendations:

This chapter discusses different approaches to improve the validity and reliability of the results obtained from the research study.

1.7.8. Appendices:

The appendices include all the relevant supporting documents that have been referenced in this research report.

2. CHAPTER TWO – LITERATURE REVIEW

The growth of technology and the advancements made to the various SDLC methodologies in the past years have led to numerous research studies conducted on the performance of these methodologies on software development teams. This research study aims to investigate the various SDLC methodologies to determine the most suitable methodology for Company X. To achieve this, this chapter will review existing investigations and conduct a literature review of the digital healthcare industry to provide a high-level understanding of the requirements planning, analysis, development, and testing of digital healthcare products.

In conducting the literature review for this section, a systematic and methodological approach was adopted. The review process involved collecting literature from various research repositories, such as IEEE, ResearchGate, Xplore, ScienceDirect, and Google Scholar. This literature was categorised into three main themes, namely:

i) The overview or context of the digital healthcare industry.
ii) The most common Software Development Lifecycle (SDLC) methodologies which were further categorised into heavyweight and lightweight methodologies.
iii) The challenges and solutions encountered by organisations during transitions to new ways of working.

In this review, a wide range of research papers were analysed to determine the structural framework, strengths, weaknesses, and applicability of the various methodologies to various types of software projects. Keywords such as *SDLC*, *software development methodologies*, *digital healthcare*, *organisational transition*, *new ways of working*, *agile*, and *waterfall* were utilised to identify the relevant research papers. This approach ensured a comprehensive collection and review of relevant literature, thus providing further insight into the purpose of this research study.

2.1. Digital Healthcare Industry

As early as the year 2000, medical professionals and researchers believed that the Internet would significantly impact the medical industry. The author Frank (2000) discussed that the rapid advancement of technology is contributing to the transformation of traditional healthcare

services into a digital healthcare landscape by providing the following five main functions (Frank, 2000):

i. Globalising information by making it more accessible to the public.
ii. Assisting medical professionals and patients in making well-informed decisions.
iii. Promoting healthier lifestyles.
iv. Developing a global and/or local healthcare community.
v. Encouraging patients to manage their healthcare would lead to decreased medical costs.

Today, we can see the above functions operate in the medical services we receive today as a result of technology. More recently, the capabilities of digital healthcare solutions have evolved with the enhancements made to artificial intelligence (AI), robotics and Big Data. Digital health products can be grouped into the following categories (Han & Lee, 2021):

- Mobile Health (mHealth) – This comprises wearable devices such as glucose monitors, electrocardiograms, oximeters and fitness watches.
- Telemedicine – The use of technology such as smartphones and tablets to diagnose members or provide patients with treatment,
- Telehealth – This includes virtual consultations with healthcare providers used to monitor and review a patient's medical conditions,
- Electronic Health Record (EHR) — The digitalisation of a patient's medical records, which allows both the patient and their treating provider to easily access records through an online medium.

The benefits of digital healthcare products, as explained by Hermes et al. (2020), allow medical professionals and patients to prevent oncoming diseases through early detection processes, such as genome sequencing for genetic disorders, as well as providing patients with the means to monitor their chronic conditions from the comfort of their own homes. Digital healthcare products also allow medical practitioners to easily prescribe tailored medication for their patients and provide them with an extensive, holistic view of the patient's health (Awad, et al., 2018). Riasanow et al. (2020) discuss that digital healthcare has the potential to improve the ability of medical practitioners to accurately diagnose and provide patients with effective treatment for current and preventative diseases. Doing so will enhance the overall healthcare

delivery for patients in the 21st century. Yamaganti et al. (2023) also highlight that the use of digital healthcare products significantly affects the medical bills that patients will have to pay as it provides patients with the opportunity to find out and treat their conditions without needing to physically visit their medical provider.

Han & Lee (2021) highlight that although there are essential benefits to the digital healthcare industry, the growth of this market has led to numerous competitors competing for a market share in the industry. Many big data corporations are attempting to penetrate the market with digital products (Cavlak & Cop, 2021). As a result, there is a race between major companies on who can implement/deliver the digital product to the market at a timely pace and ensure that the product provides a competitive advantage to encourage patients and medical institutions to utilise their products (Wu, et al., 2016). In the Digital Health Market by Application Forecast, it is estimated that the global digital healthcare market size will increase at a rate of 25.8% between the years 2022 and 2027 (TechNavio, 2022).

Yamaganti et al., (2023) highlights that one of the challenges of the digital healthcare industry is storing patients' medical health data. This data is collected in a variety of ways and sources, and therefore is a challenge to create centralised repository systems that will be able to store the data in a manner that will be easily accessible to the medical practitioner and patient, maintain its data integrity as well as being safely guarded against cybersecurity attacks (Yigzaw, et al., 2022). The author Bernstein (2021) also discusses how a significant challenge in developing digital healthcare products is the contrast between digital and medical literacy. In order to create digital healthcare products, the software development teams need to understand the medical terms and conditions, as the data must be displayed in a readable format for healthcare providers and patients to understand (Bernstein, 2021). In contrast, the author Bernstein, 2021 also discusses how digital literacy poses a challenge in developing such products, as medical professionals might not understand the details surrounding the software architecture and functionality of the digital systems and frameworks. This often leads to requirements being delivered at a high level, and the responsibility is placed on the business analyst to effectively communicate with the technical team and the end-user to ensure that both sides are aligned (Ratwani, et al., 2018). As it is not always easy for medical professionals to communicate the requirements of digital healthcare systems to the software development team, this often leads to the redesigning and redeveloping of product deliverables (Zykov, 2021).

Mathews et al., 2019 also provide an alternate review of the challenges faced in developing digital healthcare products from an operational perspective. The author highlights that although the capabilities of digital healthcare products have grown exponentially in the past couple of years, they do constrain the end-user in terms of understanding how to operate the product (Mathews, et al., 2019). Many patients and healthcare professionals have expressed the need for simplifying these digital products or additional training on utilising these systems effectively (Baldwin, et al., 2017). Failure to utilise these systems effectively can create healthcare risks for the patient and reduce the rate at which medical professionals treat patients (Lee & Yoon, 2021).

The literature review on the digital healthcare industry shows that the growth of digital healthcare products and services has a significant advantage for patients and medical practitioners. The digital healthcare industry challenges arise in the product design and implementation phases. The authors emphasise how communication in the early product development phase is a major roadblock in implementing these products as significant effort is placed to ensure that both parties are aligned. If the software team and the customer/end-user are not aligned, it leads to rework that may be costly from a resource perspective. Han & Lee, 2021 also highlight that the competitive nature of the digital healthcare market also places immense pressure on these products to be delivered promptly; however, focus needs to be placed on the reliability of these products as they significantly impact the lives of the end-user.

2.2. Heavyweight Software Development Methodologies

Heavyweight methodologies follow a development model where all project lifecycle phases are executed sequentially. This type of software development methodology emphasises defining requirements in the form of documentation and conducting extensive project planning and product design before executing the development phase (Ahmad, et al., 2016). The subsections below discuss common heavyweight methodologies utilised within the software development industry.

2.2.1. Waterfall Methodology

In 1970, Winston Royce developed the Waterfall methodology, which is a heavyweight methodology because of its sequential approach (Sinha & Das, 2021). This methodology consists of several phases, such as planning, analysis, design, implementation, testing, and maintenance (Aroral, 2021). Figure 2.1 illustrates the traditional waterfall methodology.

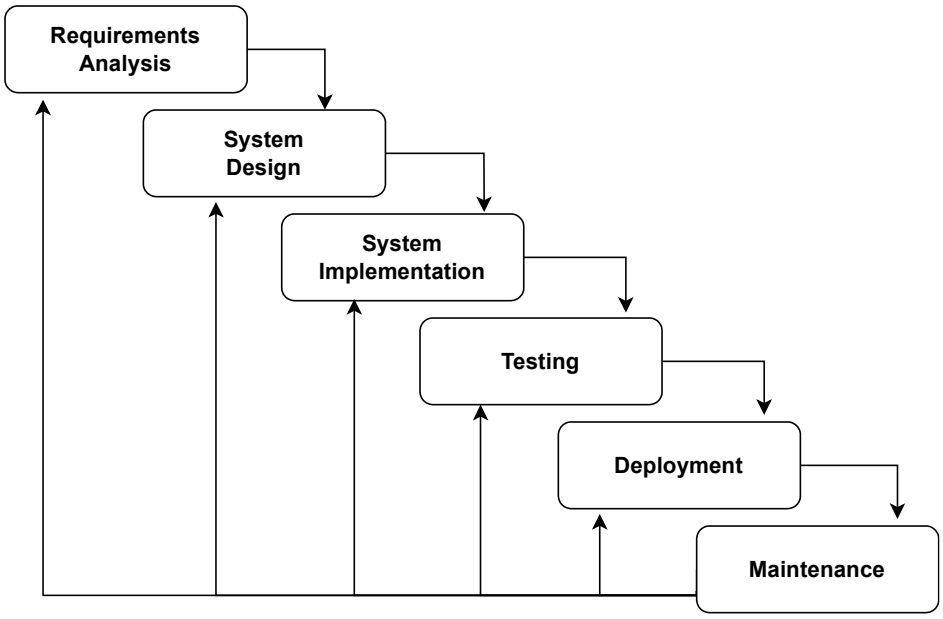


Figure 2.1: Traditional Waterfall Software Development Methodology (Aroral, 2021)

As shown in Figure 2.1, as this methodology follows a sequential approach, only a single phase may be executed at a time (the preceding phase may only be executed once the previous phase has been completed). The significant advantages of this methodology are that it provides a simple working process for a project team to follow and allows customer issues to be addressed effectively once the project lifecycle has been completed (Kumar & Bhatia, 2014). This methodology requires the project team to prepare sufficient requirements analysis and project planning documentation at the beginning of the project. As a result, this methodology does not allow any flexibility in the project's lifecycle (Chandra, 2015). As the project plan is developed before the execution of the project, it provides the customer and the software development team with an easy way to measure the project status/ progress, as all the details are defined at the start of the project (Thesing, et al., 2021). The traditional waterfall methodology also has several significant challenges, leading numerous software development companies to shift from this methodology to a more lightweight or agile model (Kuhrmann, et al., 2017). The

major challenge of this methodology includes the lack of flexibility as the project requirements and plan need to be defined at the start, and there is no room for scope creep (Senarath, 2021). Therefore, during the analysis and design phase of the SDLC, the software development team needs to ensure that the requirements provided by the customer have been well defined and in scope, as any changes to the project's scope will lead to costly and timely implications for the company (Ben-Zahia & Jaluta, 2014).

The sequential structure of this methodology also results in longer delivery times for software products, as all the phases of the project's lifecycle need to be completed before the final product can be delivered to the end user (De & Danh, 2013). As a result, the end user often has minimal involvement in the project's production. Therefore, the customer requirements must be signed off on the project design and specification documentation to ensure that both parties are aligned on the project deliverables (Bierwolf, et al., 2017).

The advantages and challenges of the traditional waterfall methodology have concluded that it is unsuitable for large-scale project deliverables as it is associated with high risk due to its inflexible structure (Ben-Zahia & Jaluta, 2014). Due to the nature of digital healthcare products being large in scale due to the level of internal and external system interaction, this literature review has showcased that the traditional methodology is not suitable for Company X and will provide many challenges due to the nature of the market and the methodology's incapability of handling these changes effectively.

2.2.2. Spiral Methodology

The spiral methodology combines the heavyweight traditional waterfall and the lightweight prototyping methodology (Shylesh, 2017). This methodology was developed in 1988 to overcome the inflexibility of the challenges experienced in the traditional waterfall methodology (Kristianto, et al., 2018). The author Devadiga, 2017 discusses how the spiral methodology follows a similar approach to the traditional waterfall method, where each phase is completed sequentially but differs as the SDLC is executed in small iterations. At the end of each iteration, a version of the software solution is delivered to the customer. Each phase in this methodology is called a spiral: planning, risk analysis, engineering, implementation, and evaluation (Chandra, 2015). The authors Ben-Zahia & Jaluta, 2014 also explain how the spiral methodology is an effective methodology that should be utilised when the customers/end users

are not fully confident in the requirements and expectations of the product deliverables. As this methodology is executed in iterations, it allows the software development team to handle scope creep and unforeseen changes in the project more effectively (Despa, 2014).

The benefits of utilising this methodology are that the requirements and project planning do not need to be fully defined at the start of the project (Alshamrani & Bahattab, 2015). Due to the flexibility of this methodology, any change in scope or requirements can be analysed during the engineering/development spiral (Ben-Zahia & Jaluta, 2014). This methodology also allows the customer to have more involvement in the delivery of the software solution, as feedback on the current solution may be obtained at any stage of the product's lifecycle with the ability to include the changes within the next iteration (Despa, 2014). The spiral methodology is also suitable for larger and more complex scaled projects (Mathur & Acharya, 2015). As a result, this allows for project risks to be handled within each spiral to manage the overall project risk more effectively.

The challenges associated with utilising this model are that it is quite costly and, therefore, unsuitable for smaller-scale software projects (Mathur & Acharya, 2015). As the risks associated with the project are handled within each spiral, expertise in risk analysis and management may be required to assist in effectively handling risks that arise (Ben-Zahia & Jaluta, 2014).

The benefits and challenges presented by the authors for this methodology showcase that the spiral methodology is suitable for larger-scale projects than the traditional waterfall methodology. Due to the nature of the digital healthcare market, the spiral methodology can be seen as a more effective heavyweight methodology, with the trade-off being that a higher cost will be generated due to the number of iterations needed to produce the final product deliverable.

2.2.3. Incremental Methodology

Another heavyweight methodology explored in this literature review is the incremental methodology. Similar to the spiral methodology, the incremental model was also introduced to solve the challenges associated with utilising the traditional waterfall methodology (Ben-Zahia & Jaluta, 2014). This methodology involves producing software solutions in smaller

deliverables through a series of incremental cycles called increments (Al-Saqqa, et al., 2020). The primary goal of this approach is to mitigate the risks associated with producing larger software solutions by implementing smaller standalone deliverables at a time (Despa, 2014). This enables sufficient testing and timely delivery, reducing the chances of any unexpected issues.

The incremental methodology differs from the spiral methodology as the cost of utilising this model is lower because this methodology is usually utilised for lower-risk projects (Alshamrani & Bahattab, 2015). Each SDLC phase is executed incrementally in this methodology until the product deliverable is complete (Al-Saqqa, et al., 2020). Similarly to the traditional waterfall methodology, the incremental methodology requires that project planning and documentation be produced at the beginning of the project (Larson & Chang, 2016) however, in the event of a change in requirements or scope creep, this model has the flexibility to handle any sudden changes effectively without impacting the project delivery (Abrahamsson, et al., 2017).

Additional benefits of this methodology include the ability to address changes in requirements between increments and the project team's ability to conduct a project retrospective on the knowledge gained from previous increments (Ben-Zahia & Jaluta, 2014). As this methodology follows an incremental approach, a functioning software solution is delivered promptly, and defects can be discovered and fixed early in the project (Despa, 2014).
The challenge with this methodology is that it is also a more costly model to implement compared to the traditional waterfall methodology, and sufficient well-defined documentation is required at the start of the project/increment to allow for better time and resource planning (Al-Saqqa, et al., 2020). Another challenge with this methodology is that as this model is usually suited for smaller project deliverables, the risk management and mitigation strategies are handled on an ad-hoc basis and may take longer to resolve, depending on the project's complexity (Abrahamsson, et al., 2017).

The benefits and challenges presented in this methodology showcase that the incremental methodology is more suitable than the traditional waterfall methodology due to its higher flexibility. Compared to the spiral methodology, this methodology is best suited for smaller-scale software projects and deliverables requiring low-level system integration and customer involvement (Ben-Zahia & Jaluta, 2014). In larger-scale projects, the spiral methodology will

be best suited as it will allow the team to handle risks more effectively and efficiently. In the digital healthcare market, the spiral and incremental models can be combined depending on the project scope, complexity, and size (Larson & Chang, 2016).

2.3. Lightweight Software Development Methodologies

Lightweight methodologies are less structured than heavyweight methodologies. They emphasise delivering functional software systems in the early stages of the development lifecycle by implementing shorter development timelines, encouraging end-user participation, and allowing software developers to work in a more flexible and rapid approach (Akbar, et al., 2018). The flexibility of lightweight methodologies enables the software development team to handle changes in requirements in a timely and effective (Matharu, et al., 2015). Common lightweight software development methodologies are discussed in the sub-sections below.

2.3.1. Prototyping Methodology

The prototyping methodology takes a different approach from the other methodologies discussed in this literature review. This methodology requires constant engagement between the customer and the software development team to understand whether the desired solution has been delivered as per the customer's expectations (Ben-Zahia & Jaluta, 2014). Prototyping allows the software development team to produce a working prototype at each stage of the project's lifecycle to allow the customer to provide regular feedback on the working model (Akbar, et al., 2018). This allows the software development team to understand whether they are on the right track or whether the current prototype needs to be re-developed (Abrahamsson, et al., 2017). As the customer provides regular feedback on the prototype, the team can build on the prototype's functionality while keeping the customer's feedback in mind (Brhel, et al., 2015). This methodology provides a more customer-focused approach compared to the heavyweight methodologies previously discussed.

The prototyping methodologies follow the following processes: requirements analysis, initial prototype development, prototype review, prototype enhancement and revision (Al-Saqqa, et al., 2020). In most cases, the prototype review and enhancement processes are repeated until customer satisfaction has been achieved (Abrahamsson, et al., 2017). The authors Ben-Zahia

& Jaluta, 2014 suggest that as this methodology may lead to constant rework of the project deliverables, the contract and budget are always open for re-negotiation.

The benefit of utilising this methodology is that regularly engaging with the customer assists in clarifying requirements at an early stage of the project lifecycle, allowing for faster development timelines and higher customer satisfaction (Brhel, et al., 2015). The software development team can demonstrate its technical capabilities from the project's onset to ensure that the customer expectations are within the software development team's capabilities (Al-Saqqa, et al., 2020). The authors Ben-Zahia & Jaluta, 2014 suggest that this methodology can be incorporated easily into various software development methodologies, including waterfall, agile, and incremental.

The challenge with this methodology is that false expectations and optimism can be made if communication and honesty are not relayed correctly (Abrahamsson, et al., 2017). The fast development timeline can lead to poor-quality prototypes being presented to the customer. As this methodology is based on a feedback-focused approach, it is challenging to maintain project documentation (Despa, 2014).

2.3.2. Rapid Application Development (RAD) Methodology

An alternative lightweight methodology is the Rapid Development Methodology (RAD), where the purpose of this methodology is to deliver higher quality software at a low cost and in a short time frame (Ben-Zahia & Jaluta, 2014). As a result, RAD has a shorter SDLC than most methodologies, and it encourages the customer/end user to provide constant feedback throughout the project's lifecycle (Chandra, 2015). This methodology consists of five main stages: business modelling, data modelling, process modelling, application generation and testing (Shylesh, 2017).

The benefits of utilising RAD are that the progress of the deliverables can be easily measured, the project deliverables are produced within a shorter time frame, and the testing process is simplified, as most software components are reused in building other deliverables or components (Despa, 2014).

The authors Olorunshola & Ogwueleka (2022) highlight that RAD will be challenging for larger and more complex projects as this methodology is designed specifically for projects that require shorter delivery times. The authors recommend that for successful project delivery, all stakeholders should have a thorough understanding of the requirements, and the developers should possess advanced skills to deliver the software solution within a tight time frame (Olorunshola & Ogwueleka, 2022).

2.3.3. Agile Methodology

The Agile software development methodology is a popular lightweight approach that prioritises market and customer needs (Rasnacis & Berzisa, 2017). It is designed to provide flexibility by consistently developing and releasing small incremental changes (Al-Saqqa, et al., 2020). This model was created in 2001 by a group of software developers who aimed to deliver high-quality, timely products while being able to adapt to changing requirements (Ben-Zahia & Jaluta, 2014). The Agile methodology is a combination of an incremental and iterative development model where interdisciplinary teams work together to develop project requirements and solutions (Sunner , 2016).

The agile methodology follows a manifesto that places importance on the following factors in a project's lifecycle (Ben-Zahia & Jaluta, 2014):

i. Functioning software deliverables over extensive project documentation.
ii. Communication, engagement, and interactions of project stakeholders with one another over the utilisation of processes.
iii. Collaborative partnerships with customers over the negotiation of project contracts.
iv. Swift response to changes within the project over following the pre-defined project plan.

The standard approach for the agile methodology starts with the planning stage. In this stage, the development timelines, scope, and features are defined (Flora & Chande, 2014). To proceed with the next phase of the methodology, the product design is required to initiate the process. However, the design does not need to be finalised or complex for the development to begin (Despa, 2014). Once the design is received and analysed, the software development team produces small, incremental, functioning code deliverables in cycles known as sprints

(Abrahamsson, et al., 2017). During the testing phase, the code deliverables undergo a series of user acceptance testing criteria to ensure that they meet the project's requirements (Pargaonkar, 2023). If the product meets all the acceptance criteria, it is deployed to production, and a post-deployment review is conducted to verify its performance (Al-Saqqa, et al., 2020). Throughout the sprint cycle, daily scrum meetings are held where each stakeholder of the software team discusses their progress and any challenges experienced so that the team can support and assist where necessary (Hayat, et al., 2019). Figure 2.2 illustrates the agile software development methodology.

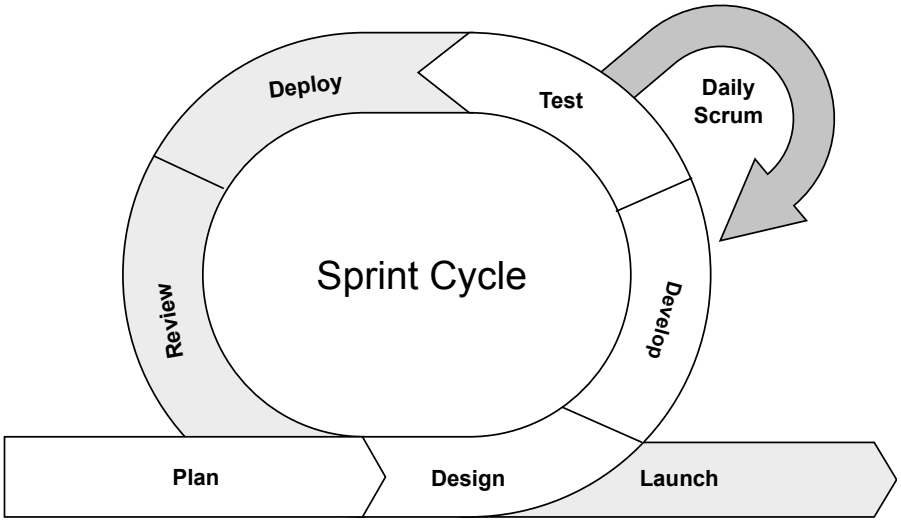


Figure 2.2: Agile Software Development Methodology *(Al-Saqqa, et al., 2020)*

The main objectives of the daily scrum, as depicted in Figure 2.2, are as follows (Hema, et al., 2020):

- To provide a platform for customers to give feedback, which can be integrated into the current or next sprint, depending on the complexity.
- To allow the project team to communicate effectively.
- To identify defects that arise during product testing.
- To coordinate tasks and deliverables.
- To enable team members to feel recognised and valued.

Scrum is an agile model utilised to implement Agile principles effectively based on the type of product being delivered or depending on the team's preference (Hron & Obwegeser, 2018). Other Agile models include Kanban, Extreme Programming (XP), Feature-Driven

Development (FDD), Test-Driven Development (TDD), Dynamic System Development Method (DSDM), and Crystal (Ben-Zahia & Jaluta, 2014).

The advantage of using an agile methodology is that projects can commence without having all the requirements fully defined. This approach enables additions and modifications to be made during the development stages (Despa, 2014). Working software deliverables can be produced within a short time frame, allowing customers to provide feedback and track progress (Al-Saqqa, et al., 2020). Collaborative teamwork and shared responsibility enhance the identification of defects and bugs at an early stage, enabling them to be rectified before the final solution is delivered to the market (Sunner , 2016). The agile methodology also promotes face-to-face communication, leading to better customer satisfaction and the building of collaborative relationships (Flora & Chande, 2014). The software is delivered at a higher quality through short iterative sprints, allowing customers to provide changing requirements and feedback that can be implemented throughout the project's lifecycle (Abrahamsson, et al., 2017). The agile methodology also enables the software development team to handle risk and varying complexity in a timely and effective manner (Sinha & Das, 2021).

The agile methodology also has some drawbacks that need to be considered. One of them is that sometimes, (Al-Saqqa, et al., 2020) there is not enough planning done at the beginning of the project. This could result in the team needing effective risk management and mitigation strategies. The lack of documentation on requirements is also a factor that contributes to this issue. While the methodology is quite flexible, it is extremely vulnerable to scope creep and high expectations placed on short delivery times (Ben-Zahia & Jaluta, 2014). Additionally, the software development team may need to receive training on agile techniques to ensure the timely completion of the development process (Shylesh, 2017). Authors Sehrish et al. (2017) suggest that it is also possible that some team members may feel that the project is not progressing as expected. This can happen because measuring project progress can be difficult when there are sprints that are still ongoing or that have not yet been planned. These sprints may not have been anticipated at the start of the project, which can make tracking progress even more challenging (Sehrish, et al., 2017).

Based on the benefits and challenges discussed in this literature review, it is evident that agile methodology provides more flexibility and promotes the delivery of high-quality code within a shorter timeframe. However, like any methodology, agile has its drawbacks when not

implemented successfully. For instance, there is limited documentation produced during the project, the software solution may become fragmented due to incremental releases, and there may be poor resource allocation. Additionally, there may be no clearly defined deadline for the final product.

