Towards a Safer and Healthier Work Environment: Investigating Interface Design Principles for Cognitive Offloading in Emergency Medical Services

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor used artificial intelligence tools or generative artificial intelligence tools (except for grammar and spellchecking as well as for minor writing style improvements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

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Abstract

This research investigates redesign opportunities in emergency medical services, aiming to reduce cognitive load for critical care paramedics using Mobile Data Terminals (MDTs) in ambulance vehicles. By improving interface and interaction design, the project seeks to enhance user wellbeing, efficiency, and performance during high-stress scenarios such as emergency responses.

Due to limited access to participants, the study relied on secondary research to inform design requirements. A low-fidelity prototype was developed in Figma, allowing for iterative reflection and speculative evaluation. The design incorporates both software and hardware improvements. Software changes were guided by Hick's Law and progressive disclosure to minimise on-screen complexity and support clear, focused task flow. Hardware enhancements include the integration of physical buttons for essential functions like Lights On, Call, and Toolkit, alongside added communication features such as a speaker and microphone to streamline critical interactions.

The proposed system aims to support faster decision-making for paramedics, accurate documentation, and reduced mental strain by aligning interface design with the realities of emergency contexts. Drawing on literature and expert input from AUT paramedic staff, the project highlights how interruption-resilient design, visual hierarchy, and thoughtful automation may produce systems that improve cognitive performance under pressure. It also considers institutional barriers to innovation in paramedicine, advocating for system-level change to enable sustainable technological adoption.

Positioning the Researcher

This research builds on both, my academic background, and personal experiences. I come from a background in service design, graphic design, and user interface/user experience (UI/UX) design. I have a strong commitment to human-centred approaches and collaborative design practices. My professional and academic focus has consistently been on creating intuitive, efficient, and empathetic systems that respond to the needs of users. I am passionate about working with people, better understanding their challenges, co-designing solutions, and translating complex needs into accessible, functional outcomes.

Beyond my professional and academic interest, this research topic holds personal significance. I come from a family of doctors and medical practitioners, and I have witnessed first-hand the mental strain and emotional toll associated with working in high-pressure environments, particularly in emergency medical services (EMS). These experiences have helped shaped my empathy for those working in the healthcare system and have inspired me to apply my design skills in ways that can make tangible, positive differences in the lives of EMS worker.

This project represents the intersection of my design expertise and my personal motivation to contribute to the well-being of healthcare professionals. By applying UI/UX and service design principles within the EMS context, I aimed to reduce cognitive load by enhancing the usability of digital tools to improve user experiences for ambulance personnel. I drew on methodological approaches such as human-centred design and systems thinking to ensure that the proposed solutions are both contextually relevant and responsive to the lived experiences of users.

Setting out on this research, I hoped that my interest in the subject matter would motivate me to bridge the gap between technological innovation and human needs and would result in solutions that are functional and meaningful in the day-to-day realities of emergency medical care.

Introduction

Emergency medical service (EMS) personnel operate in environments characterised by rapid decision