2.4. Transitioning into a new methodology

Transitioning a team or an organisation to a new technology or a new way of working is one of the toughest challenges that management faces in every industry. Such a transition can have a significant impact on financials, performance, and human well-being. Therefore, it is crucial for management to utilise technology change management strategies that ensure a smooth transition without adversely affecting the team's performance and well-being.

Hanelt et al. (2021) emphasise that while digital transformations in an organisation can increase the profitability and security of digital systems and optimise current workflow processes, they also present various challenges. According to Hanelt et al. (2021), it is important for management to recognise that digital transformation involves not only the adoption of new technologies but also the implementation of new business models. Therefore, management should strive to comprehend these new working models and their potential impact on both customers and employees.

There is a consensus among Hanelt et al. (2021), Belias and Koustelios (2014), and Palmer et al. (2016) regarding the main challenges of digital transformation and the keyways to overcome them. These are as follows:

2.4.1. Poor planning by top management

According to Palmer et al. (2016), top management often lacks a well-defined plan for introducing new technology into the company or team. This is because they tend to focus only on a few aspects of the change, such as specific components, rather than considering multiple factors like team culture, work processes, team structures, and finances. To address this issue, Palmer et al. (2016) suggest the following ways to improve change management strategy:

- Planning – Management should analyse existing and new processes to establish priorities. The goals and objectives of the digital/ technological transformation should

also be clearly defined and aligned with the company's vision. All the details regarding the changes, including processes, timelines, resources, budget, phases, etc., should be documented (Palmer, et al., 2016).

- Communication from top management – Effective communication of changes from top management to the rest of the organisation or team is crucial to ensure that everyone is aware of the changes to the team/company structure and how it will impact them. Open forums and meetings should be conducted to provide employees with an opportunity to express their opinions and to ensure that their feedback is acknowledged by management.
- Roadmap – As part of the change management strategy, it is important to create an organisational roadmap that outlines each phase of the transformation and the timelines for when the changes will take effect. This will ensure that all stakeholders or parties involved understand the process and are aligned.
- Monitoring – As the company undergoes transformation, it is important for management to closely monitor each phase of the process. This will help identify any issues or challenges that may arise and gain better control over the company during this time. Additionally, this monitoring will enable management to measure the progress towards achieving the pre-defined goals of the company or team.

2.4.2. Lack of knowledge and expertise in new technology

Palmer et al. (2016) and Hanelt et al. (2021) highlight that a lack of knowledge of the new technology to be adopted is often a change in digital transformation. It is crucial for both management and the affected team to have a clear understanding of the changes to be implemented and how they will be carried out. Often, team members lack the expertise to operate or function in the new technology. To overcome this challenge, Belias & Koustelios (2014) suggest hiring a digital transformation consultant to guide and assist the team during the transition period. Additionally, Palmer et al. (2016) suggest that the organisation can provide training to employees to help them upskill and better understand how to navigate the new changes that will be made within the team or company structure.

2.4.3. Resistance to change by employees.

Palmer et al. (2016) and Belias & Koustelios (2014) both highlight that employees resisting the adoption of new technologies can affect the success of the transition. To overcome this

challenge, authors Belias and Koustelios (2014) suggest that it is essential to keep employees engaged throughout the transition process and ensure that management is transparent about important decisions and factors that affect the company. Belias & Koustelios, 2014 also recommend that organisations start with slower transitions in the earlier phases as it allows employees to prepare for the changes that will be made to the organisation and help shift their mindsets and perspectives. Therefore, when the transition process starts to pick up pace, the employees will already know what is expected and will provide them with a sense of security. Palmer et al. (2016) provide an alternative approach by suggesting that management should plan for resistance to change as it is inevitable as humans all cope differently. Palmer et al. (2016) highlight that this can be done by creating a resistance management plan, which will be used to identify the areas in which resistance will arise and the plan in which management can assist in mitigating these issues or providing a sense of stability in those areas.

2.4.4. Budget Concerns

Cameron & Green (2019) and Hanelt et al. (2021) discuss how digital transformation provides financial pressure for an organisation and/or team, as introducing new processes and resources within a team requires a significant amount of investment made in strategic planning. Hanelt et al. (2021) suggest that to overcome this challenge, management should put in place a financial roadmap and budget to plan how financial resources will be utilised during the transition period. Cameron & Green, 2019 highlight that when a budget is being drawn up, it is essential to be flexible to take in any unforeseen costs that may arise.

From an SDLC perspective, many software development companies transition from their traditional methodologies into a more agile approach to try and improve their output. Transitioning into an agile software development methodology will not be an effortless and seamless process (Sumrell, 2007). The author discusses the changes that teams may have to make to ensure that the team aligns suitably with the agile framework (Sumrell, 2007). (Sumrell, 2007) highlights that for an easier transition, it is essential to consult with an agile coach to gain expertise on the type of agile methodologies suitable for the specific team (Sumrell, 2007). It was also discussed that it is essential for each stakeholder of the development team to understand that their responsibilities are not defined by their job role, as everyone needs to take ownership of the quality of the final product (Sumrell, 2007).

From a general technology perspective, the authors (ten Brummelhuis, et al., 2012) discuss the effects of new working methods on an organisation. From this research study, the authors

performed a five-day observational study where they concluded that new ways of working have a positive effect on team engagement as it allowed team members to interact with each other in a more effective way that encouraged productivity (ten Brummelhuis, et al., 2012). The authors also noticed a negative effect on team exhaustion as communication among team members became more effective (ten Brummelhuis, et al., 2012). The authors highlighted that if new ways of working are implemented successfully within an organisation, it may promote a higher level of team engagement and synergy, which will have a positive effect on the output of the organisation (ten Brummelhuis, et al., 2012).

In terms of digital transformation with transitioning into new ways of working, authors ten Brummelhuis et al. (2012), Cameron & Green (2019), and Hanelt et al. (2021) highlight the various challenges that are faced when adopting new processes. There is a consensus among the authors that adopting new technologies promotes efficiency in work processes.

2.5. Literature Review Conclusion

The literature review discussed in this section confirms that the current traditional SDLC methodology utilised by Company X is no longer suitable for the growing software development market. Other heavyweight methodologies, such as the incremental and spiral methodologies, have been implemented to overcome the challenges experienced in the traditional waterfall methodology. Therefore, this also supports the need for Company X to transition to a new software methodology. The lightweight methodologies all focus on delivering incremental changes and encourage regular customer feedback for quality software deliverables to be produced at the end of the project's lifecycle. (Ben-Zahia & Jaluta, 2014) evaluate the factors that influence the selection of the appropriate software development methodology. The authors emphasise that there is no single methodology that can solve all the challenges faced by a development team (Ben-Zahia & Jaluta, 2014). However, several factors must be considered before choosing the appropriate methodology for the team. Such factors include project risk, requirements, documentation, cost, and delivery time (Ahimbisibwe, et al., 2015). The authors also support the idea that, in many cases, a hybrid model can be utilised, which combines multiple methodologies to produce the desired output for the team.

Therefore, to mitigate the challenges experienced within the traditional waterfall methodology, a new or enhanced (hybrid) SDLC methodology will need to be developed for Company X. This research study will investigate this further.

2.6. Comparative Analysis

Based on the literature review, a comparative analysis has been conducted on heavyweight and lightweight methodologies. This analysis provides an overview of the characteristics, advantages, disadvantages, and circumstances in which each methodology is best suited. The comparative analysis is shown in Table 4 of Appendix A.

2.7. Conceptual Framework

A conceptual framework has been developed based on the literature review to illustrate the relationship between the dependent and independent variables of this research study. As shown in Figure 2.3 below, the following variables affect the overall customer satisfaction in the delivery of digital healthcare software products:

- Quality
- Cost
- Time
- Scope

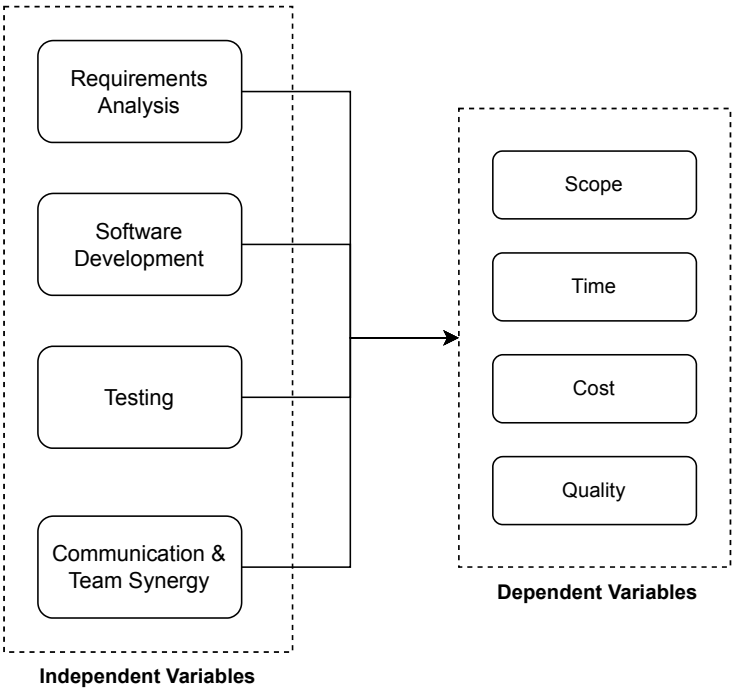


Figure 2.3: Conceptual Framework Model

The variables listed represent the dependent variables in the current research study as they measure the contributing factors that ensure the success of the project. The independent variables in this study are the main phases of the software development cycle, including analysis, development, testing, and customer feedback/communication. These variables have a direct impact on the quality of the overall software deliverable, the time frame allocated for product delivery, the cost of production, and the scope/requirements (functionality) of the final deliverable.

3. CHAPTER THREE – RESEARCH METHODOLOGY

As part of the research study, semi-structured interviews were conducted with participants from Company X to answer the critical research question and meet the objectives of the study. This chapter presents the research design and instrumentation used to measure research variables, as well as sampling, data collection, and analysis. Additionally, the validity and reliability of the research study will be discussed.

3.1. Research Design

The research problem that was investigated in this research study is centred around the traditional waterfall methodology and the challenges that Team A of Company X encounters when using this methodology to deliver digital healthcare product deliverables. As Company X delivers digital healthcare products to the digital healthcare market, these products must be produced at a high quality and in a timely manner. As the digital healthcare market is consistently developing with new technologies, Company X needs to enhance their operations to ensure that it maintains a significant market share over its competitors.

Thus, the critical research question is how Company X can introduce a new or enhanced SDLC methodology suitable for enhancing the development of digital healthcare products.

The research methodology for this project followed a qualitative approach, as most teams in Company X use an agile methodology, while some members of Team A believe in a traditional waterfall methodology. As the traditional waterfall methodology is classified as a heavyweight

methodology, significant focus is placed on the initial stages of the project (such as project documentation, planning, analysis, and development). Therefore, interviewing stakeholders of these teams and analysing the answers noted in the interview transcripts using quantitative analysis techniques has allowed the researcher to identify common themes and patterns experienced by the participants employed by Company X. The comparison of participants' answers has also enabled the researcher to understand why Team A of Company X operates on a different SDLC model from their counterparts.

The findings from this study have also been compared to existing literature through the comparative analysis conducted in Appendix A to verify the validity of the results.
A qualitative approach was appropriate for achieving the research objective based on the following reasons:

1) For the first objective, interviews with members of the software development team in Company X were analysed to evaluate the current challenges of the waterfall methodologies and identify the phases in which these challenges arise.

2) The second objective was achieved by conducting an extensive literature review in Chapter 2 on the various software development methodologies. A comparative analysis has also been conducted to compare the findings from the literature review to the methodologies utilised by Company X.

3) The third objective was achieved by conducting interviews with the various stakeholders within the software development team to understand how management can ensure that the team successfully transitions to the new software methodology. The literature review will also be utilised to identify ways in which the software development team can successfully transition to a new way of working.

The methodology used in this study involved a thorough analysis of data collected through semi-structured interviews with various software development teams in Company X. The objective was to gain a comprehensive understanding of the teams' processes, practices, and challenges, which would be used to identify areas for improvement. Further details on data collection and analysis methods will be discussed in Sections 3.4 and 3.5, respectively.

3.2. Instrumentation

In this research study, data was collected using semi-structured interviews. The interviews were conducted with stakeholders from the software development team, who were asked a series of 18 questions about their current working methods and associated challenges.

Semi-structured interviews were appropriate to use in this research study as this instrument allows the researcher to understand the participant's experiences and perspectives on the current methodology (Wengraf, 2001) , which is utilised in Company X, as well as the challenges each participant has experienced or witnessed. Creswell's (2007) and Wengraf's (2001) research findings highlight the importance of utilising semi-structured interviews in qualitative research studies. These types of interviews offer a more flexible approach to both formulating questions and obtaining answers where the interviewer can adapt interview questions to fit the participant/interviewees' experiences, perspectives, and knowledge (Wengraf, 2001). Additionally, participants can respond in their own words and at their own pace, providing rich and meaningful data. This provides the researcher with the ability to explore deeper thoughts and topics from the participants, which would not be able to be provided as much in more structured interview approaches (Creswell, 2007).

The interview questions for this research study were developed using the Wengraf Pyramid Model (Wengraf 2001), which is shown in Figure 3.1.

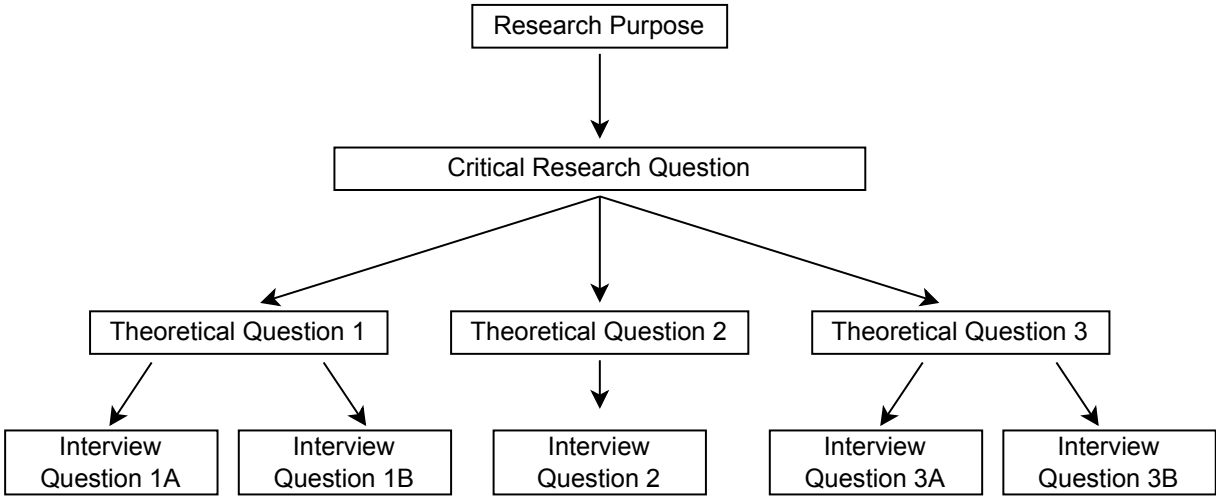


Figure 3.1: Wengraf Pyramid Model (Wengraf, 2001)

The model presented in Figure 3.1 demonstrates a progression in the formulation of interview questions, starting from the research purpose and moving towards the critical research question

(CRQ), then to the theoretical question. Lastly, it concludes with the development of the interview question from the theoretical question (Wengraf 2001). The theoretical questions have been developed using the literature review in Chapter 2, as recommended by Wengraf (2001). The interviews conducted followed a semi-structured approach as it allowed the participants to share openly their experiences with utilising the traditional waterfall methodology within their respective project teams (Wengraf 2001).

The interview questions generated for this research study are shown in Appendix G.

Tables 3.1 and 3.2 illustrate an impact analysis based on the conceptual framework in Figure 2.3 of how the instrumentation will measure this research project's dependent and independent variables.

Table 3.1: Impact Matrix detailing the effect of the instrumentation for the research project on the dependent variables.

Variable	Variable Type	Semi-structured Interviews
Scope	Dependent Variable	Interviews conducted with the business analysts have been used to understand the impact of the project as well as how the impact analysis was conducted at the beginning of the SDLC.
Time		The interviews with the project team have been able to provide clarity on why certain deadlines were not met and how the timelines/estimates for the project were established.
Cost		Interviews conducted with the certain stakeholders of the project team have been used to understand what factors/issues led to the project cost being high or low in certain circumstances.
Quality		Interviews conducted with the test analysts have been used to determine what defects were picked up during the testing phase and what issues in the code was missed that led to a change request and how these issues were only picked up after the project was delivered.

Table 3.2: Impact Matrix detailing the effect of the instrumentation for the research project on the independent variables of the research project.

Variable	Variable Type	Semi-structured Interviews
Team Synergy and Communication	Independent Variable	Interviews have been able to provide some insight how the current methodology utilised affects the working relationships and cohesion within the team.
Testing		Interviews conducted with the testing stakeholders have been able to provide insight into understanding any issues within the SDLC that affected the testing timelines.
Requirements Analysis		Interviews conducted with the participants of various roles have been able to provide insight into the understanding of issues within the analysis and design phase of the SDLC that affected the testing timelines and project delivery.
Development		Interviews have been beneficial to measure this variable as participants have been able to provide some insight into how their current methodology has affected/impacted the development phase of the SDLC.

3.3. Sampling

Although this research study primarily focused on Team A of company X and the methodology believed to be used within their team, participants from Teams B—D were also included to provide a broader perspective of the digital healthcare industry and the challenges encountered by teams utilising other software development methodologies. Each participant was asked a series of 18 questions, which is shown in Appendix G.

In this research study, the sampling techniques used were a combination of random probability sampling and purposeful sampling. The following section will give you an overview of how the sampling was conducted.

As mentioned above, both random probability sampling and purposeful sampling were utilised to collect qualitative data from participant interviews. Random probability sampling was used to gain a collective understanding of the experiences of various participants in Company X in relation to the methodologies utilised within the participant's current teams. This allowed the researcher to eliminate any biases that may arise within a certain group of participants in a specific job role (Shaheen, et al., 2019). In contrast to random probability sampling, purposeful sampling was used to understand the thoughts and experiences of certain stakeholders operating in specific stages in SDLC (Shaheen, et al., 2019). For example, during the development phase of a Software Development Life Cycle (SDLC), software developers played a vital role and thus provided significant insights on questions pertaining to this particular phase than other participants. Similarly, test analysts provided more valuable feedback on questions pertaining to the testing phase, as they played a significant role in this phase. Therefore, to ensure that all stakeholders involved in each specific aspect or phase of the SDLC have an opportunity to provide their thoughts and insights, the sampling techniques chosen for this research study were selected accordingly.

The sample of Company X stakeholders who participated in the research study was characterised using the following elements:

- Job Role (business analyst, software developer, test analyst, etc).
- Rank (junior, intermediate, senior).
- Experience in the Software Industry.
- The team within Company X.

The researcher had limited control over certain physical characteristics of the sample set, such as race, gender, or age, as those characteristics were solely dependent on the members of the project teams interviewed. The only element that could be controlled in the sample set was the number of teams interviewed within Company X.

The sample set of participants was also selected upon participant availability to partake in the research study. All 24 participants who were selected as part of the sample set agreed to participate in the research study. A summary of the number of participants categorised by their job role is shown below:

- Total number of Business Analysts: **6**
- Total number of Software Developers: **9**
- Total number of Test Analysts: **2**
- Total number of Digital Product Owners: **1**
- Total number of System Architects: **1**
- Total number of Managers (which includes Development and Delivery Managers): **5**

Table 4.1 in Chapter 4 provides a more detailed overview of this research study's sample set.

3.4. Data Collection

This section aims to provide an overview of the data collection method employed in this research, which involved semi-structured interviews. None of the participants were provided with any incentives for their participation in this research study.

The data provided from each interview has been stored in the following data storage mediums:

- OneDrive – provided by the University of the Witwatersrand
- External Hard Drive (consisting of a storage size of 2TB)
- One Drive – provided by Company X (as the interviews were conducted using the Researcher's company X Teams Profile)

Prior to scheduling interviews, permission was requested via email from Company X's management to interview stakeholders from different teams. The Letter of Permission is shown in Appendix D. Once the organisation provided permission for the interviews to be conducted, the sample set was selected using the process described in Section 3.3.

Upon selecting the sample set of participants, a letter of participation was dispatched to the potential participants via email. The Letter of Participation is provided in Appendix E. Additionally, a call was scheduled with the participants to familiarise them with the aim, objectives, and ethical considerations of the research study. This was done to address any queries or concerns any participants may have had when reading the information letter and to ensure their participation was informed and voluntary.

Upon agreement to participate in the research study, a letter of consent was dispatched to the participants via email; the purpose of this letter was to obtain written consent from each participant, ensuring that they agreed to partake in the research study. The Letter of Consent is provided in Appendix F.

Once the Letter of Consent was signed, the interviews were scheduled with the participants depending on their availability. All interviews with the selected participants were conducted virtually on Microsoft Teams. Each interview lasted an average duration of 30 – 60 minutes, depending on the participant's engagement and the length of the answers provided. During the interview, each participant was asked a series of questions pertaining to their role and experiences during the project's delivery, utilising their team's current SDLC methodology. Each interview was transcribed and recorded using the built-in recording and transcription functionality on Microsoft Teams, allowing the researcher to listen intently to the answers provided by each participant. During the initial review of the interview transcripts, a couple of wording inaccuracies were noted in the cases where participants had accents or did not enunciate their words clearly during certain parts of the interview. After comparing all the interview transcripts and recording side-by-side, any inaccuracies were corrected.

3.5. Data Analysis

The analysis of the research data has been conducted thoroughly to meet the objectives of this study, as shown in Appendix J. The method by which the data will be analysed in this study has been discussed further below.

3.5.1. Thematic Analysis

The Wolcott (1994b) general data analysis strategy was followed as shown in the steps below:

i. The project interview transcripts were organised by highlighting or noting specific information, which was then collated in a descriptive paragraph (Creswell, 2007).
ii. Company X's traditional waterfall methodology was segmented using a coding process to identify patterns, phenomena, or irregularities (Creswell, 2007).
iii. Compare and contextualise the identified patterns and irregularities to the literature (Creswell, 2007).
iv. Represent the data and results in a presentable format, such as figures and tables (Creswell, 2007).

Additionally, for further analysis of the qualitative data collected through the interviews, the Theoretical Thematic Analysis procedure discussed by Braun & Clarke (2006) has been utilised. This analysis technique has allowed the researcher to identify common patterns and themes in the data collected as part of this study (Maguire & Delahunt, 2017).

The following procedure, highlighted by Braun & Clarke (2006), was also used to analyse the research study's data (Maguire & Delahunt, 2017).

a. Data Familiarisation:

- Thoroughly reading interview transcripts was essential to become familiar with the data that had been collected (Maguire & Delahunt, 2017).
- During the review, any notes or thoughts that related to the critical research question and made an impression on the author were recorded (Maguire & Delahunt, 2017).

b. Initial Code Generation

- The data that was collected was organised in a systematic manner to allow the researcher to segment the data into smaller and more useful sections for analysis (Maguire & Delahunt, 2017).
- An open-coding method was utilised to develop and modify codes during the analysis to ensure that the data was not segmented based on the researcher's initial thoughts. This allowed the researcher to develop and modify codes as the data was worked through (Maguire & Delahunt, 2017).
- The coding process was conducted using Microsoft Excel 2016 to segment data and identify themes in the project documentation and interviews (Maguire & Delahunt, 2017).

c. Identification of Themes

- In the previous step, codes were generated, and patterns or themes in the segmented data were identified (Maguire & Delahunt, 2017). The themes were identified by ensuring they related to the research question and objectives of the study.
- The codes that correlate to a specific theme has been collated (Maguire & Delahunt, 2017).

d. Review of Themes

- The themes that were generated in the previous step have been reviewed and modified to ensure that they aligned with the objectives of the research study (Maguire & Delahunt, 2017).
- Microsoft Excel was used to colour-code the data that related to a specific theme, and these themes were reviewed to identify whether the coded data did, in fact, support the theme (Maguire & Delahunt, 2017).
- Cases in which the themes were not coherent or distinct from one another were either modified, further developed, or discarded (Maguire & Delahunt, 2017).

e. Define Themes

- In this step, the themes were refined to identify the following key points (Maguire & Delahunt, 2017):
  - What is the theme conveying?
  - How do subthemes correlate to the overall main theme?
  - Is there a relationship between the themes?

f. Write-up

- The findings obtained in the thematic analysis were conveyed in the research report (Maguire & Delahunt, 2017).

3.5.2. Comparative Analysis

During the comparative analysis, we generated the matrix in Appendix A using Maguire & Delahunt's (2017) thematical analysis process. The process we followed included the following:

- As part of the literature review, six software development life cycle (SDLC) methodologies that are commonly used in the industry were examined. These methodologies were selected based on their popularity in various research papers.
- The coding process involved becoming familiar with the various research papers discussing each methodology and its applications in detail.
- Preliminary codes were generated from each methodology and then categorised into four broad themes: methodology structure, advantages, disadvantages, and the type of projects the methodology is best suited for.

- After categorisation, a matrix was generated to compare the SDLC methodologies based on the themes. The matrix allowed for a side-by-side comparison of the methodologies, highlighting their strengths, weaknesses, and suitability for different types of projects.
- Furthermore, semi-structured interviews were conducted to gather information on Company X's methodologies. The codes extracted from the interviews were then compared to the literature review to understand how Company X's methodologies compared to those described.

3.6. Validity and Reliability

In this qualitative research study, it was crucial for the researcher to ensure that the results were credible. To establish the validity and reliability of the research, it was important to first understand the meaning of these terms and the factors that can impact them.

3.6.1. Definition of Validity:

According to LeCompte and Goetz (1982), validity in qualitative research refers to the degree to which a research study's findings are accurate and reliable. This includes the accuracy of the research instruments used and how well they measure the research variables.

3.6.2. Definition of Reliability:

According to LeCompte & Goetz (1982), reliability in qualitative research refers to the consistency of the feedback provided by research participants in comparison to previous studies. Additionally, it also refers to the researcher's ability to reproduce similar results over multiple testing periods using the same research methodology.

3.6.3. Risk Factors Impacting the Validity and Reliability of the Research Study:

One crucial step in determining the research methodology of a qualitative study is to identify and comprehend the risk factors that could affect the study's validity and reliability. Based on the insights provided by Brink (1993), the following risk factors have been identified.

i. Researcher bias

It was important to consider the potential bias of the researcher in the validity and reliability of the research study, as Company X currently employs the researcher (author) in Team A. The researcher's personal experiences within the team could have affected their opinion on the methodology used by Team A and the associated challenges faced in its execution. Therefore, it was crucial for this bias to be acknowledged so that appropriate measures could be taken to mitigate it. This was done to ensure that the results presented in the research study were solely based on the analysis of semi-structured interviews with the participants from Company X and the comparative analysis of various SDLC methodologies in the literature review. The acknowledgement of researcher bias is presented in Chapter 4 – Section 4.1.

ii. The participants of the research study

It is also important to recognise the ways in which the participants selected for this research study may impact the outcome of the research results. The ways in which the participants may impact the validity and reliability of the results have been divided into three parts as follows:

- Reactivity – The dynamic between a participant and a researcher can influence the participant's behaviour and responses during an interview. Participants may feel compelled to answer questions in a way that aligns with the researcher's expectations or the opposite. Moreover, the mere presence of a researcher can make some participants feel uneasy, leading them to behave in ways that differ from their typical responses in a survey or questionnaire.

- Participant Bias – Given that this research study is based on qualitative data, it was imperative to consider the participants' feelings and opinions regarding the current methodology to answer the research question accurately. However, it was equally important to acknowledge participant bias as a potential risk factor. If a participant holds negative feelings towards the company or management or is a disgruntled employee, their feedback may influence the research results in a specific direction. Therefore, it is possible that feedback from such participants may not provide an honest depiction of the way Company X operates.

- Sample selection – The research study's sample set of participants may affect the validity of the research results. The participants were selected using the sampling process described earlier in this chapter. Additionally, it's important to note that not all stakeholders from various teams in Company X were able to participate in the interviews due to availability. As a result, the perception of how Company X operates may be impacted by the fact that one team had more participants than another.

iii. The environment, industry, or socio-cultural influence of the research study.

In the earlier part of this chapter, the researcher mentioned that the semi-structured interviews were conducted in a digital setting. Microsoft Teams was used to record and transcribe the interview. This setting may have affected the way participants answered certain questions. Some participants may have been worried that their company could access the recording without their consent, or they may have been in an environment where someone could overhear their responses. Therefore, they may not have felt comfortable expressing their true thoughts and opinions. To address these concerns, the researcher initiated a call with each participant before the interview to answer any questions and ensure their identity would be protected.

iv. Data collection and analysis methods

Researcher bias can have a significant impact on the collection and analysis of interview data during a study. Researchers may unconsciously develop codes and themes based on their own thoughts and opinions about the expected outcome of the research. As the interview questions are open-ended, the researchers may also unintentionally influence the participants to provide answers that align with their own opinions. This can lead to inaccurate and invalid results, affecting the study's credibility and reliability.

3.6.4. Ways used to increase the validity and reliability of the research study:

To increase the validity and reliability of this research study, the following actions have been conducted:

i. Acknowledging researcher bias and any presumptions of the research results.

As mentioned earlier, the researcher of this study currently works in Team A of Company X, so the researcher’s observations/opinions on the methodology are clearly stated in the research report.

ii. Triangulation

The results generated from that research study were validated or compared to that of existing literature and similar studies to ensure that the results aligned with research where the hypothesis/theory had already been proven in previous studies (Heale & Twycross, 2015).

iii. Detailed Data Collection and Note-taking.

The researcher in this study followed the recommendations of author Brink (1993) by ensuring that the data collected was recorded in detail, using both audio recordings and transcripts. This allowed for a clear understanding of the researcher's interpretations of the data and provided a way to audit the research. By making the research auditable, the reader can follow the events leading to the study's conclusion.

iv. Comparative Analysis

The research study results were verified against existing literature and similar research studies to determine alignment or discrepancies. To increase the validity of the research results, this study utilised the process described by Heale and Twycross (2015) to determine the correlation between the research instrumentation when measuring the dependent and independent variables. Additionally, to increase the validity of the research results, the recommendation put forward by Brink in 1993 was also explored. This involved finding existing studies that contradicted the findings of the research study. However, after studying the literature sources obtained, it was found that all of them supported the research results presented in this report.

3.7. Ethical Issues and Clearance

Ethics clearance was obtained by the School of Mechanical, Industrial and Aeronautical Engineering (MIA) Ethics Committee for conducting interviews with project stakeholders in the software development team of Company X. As mentioned in Section 1.5 of this report, the University's Main Ethics Committee (non-medical) granted ethical clearance to conduct interviews as part of this research study. The ethics clearance number assigned is **MIAEC 073/23.**

To ensure that the ethical principles of this study were upheld, the following actions have been conducted:

- The organisation analysed in this research study was anonymised using the pseudonym *Company X*.
- The identifying details of the participants interviewed as part of the research study were removed from the transcripts to keep their identities confidential.
- As mentioned earlier in this chapter, participant consent was requested by means of a participation and consent letter prior to conducting any interviews as part of this research study. If a participant decided to withdraw from the data collection process, any data provided by the participant was appropriately discarded and not used in the research results.
- All participants were informed prior to the interview about the purpose of the research study as well as how the provided data would be utilised and stored.

Further note: Management of Company X granted permission to use the company as the research subject of this study. This was granted on the basis that the organisation's identity and any identifiable company information have been anonymised and kept confidential.

4. CHAPTER FOUR – RESEARCH RESULTS AND DISCUSSION

This chapter presents the results collected from the semi-structured interviews conducted at Company X and analyses the data using qualitative analysis techniques to answer the critical research question and address the research objectives. The interpretation and discussion of the results are included in this chapter as they provide the basis for the next chapter, which presents an enhanced SLDC methodology.

4.1. Interview Participant Profile

A total of 24 participants in Company X were interviewed, consisting of varying job roles, levels, industry experiences, and teams. The participant profile is shown in Table 4.1.

Table 4.1: Participant Profile of the participants in this research study

No	Participant Pseudonym	Job Role	Level	Experience in Industry	Team within Company X
1	ARC 1	Systems Architect	Junior	7.5 years	No team - works with all teams
2	BA_1	Business Analyst	Intermediate	3 years	Team A
3	BA_2	Business Analyst	Senior	3.5 years	Team B
4	BA_3	Business Analyst	Senior	25 years	Team B and D
5	BA_4	Business Analyst	Senior	12 years	Team B
6	BA_5	Business Analyst	Senior	10 years	Team B
7	BA_6	Business Analyst	Intermediate	2 years	Team D
8	DEV_1	Software Developer	Intermediate	2.5 years	Team B
9	DEV_2	Software Developer	Intermediate	3 years 7 months	Team B
10	DEV_3	Software Developer	Intermediate	3 years	Team B
11	DEV_4	Software Developer	Intermediate	3.5 years	Team B
12	DEV_5	Software Developer	Junior	1 year 1 month	Team B
13	DEV_6	Software Developer	Junior	1.5 years	Team B
14	DEV_7	Software Developer	Senior	6.5 years	Team D
15	DEV_8	Software Developer	Senior	2.5 years	Team D
16	DEV_9	Software Developer	Senior	3 years	Team D
17	DEV_10	Delivery Manager	Junior	4.5 years	Team D
18	DM_1	Development Manager	Intermediate	10.5 years	Team A

19	DM_2	Development Manager	Intermediate	5 years	Team B and D
20	DM_3	Development Manager	Senior	13 years	No team - works with all teams
21	DM_4	Development Manager	Intermediate	6 years	Team C
22	DPO_1	Digital Product Owner	Junior	2 years	Team C
23	TA_1	Test Analyst	Junior	2 years	Team B
24	TA_2	Test Analyst	Junior	7 months	Team B

4.2. Current Methodology Utilised in Company X

In the semi-structured interviews, the participants were asked to identify and describe the SDLC methodology that they personally believe is utilised within their team. Participants from Teams B-D were all aligned in their answers, as they all identified that an agile methodology was being utilised in their team. Most participants indicated that the agile methodology is not being used fully or enforced strictly in their respective teams.

Participants from Team A had opposing views on the type of SDLC methodology being utilised within their team. A wide range of hybrid methodologies were identified and described. The graph below depicts a summary of the results of the methodology believed to be utilised in Team A.

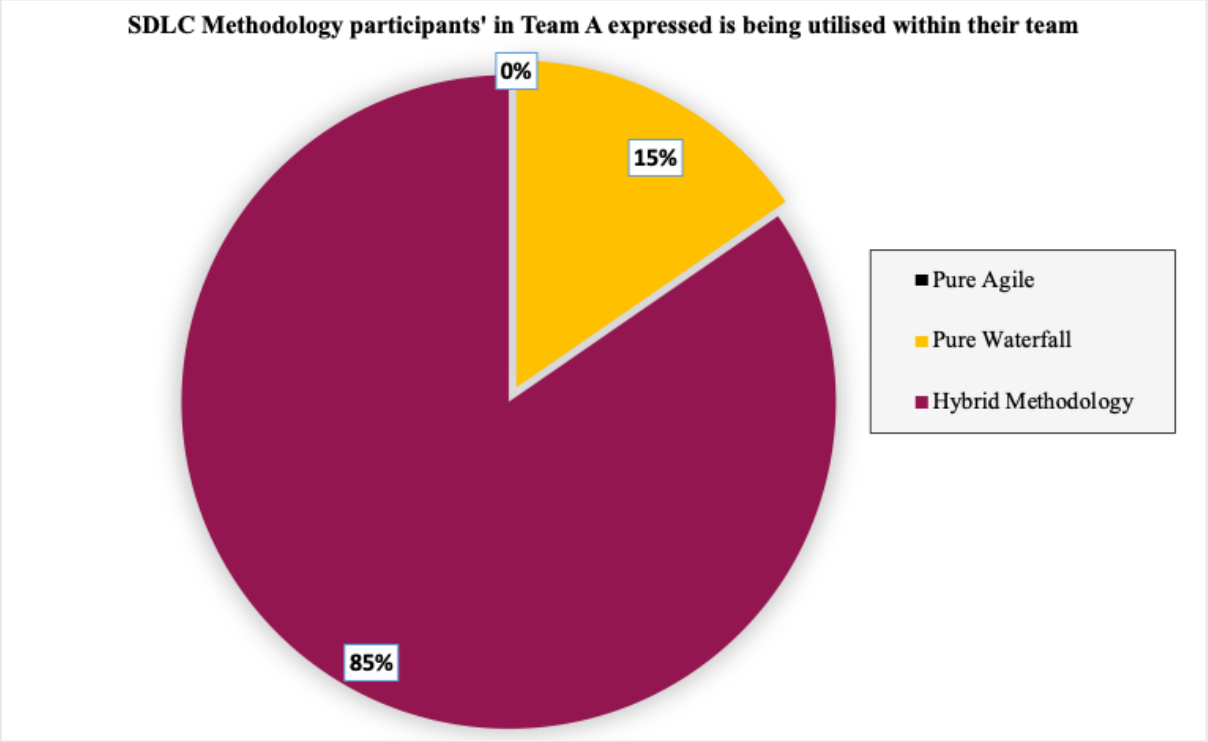


Figure 4.1: SDLC Methodology Team A participants believe is being utilised within their team

Figure 4.1 depicts that all the participants from Team A agree that their team does not follow a pure agile methodology. 15% of the participants from Team A believe that a pure waterfall methodology is followed in the delivery of digital healthcare products, while 85% of participants believe a hybrid (agile-waterfall) methodology is utilised. The thematic analysis presented below will provide insight into why Team A has contrasting views on the methodology utilised.

4.3. Thematic Analysis Overview

Qualitative analysis coding techniques, as discussed in the Research Design, were used to analyse the transcripts of the participants' interviews, breaking up the content into codes and then further into themes. The themes were further reviewed to ensure that the most relevant themes, which answered the research question and objections, were utilised. A more detailed depiction of the qualitative analysis is shown in Appendix H. The themes can be seen in column 3 of the analysis.

The finalised themes from the data transcripts are as follows:

i) Digital Healthcare Industry and Work Environment.
ii) Communication and Collaboration with Business and External Clients
iii) Team Culture and Relationships.
iv) Current Team Methodology and Processes.
v) Project Management and Planning.
vi) Improvement of current Methodology or adoption of new methodology.
vii) Change Management.

Further discussion on the themes presented above will be presented in the Research Results and Discussion sub-sections below.

4.4. Research Results and Discussion

In this section, the research results are presented and analysed through thematic analysis. This includes a discussion on the significance of the themes and sub-themes, with direct quotes from the transcripts supporting these themes. The interpretation of the sub-themes is also presented alongside the overall conclusions of the themes. The results were generated by collating the frequency of codes for a specific theme, showcasing how often a particular answer was mentioned by the participant sample. These frequencies are displayed in bar charts, illustrating the comparison of code frequencies against codes/subthemes. Additionally, some results are depicted through pie charts, which show the percentage of participants from Company X who have indicated experiencing a particular subtheme within their teams.

4.4.1. Theme 1: Digital Healthcare Industry and Work Environment

Relevance of Theme: This theme is essential to the study as it provides insight into the participants' views on the digital healthcare industry and the environment in which their teams currently operate. Understanding the participants' views on these areas provided the foundation for understanding the challenges encountered in their current methodology as well as their beliefs on how a new methodology would impact their work environment.

In the interview, 24 participants were asked to describe the digital healthcare industry and Company X's working environment. The researcher generated the subthemes from the answers

given below due to the frequency with which specific codes were generated from the interview transcripts.

The subthemes generated are the following:

i) Fast-paced, demanding, risky, competitive, and driven.

ii) Innovation and experimentation.

iii) Evolving customer needs, Growth, opportunity, Delivery, and impact on Client expectations

iv) Business returns over quality

v) Changing Market and Technology, Specialisation, and Skills.

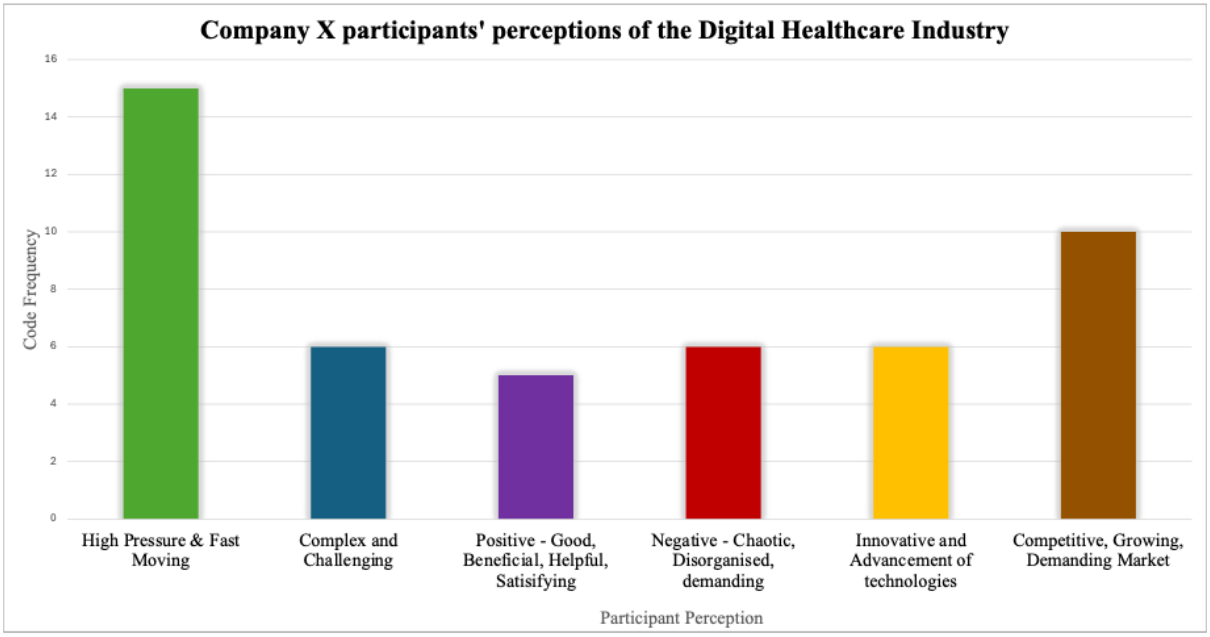


Figure 4.2: Company X participants' perceptions of the Digital Healthcare Industry

In Figure 4.2, most participants indicated that the Digital Healthcare Industry is high-pressure and fast-moving, followed by being competitive and having a growth market. The figure also shows that there was an equal frequency of perception among the participants that the industry is complex, challenging, and innovative. Additionally, some participants perceived the industry negatively, using codes/answers such as chaotic, disorganised, demanding, and unfair. The least mentions were made by participants of the digital healthcare industry being perceived as positive, where this perception was linked to codes/answers such as good, helpful, satisfying, and beneficial.

a) Sub-theme 1-1: Fast-paced, demanding, risky, competitive, and driven.

A common thought raised by most of the participants is the working pace and pressure of the digital healthcare industry. Participants noted that the industry is rapidly evolving and highly pressured.

Interpretation: This observation provides some insight into the industry's working environment. It shows that a suitable working process should allow digital products to be rolled out rapidly to customers in order to gain a competitive advantage.

Table 4.2.1: Subtheme 1-1: Supporting Quotes from Participant Transcripts from Team A

Team	Supporting Quotes from Participant Transcripts
A	*DEV_1 - "And I also feel that based off of, you know, what we are trying to achieve, especially in terms of goals, you know, market competitiveness, that sort of thing, it's really you have to be on your toes 24/7, there's not just one particular way of working that I think you know applies to our space... And I feel that it's quite revolutionary in that sense."* *BA_3 – "No, The thing also depends on the time of year, and, to be honest, usually the environment is fast-moving, and sometimes the deadlines will be ridiculously tight, especially if it's like an R&D project with high-pressure deadlines."* *DEV_2 - "The working environment can be filled with a lot of pressure, or sometimes, just because of the nature of the work, a lot of people depend on some of the services that we provide. Therefore, there is a lot of strain to ensure that everything runs smoothly and gets done in time just because of the reliance on it."* *DM_2 - "And I think that in itself, it spells challenges on all the development teams to come up with ways to deliver, get to the market sooner, and show that value that we add, and it's in every step."* *TA_1 - "So, from my little experience here, I realise that it's a very rapidly changing environment; obviously, the work that we produce here is quite rapid. "*

	TA_2 - "they are very strict on timelines." *BA_2 -"You know we are chasing something because we want to be the first people to do it to market in the digital health space."* *BA_3 - "And we need to keep up with the times if we're going to remain relevant and engaged with our client base. Granted, we also need to cater to various populations. Like if you think about the young versus the old."* *DEV_1 - "And I also feel that based off of, you know, what we are trying to achieve, especially in terms of goals, you know, market competitiveness, that sort of thing, it's really you have to be on your toes 24/7, there's not just one particular way of working that I think you know applies to our space... And I feel that it's quite revolutionary in that sense."* *DEV_5 - "• Cutting edge and very fast-paced."*

Table 4.2.2: Subtheme 1-1: Supporting Quotes from Participant Transcripts from Team B

Team	Supporting Quotes from Participant Transcripts
B	*BA_1 - "It's very fast-paced, I agree. Yeah, because I think you know. More products get introduced more frequently, and I guess that's based on what it is that they see from the markets and all of that. And you know, because we do want to be, you know, the best medical service thing out there, we will always try to make sure that we. Get those enhancements over the line and just be the you know."*

Table 4.2.3: Subtheme 1-1: Supporting Quotes from Participant Transcripts from Team C

Team	Supporting Quotes from Participant Transcripts
C	*DPO - "It's a funny thing cause fast pace is, I guess, how you would describe it if you like coming from the outside in. But this is the pace at which we work, and we're accustomed to working at, so it's quite fast-paced."*

Table 4.2.4: Subtheme 1-1: Supporting Quotes from Participant Transcripts from Team D

Team	Supporting Quotes from Participant Transcripts
D	*DEV_7 - "So it's, yeah, a very complex environment actually and very competitive."*

	DEV_8 - "I think there can be pressure at times just because of our competitive market, and we've certainly seen that with the products we take to market... *There's been a lot of, like, compromises and rough deadlines because they're trying to be competitive in the space, and then obviously that's sort of.. there's back pressure on the teams for that, which you know, you obviously want to try and mitigate as much as possible."* *DEV_9 - " I'd say one thing that never changes is the pace. It's rapid; it's ever-changing."* *DEV_10 - "That's a fast pace and also like comfortable.."* *DEV_7 - "it is quite a competitive industry."* *DEV_8 - "Yeah, it's also pretty competitive, you know, competitive,"*

Table 4.2.5: Subtheme 1-1: Supporting Quotes from Participant Transcripts from No Team

Team	Supporting Quotes from Participant Transcripts
N/A	*ARC_1 - "OK, so let's suppose the technical level. So, I think from a technical perspective, it's nice, challenging, and cool with all the things we do. From a management perspective, I think it's very high pressure, very strict, or like impossible deadlines that we need to meet, and then I think that's about it."*

Discussion: Stakeholders within these software development teams also need to be driven to rapidly push out digital products of the best possible quality. The balance between quality and speed may be challenging. Therefore, it is important that the SDLC methodology not only caters to rapid rollout but also to the quality assurance of these products. Emphasis also needs to be placed on the maintenance phase of the SDLC lifecycle in the digital healthcare industry, as with rolling out products rapidly to clients, there will be some level of maintenance and continuous improvement that would be required as there are always bugs and defects that would be picked up after products are released to the market. However, it is important to ensure

that when these defects have been identified, the team has a suitable maintenance/defect management process in place to rectify defects and deploy fixes as soon as possible.

b) Subtheme 1-2: Innovation and experimentation

A few participants from Team C and D made an alternative observation of the digital healthcare industry, describing it as innovative and supportive of experimentation. This is shown in tables

Table 4.3.1: Subtheme 1-2: Supporting Quotes from Participant Transcripts from Team C

Team	Supporting Quotes from Participant Transcripts
C	*DM_4 - "So yeah, so fast-paced, innovative, and busy…* *And yes, I think trend-setting if that's yeah, if that makes sense. So we're doing a lot of new stuff, which was really cool and exciting."* *DPO_1 - "I think it's really dynamic in the sense that on most days, no two days are the same...* *I also think that the environment is quite supportive of your experimenting, which I always find refreshing.* *So, a relatively fast pace allows for exploration and experimentation, which I think is good. Then, I think it supports the three main themes."*

Table 4.3.2: Subtheme 1-2: Supporting Quotes from Participant Transcripts from Team D

Team	Supporting Quotes from Participant Transcripts
D	*DEV_7 - "So yes, that's it. Drives a lot of a lot of rapid delivery and rapid innovation."*

Table 4.3.3: Subtheme 1-2: Supporting Quotes from Participant Transcripts from No Team

Team	Supporting Quotes from Participant Transcripts
N/A	*DM_3 - "So all of those become quite critical to build, you know, the broader system, as I would call it, the third part. I think it's rapidly evolving and quite exciting. And then I think the fifth one is it's the method really invested in an expensive to innovate."*

Discussion: This observation of the industry is profound as it describes how the way of working in developing digital healthcare products should allow a level of innovation and experimentation. Therefore, to some degree, the standards and processes that previous software development methodologies have defined should be adhered to. However, an aspect of the software development methodology should allow stakeholders to experiment with new technologies and processes in the delivery of these digital products.

c) Subtheme 1-3: Evolving customer needs, Growth, opportunity, Delivery, and impact on Client expectations

A couple of participants also explained how the digital healthcare industry has evolving customer needs. The need that the customers had yesterday might not be the same need that the customers require tomorrow. As a result, the industry is everchanging and rapidly growing. This is shown in Tables

Table 4.4: Subtheme 1-3: Supporting Quotes from Participant Transcripts from Team A

Team	Supporting Quotes from Participant Transcripts
A	*DM_2 - "So healthcare in itself is almost moving between being either a necessity or a luxury item to have, and if you think about it that way, when people do have healthcare, they want to engage with healthcare…* *With that being said and the market demanding more from us, I think there's a lot of innovation, a lot of opportunity. I think the working environment is more pressured than before COVID."* *• I would say, like any work in general, there are opportunities everywhere, but it depends on the individual to actually be ambitious enough to take those opportunities.* *The digital healthcare environment has evolved over the last two years; we are looking at a time when people want to be more aware of what they're getting for the money that they are spending.*

	• The market is pressing people with higher fuel prices, interest rates, other necessities, inflation, and other necessities that people need in their lives. So healthcare in itself is almost moving between being either a necessity or a luxury item to have, and if you think about it that way, when people do have healthcare, they want to engage with healthcare. *So, the digital aspect of that engagement has also grown tremendously over the last two years, especially after COVID, making people more aware of what benefits and coverage they have from a healthcare perspective.* *• With that being said and the market demanding more from us, I think there's a lot of innovation, a lot of opportunity. I think the working environment is more pressured than before COVID. I think there is more pressure on us to deliver the right things at the right time to ensure our customers are engaged, that we don't have lapses in any products and that we offer them value for money.* *• And I think that in itself, it spells challenges on all the development teams to come up with ways to deliver, get to the market sooner, and show that value that we add, and it's in every step. I mean, you can't just launch your product without understanding the end-to-end value chain of what it takes. So I think everyone across the different skill sets within it needs to come together to actually deliver that value for the member with the member in mind. It's more keen now than it was ever before.* *TA_2 - "Very highly expected of us. So we do have to sometimes set up meetings with them to make them also understand what we have to go through and how the stages work so we can provide a more valuable and quality assurance product."*

Discussion: With the needs of the customers growing and changing, as highlighted in the previous sub-themes, the methodology utilised to deliver these products should allow for fast delivery. However, to keep up to date with clients and their needs, communication is essential. Software development teams need to ensure that the manner in which they develop their digital products allows for sufficient communication and feedback throughout the various stages to

ensure that customers' needs are met. As a result, the analysis and planning stages of the SDLC methodology are essential in this aspect, as research and planning need to be conducted to ensure that the delivered product meets clients' expectations as well as provides a competitive advantage in the market.

Interpretation: This, in turn, also allows for increased opportunity and growth in the industry. It allows companies in the digital healthcare space to develop various products to cater to various healthcare needs. This will allow these companies to integrate into newer target markets by providing a product offering that other companies have not offered. With increased opportunity and growth in the industry, there will also be an increase in client expectations in the quality and delivery of these digital products. It is also essential for software development teams in this space to ensure that their deployment and testing processes are conducted at a level where they will meet client expectations.

d) Subtheme 1-4: Business returns over quality

On the topic of client expectations, one of the participants noted that there seems to be more of a focus placed on a business return/value perspective to ensure that the customer or business unit is satisfied with the various aspects of the delivery, such as speed and the number of features, while the quality of the overall product becomes a trade-off.

Table 4.5: Subtheme 1-4: Supporting Quotes from Participant Transcripts from Team A

Team	Supporting Quotes from Participant Transcripts
A	*DEV_4 - "It feels like there's more focus on the business aspect in business return as opposed to from a technical perspective. If we had said no takes, it would have taken a week to code something because we want to follow TDD and best practices... We will be forced to complete it within two days or three days; granted, we tell the business unit it's going to take a week because we're writing tests to make sure we follow the best coding practices and standards."*

Discussion: In an industry where the quality of the digital product produced not only impacts the satisfaction of the client but also impacts the client's health and well-being, it is essential that the quality of the product is adhered to from a technical perspective. Therefore, the software methodology utilised needs to enforce a level of technical practices in the

development phase to ensure that the quality of the code is of a high standard. This will not only reduce the number of defects and bugs identified after release but also ensure that the quality assurance processes meet the required standards.

e) Subtheme 1-5: Changing Market and Technology, Specialisation, and Skills.

Various participants have noted that the digital healthcare industry encourages the adoption of new technologies due to the changing market. Many competitive companies in the industry are finding new and unique ways to provide a competitive advantage to their customers. Also, the technology landscape has grown in recent years. Therefore, if companies in this industry do not improve their technology stack, the manner in which they process information and deliver digital products will become outdated. If not managed correctly, it can lead to customers moving to competitive products.

The participants also described how the digital healthcare industry has become specialised in terms of the skills various stakeholders and teams are required to have to produce various products. This also ties into the point of changing technology.

Table 4.6.1: Subtheme 1-5: Supporting Quotes from Participant Transcripts from Team A

Team	Supporting Quotes from Participant Transcripts
A	*DEV_1 - "I think to break it down in terms of where we kind of operate in, well, I feel that we work within the obviously the software industry, but on top of that, going more specialised specifically in the health industry, and I feel that that comes with its own set of challenges."*

Table 4.6.2: Subtheme 1-5: Supporting Quotes from Participant Transcripts from Team B

Team	Supporting Quotes from Participant Transcripts
B	*DM_1 - " love to be, you know, working in the back-end environment. So the technology I find very interesting. But what I also enjoy about Digital Healthcare is the fact that you're not just limited to technology or to a very, very narrow space that you're working in; you tend to work with a lot of new technologies, a lot of new people, a lot of new external parties and that blend of the force changing technology, the very interesting and complex technology, but also the need for interacting with people and different people from different organizations."*

Table 4.6.3: Subtheme 1-5: Supporting Quotes from Participant Transcripts from No Team

Team	Supporting Quotes from Participant Transcripts
N/A	*DM_3 - "So that's the first one, and I think the second part is fairly complex. I'll talk about complexity from a number of issues. Number one is that technology and the technology stacks are becoming more and more integrated. So what I mean by that is it's not just a combination of hardware and software, but it's hardware. It's software, it's processes, it's wearables, and it's connected with your network."*

Discussion: It is important for stakeholders in these teams to understand that an important part of the SDLC is continuous improvement both on the level of a product and from an individual perspective. Continuous improvement at an individual level goes beyond formal education and training. It also includes learning from other team members who excel in certain areas to ensure that the final product meets all expectations. For software development teams, it is essential to constantly explore ways to provide the most business value to the customer. This can be achieved by offering after-sales support and features that enhance the user experience and member journey.

Conclusion of Theme 1:

Based on the answers provided by the participants, due to the nature of the Digital Healthcare Industry and the working environment of Company X, the methodology used by Company X needs to be flexible. The flexibility of the methodology used in the digital healthcare environment is very important as the growth of technology and market competitiveness needs to be catered to in the way of working to allow for these types of demands to be met. For Team A and, eventually, Company X not to experience the current issue of having an outdated methodology, the methodology needs to have a continuous improvement approach to allow the methodology to adapt to new ways of working in the industry as well as to market trends.

Further details on the subthemes and answers provided are shown in Appendix H.

4.4.2. Theme 2: Communication and Collaboration with Business and External Clients

Relevance of Theme: This theme is essential to the research study as it provides insight into the participants' relationship and communication with customers in the digital healthcare industry. Understanding the participants' experience in these areas will provide some insight into understanding the challenges encountered in their current methodology as well as the specific phase or area in which certain challenges arise with these stakeholders.

In the interview, 24 participants were asked to describe their relationships with business stakeholders and external third-party clients. The researcher generated the subthemes below from the answers given due to the frequency with which certain codes were generated from the interview transcripts. Additional quotes to support the subthemes below are shown in Appendix H.

The subthemes generated are the following:

i) Positive, Supportive Stakeholders, Open and Transparent Communication
ii) Challenges with Stakeholders
iii) Varying Levels of Involvement and Understanding
iv) Misaligned Priorities and Vision

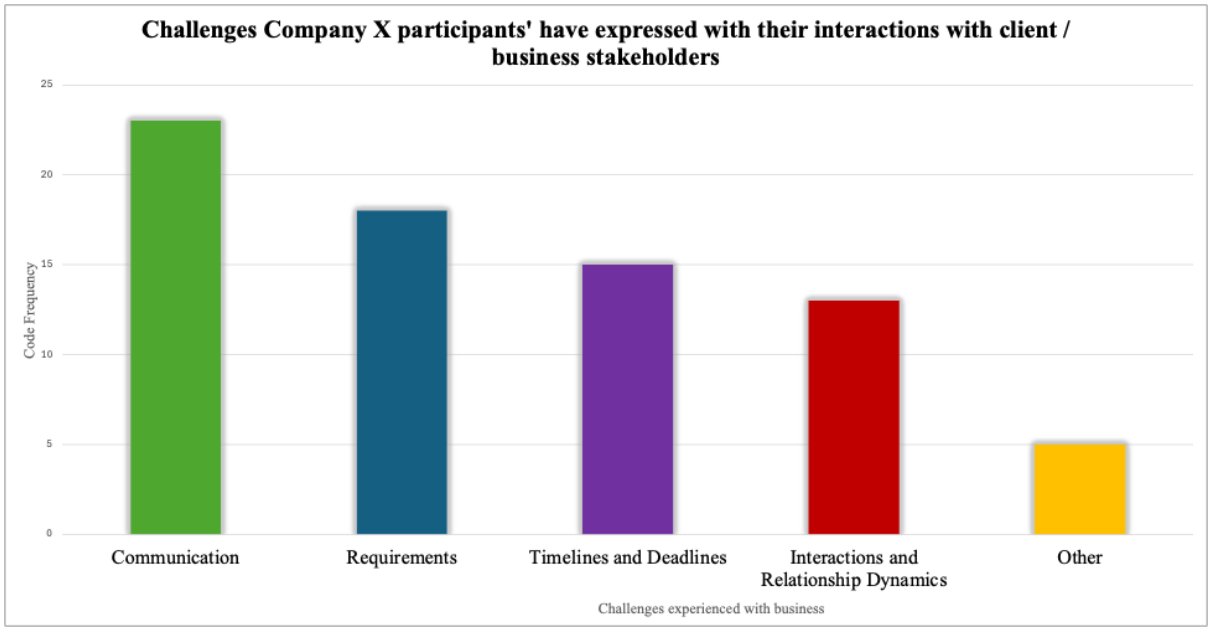


Figure 4.3: Challenges Company X participants' have expressed with their interactions with client/business stakeholders

In Figure 4.3, the data indicates that a significant number of participants have identified communication as the most prevalent issue in their interactions with business/client stakeholders. This finding underlines the critical role of effective communication in project

management and stakeholder engagement. Furthermore, the data reveals that the second most prominent challenge pertains to requirements. This includes issues such as changing requirements, ill-informed requirements, unrealistic expectations, isolated requirements, and unclear specifications due to a lack of clarity from the business regarding the purpose of the product/service.

The median concern identified by participants is related to timelines and deadlines. The feedback suggests that unrealistic and short deadlines are common within their business and client interactions. Moreover, there is a perceived lack of understanding about the amount of time required to deliver specific deliverables. Participants have also expressed that challenges related to their relationship dynamics with business stakeholders, such as trust, conflict, lack of patience, and inconsistent feedback, are not as prevalent as communication. This insight sheds light on the areas where improvements in stakeholder relationships and communication can yield significant benefits in project execution and delivery.

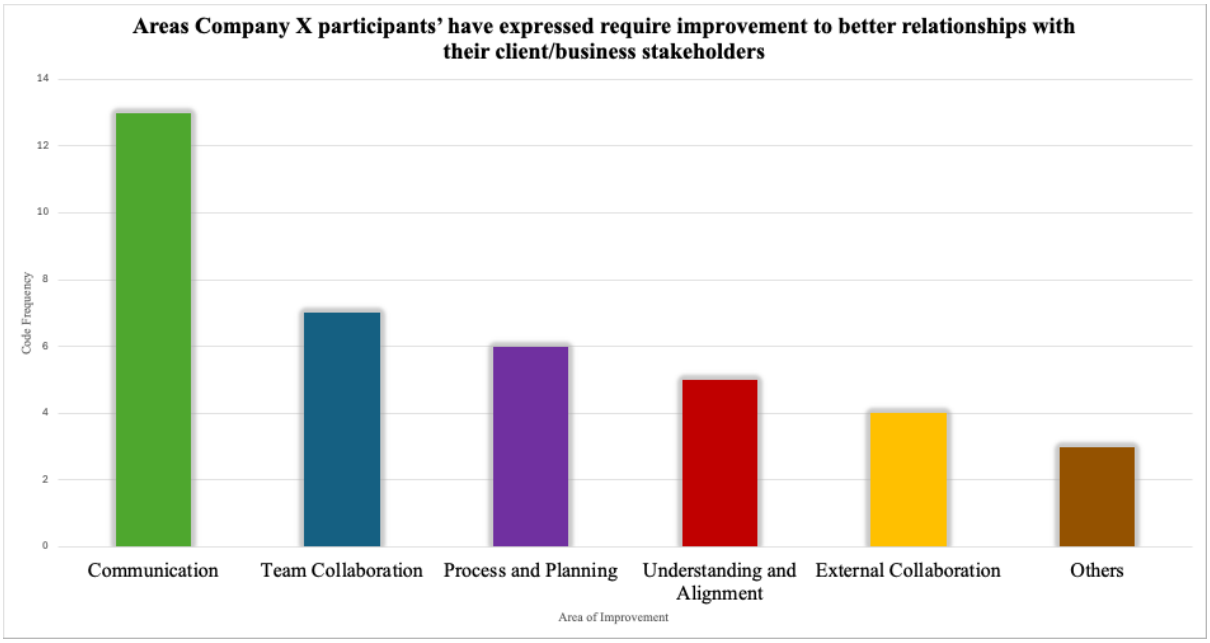


Figure 4.4: Areas Company X participants' have expressed require improvement to better relationships with their client/business stakeholders

As a result of the challenges expressed by the participants in dealing with client/business stakeholders, Figure 4.4 illustrates the areas that the participants have identified as needing improvement in their relationship with business stakeholders. The majority of the participants have identified communication as a key solution. This was further explained in the interviews, emphasising the need to articulate requirements better, provide sufficient time for review, focus on common goals, discuss and clarify any uncertainties, and establish processes and standards

for feedback at various stages of the project lifecycle within specific time frames to prevent scope creep. A significant portion of participants also highlighted team collaboration as a favoured solution. They emphasised the inclusion of both technical and non-technical team members, such as developers and test analysts, in business meetings and discussions to contribute to topics that may impact their role in the project lifecycle.

Additionally, participants stressed the importance of increased collaboration between business stakeholders and the development team, emphasising the need for patience and accountability. Less common responses included improving planning and establishing processes, such as managing time more efficiently, assigning product owners, and allowing architects to propose high-level solutions before project development begins to ensure effective project delivery. A few participants also noted the importance of understanding and alignment, emphasising the need for all parties to listen to each other to ensure a clear understanding among all stakeholders. They also stressed the importance of involving business stakeholders early in the project, rather than during the final stages when artifacts and testing need to be signed off. Clear documentation, clarification, and understanding of all requirements by all stakeholders prior to development were also highlighted to prevent rework.

Finally, some participants mentioned ways to improve the relationship with third-party and external clients, such as researching the best third-party vendors to partner with, understanding the product offerings of third-party vendors, validating the offerings of external partners compared to Company X, transparency, building trust, and involving technical stakeholders and team members in discussions with third-party vendors earlier in the project.

a) Subtheme 2-1: Positive, Supportive Stakeholders, Open and Transparent Communication

Tables 4.7.1 – 4.7.5 presented in this subtheme provide extracts from the semi-structured interviews where the majority of the stakeholders advised that their team has positive and supportive relationships with business stakeholders, whereas some describe the relationship as close and honest as it supports the overall goal and objective of the project.

Table 4.7.1: Subtheme 2-1: Supporting Quotes from Participant Transcripts from Team A

Team	Supporting Quotes from Participant Transcripts

A	*TA_1 - "So I think we have quite an up-front relationship when it comes to business. Often, we do when we get emails from the business or ask for follow-ups; the team is quite responsive in that sense, so from my perspective, it seems like the team and business have quite a good relationship and quite a responsive relationship. So a lot of that good communication goes into that between the business and us as well as the internal clients."* *DEV_6 - "I'll describe it as a good relationship."* *DEV_2 - "So I think their relationship is decent because we do seem to output a good amount of work for them to trust our opinion."* *DEV_1 - "So yeah, I believe we do have quite a good relationship with them."* *BA_5 - "So I think from my point of view, my experience, BAs are pretty solid in having that relationship with the business owners."* *BA_2 - "I think we are very good with that; in the space, you know, the business area is very good, and I think there's a mutual respect, you know, for what we can do and how we can help them."*

Table 4.7.2: Subtheme 2-1: Supporting Quotes from Participant Transcripts from Team B

Team	**Supporting Quotes from Participant Transcripts**
B	*DM_1 - "Then you are working with external providers again; you tend to make assumptions on what people should know and how technologically enabled they should be. But if we're often mistaken with that, we are surprised. Time and time again, by the types of questions that we have to answer and all the types of things that we have to make clear.* *So I think what I've learned is never to assume that somebody understands something or that they've got it; they'd always rather overcommunicate than communicate. That is kind of a principle that we're trying to instill within our team."*

	BA_1 - "There also needs to be a kind of a good working relationship, and also I feel like there needs to be a well we just also need to understand one another cause there would be some cases where we won't be able to implement the changes that they want and I guess they kind of need to understand why we can't do that."

Table 4.7.3: Subtheme 2-1: Supporting Quotes from Participant Transcripts from Team C

Team	Supporting Quotes from Participant Transcripts
C	*DM_4 - "I think they have good relationships with the business stakeholders. They work quite closely together, so those relationships are key."*

Table 4.7.4: Subtheme 2-1: Supporting Quotes from Participant Transcripts from Team D

Team	Supporting Quotes from Participant Transcripts
D	*DEV_10 - "I'd say the relationship is pretty good."* *DEV_9 - " love it, and the people are always really great.* *• They're very nice.* *• The meetings are pleasant."* *DEV_8 - "I think the people have something to do with it too, you know, like the stakeholders that we dealt with, they are very amenable. You can have a conversation with them."* *DEV_7 - "I believe stronger than you would get, so you would expect like we've had very close, very close relations with business since the beginning."* *BA_6 - " I think it's well,"* *BA_3 - "it also depends on the business stakeholders. In my experience, most of our relationships with business stakeholders are very good because our team is honest; we don't play games and give them the information."*

	DEV_8 - "We can be honest with each other, and I think that helps a lot. So we obviously have a united front when it comes to, you know, dealing with and integrating with partners and working with partners and stuff like that. I think that helps, as well. It's not an us versus them mentality per se, but it feels like we are part of a greater team."

Table 4.7.5: Subtheme 2-1: Supporting Quotes from Participant Transcripts from No Team

Team	Supporting Quotes from Participant Transcripts
N/A	ARC_1 - "I think it's pretty good."

Interpretation: Participants from various teams that deal with external/third-party providers highlighted the significance of building strong relationships with their business stakeholders. They pointed out that such relationships play a crucial role in providing a united front during the negotiation and planning phase with external stakeholders. The participants emphasised that having a unified voice and shared objectives between internal and external stakeholders can help in achieving favourable outcomes in negotiations.

Discussion: In a highly competitive software development industry, building strong relationships with business stakeholders is crucial. This helps the development team to receive the necessary support from a client's perspective. Under the pressure of fast-paced competition, development teams are expected to deliver products quickly while maintaining high code quality and performance. Having supportive stakeholders breaks down perceived silos between the business and development teams, fostering a sense of collaboration. Open communication channels between these two sides allow for the expression of any difficulties or challenges, which builds trust. Trust, in turn, enables stakeholders to work together effectively towards a common goal, going above and beyond expectations.

b) Subthemes 2-2: Challenges with Stakeholders

The participants of this research study noted a plethora of challenges experienced by business stakeholders. Different teams experience a certain level of challenges with their business stakeholders based on their way of working and the products that they are responsible for producing.

The most common challenges noted are the following: managing expectations, poor communication and scope creep.

Table 4.8.1: Subtheme 2-2: Supporting Quotes from Participant Transcripts from Team A

Team	Supporting Quotes from Participant Transcripts
A	*TA_2 - "Sometimes business would give us something totally ridiculous, like the other day I had this specific project… you were given just scenarios that the business would list out, and you are expected to follow those scenarios without CRS in place, so it's not even the requirements phase as yet. There would be no documentation at all, and they would expect you to come up with scenarios based on the gibberish that they wrote, so that's one of the that's happened twice, actually."* *DM_2 - "I've witnessed it before; I think with a third party, like one of my team members, I got very irritated with the lack of understanding from the third party that we were integrating with, and rightfully so."* *BA_5 - " It's very difficult to get time from the business owners, and that creates a blocker for me, but also that unfamiliarity with the business owner that you are going to engage with and that you need a lot of answers from that."* *BA_4 - "• So as much as we can get irritated with certain aspects at the end of the day like I always say, there's a client at the end of the line, so we need to put our differences aside at most times, but I find that they are individuals that cannot separate the two."* *BA_3 - "It also depends on who you work with, especially with some other projects. They'll document stuff, and they'll sign it off, but the requirements keep on changing that. We will set in external team meetings, and things will bring up a brand new requirement that was never in the concept documents, which was never discussed. Then, I mean, you can't discuss it in front of third parties, right?"*

	BA_2 - " I think with a particular business, they tend to get frustrated easily. They are condescendingly impatient. And they will escalate you. Every hour of every day, you know, if you don't if you don't send a response to an email that they've sent." *BA_3 - "But then sometimes you get difficult stakeholders because the stakeholders weren't very helpful and don't share information."*

Table 4.8.2: Subtheme 2-2: Supporting Quotes from Participant Transcripts from Team B

Team	**Supporting Quotes from Participant Transcripts**
B	*DM_1 - "• With business, internal business, I would say there's often a bit of a disconnect between what is promised and what can reasonably be delivered in a reasonable time. It feels like there are promises made before a reality check is done. And I mean, this is a common problem, and we're trying to work towards solving it and getting better at it. But systems need to be more ingrained in the consultation capacity when concepts are being devised from the start, and then win-win; it's cool.* *• In negotiations or done with third parties and when ideas are hatched, systems should be inserted in there fairly soon and earlier. So that's something that I think can be done differently. Oftentimes, a business comes up with an idea that is sold to executive management, and it's not really feasible in the way that it was promised, so it's a big challenge there.* *• Then you are working with external providers again; you tend to make assumptions on what people should know and how technologically enabled they should be. But if we're often mistaken with that, we are surprised. Time and time again, by the types of questions that we have to answer and all the types of things that we have to make clear.* *So I think what I've learned is never to assume that somebody understands something or that they've got it; they'd always rather overcommunicate than communicate. That is kind of a principle that we're trying to instill within our team."* *DM_1 - "In negotiations or done with third parties and when ideas are hatched, systems should be inserted in there fairly soon and earlier. So that's something that*

	I think can be done differently. Oftentimes, a business comes up with an idea that is sold to executive management, and it's not really feasible in the way that it was promised, so it's a big challenge there." *BA_1 - "when requirements are not properly ironed out by business, that causes a lot of, I guess, but it's a challenge."*

Table 4.8.3: Subtheme 2-2: Supporting Quotes from Participant Transcripts from Team C

Team	Supporting Quotes from Participant Transcripts
C	*DPO - "OK, so my team overall, I think one of the things that, and having had been on the outside, having been in a business space, I think that sometimes the communication maybe could make a business owner anxious. In the way in which we kind of tell them where we are or what we're doing about a particular task or whatever the case is, I think that could create some anxiety. I think that there is a lot of trust, though, which is kind of like, I guess, a contradiction if you are not really communicating well; how is the trust?"* *DM_4 - " Yes, so there have been cases where the business signed off specs and signed off designs, etc, and then something completely different was implemented. So that has damaged that relationship a little bit, but I must say that the business stakeholder was very understanding about it."* *DPO_1 - "and then I think from a business perspective, the challenge is that and I used to experience this when I was in business is like when things are being kind of communicated from systems to business perspective, it's quite technical and complex to understand.* *• And so it leaves you in a difficult position to make decisions on what should go first or what shouldn't go first, right?* *• And then, a lot of times, these systems teams rely on the business team to inform the requirements, whereas the business teams are looking for the systems teams to help them develop their requirement.*

	• *So there's kind of like this tension in that space to say, well, this is what I want, this is what I wanted to do."*

Table 4.8.4: Subtheme 2-2: Supporting Quotes from Participant Transcripts from No Team

Team	Supporting Quotes from Participant Transcripts
N/A	*DM_3 - "The mandates are not necessarily equivalent, and so it becomes, you know, quite a challenge sometimes to manage expectations both internally and externally and to coordinate delivery that actually depends on certain items happening in an orchestrator or coordinated manner, so that is kind of some of the big challenges we've seen...* *And then I think obviously the cost challenges, that was always things that are there and those play hand in hand with the then you want to lack predictability with building new things."* *ARC_1 - "responsiveness to the questions being asked."*

Interpretation: Based on the transcripts, it is evident that all participants, regardless of their team or methodology, face challenges when it comes to business interactions. This indicates that no methodology is perfect in completely mitigating challenges. However, a good methodology should have a principle in place to cater to unforeseen challenges that arise unexpectedly. This also highlights the importance of good stakeholder management techniques, which can be used to ensure that open communication is present while managing expectations appropriately.

Discussion: It is crucial for project stakeholders to establish a good relationship and maintain effective communication with their customers or business stakeholders, as feedback is vital to ensuring that the project stays on track. Based on the interviews conducted, it appears that many issues related to scope creep and lack of requirements stem from broken or insufficient communication. From the discussions, it is evident that when there is constant communication and stakeholder involvement from the beginning of the project, the common challenges are significantly reduced.

c) Subtheme 2-3: Varying Levels of Involvement and Understanding

An interesting observation noted by a few of the participants is that there is a lack of familiarity from both a business and system perspective. The business stakeholders are not quite familiar with the processes that the software development teams follow in order to deliver and build digital products. The same is true for the systems teams; the systems development teams are also not quite familiar with the processes that the business stakeholders need to take to ensure that software features are communicated effectively to the users, as well as the costing, partnerships, and agreements involved in collaborating with external providers.

Table 4.9.1: Subtheme 2-3: Supporting Quotes from Participant Transcripts from Team A

Team	Supporting Quotes from Participant Transcripts
A	*DEV_5 - "So obviously, from a business perspective, they'd ask for something, but they have no idea what the architecture will actually allow. If everybody's in the same meeting, they can raise that they want us the dev…* *• It's not that business is unrealistic with their requirements; it's that they don't understand that this thing can't be built that way."* *DPO_1 - "OK, so I think the biggest challenge from a systems perspective that I've experienced is like the business doesn't know what they want, and they want everything. So if you offer them something, they will want it because it sounds good; they will if you just say, OK, well, we could; what about if you consider this as that and that, yes, we want that?"* *DPO_1 - "The business teams aren't really able to answer those sorts of questions. So it makes it a little bit challenging"*

Table 4.9.2: Subtheme 2-3: Supporting Quotes from Participant Transcripts from Team D

Team	Supporting Quotes from Participant Transcripts
D	*DEV_9 - " Sometimes, you need to go the extra mile where they don't have the ability to necessarily do what they need to do on their end for us. So then we have to*

	reprioritise again and kind of do that extra mile work to accommodate for them. Sitting in the sessions,"

Table 4.9.3: Subtheme 2-3: Supporting Quotes from Participant Transcripts from No Team

Team	Supporting Quotes from Participant Transcripts
N/A	*DM_3 - "The second one, I think, is a lack of familiarity around both business processes, which I've kind of described earlier, The second one, I think, is a lack of familiarity around both business processes, which I've kind of described earlier"* *DM_3 -"There's a there's a gap in understanding both from a business perspective around what the technology is, how hard a potential solution would work, what it could look like, and also the, I guess, the costs, the time to implement, and the risk thereof."*

Discussion: It has been observed that some stakeholders in a project may not be willing to participate in aspects that do not directly concern them, or they may not be informed of challenges when they arise. This issue is related to communication between business and systems teams, just like the previous discussion on subthemes. There is a disconnect or a wall between the two sides, and there is no open communication that can allow both sides to become more involved in certain aspects of the project. One of the participants also pointed out that businesses may not understand the technical language that the systems teams use, which makes it harder for them to get involved in the project. Similarly, systems teams may not use simpler terms to enable businesses to understand the technical language and processes. As both sides do not understand each other, it creates a lack of involvement, which can lead to a lack of ownership.

d) Subtheme 2-4: Misaligned Priorities and Vision

This subtheme is a symptom of subthemes 2-3, as due to a lack of involvement and understanding of processes from both a business and system perspective, priorities become misaligned, as well as the vision of the overall product. A few participants have noted that there are some gaps and missing information related to the objectives, motivations and goals of the project.

Table 4.10.1: Subtheme 2-4: Supporting Quotes from Participant Transcripts from Team A

Team	Supporting Quotes from Participant Transcripts
A	DEV_2 - "I think there's a disconnect sometimes between maybe product owners and certain stakeholders. They, I mean, aren't always extremely involved, and some of them aren't very well learned around certain topics or certain products that we play a big part in. So maybe the expectations are a bit skewed, or knowledge is just not to scratch all the time." BA_4 - "It's also building things that don't yield the result that was anticipated, and there's no recourse for it, if you get what I mean. It's just wasted time and money. • Understanding what is required within the market and also sometimes making decisions based on statistics and not umm. • Its concepts are not really thought through properly or accurately" BA_3 - "as they then go through the thinking process, they'll somewhere start changing their minds on stuff, which is quite frustrating, right, because we're trying to bed down the requirements, and then the next day, it will be something totally else. "

Table 4.10.2: Subtheme 2-4: Supporting Quotes from Participant Transcripts from Team C

Team	Supporting Quotes from Participant Transcripts
C	DPO_1 - "So sometimes I think from a business side there could be a misalignment with the objectives, and explaining that to a systems team is difficult to understand because there are 100 things you want us to do and everything you want us to do; we need to deliver it in a short space all that time and quality, which is not very practical, right?"

Table 4.10.3: Subtheme 2-4: Supporting Quotes from Participant Transcripts from Team D

Team	Supporting Quotes from Participant Transcripts

D	DEV_10 - "That includes scope creep, and you can also add the realigning of priorities. Something is important and needs to be done, and then once you do the analysis, that no, this needs to be done." DEV_9 - "Sometimes, you need to go the extra mile where they don't have the ability to necessarily do what they need to do on their end for us. So then we have to reprioritise again and kind of do that extra mile work to accommodate for them. Sitting in the sessions," BA_6 - "Business has like different business units. So, at times, they want different things. So, at times, we get that degree requirement from this certain business unit, and then when it reaches another business unit, they wanted in a different way. So I think that has been like a challenge for us where, like, we have a lot of like scope creep, and that comes into a requirement because, like, there are different people that run different things, and we can't get to like a resolution."

Table 4.10.4: Subtheme 2-4: Supporting Quotes from Participant Transcripts from No Team

Team	**Supporting Quotes from Participant Transcripts**
N/A	DM_3 - "And on the flip side, I would say there's also not necessarily a complete awareness of the risk factors, the business motivations, and some of the rationale. • So part of the work we have to do is really to close those gaps because once you know, once everyone is clear about what's trying to be accomplished, it removes a lot of those. That's the one."

Interpretation: Without the systems teams understanding the product's objectives, overall rationale, and associated risks, it is difficult for the team to ensure that their tasks and priorities align with those of the business stakeholders.

Discussion: It is important to understand that each person will have their own priorities, which are shaped by their environment or circumstances. From the transcripts, business priorities are based on factors or issues that directly affect them. The same can be said for the systems team,

where their priority is based on the technical aspects of developing the digital healthcare product. As discussed earlier, a lack of communication leads to a lack of involvement, which can result in misaligned vision and priorities. Therefore, it is essential for both parties to ensure that there is an open line of communication. It is crucial that both sides discuss the vision and list of priorities. At the end of the day, the end-user of the digital healthcare product will be the one who is affected by any issues that arise during the development phase and may carry over into production.

Conclusion of Theme 2:
From the answers provided by the participants, it is essential for all software development teams to have open and honest communication with the business stakeholders. Without constant, open, and honest communication, it is harder for the systems teams to align their priorities with business and ensure that the digital product delivers the utmost business value. The improvement of communication can be supported from both a team culture perspective as well as from a methodology perspective. Company X needs to enhance their methodology to encourage constant communication at multiple steps/phases of the project to ensure that both sides are in constant agreement on what is expected, as well as the processes that are being followed to ensure the successful delivery of the digital healthcare product.

4.4.3. Theme 3: Team Culture and Relationships.

Relevance of Theme: This theme is essential to the study as it provides insight into the participants' synergy with members within their team and even broader teams. Understanding the participants' experience in these areas will provide some insight into the importance of team culture and relationships in delivering digital products.
In the interview, participants were asked to describe their team culture and relationships with members of their immediate teams. The researcher generated the subthemes below from the answers provided in the interviews.

Further details on the subthemes and answers provided are shown in Appendix H.

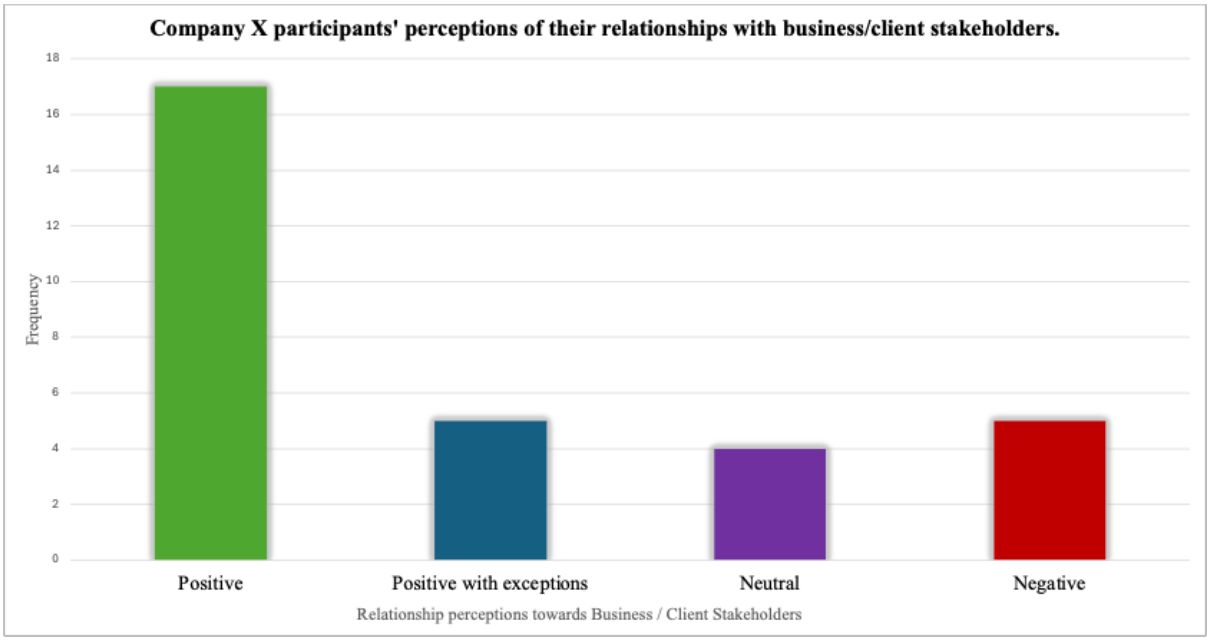


Figure 4.5: Company X participants' perceptions of their relationships with business/client stakeholders

In Figure 4.5, the data shows the different opinions of Company X participants about their relationships with business and client stakeholders. The analysis reveals that a significant majority of the participants had positive feelings and described their relationships as good, strong, and solid. Many participants also mentioned that they generally have a positive relationship with stakeholders, while acknowledging specific areas for improvement and occasional challenges. On the other hand, a smaller group of participants stated that they have neutral or negative relationships with their business and client stakeholders due to challenges such as unhelpful stakeholders and a lack of sharing information that may be necessary in the delivery of the project.

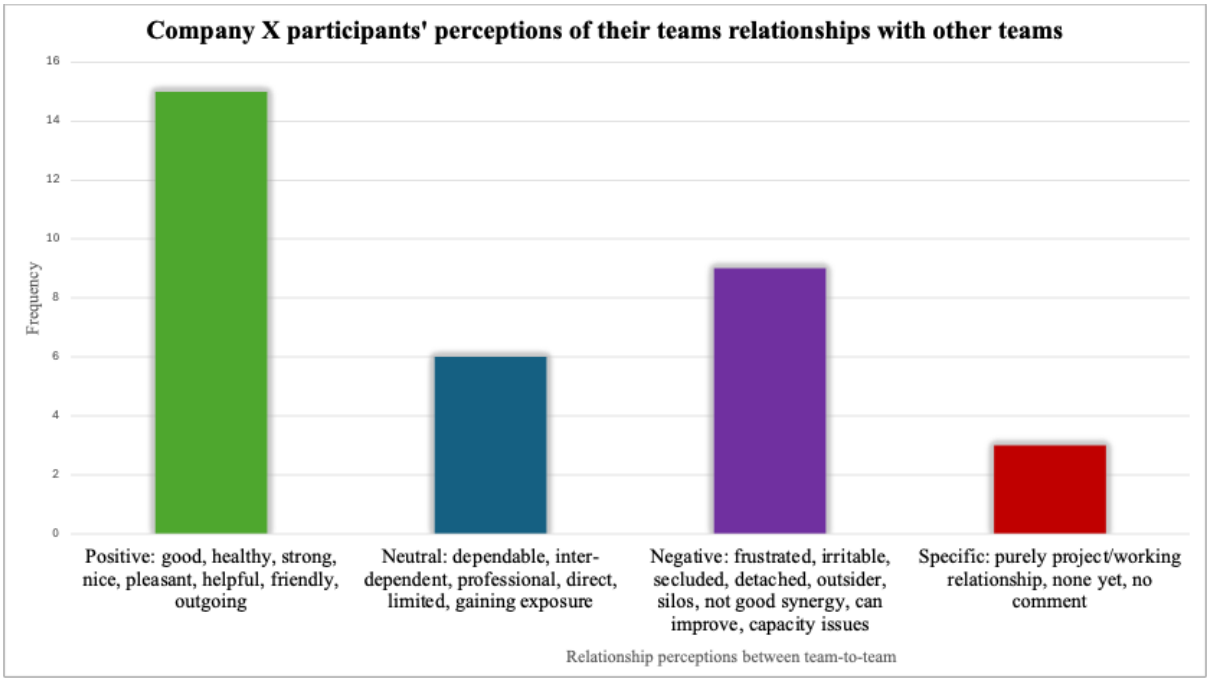


Figure 4.6: Company X participants' perceptions of their relationships with other teams

In Figure 4.6, the data illustrates the diverse perspectives of Company X participants regarding the relationships their team maintains with other teams within the organisation. Similar to the findings depicted in Figure 4.5, a significant majority of the participants expressed positive sentiments, indicating that their team enjoys robust, collaborative, and amicable relationships with other teams. These relationships are perceived as helpful and friendly, contributing to a positive overall working environment. Conversely, a portion of the responses highlighted negative dynamics within inter-team relationships, leading to frustration and irritation. Participants noted instances where other teams operated in silos, leading to blurred lines and delayed responses, consequently straining working relationships.

Furthermore, a smaller number of responses indicated that some participants perceived their team's relationships with other teams as neutral or purely transactional, lacking definitive categorisation as either positive or negative, being quite slow to respond, placing a negative strain on their working relationship. A smaller number of responses indicated that a few participants noted that their team has a neutral relationship or a purely working relationship, which cannot be defined as either good or bad.

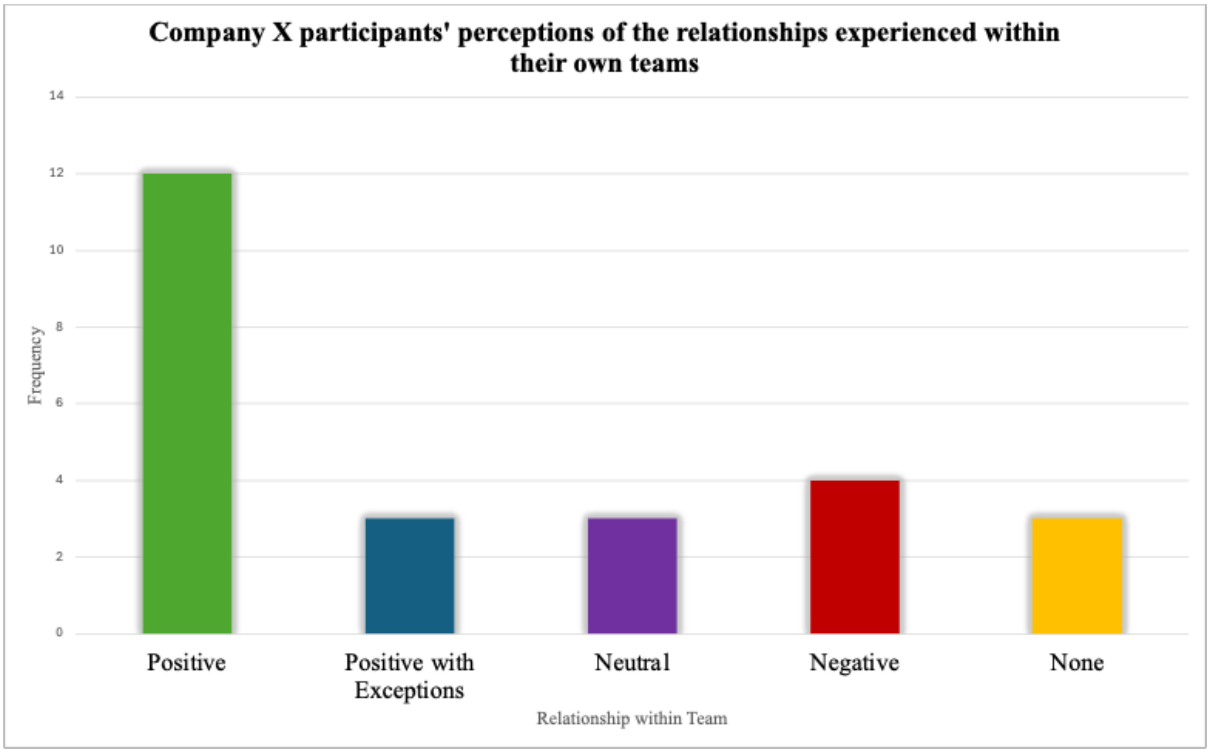


Figure 4.7: Company X participants' perceptions of their relationships experienced within their own teams

In Figure 4.7, the results from participants of Company X regarding the relationships in their teams are presented. The majority of the participants have noted positive attributes of their team's synergy and their relationships with each other. Many comments mentioned that the team relationships were friendly, good, inviting, and helpful. The figure also shows that the second most common perception of team relationships, which was not expressed much, was negative, such as drama, friction, tension, and conflict being experienced within the team. An equal number of participants noted that there was a neutral or no apparent relationship within their team. This data shows that the majority of the participants of Company X believe that their teams have good synergy and work well together. Although there may be some conflict, overall there is a positive relationship experienced within the teams in this organisation.

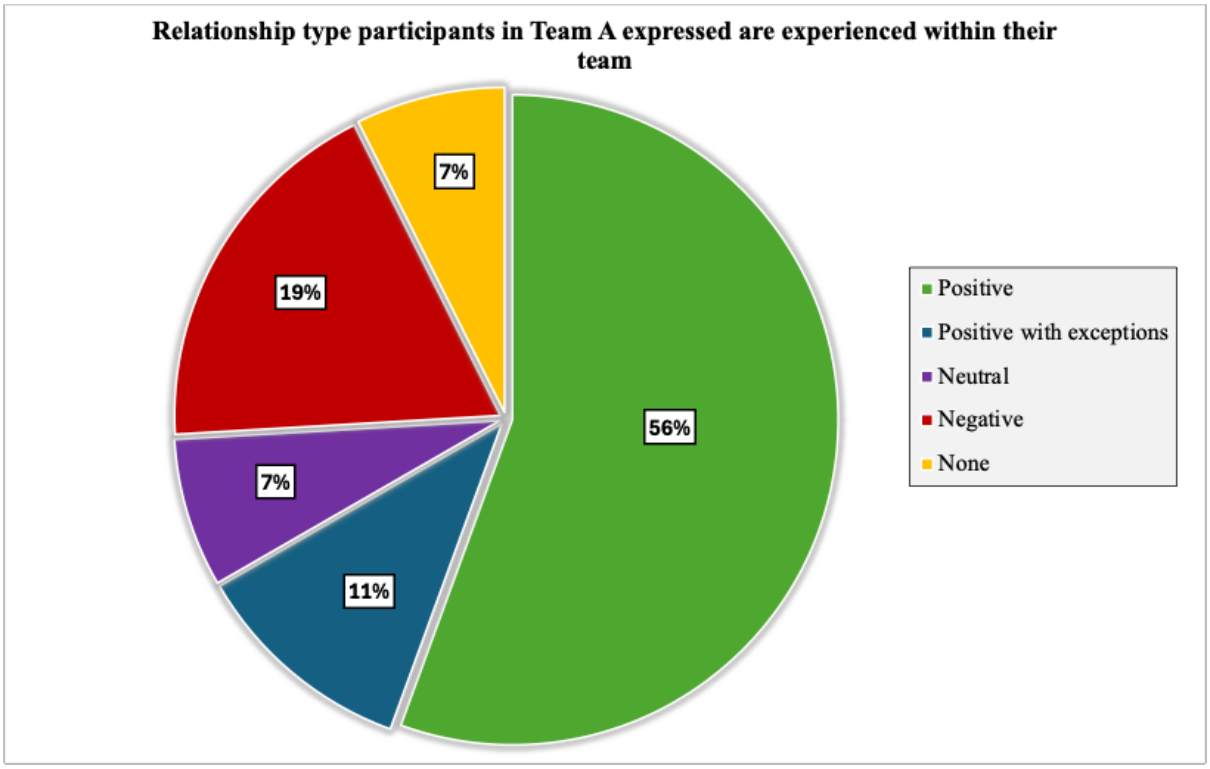


Figure 4.8: Relationship-type participants' in Team A expressed are experienced within their team

Further analysis was conducted to delve deeper into the relationships among the participants in Company X. Specifically, the perceptions of the participants of Team A regarding their relationships within the team were explored, as depicted in Figure 4.8. The data in Figure 4.8 aligns with the findings in Figure 4.7, indicating that the majority of participants in Team A have reported experiencing a positive relationship within the team. It is important to note that while a few participants mentioned experiencing negative or neutral relationships, these occurrences were not statistically significant and were consistent with the overall perceptions of the participants in Company X.

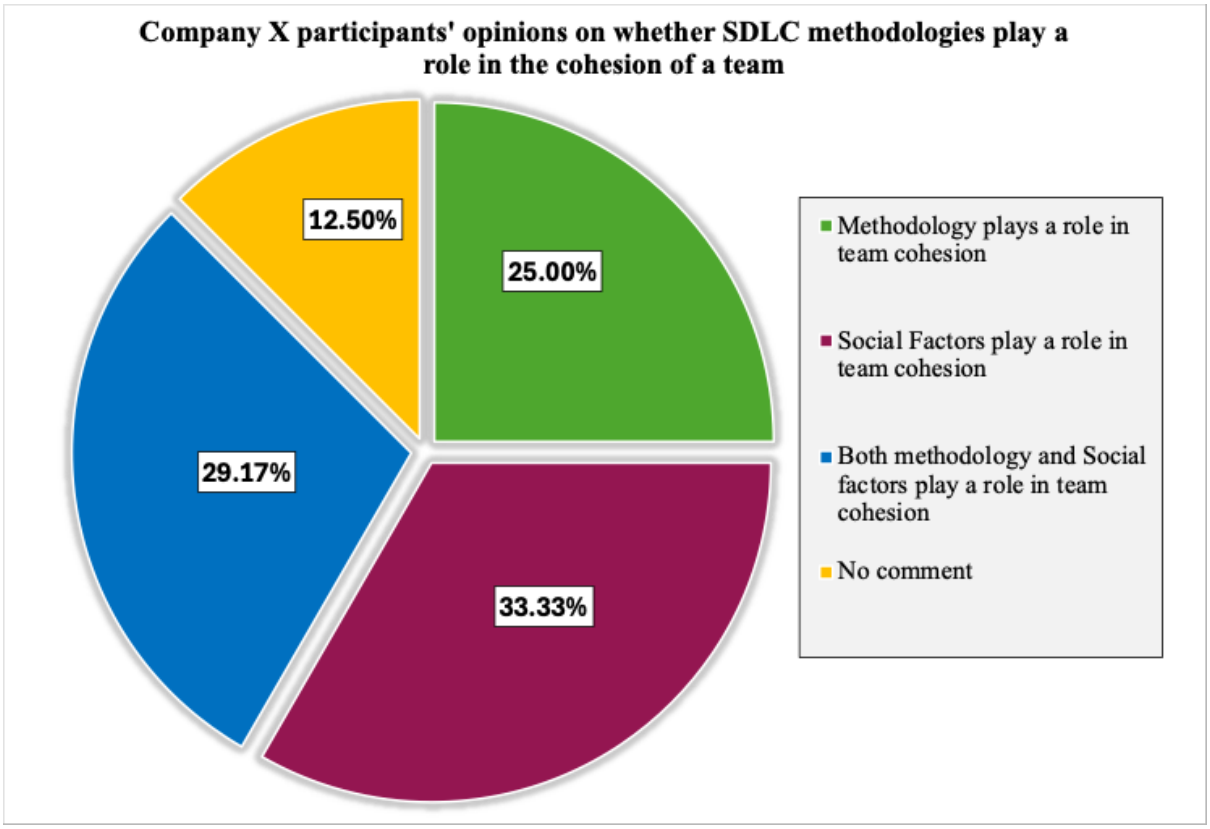


Figure 4.9: Company X participants' opinions on whether SDLC methodologies play a role in the cohesion of a team

In the semi-structured interview, the researcher asked the participants about their views on the impact of methodologies on team cohesion. The findings are shown in Figure 4.9. It was noted that 25% of the participants believed that methodologies contribute to team cohesion by facilitating effective communication and guiding stakeholder and team interaction. 33.33% of the participants expressed the opinion that methodologies do not influence team cohesion and that social factors such as team culture and the personalities of team members play the sole role. 29.17% of participants agreed with both views, stating that the methodology supports team cohesion alongside social factors within a team. 12.5% of participants did not provide a comment on this question. Therefore, the data highlights a mix of opinions on what factors create cohesion within a team.

This result shows a variety of perceptions among team members about what factors are most influential in creating or influencing team cohesion. This insight is important for organisations such as Company X to understand that there is no single solution to enhancing team cohesion. Instead, building team cohesion and synergy may require a dual approach; therefore,

incorporating an effective SDLC methodology and cultivating positive team dynamics and culture is essential for the delivery of digital healthcare products.

a) Subtheme 3-1: Team Dynamics and Relationships

On the topic of team culture and cohesion, most participants have noted that they have good relationships with people within their teams. Individuals get along with each other, and there is a "family" culture within the team, where team members care about each other beyond the level of work.

Table 4.11.1: Subtheme 3-1: Supporting Quotes from Participant Transcripts from Team A

Team	Supporting Quotes from Participant Transcripts
A	*DEV_7 - "People in the team are really nice so it makes it easy to get along with everyone."* *DEV_4 - "I would describe my relationship with the team as pretty good. I feel like I can communicate with any single member of the team."* *DEV_2 - "• I think the team has pretty good synergy and cohesiveness. I know that's not always the case.* *We are very cohesive and team-oriented, especially when it comes to development in certain projects or enhancements, whether it be within the dev groups or with the BAs and testers in your stream."* *BA_5 - "• I think we are great as a team. We help each other. We assist each other. And we, what you call, depend on each other. We acknowledge.*

Table 4.11.2: Subtheme 3-1: Supporting Quotes from Participant Transcripts from Team B

Team	Supporting Quotes from Participant Transcripts
B	*DM_1 - "No, we've got a really, really good relationship within our team. It's a bit cliche, but we refer to our team as having, you know, family culture."* *BA_1 - "It's just that sometimes it is difficult to communicate with the developers.*

	There are instances where you know you need answers, and the devs don't communicate that to you, or changes would be made, and you would always be the last person to find out or find out in like a stand-up or something, and then it comes as a shock and as a surprise that you didn't know and then the Dev manager asks how is it that you didn't know this and you're like I just found out the same way you found out, and it kind of makes you look like you just not doing your job."

Table 4.11.3: Subtheme 3-1: Supporting Quotes from Participant Transcripts from Team C

Team	Supporting Quotes from Participant Transcripts
C	*DM_4 - "And so that's an interesting one because some of my teams are geographically dispersed. I think, despite the geographical location. So some of the team, they haven't met each other in person, and I think that they do have quite strong, quite good working relationships. So we try to do a lot of regular social catch-ups as well as just our daily stand-ups to make sure that the team engages in a comfortable way with each other.* *DPO_1 - "My squad, specifically, always likes to know the context of why we're doing something, and they always want to. They'll always challenge something they'd receive it as the gospel and say, OK, well, because you said that we need to do it this way. Is that the only way? If there's a different way of approaching it, the squad will be like, OK, well, why are we not trying it this way? Let's try it this way.* *But I don't think this cohesion just yet. There are instances where my devs and my testers are not speaking to each other. There are times when I've had to call them separately to have difficult conversations with them."*

Table 4.11.4: Subtheme 3-1: Supporting Quotes from Participant Transcripts from Team D

Team	Supporting Quotes from Participant Transcripts
D	*DEV_10 - "I feel like I wouldn't say that exactly. Mainly because it's the whole work-from-home kind of thing. Yeah, they work well in isolation, but I don't think they have proper working relationships yet. They do work well together, and I don't take away from that. But I don't know if it's as much a team as in the traditional sense.*

	Where, you know, everybody cares about everyone and making sure they are all doing their stuff right. I don't think the people who just joined haven't had that opportunity yet." *DM_2 - "I think in every team that synergy and cohesiveness can get a little miscalibrated, and that's the case… you just need to bring it back in line.*

Table 4.11.1: Subtheme 3-1: Supporting Quotes from Participant Transcripts from No Team

Team	**Supporting Quotes from Participant Transcripts**
N/A	*ARC_1 - "Depending on what team you're talking about, some teams I think there's a big disconnect between teams that have people sitting and like contractors are sitting and like offshore that is a problem. But teams that just have some South African-based staff generally have good relationships."*

Interpretation and Discussion: Despite generally positive relationships within teams, a handful of participants have voiced concerns regarding poor relationships with certain team members, either within their own team or across teams. These participants have identified poor communication as the main cause of these problems. Specifically, they have noted that misunderstandings and conflicts arise when people are unable to communicate effectively with one another. It is crucial for team members to foster healthy relationships with one another, as it can greatly assist in the development process. When individuals can effectively communicate with one another, they are better able to collaborate, share ideas, and work towards achieving common goals.

Interpretation and Discussion: One participant brought up an issue that many teams face in today's global work environment: how to form strong connections with colleagues who are located in different parts of the world. When team members are unable to meet their offshore counterparts face-to-face, they may feel challenged in building the same level of camaraderie and trust as they would with colleagues in the same location. This can lead to difficulties in effective collaboration and communication. To address this issue, it's essential to establish some form of team engagement that can facilitate the development of stronger relationships with offshore team members. By fostering a sense of unity and shared purpose, teams can

overcome the barriers of distance and cultural differences to achieve greater success and productivity.

b) Subtheme 3-2: Role of methodology in team cohesion

In the interview, participants were asked to provide their opinions on whether the cohesion of a software development team is solely dependent on the team culture or whether the methodology plays a role in the team's cohesiveness. A mix of answers was provided. Some participants noted that cohesion is solely dependent on the culture, while others contrasted this view, advising that the methodology plays a role to an extent. It helps support team cohesion through the processes that drive team communication and collaboration. A number of participants also believe that both culture and the methodology utilised within a team contribute to the cohesion or synergy of a team.

Table 4.12.1: Subtheme 3-2: Supporting Quotes from Participant Transcripts from Team A

Team	Supporting Quotes from Participant Transcripts
A	*BA_5 - "Yes, as a team, the methodology supports this obviously because we are working together as a team to get the projects done or get delivery right. We are together because of 1 common purpose."* *DM_2 - "I would say it's entirely dependent on the type of culture that we instilled and what we are working in. I wouldn't prescribe in those sessions any type of methodology I would prescribe. I would instruct that the objective is for you guys to understand what you need to deliver."* *BA_3 - "Yes, because the whole thing is that the team needs to work together and stuff. So, with the methodology, it helps that everybody is on the same page and work together. You know exactly what the goals are, and this is probably where the agile argument is going to come in, right?* *BA_4 - "The team culture."* *TA_1 - " Yeah. I think it's more the culture."*

Table 4.12.1: Subtheme 3-2: Supporting Quotes from Participant Transcripts from Team B

Team	Supporting Quotes from Participant Transcripts
B	*DM_1 - " Yeah, I don't think those things are independent, right? The culture within the team is flexible. And we allow flexibility in terms of the way that we work. Let me put it like this: even if you've got personal time right and things that you need to do, we've got a flexible culture around that."*

Table 4.12.2: Subtheme 3-2: Supporting Quotes from Participant Transcripts from Team C

Team	Supporting Quotes from Participant Transcripts
C	*DM_4 - "I think it's both. I think the culture and team are important, and so that is an important one. But I also think the methodology that we use, where we have regular catch-ups and regular interactions with each other, is also a contributing factor."* *DPO_1 - "I think it's both because, and that's why I said earlier that sometimes it's easy to hide things under agile. To say, well, we don't do this because it's not agile, and then that creates complexities because the way in which we each interpret agile is different, right?"*

Table 4.12.3: Subtheme 3-2: Supporting Quotes from Participant Transcripts from Team D

Team	Supporting Quotes from Participant Transcripts
D	*DEV_7 - "And I definitely think the methodology is, well, as we alluded to, stand-ups, you know, having daily check-ins with everyone understanding every day what they're struggling with."* *DEV_8 - "It's like the methodology can help you, but you can definitely follow the methodology and not get any of the benefits if you're just checking the boxes."* *DEV_10 - "I think the latter. It is the culture. You can't teach people to be friends with each other or work together. It's something that grows with time."*

	DEV_9 - "That to me, I think a personality does play a big role, but it's more of a like kind of just the median of the team's personality level, if you understand what I mean." *DEV_8 - "It's actually. I agree with the point there where it's like I think the methodology helps, but it's definitely possible for the methodology not to do anything if you don't have the right motivations for following it."*

Table 4.12.4: Subtheme 3-2: Supporting Quotes from Participant Transcripts from No Team

Team	Supporting Quotes from Participant Transcripts
N/A	*ARC_1 - "So, I think from a methodology perspective, if you do everything, it definitely contributes.* *But I still believe that the team culture trumps that."* *ARC_1 - "I think more about the culture and then the methodology.* *• I think it depends on how you apply it. So if you take our team that stood up and was in different squads, essentially, you don't see 2/3 of the team ever, really. But if you take the team, you're squad, then the methodology helps, especially on all the ceremonies, because you get to interact more."* *DM_3 - "my fundamental belief is that if you've got good people with whom you work, they are confident in trusting with and in each other. Then, I think the methodology for the approach is a layer you can apply afterward.* *In other words, you can apply the best approaches in the world if the execution is executed. I mean, you know, the role players that are part of that execution are not necessarily brought in. They're not engaged; they're not committed. And they're not giving their best.* *The process will yield a bit, but ultimately, if I had to change the two. If you said to me, take really good people and the terrible process or take a phenomenal process*

	and poor people, like without hesitating, would always go for the good people because they'll figure out a way to work better."

Interpretation: A third view was also discussed by a few participants, who highlighted that team cohesion is dependent on the individual's personality. There can be a good team culture and methodologies in place, or even the opposite, where there isn't much of a good team culture or methodology. However, depending on the individual and their mentality, team cohesion can be driven despite having a methodology that doesn't quite support or contribute towards it.

Conclusion of Theme 3:

From the answers provided by the participants, it is evident that there are both positive and negative relationships within the various teams. This may be due to personality, cultural or external differences. It is not always possible to make various individuals get along. However, the team culture can support driving good professional relationships so that team members can meet their common goals. Participants have mixed views on the role of methodology in the cohesiveness of the team, whereas contrasting views have been proposed that it is only team culture or both culture and methodology that drive cohesion. A third view was also posed that the cohesion between individuals is dependent on the individual's personality. We have little to no influence on the type of personality individuals within the team possess. It would be beneficial for Company X to adopt a methodology that supports the team culture and drives cohesion within the team. Whether it is from daily stand-ups or retrospectives that drive engagement from all stakeholders within the team, it is essential that there is some level of cohesion in delivering digital healthcare products, as it may have an impact on the overall success of product delivery.

4.4.4. Theme 4: Current Team Methodology and Processes

Relevance of Theme: This theme is essential to the study as it provides insight into the methodologies each participant believes are utilised within their team. Each participant's answer is based on what they have personally experienced and not what management expects from the current working practices utilised within their space. Understanding the participants' experience in their various ways of working will provide sufficient detail into the processes

utilised within their team, the areas in which issues are encountered, and the reasoning for why the current methodology is utilised in product delivery.

In the interview, participants were asked to describe the current methodology and process their team utilises to deliver digital healthcare products. From the answers given to the researcher, the below subthemes were generated.

Further details on the subthemes and answers provided are shown in Appendix H.

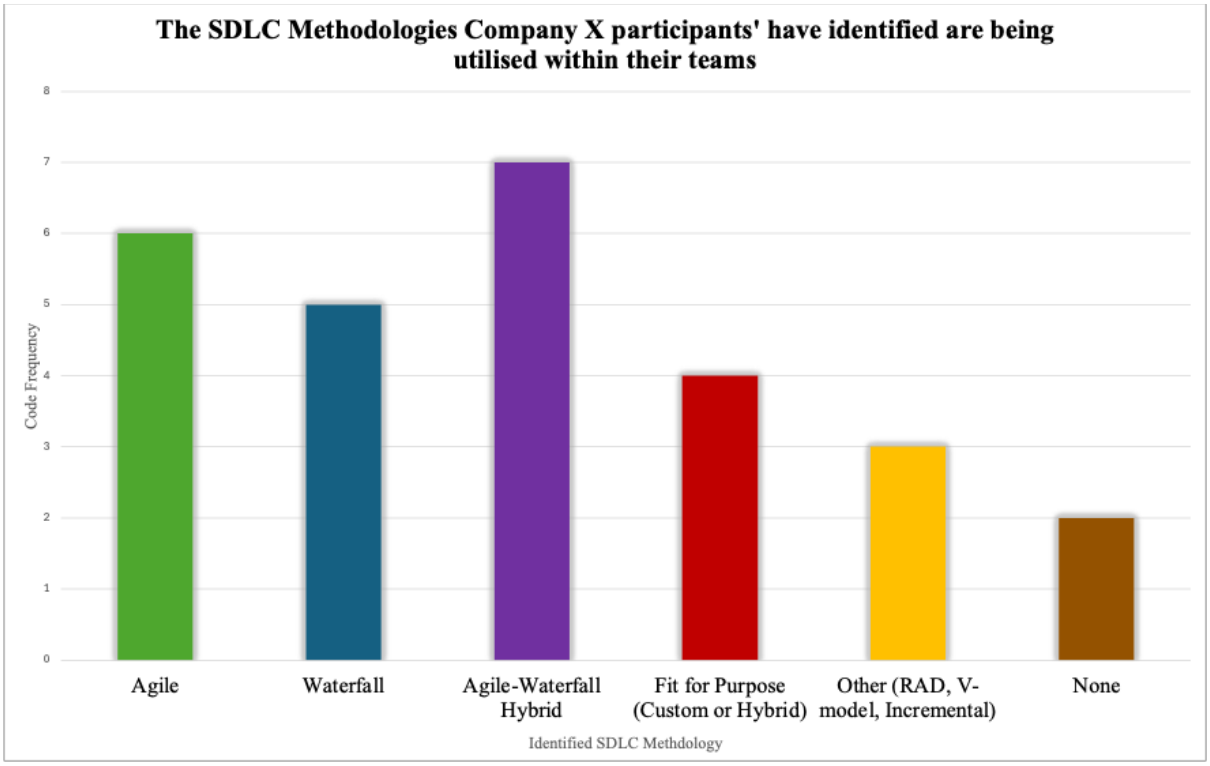


Figure 4.10: The SDLC Methodologies Company X participants' have identified are being utilised within their teams

In Figure 4.10, the interviewer asked all participants to identify the type of methodology being used within their respective teams. The responses revealed that the majority of participants noted the use of an agile-waterfall hybrid, followed by agile and then waterfall methodologies. The median of the responses indicated that participants described a hybrid or custom methodology known as "fit-for-purpose," which is tailored to the specific requirements of a project and does not strictly adhere to a single approach. Some participants mentioned the use of less popular methodologies such as RAD, V-model, and Incremental model within their teams. A few participants also stated that their teams did not follow a specific methodology due to a lack of clear definition or articulation.

Similarly to Figure 4.1, which focused on Team A, the majority of participants from Team A also reported the use of an agile-waterfall hybrid methodology. However, in contrast to the data in Figure 4.1, the second most noted methodology within Team A was agile, indicating that a pure agile methodology was not being utilised within the team. This suggests that Teams B-D of Company X have adopted different SDLC methodologies compared to Team A, which utilises a hybrid agile-waterfall and a traditional pure waterfall methodology exclusively.

a) Subtheme 4-1: Identification of Methodology

Table 4.13.1: Subtheme 4-1: Supporting Quotes from Participant Transcripts from Team A

Team	Supporting Quotes from Participant Transcripts
A	*BA_2 - "We definitely don't use agile in our space. It's not even a hybrid of agile because it doesn't exist. We use waterfall mostly."* *DEV_4 - "Yeah, because as I understand, the waterfall method, there's a feature, and you get nothing out until the right at the end, and then you go back. I think we've just followed the waterfall method, but we produce a lot of things faster."* *TA_1 - "So, in our space, we definitely follow the agile development process as closely as we can."* *TA_2 - "I do believe that we follow the waterfall model, the old one, not the new one…That's what I believe in, so everything is in flow, and you can start the next phase once the previous one has been completed.""* *"BA_4 - "So yes, we are working more in an agile methodology method, but if we look at it realistically, we are actually working waterfall because we have to realise our features at the beginning and then understand the dependencies for the feature and what can be released with or without certain features in place."* *BA_5 - ""Waterfall with a combination of agile.""*

	DEV_2 - "So, for the most part, I think we do use a waterfall. But it's more of an iterative waterfall model, and I know we do generally use aspects from an agile methodology as well. " *DEV_1 - "So yeah, I think there's a bit of change, I would say, in the team right now, but it's mostly waterfall outside… So, like I'm saying, in terms of the new project that we were looking at, the prototyping approach was actually used."* *DEV_3 - "Yes, that's a bit of a difficult one because I don't think that they are strictly following any one of these, you know, and yeah, but I would explain our life cycle like an agile waterfall.* *DEV_6 - "We use the incremental model."* *BA_3 - "Because honestly, Team B actually uses a fit-for-purpose methodology."* *DEV_5 - "don't really fully understand the difference between the rapid one and prototyping. But I'd say one of those they definitely do use. And then also the agile one."* *DM_2 - "As I said in my previous answer, it's a combination of software methodologies. It's very fit for purpose. It depends on the project and the level of engagement that we need for that project. Typically, we use aspects of both agile and waterfall with a more agile spin to things to ensure that we progress but do not lose the detail and the governances that some of the more traditional methods provided us."*

Table 4.13.2: Subtheme 4-1: Supporting Quotes from Participant Transcripts from Team B

Team	Supporting Quotes from Participant Transcripts
B	*DM_1 - "Stay finitely, not waterfall, but it's definitely not pure agile. As soon as you start working with a deadline, if you've got, if you start with the deadline 1st and*

	then you need to plug in all of your work after the fact and make sure that you get there, that is not a pure agile approach" *BA_1 - "So we are mostly agile, and then I want to say waterfall in the sense that we can't test until changes have been made."*

Table 4.13.3: Subtheme 4-1: Supporting Quotes from Participant Transcripts from Team C

Team	Supporting Quotes from Participant Transcripts
C	*DM_4 - " So we like to think that we are agile, but we actually are not. We've got our own variation of agile; it's not 100% agile, but that is certainly our aspiration."* *DPO_1 - "So agile, V model, and the incremental model. So I think it's a combination of these three, to be honest."*

Table 4.13.4: Subtheme 4-1: Supporting Quotes from Participant Transcripts from Team D

Team	Supporting Quotes from Participant Transcripts
D	*BA_3 - "But then again, in Team D, we lean more towards agile "* *BA_6 - "We are very agile. We use the Agile methodology quite a lot."* *DEV_8 - "And so, yeah, I'd say agile and then inside that, I mean, I think that the final details are typically the sticking points here where it's like, you know, you will say like scrum, but like typically, it's a different kind of version like we kind of have like it's agile but they exactly like implementation is kind of flexible."* *DEV_9 - "Agile."* *DEV_ 10 - "I guess it's not the strict agile. It's more like a loose kind of agile. You pick what works for you, and you don't do what doesn't."* *DEV_7 - "Yeah, we kind of got a custom version, but we almost follow in our team, a weird hybrid of Scrum and Kanban."*

Table 4.13.5: Subtheme 4-1: Supporting Quotes from Participant Transcripts from No Team

Team	Supporting Quotes from Participant Transcripts
N/A	*ARC_1 -"So we all strive towards being agile, but then we like this waterfall approach, but kind of agile. So we are formally following agile, but we're not completely agile. But I don't think if you get something like that, it's completely agile because then it's also just agile, right?"*

Discussion: As mentioned in Section 4.2: Current Methodology Utilised in Company X, there is not an alignment among Team A participants on the type of methodology utilised in their team. Participants in Teams B-D agree that an agile methodology is being utilised within their team, although in some instances, agile might not be followed 100%. So, the agile methodology is being utilised in the delivery of digital healthcare products in majority of Company X. However, in Team A, participants have raised multiple methodologies that are being utilised depending on the type of product being developed.

Conclusion of Theme 4:

From the answers provided by the participants, it is evident that there are contrasting views on the type of methodology utilised in Team A. The mixed answers seem to stem from different methodologies being utilised in different projects instead of having one standard methodology followed across the board, like in Teams B-D. Each methodology identified by the participants has its own set of challenges; therefore, to compact these challenges, Company X needs to clearly define the type of SDLC methodology being used by each team. Whether the methodology is a fit-for-purpose approach or a more traditional SDLC methodology, it is essential for team stakeholders to understand the type of methodology being utilised and why it is being utilised over others. If a new methodology is to be adopted in Company X, it is essential for the new methodology to tackle the challenges that have been raised by all the participants.

4.4.5. Theme 5: Project Management and Planning.

Relevance of Theme: This theme is essential to the study as it provides insight into the participants' views on the manner in which a project is managed and planned in the digital healthcare industry. Understanding the participants' experience in these areas will provide some insight into understanding the challenges encountered in their current methodology as well as the specific phase or area in which certain challenges arise with these stakeholders.

In the interview, participants were asked to describe any additional challenges or concerns that they have experienced with the current methodology followed by their team. From the answers given to the researcher, the below subthemes are generated:

Further details on the subthemes and answers provided are shown in Appendix H.

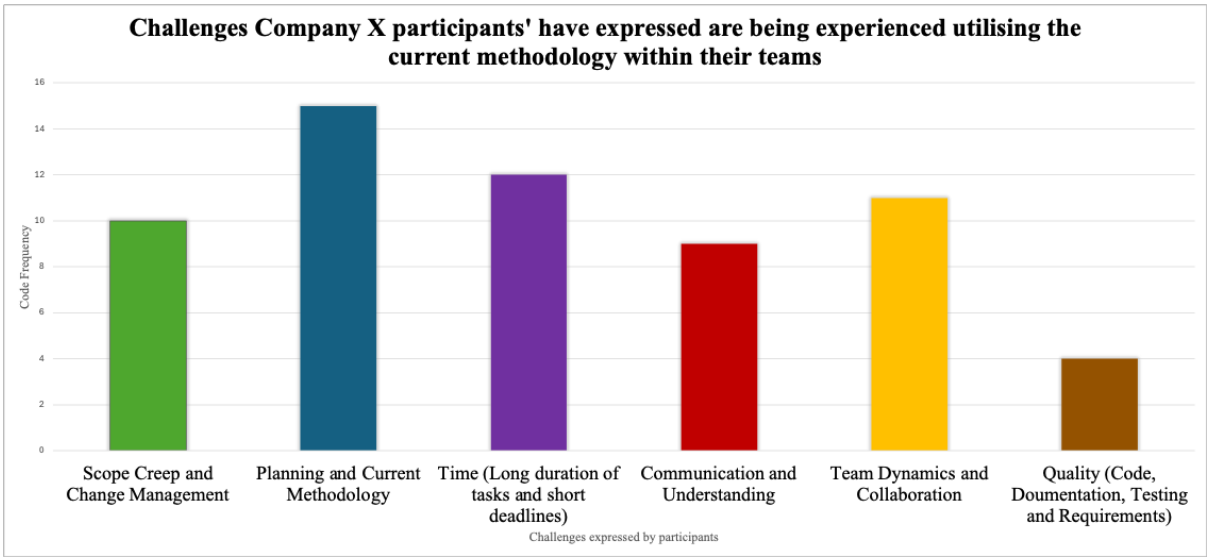


Figure 4.11: Challenges Company X participants' have expressed are being experienced utilising the current methodology within their teams

In Figure 4.11, we delve into the specific challenges encountered within Company X's Software Development Life Cycle (SDLC) methodologies. The feedback from Company X's participants highlights that the primary source of these challenges stems from issues in project planning and the methodologies currently in use. A significant portion of the participants pinpointed that the inefficiencies in planning and outdated or unsuitable methodologies are the root causes of many problems encountered during the SDLC process.

Following closely, the issue of timelines emerges as the second most significant challenge. This includes both the tight deadlines set for project completion and the actual time required to complete tasks, suggesting that unrealistic timeframes or poor time management could be contributing to the pressure on development teams. Team dynamics and collaboration were also identified as critical areas of concern. The findings suggest that ineffective teamwork and collaboration issues can hinder the progress of projects, possibly due to miscommunication or conflicting working styles among team members. Additionally, scope creep and change management were highlighted as prevalent challenges, indicating that projects often undergo changes that are not adequately managed, leading to further complications in the development process.

A moderate number of responses underline communication and understanding as challenges, pointing towards possible gaps in clear and effective communication between team members and stakeholders and misunderstandings regarding project requirements or objectives. Interestingly, the quality of outcomes, encompassing documentation, code, testing, and requirements, received the least concern from participants. This suggests that while the quality of deliverables is maintained, the processes leading to these outcomes face significant hurdles that impact the efficiency and effectiveness of Company X's SDLC methodologies.

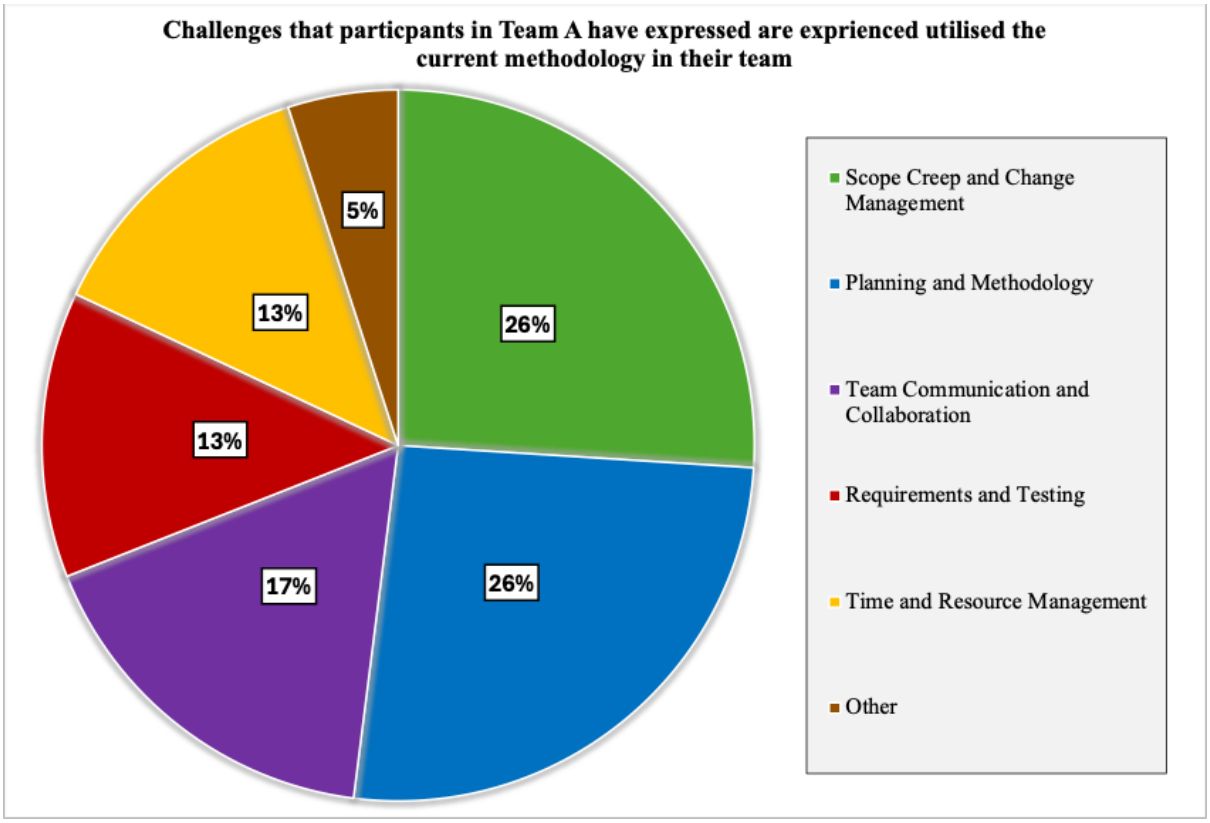


Figure 4.12: Challenges that participants in Team A have expressed utilised the current methodology in their team

To gain a deeper understanding of the challenges encountered when implementing Company X's current methodology, a further analysis was undertaken, focusing particularly on the feedback from Team A members about the methods applied within their group. This analysis is illustrated in Figure 4.12. The data presented in the figure reveals that a significant portion of the challenges, 26%, is attributed to Scope Creep and Change Management issues. These challenges arise from difficulties in maintaining the initial project scope amidst evolving requirements and the need for effective adaptation to these changes. Similarly, 26% of the responses also highlighted Planning and Methodology as a challenge for Team A. This indicates that Team A members are dealing with aspects of project planning and the effectiveness of the methodologies currently in place, suggesting that a methodology will need to be put in place which supports effective project planning.

Furthermore, the analysis shows that 17% of Team A participant's responses have identified team Communication and Collaboration as a significant challenge. This highlights the importance of effective communication and collaborative processes within the team and suggests that current methods may be inadequate in fostering a cohesive working environment.

Additionally, 13% of the responses shed light on issues related to Requirements & Testing and Time and Resource Management. These challenges reflect difficulties in clearly defining project requirements, ensuring thorough testing, and efficiently managing time and resources. If addressed correctly, these challenges may lead to delays, increased costs, and compromised quality. Lastly, a smaller percentage, 5%, of responses indicate that miscellaneous challenges, such as error handling and technical issues, are being experienced by Team A.

4.4.6. Theme 6: Improvement of current Methodology or adoption of new methodology.

Relevance of Theme: This theme is essential to the study as it provides insight into the participants' views on the factors that are missing from their methodology and how their methodology can be improved. Understanding the participants' thoughts in these areas will provide some insight into how to create or enhance a methodology that can mitigate the challenges encountered in their current methodology, as well as the specific phase or area in which certain challenges arise with these stakeholders.

In the interview, participants were asked to describe how they believe the current methodology used within their team can be improved.

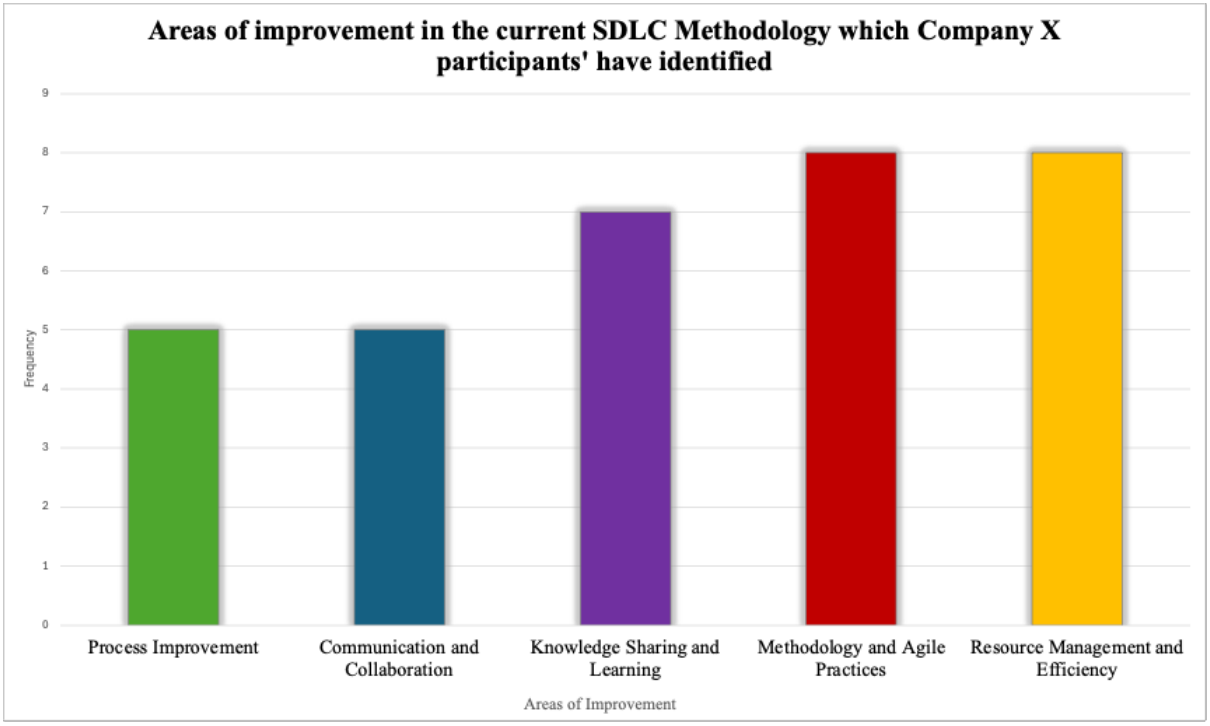


Figure 4.13: Areas of improvement in the current SDLC Methodology which Company X participants have identified

Figure 4.13 presents the results from the interview conducted with participants from Company X, focusing on identifying potential areas within their current SDLC methodologies. The data reveals several key insights into where enhancements could be most beneficial, which is further depicted in the Table 4.14.

Table 4.14: SDLC Methodology Areas of Improvement noted by participants' in the semi-structured interviews

Categorised Areas of Improvement	**Detailed Areas of Improvement noted by Participants in the semi-structured interviews**
Process Improvement	*Improve management of changing requests*
	Become more agile
	Streamline maintenance process
	Improve deployment process, maintenance, and documentation
	Define a proper process/methodology
Communication and Collaboration	*Involve business more in methodology/delivery*
	Better communication with developers
	Improve communication with business

	Include devs and testers in analysis phase
	Improve team relationships
Knowledge Sharing and Learning	*Understand project as a whole*
	Learn from mistakes
	Expand knowledge and skillset
	Training
	Recall from previous knowledge and experiences
Methodology and Agile Practices	*How the methodology is executed*
	Need a holistic view of project
	Segment components/aspects
	Analyse
	Improve analysis + documentation
	Alignment across project stakeholders
	Apply a specific methodology
	Don't mix methodologies
Resource Management and Efficiency	*Reduce meeting and ceremonies times*
	Remove weekly deployment cycle
	Set a standard period for items to be deployed to production
	Hire dedicated support team
	Focussed time to work on a project without disruption
	Smaller releases
	Time management
	Allow testers to be more involved in delivery

A significant portion of the feedback has been highlighted around the need for better resource management and improvements in the methodology itself. This suggests that there is a perceived inefficiency in how resources are allocated and utilised throughout the project lifecycle, as well as potential gaps or inefficiencies in the methodologies currently in use. Participants expressed an improved is required for a more streamlined, effective approach that could potentially accelerate development times and optimise resource use.

Furthermore, the interview results highlighted that Knowledge Sharing and Learning as areas that also require improvement. This feedback points to a possible lack of effective processes for sharing insights, learnings, and best practices among team members. By enhancing these aspects could encourage a more collaborative environment which promotes learning and improvement, eventually leading to a more skilled and adaptable development team.

Communication and collaboration and Process Improvement were also identified as areas needing improvement, with each mentioned equally in the participant responses. This indicates a recognition of the importance of clear, effective communication and collaboration among team members and the need for ongoing evaluation and refinement of processes. From the answers provided by the participants, it is evident that the areas that require improvement are communication, collaboration, processes, and tools.

4.4.7. Theme 7: Change Management

Relevance of Theme: This theme is essential to the study as it provides insight into the participants' thoughts on change and techniques that management can implement in order to ensure that transitions to a new way of working are successful. Understanding the participants' thoughts in these areas will provide some insight into the change management process and the new methodology that team members would be comfortable/willing to accept if any changes are made to the current software development delivery structure.

In the interview, participants were asked to describe their personal feelings towards changes in the current methodology and the ways in which management can ensure that the team feels comfortable with the transition to a new way of working.

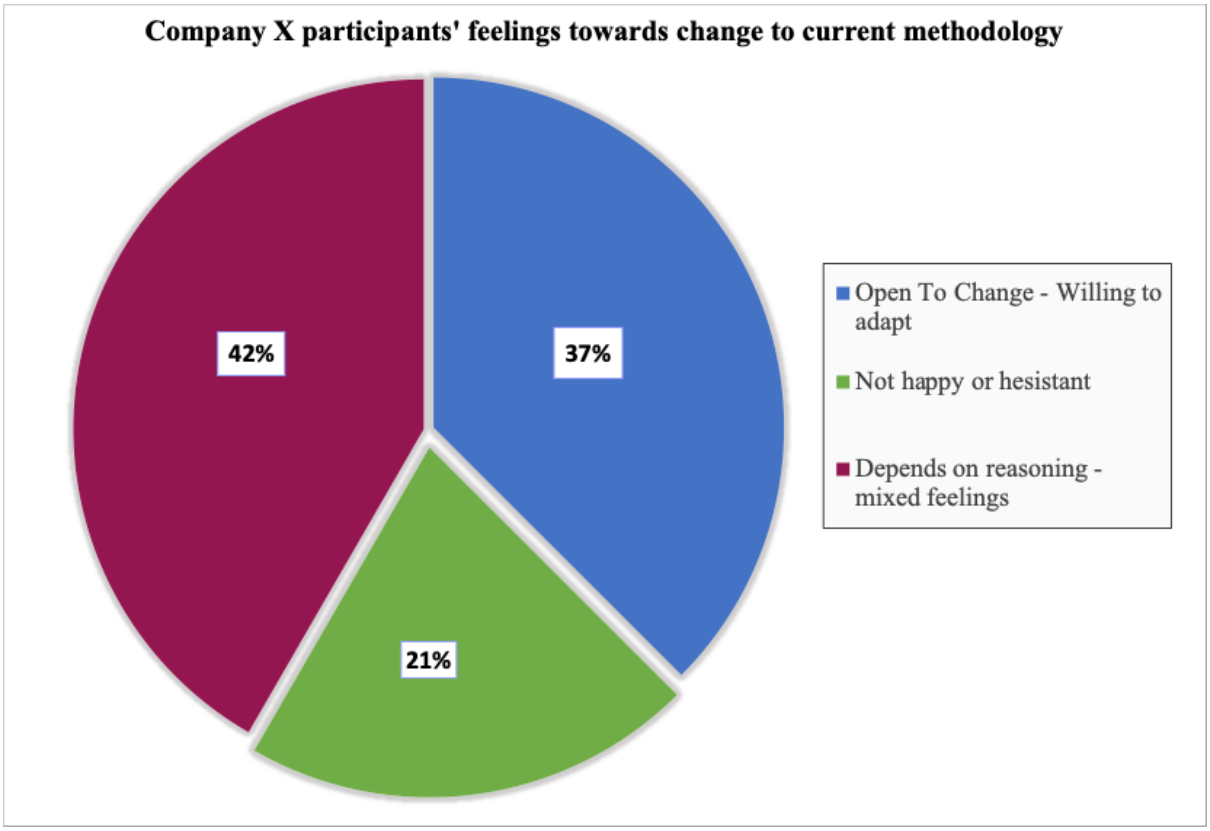


Figure 4.14: Company X participants' feelings towards change to current methodology

Figure 4.14 shows a graphical depiction of all the participant's feelings toward changing their current methodology. Only 21% of participants would not be happy or hesitant about changing the current methodology utilised within their teams. While 42% of participants noted that they have mixed/neutral feelings about the change, their overall feelings would depend on management's reasoning for the change. 37% of participants noted that they would be open to or comfortable with the change in SDLC methodology. The participants were all asked to advise on the ways that management can ensure that the team is onboard or more comfortable with the transition.

A summarised list of change management tasks to be performed to ensure a smooth transition to a new methodology is shown below:

- Solid Change Management Process
- Managerial Leadership and Ownership
- Justification and Value Proposition
- Piloting and Testing
- Phased Approach and Evaluation
- Controlled Environment and Risk Management

- Training Guidance
- Building Buy-In and Involvement
- Open Forum for Feedback and Concerns
- Collaborative Planning and Adjustment
- Discussing Advantages and Disadvantages
- Explaining Rationale and Vision:
- Sharing Information and Knowledge

A more detailed depiction of how the methodologies in each team can be improved is shown in Appendix H.

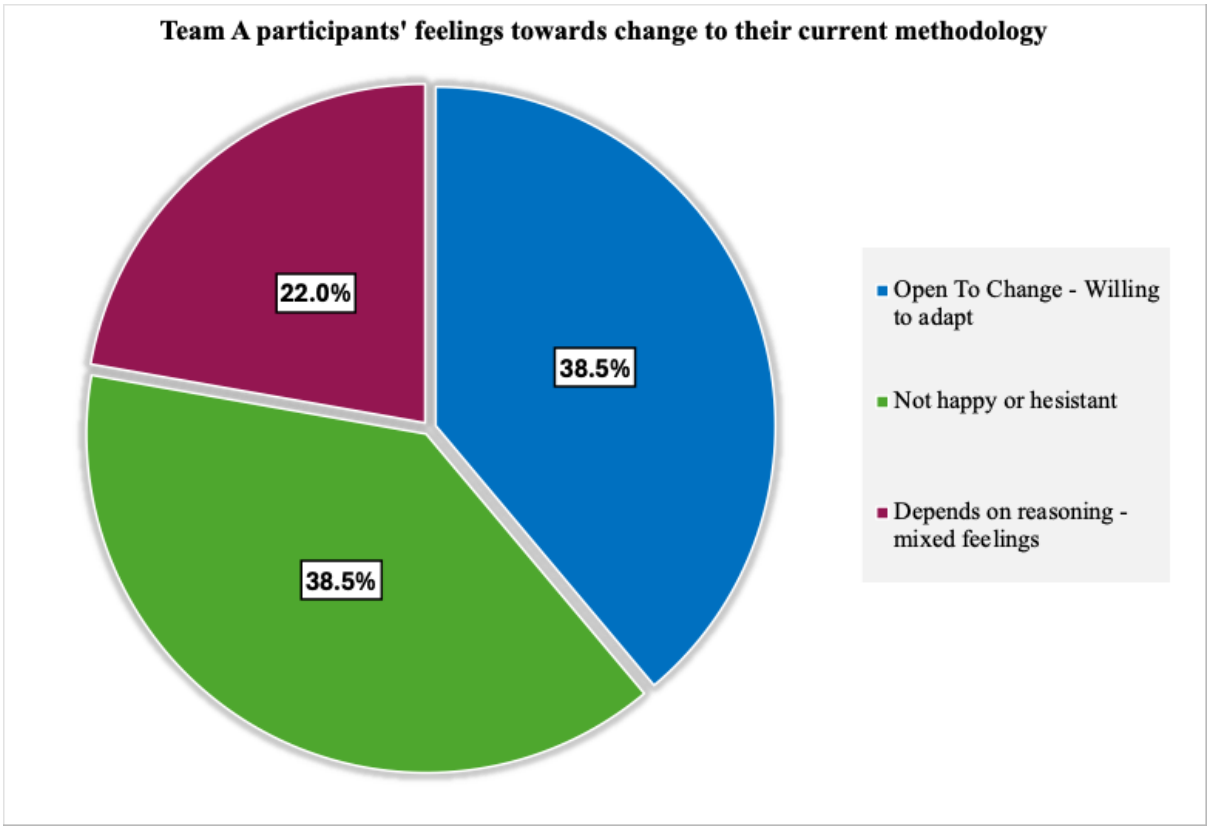


Figure 4.15: Team A participants' feelings towards change to their current methodology

Furthermore, Figure 4.15 provides a focused perspective aimed at understanding the specific sentiments of Team A's participants towards changes to their current methodology. This figure reveals that there is an equal distribution of sentiments among Team A's participants, with 35% expressing openness to change and another 35% displaying hesitancy towards changing their current methodology (whether this be adopting a new or enhancing the current methodology).

Additionally, 22% of the participants mentioned that their receptiveness to change would largely depend on the justifications provided by management.

The data presented in Figure 4.15, not only offers a clear insight into Team A's mindset regarding changes to their ways of working but also aligns with the sentiments expressed by participants of other teams within Company X, as indicated in Figure 4.14. This consistency across different teams underscores a common perspective within the company regarding changes to existing methodologies, highlighting the importance of management's role in effectively communicating the reasoning behind proposed changes to gain support amongst employees as well as to reduce any forms of resistance to change.

Conclusion of Theme 7:
From the answers provided by the participants, it is evident that a smaller group of participants would be hesitant to change methodologies as they believe that the methodology allows for the team to meet their delivery goals. 37% of the participants are willing to a change in methodology, while the majority of the participants, 42%, have neutral feelings towards the change. These figures show that as long as management can effectively justify the need to change methodologies as well as provide suitable change management processes, the transition to the new methodology would be mostly accepted among Company X.

As Team A in Company X does not have a clearly defined SDLC methodology, as part of this research, a study of a conceptual framework for a new SDLC Methodology will be developed in the next chapter.

5. CHAPTER FIVE – THE ENHANCEMENT OF SDLC USED IN DIGITAL HEALTH (NEW CONCEPTUAL FRAMEWORK)

This chapter will present the conceptual framework for the new SDLC Methodology, which can be adopted by Team A of Company X or the entire Company to mitigate the challenges associated with utilising a more traditional waterfall approach in delivering digital healthcare products.

5.4. Common Issues identified with current SDLC Methodology

From the themes presented in the previous chapter, the common issues with the existing methodology include the following:

i. Communication between business stakeholders and internal team members.
ii. Lack of business understanding and involvement in the development process.
iii. Lack of involvement of technical staff in analysis and business discussion.
iv. Poor planning and unrealistic deadlines.
v. Scope Creep.
vi. Lack of a clearly defined methodology.
vii. Lack of flexibility (dependent on the type of methodology utilised.)

5.5. Key Principles of the new SDLC Methodology

Based on the common issues identified with the current SDLC Methodology, as well as the nature of the digital healthcare industry, the following key principles have been developed for the new SDLC Methodology:

5.5.1. Continuous Feedback and Communication

This new SDLC Methodology will encourage and impose feedback and communication at each phase in order to ensure that all stakeholders are aligned on the progress of the project. The various communication meetings to be utilised include the following:

- Team and Business Alignment Sessions
- Scrum / Daily Stand-up Meeting
- Check-ins meetings
- Planning sessions

- Retrospectives

5.5.2. Cross-functional Collaboration

The new SDLC Methodology will promote and encourage the inclusion of various stakeholders in various phases of the SDLC. Multiple participants in the research study interviews suggested that it would be beneficial to include various stakeholders in other stages of the lifecycle for knowledge sharing and technical input.

5.5.3. Sprint Planning for Phased delivery

The new SDLC Methodology will follow an agile approach by releasing digital products in sprints to the public. Each sprint will run for three weeks to provide sufficient time for development, testing, and defect management to be conducted before the product is deployed to production. In order to ensure that this phased delivery approach is implemented successfully, at the beginning of each sprint, a sprint planning session will be held with all the project stakeholders to ensure that everyone is aligned with all the features being accommodated in the sprint and the date when the digital product will be rolled out to users in production.

5.5.4. Continuous Improvement and adaptive Flexibility

The new SDLC Methodology will follow a continuous improvement approach using the feedback provided by retrospectives. This will allow the methodology to adapt based on feedback raised by stakeholders, changing technologies, and market trends. As a fit-for-purpose approach has also been utilised within company X, various levels of flexibility would be beneficial for this methodology depending on the type of project.

5.6. Conceptual Framework for the New/Enhanced SDLC Methodology

In Figure 5.1, a conceptual framework has been developed from the literature review, research results and discussion to visually represent the various factors that influence the implementation of a new or enhanced Software Development Life Cycle (SDLC) methodology. This framework aims to illustrate the impact of the new/enhanced SDLC methodology on Company X and, more specifically, on Team A. Additionally, the framework incorporates mediating and moderating variables to address the critical research question:

"How can Company X effectively introduce a new or enhanced SDLC methodology to drive improvements in the development of digital healthcare products?"

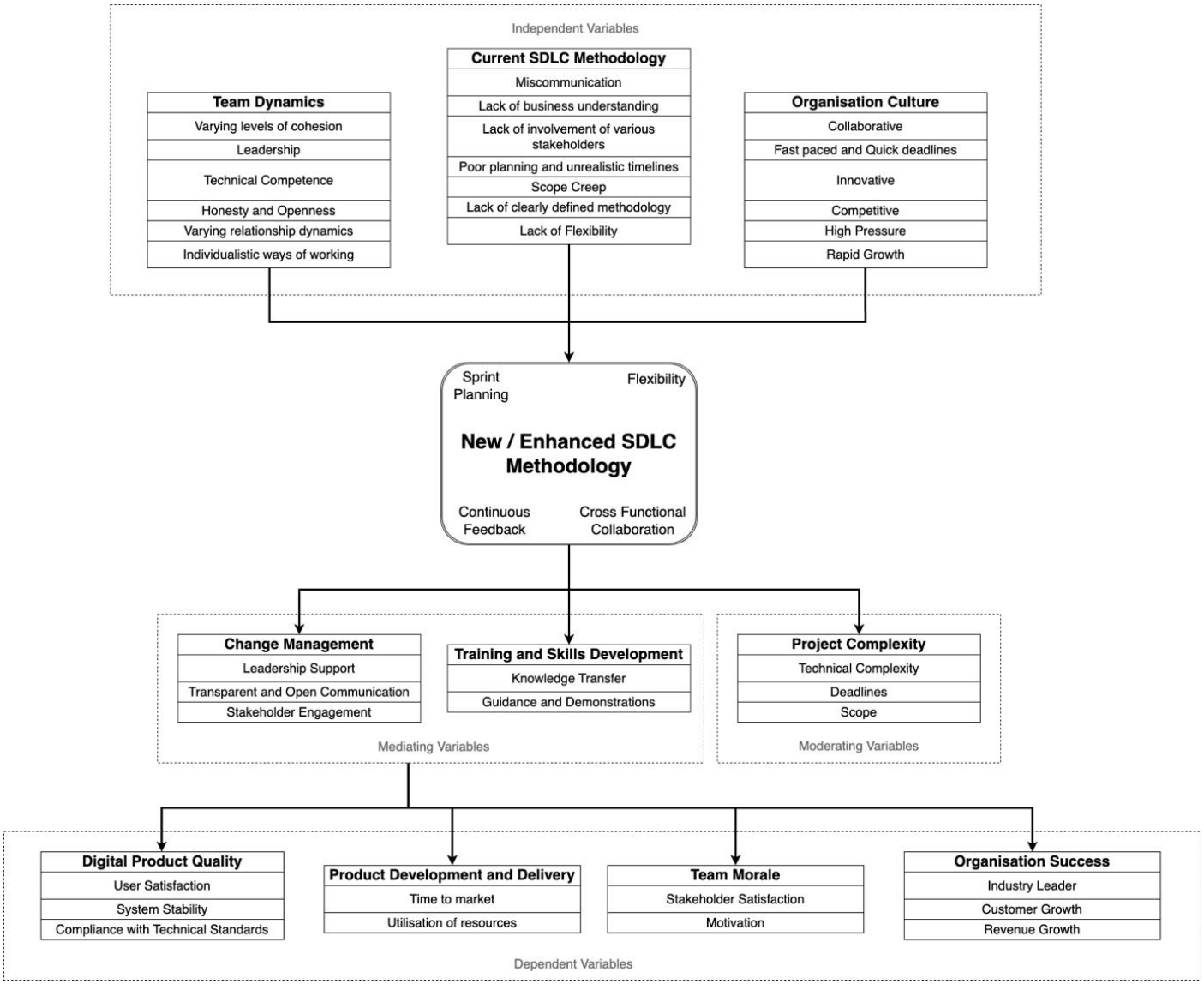


Figure 5.1: Conceptual Framework for the New / Enhanced SDLC Methodology

In developing the conceptual framework, various types of variables have been incorporated, drawing from extensive literature reviews, research findings, and discussions. They include independent variables, which influence other variables; dependent variables, which are affected by the independent variables; and mediating variables, which explain the relationship between independent and dependent variables (Green, 2014). Additionally, moderating variables that impact the strength of the relationship between the independent and dependent variables are also considered (Green, 2014).

5.6.1. Independent Variables:

In the context of the conceptual framework for the new or enhanced SDLC methodology, the independent variables include:

a) Team Dynamics - This refers to how Team A interacts, communicates and collaborates with each other. It also includes aspects such as team cohesion, technical competencies, and relationship dynamics, which can influence the efficiency and effectiveness of the SDLC process.

b) Current SDLC Methodology —This refers to the current methodology, processes, tools, and practices that Team A uses to deliver digital healthcare products. The current methodology may affect the adoption and success of the new or improved SDLC methodology by providing a point of reference or indicating areas for improvement. As indicated in Chapter 4, most participants (42%) stated that their willingness to transition to a new SDLC methodology would depend on the justification. Therefore, if the new methodology does not significantly improve the current way of working, its effectiveness will not be apparent.

c) Organisational Culture—This variable refers to the values, behaviours, and practices attributed to or defined by Company X. An organisation's culture can affect how new methodologies are perceived, adopted, and implemented across teams and the organisation as a whole.

These independent variables are considered to have a direct or indirect influence on the implementation and outcomes of the new or enhanced SDLC methodology, potentially affecting its success and the improvements it can bring to the development of digital healthcare products.

5.6.2. Central Node:

In this research study, the new or enhanced SDLC methodology has been identified as the central node. As mentioned earlier in this chapter, the new methodology will include key principles such as sprint planning, flexibility, cross-functional collaboration, and continuous improvement. These principles were recognised as common solutions to the challenges faced

by Team A of Company X, as reported by the participants and existing literature. The incorporation of these principles aims to address specific issues encountered during the software development life cycle, with a focus on improving the overall efficiency and effectiveness of the methodology.

5.6.3. Mediating Variables:

In the context of the conceptual framework for the new or enhanced SDLC methodology, the mediating variables include the following :These variables encompass change management techniques, training, and skills development, as they are critical in ensuring the successful adoption of the new or enhanced methodology.

5.6.4. Moderating Variables:

In this conceptual framework, the moderating variable is project complexity, which can be further broken down into the following:

a) Technical complexity which refers to the intricacies involved in the development process, including the technology stack, integration with existing systems, and the need for innovative solutions to meet healthcare standards. Higher technical complexity demands more robust communication and cross-functional collaboration to ensure that all team members understand the technical requirements and challenges.

b) Project scope defines the breadth and depth of the development effort, encompassing the features, functionalities, and user experiences to be delivered. A well-defined scope, aligned with sprint planning for phased delivery, ensures that the project remains focused and delivers value incrementally, preventing scope creep and ensuring that the project meets its objectives within the desired timelines.

c) Deadlines represent the time constraints within which the project or its phases must be completed. Strict deadlines can increase pressure on the team, necessitating efficient planning sessions, frequent check-ins, and retrospectives to monitor progress and adjust plans as necessary. Deadlines act as a force that compels the team to prioritise tasks, manage resources effectively, and make timely decisions to stay on track.

Together, these moderating variables influence the application of the key principles of the new SDLC Methodology, such as continuous feedback and communication, cross-functional collaboration, and sprint planning for phased delivery. They require the methodology to be flexible and adaptable, ensuring that it can accommodate varying levels of technical complexity, project scopes, and deadlines while still achieving the goals of delivering high-quality digital healthcare products efficiently.

5.6.5. Dependent Variables:

In this conceptual framework, the outcomes of the new/enhanced SDLC methodology are the following:

a) Product Quality: The conceptual framework promotes continuous feedback and communication at each phase of the SDLC, ensuring that all stakeholders, including business and technical teams, are aligned. This alignment helps in identifying and addressing issues early, incorporating diverse insights, and ultimately enhancing the overall quality of digital healthcare products by making them more relevant and user-centric.

b) Team Morale: By encouraging cross-functional collaboration and including various stakeholders in different phases of the SDLC, the framework fosters a more inclusive and engaging work environment. This approach not only allows for broader input and knowledge sharing but also boosts team morale by valuing each member's contributions and fostering a sense of ownership and collective achievement across the project lifecycle.

c) Organisational Success: The adoption of an agile approach to product development and delivery, characterised by sprint planning and phased delivery, positions the organisation to be more adaptable and responsive to changes. This flexibility enhances the organisation's ability to meet market demands effectively, address challenges promptly, and leverage opportunities more efficiently, contributing to overall organisational success.

d) Product Development and Delivery: The framework's key principles are designed to streamline the product development and delivery process. Continuous feedback loops,

cross-functional collaboration, and agile methodologies lead to more efficient workflows, reduced time to market, and the ability to iterate on products based on real-world feedback. This agile and inclusive approach ensures that products are not only developed and delivered more efficiently but also align closely with user needs and business goals.

When developing a new SDLC methodology for digital health, the conceptual framework provides a systematic approach to identify gaps in existing methodologies, propose innovative solutions, and evaluate the effectiveness of these solutions in addressing the identified challenges. This conceptual framework for the new/enhanced SDLC methodology will need to be tested initially to determine its effectiveness and to incorporate any improvements gained from implementing the new methodology.

In conclusion, developing a new SDLC methodology suitable for the delivery of digital healthcare products represents a significant step forward in addressing the unique challenges within this domain. The conceptual framework serves as a guide, providing a systematic approach to evaluate the impact of the new/enhanced SDLC methodology. It is recommended that this framework undergoes testing and continuous improvement to ensure that it holds the aim of enhancing the development process and ensuring that digital healthcare products are developed at the expected standard of quality.

6. CHAPTER SIX – CONCLUSION AND RECOMMENDATIONS FOR FUTURE WORK

6.5. Summary and Conclusion

The purpose of this research study is to answer the following critical research question:

"***How can Company X introduce a new or enhanced SDLC methodology that will be suitable for optimising the development of digital healthcare products?***"

The critical research question would be answered by meeting the objective of this study:

- ***To investigate how Company X can introduce a software development methodology that will enhance the development of digital healthcare products and mitigate the challenges faced when utilising the traditional waterfall methodology.***

The sub-objectives of this research study are:

- To evaluate the challenges that are experienced when executing the current SDLC methodology in the delivery of digital healthcare products, as well as the areas in which these challenges arise.

- To analyse various software development methodologies and compare these methodologies to the current model that Team A of Company X currently utilises.

- To identify ways management can ensure the successful transition or adoption of the new software development methodology into the team.

In order to answer the critical research question, a conceptual framework was developed based on the literature review conducted and the results provided by the semi-structured interviews. The semi-structured interviews were analysed using thematic analysis, and several themes were generated to provide a view of how the participants view the digital healthcare industry, challenges experienced with their current methodology, as well as change management strategies management can incorporate to ensure the smooth transition to a new SDLC Methodology.

A summary of the themes presented in the research report are as follows:

- Digital Healthcare Industry and Work Environment.
- Communication and Collaboration with Business and External Clients
- Team Culture and Relationships.
- Current Team Methodology and Processes.
- Project Management and Planning.
- Improvement of current Methodology or adoption of new methodology.
- Change Management.

From the research results, it was discovered that the main challenges of the methodology that Company X utilises are the following:

i. Communication between business stakeholders and internal team members.
ii. Lack of business understanding and involvement in the development process.
iii. Lack of involvement of technical staff in analysis and business discussion.
iv. Poor planning and unrealistic deadlines.
v. Scope Creep.
vi. Lack of a clearly defined methodology.
vii. Lack of flexibility (dependent on the type of methodology utilised.)

It was also highlighted through the interviews that 15% of Team A believe that a pure waterfall methodology is being utilised, while 85% of Team A believes that a hybrid methodology primarily consisting of agile, waterfall, and prototyping is being utilised. Through conversations with Team A participants, various methodologies are utilised as there is no clearly defined process that the team is to follow. The various software projects that the participants of Team A work on utilise a "fit-for-purpose" methodological approach, where an SDLC methodology will be selected and executed depending on the type of project.

As shown in the comparative analysis matrix in Appendix A, any of the six methodologies can be best suited for a project depending on specific characteristic combinations such as project size, complexity, and timelines. Therefore, by not truly defining a methodology, Team A will be open to a various number of methodologies which may or may not assist in an effective project delivery plan.

The participants from Team A-D were asked about their feelings towards changing the current methodology their current team utilises. From the answers provided, 21% of participants would not be happy with changing their current methodology, and 37% of participants would be willing to change their current methodology, whether by adopting a new methodology or simply enhancing the current methodology. The remaining 42% of participants indicated that they are indifferent towards the change to their current methodology; however, their feelings would change depending on the reasoning for the transition. Therefore, in order for management to introduce a new methodology, an effective change management plan would need to be put in place to drive the transition and ensure all stakeholders are on the same page.

A new conceptual framework was generated to mitigate the issues experienced by Company X; where the key principles of this new framework are as follows:

a. Continuous Feedback and Communication
b. Cross-functional Collaboration
c. Sprint Planning for Phased delivery
d. Continuous Improvement and adaptive Flexibility

To evaluate the new conceptual framework and assess its effectiveness, it is recommended that a small software development team be formed. This team would implement and test the SDLC Framework in a non-production environment to ensure that no users are impacted.

For future work, it is recommended that the sample size of participants be increased in order to provide more perspectives from other individuals in Company X. It has also been recommended that a comparative study be conducted with another company operating in the digital healthcare industry. This will allow the researcher to establish whether the challenges noted by the participants of Company X are only privy to Company X or experienced by the industry as a whole.

6.6. Recommendations for Future Work

This section will present the recommendations and future work that can be conducted to improve the validity of this research study.

6.6.1. Increase the sample size of participants using the following criteria:

- Number of participants in various job roles, with experience, and in teams in the software development industry.
- Inclusion of participants from other teams in Company X to gain more insight on the other methodologies utilised in other teams in the company.
- Inclusion of other stakeholders within the software development industry, such as business stakeholders, project managers, scrum masters, release analysts, and delivery managers.

6.6.2. A comparative study using an additional company as a reference:

- Conduct a comparative study at another company operating in the digital healthcare industry to establish whether the challenges and SDLC methodology discussed in this research study are only prone to Company X or whether similar challenges and ways of working are experienced within other companies as well in the industry.

6.6.3. Establish a pilot program to test findings:

- Establish a small software development team to adopt and test the SDLC Framework developed in this research study to validate whether the delivery of digital healthcare products has mitigated the challenges experienced in Team A of Company X.

6.6.4. Qualitative Analysis Software

- Utilise Qualitative Analysis software tools to enhance the accuracy and effectiveness of code tracking and theme generation.

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APPENDIX SUMMARY

The following appendices in this section of the document are used to provide additional detail and context to this research study. A short description has been provided below in order to indicate the type of document in each section of the appendix and the information provided.

APPENDIX A: SOFTWARE DEVELOPMENT METHODOLOGIES COMPARATIVE ANALYSIS

This appendix presents the comparative analysis of various software development lifecycle methodologies studied in Chapter 2 – Literature Review.

APPENDIX B: RESEARCH TIMELINE

This appendix contains the timelines for this research project in the form of a Gantt Chart from January 2023 to March 2024. Each of the tasks required in the delivery of this research study has been listed in the chart, and a colour legend has been provided to note the status of each corresponding task.

APPENDIX C: ETHICS CLEARANCE

This appendix contains the feedback on the ethics clearance application from the School of Mechanical, Industrial, and Aeronautical Engineering. This email indicates that the ethics clearance has been granted, and the ethics clearance number MIAEC 073/23 is to be used as a reference for all future correspondence on this matter.

APPENDIX D: LETTER OF REQUEST TO COMPANY X

This appendix contains the letter of request sent to the HR Department and Management Team of Company X to request permission for this research study to be conducted at Company X.

APPENDIX E: LETTER OF PARTICIPATION

This appendix contains the letter of participation which was sent to each participant of this research study to provide clarity and context on what the study contains as well as how the data obtained from the interview would be utilised and stored.

APPENDIX F: LETTER OF CONSENT

This appendix contains the letter of consent, which was sent to each participant alongside the letter of participation in order for the participant to indicate whether they consented to participate in the interview.

APPENDIX G: INTERVIEW QUESTIONS

This appendix contains the 18 questions used to conduct the semi-structured interviews at Company X.

APPENDIX H: INTERVIEW TRANSCRIPTIONS

This appendix contains the transcriptions of 22 interviews conducted at Company X. The participants of the interviews consist of various stakeholders within the software development lifecycle, such as Business Analysts, Software Developers, Test Analysts, Development Managers, etc.

APPENDIX I: ANALYSIS AND CODING

This appendix contains the analysis and coding document used to analyse the interviews of the research study.

APPENDIX A: SOFTWARE DEVELOPMENT METHODOLOGIES COMPARATIVE ANALYSIS

Table 5: Software Development Methodologies Comparative Analysis

SDLC Methodology	Structure of Methodology	Strengths /Advantages	Weaknesses / Disadvantages	Best Suited Project Application
Waterfall	Sequential process (one phase executed after the other): • Planning • Analysis • Design • Implementation • Testing • Deployment • Maintenance	• Simple to follow. • Issues can be addressed after the lifecycle is completed. • Sufficient planning, requirements gathering and documentation. • All planning done at the start of the project. • Easy measure of project progress.	• Not flexible. • Long timelines and delivery. • All phases need to be completed before product can be delivered. • Minimal involvement from end-user • Not suitable for large scale projects due to risk.	• Small projects. • All requirements and designs are known upfront.

Spiral	Interactive-incremental process: • Planning. • Risk analysis. • Engineering. • Implementation. • Evaluation.	• Requirements and planning do not need to be fully defined at the beginning of the project. • Flexible. • Higher customer involvement. • Feedback can be obtained at any stage of lifecycle. • Good risk management	• Costly. • Unsuitable for smaller-scale projects. • Additional training for stakeholders may be required for risk analysis and management	• Suitable when customer / end-users are not confident in the requirements and product deliverables. • Large, complex projects
Incremental	Incremental deliverables: • Phases are same as waterfall (executed done in multiple increments)	• Lower cost than incremental. • More flexible than waterfall. • Quick delivery. • Easy defect identification. • Project retrospective. • Address changes between increments.	• Project documentation and planning needs to be done at the start of the project. • Higher cost than waterfall.	• Low risk projects. • Large- and small-scale projects

		• Suitable for large and small scale projects		
Prototyping	Incremental deliverables at each stage: • Requirements analysis. • Initial prototype development. • Prototype review. • Prototype enhancement. • Revision.	• Good understanding on whether project is on track and/or whether deliverables meet expectations. • Regular feedback. • Customer focussed. • High customer satisfaction. • Easily incorporated with other methodologies.	• Constant engagement with customer to verify whether solution meets requirements. • Constant rework contract and budget under constant negotiation. • May lead to high costs. • False expectations / optimisms. • Fast delivery leads to poor quality prototypes. • Poor documentation.	• Good communication / relationship with customer • Small scale • Quick delivery projects
RAD	Quick delivery: • Business modelling. • Data modelling. • Process modelling. • Application generation.	• Project progress can be easily measured. • Short project delivery. • Simplified testing process.	• High pressure - very shorter deadlines. • Less focus on documentation. • High skilled developers required for quick delivery	• Low-cost, high quality, quick delivery projects. • Small scale projects

	• Testing.	• Re-usable deliverables in future projects.		
Agile	Sprints (combination of incremental and iterative): • Plan • Design • Develop • Test • Deploy • Review • Launch • Daily Scrum	• High flexibility. • Development can begin without finalised requirements. • Collaboration. • Good feedback and communication. • Better client satisfaction. • Good Risk management. • Fast project delivery. • High quality code.	• Poor documentation. • Insufficient planning at the beginning of project • Scope creep. • High expectations. • Team may need expert training. • Poor measure of project progress.	• Uncertain / unclear requirements. • Fast paced environment. • Quick deadlines. • Customer focussed projects.

APPENDIX B: RESEARCH TIMELINES

The project schedule depicting the timelines for the research project Timelines is shown in the Gantt chart below.

Table 6: Gantt Chart Showing the Timelines for The Research Project

Research Project Gantt Chart															
	Jan-23	**Feb-23**	**Mar-23**	**Apr-23**	**May-23**	**Jun-23**	**Jul-23**	**Aug-23**	**Sep-23**	**Oct-23**	**Nov-23**	**Dec-23**	**Jan-24**	**Feb-24**	**Mar-24**
Define Research Topic															
Development and Submission of the Research Proposal															
Ethics Clearance Application															
Collection of Research Data (Primary and Secondary Data)															
First Draft Research Project															
First Draft: Literature Review															
First Draft: Research Methodology															
First Draft: Research Results and Analysis															

Write: Discussion of Results															
Write: Future Work and Recommendations															
Write: Conclusion															
Write: Introduction and Abstract															
Review and Amendments to the Draft Research Project Report															
Write: Final Research Project															
Submission of Final Research Project															

Table 7: Gantt Chart Colour Legend

Colour Legend	
	Completed
	In progress
	Backlog / to be picked up

APPENDIX C: ETHICS CLEARANCE

Subject: **Your ethics clearance number**

From: Bruno Emwanu <Bruno.Emwanu@wits.ac.za>
To: me

31 Jul 2023, 18:52

B

Dear Michael,

I am pleased to inform you that the School Ethics Committee completed assessing your ethics application for your MSc Eng (50/50) research project titled: “The Optimisation of the Software Development Life Cycle in the Delivery of Digital Healthcare Products” and it has been ratified by the University Main Ethics Committee (non-medical). Your ethics clearance number is MIAEC 073/23.

Please use your ethics clearance number as a reference for all future correspondence on this matter.

Regards,
Dr. Emwanu

APPENDIX D: LETTER OF REQUEST TO COMPANY X



University of the Witwatersrand, Johannesburg
Faculty of Engineering and the Built Environment,
School of Mechanical, Industrial and Aeronautical Engineering,
1 Jan Smuts Ave,
Johannesburg,
2000

Discovery Health Systems,
1 Discovery Place,
Sandton,
2196

27th June 2023

Dear Sir/Madam,

Re: Formal Letter of Permission to Conduct Masters Research Study at Discovery Limited.

My name is Michael Asamoah-Bekoe and I am currently completing my Master of Science in Engineering Management and in order to fulfill the requirements of my degree, I am currently writing my research report.

The title of my research report is namely: **The Enhancement of the Software Development Lifecycle in the Delivery of Digital Healthcare Products**.

The aim and objectives of this study are as follows:

- To investigate how *Company X* can introduce a software development methodology that will enhance the development of digital healthcare products and mitigate the challenges faced when utilising the traditional waterfall methodology.
- To evaluate the current challenges that are experienced when executing the traditional waterfall methodology in the delivery of digital healthcare products, as well as the areas in which these challenges arise.
- To analyse various software development methodologies and compare these methodologies to the current traditional waterfall model that *Company X* currently utilises.
- To identify ways in which management can ensure the successful transition or adoption of the new software development methodology into the team.

For the data collection required for the analysis of this research study, the following research Instrumentation will be used:

- Individual Interviews with stakeholders within a software development team (such as CHS, B2B, VHI, D2HP, Health App Team and/or DAS)
    - Interviews will be scheduled and planned around participants' working schedules so as not to impact any work they are currently executing.
    - The interview will be set for a duration of 30 – 40 minutes.
    - The participants will be asked questions about their roles and experiences during the project delivery.
    - Each interview will be transcribed and recorded using the built-in recording and transcription functionality on Microsoft Teams.

- Project Documentation (Requirements documentation, Work breakdown structures, Jira Reports indicating the number of passed/failed test cases)
    - For 10-15 software development projects delivered between January 2020 and April 2023 at *Company X.*
    - All project documentation will be kept confidential on the company laptop.

In order to ensure that the ethical principles of this study are held, the following actions will be conducted:

1. The organisation analysed in this research study will be anonymised using the pseudonym Company X. (Company X may refer to the organisation / specific team within the organisation)

2. The project documentation produced by Company X as well as the identity of the document authors will be kept confidential throughout all stages of this study. All project documentation will be kept on the company laptop and any identifiable information will be altered or excluded in order to protect the company's identity.

3. The details of the participants to be interviewed as part of this research study will also be kept confidential.

4. Consent will be requested in the form of a participation letter to every participant being interviewed as part of this research study before any interviews are conducted. In the event that the participant no longer wants to be utilised in the data collection of this study, any data noted by the participant will be discarded appropriately and will not be used in the research analysis of results.

5. The participant will be notified prior to the interview on the purpose of the research study and how the data provided will be utilised and stored.

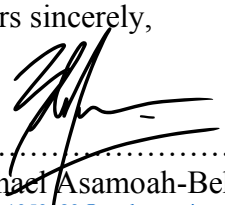
If you are comfortable with the above, please may I request approval indicating that management is comfortable with the research study being conducted at the company as I would need formal permission in my ethics clearance application, which is to be submitted by the **2nd of July, 2023**.

I have attached my research proposal, which the University has accepted, the proposed sample research questions, proof of registration, and proof indicating that the proposal has been accepted.

If you have any questions, please feel free to contact my supervisor (Dr Bernadette Sunjka: bernadette.sunjka1@wits.ac.za) or me.

Looking forward to your response.

Yours sincerely,



……

Michael Asamoah-Bekoe
Email: 1353083@students.wits.ac.za
Tel: 079 253 0402

Supervisor: Dr. Bernadette Sunjka
(Pr.Eng., PMP)
Head of Stream: Industrial Engineering
Senior Lecturer
Post-graduate Co-ordinator
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Tel: (011) 717-7367

APPENDIX E: LETTER OF PARTICIPATION



UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Participant Information Sheet

Good day Sir / Madam,

My name is Michael Asamoah-Bekoe, and I am a Masters student in the School of Mechanical, Aeronautical and Industrial Engineering at the University of the Witwatersrand, Johannesburg. As part of my studies, I am conducting a research study, to investigate the Enhancement of the Software Development Lifecycle utilised in the Delivery of Digital Healthcare Products under the supervision of Dr. Bernadette Sunjka.

This research project aims to investigate how Company X can introduce a software development methodology that will enhance the development of digital healthcare products and mitigate the challenges faced when utilising the traditional waterfall methodology.

As part of this research study's data collection phase, I would like to invite you to participate in a 30 – 40-minute interview. This interview will involve answering questions based on your experience utilising the traditional waterfall methodology or other software development methodologies within your team/company. The interview will take place online via Microsoft Teams or in person via request. Participation in this study is voluntary, and you may withdraw anytime. In the event that the participant no longer wants to be utilised in the data collection of this study, any data noted by the participant will be discarded appropriately and will not be used in the research results. The interview discussion will be recorded and transcribed using the built-in transcription functionality on Microsoft Teams.

The interview recording will be stored on the company's OneDrive repository, which only the researcher can access. Similarly, the transcription will be converted into a Word document that will be password-protected and stored on the University's OneDrive repository and on an external hard drive that will only be accessible to the researcher.

The identity of participants and the company will be kept strictly anonymous and confidential. A pseudonym (e.g. Dev-1, BA-3, TA-9) will be used to represent your participation in my final research report. If you experience any distress or discomfort at any point in this process, we will stop the interview or resume the interview at another time at your convenience.

The study results will form part of my MSc Research Report and may also be reported in academic papers and at conferences. A summary of the research results will be made available to you upon request.

Please contact me if you have any questions about the research or your participation in the study. I look forward to hearing from you.

Yours faithfully,

.....

Michael Asamoah-Bekoe
Email: 1353083@students.wits.ac.za
Tel: 079 253 0402

Supervisor: Dr. Bernadette Sunjka
(Pr.Eng., PMP)
Head of Stream: Industrial Engineering
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Email: bernadette.sunjka1@wits.ac.za
Tel: (011) 717-7367

APPENDIX F: LETTER OF CONSENT



Dear Participant,

Thank you for accepting to participate in this study. Please complete this consent form as you see appropriate. By signing this consent form, you are indicating that you have read and understood the description of this study and that you agree to the terms as described below:

	Mark with X	
	YES	NO
I confirm that I have read and understood the information about this study as provided in the participant's information sheet.		
I understand that my participation is voluntary and that I am free to withdraw at any time without any penalties or negative consequences against me.		
I grant permission for the interview to be audio recorded.		
I agree that the information I provide may be treated as strictly confidential and anonymous and only the research team will have access to the interview data.		
I understand that the information acquired from the interview will not be recorded in excess of what is required for this study.		
I agree that the results of this study may be recorded in academic journals and at conferences.		
I have had the opportunity to ask any questions related to this study and I have had all my questions answered to my satisfaction.		
I may request a report summary, which will come as a result of this study.		

With full knowledge of all the above-mentioned terms, I agree to participate in this study.

Participant		Consent taken by (Researcher)	
Name		Name	
Signature		Signature	
Date		Date	

APPENDIX G: INTERVIEW QUESTIONS

1. How many years have you been working in the software development industry, specifically the health space?

2. What is your role within the team?
   - Are your responsibilities aligned with your job role?
   - Do you feel like everyone acts like a project owner? Takes responsibility.

3. How would you describe the working environment, the business sector, or the industry in which the digital product your team produces operates?

4. How would you describe your team's relationship with the client/business stakeholders of the digital healthcare product?

   - Within your space
   - Relationships within the team

5. What challenges are experienced with your or your team's interaction with clients/business stakeholders?

6. How would you improve the relationship with the client/business stakeholders?

7. Describe what you understand about the SDLC.

8. What SDLC methodology does your team currently utilise?

9. Describe the characteristics of this methodology.

10. In which area or phase within the project lifecycle would you say that you play the biggest role?

    - Are there any other areas/phases of the lifecycle that you have an impact on?

11. What are the challenges you have experienced or witnessed with this methodology? How do you think these challenges could be mitigated?

12. What are the benefits or aspects that work well with using this methodology?

13. How would you improve your team's current/existing methodology?

14. How would you describe team synergy or cohesiveness? Is there anything you would change and why?

    - Would you say that the methodology plays a role in the cohesiveness?

15. Have you heard about other SDLC methodologies/frameworks? Please elaborate.

16. If you had a choice to keep the current methodology or adopt a new methodology within your team – which option would you choose and why?

17. If your manager were to introduce a new methodology within your team, how would you feel about the change?

18. What can your manager do to make you feel more comfortable with changes within your current ways of working?

    - If the participant is a Development Manager – How would you go about implementing a new change within your team?

APPENDIX I: INTERVIEW TRANSCRIPTIONS

This appendix contains the transcriptions of 22 interviews conducted at Company X with various project stakeholders. The interview transcriptions have been uploaded to the author's University of the Witwatersrand One Drive directory and can be accessed using the links shown in the table below.

Table 8.1: Showing the links to the Interview Transcriptions

Participant Pseudonym	Job Role	Link
ARC 1	Systems Architect	Masters Research Interview - ARC_1.docx
BA_1	Business Analyst	Masters Research Interview - BA_1.docx
BA_2	Business Analyst	Masters Research Interview - BA_2.docx
BA_3	Business Analyst	Masters Research Interview - BA_3.docx
BA_4	Business Analyst	Masters Research Interview - BA_4.docx
BA_5	Business Analyst	Masters Research Interview - BA_5.docx
BA_6	Business Analyst	Masters Research Interview - BA_6.docx
DEV_1	Software Developer	Masters Research Interview - DEV_1.docx
DEV_2	Software Developer	Masters Research Interview - DEV_2.docx
DEV_3	Software Developer	Masters Research Interview - DEV_3.docx
DEV_4	Software Developer	Masters Research Interview - DEV_4.docx
DEV_5	Software Developer	Masters Research Interview - DEV_5.docx
DEV_6	Software Developer	Masters Research Interview - DEV_6.docx
DEV_7	Software Developer	Masters Research Interview - DEVS_789.docx
DEV_8	Software Developer	
DEV_9	Software Developer	
DEV_10	Delivery Manager	Masters Research Interview - DEV_10.docx
DM_1	Development Manager	Masters Research Interview - DM_1.docx
DM_2	Development Manager	Masters Research Interview - DM_2.docx
DM_3	Development Manager	Masters Research Interview - DM_3.docx
DM_4	Development Manager	Masters Research Interview - DM_4.docx
DPO_1	Digital Product Owner	Masters Research Interview - DPO_1.docx
TA_1	Test Analyst	Masters Research Interview - TA_1.docx
TA_2	Test Analyst	Masters Research Interview - TA_2.docx

APPENDIX J: DATA ANALYSIS AND CODING

The data analysis and coding document utilised in this research study has been uploaded to the author's University of the Witwatersrand One Drive directory and can be accessed using the following link: Appendix J - Data Analysis and Coding.docx.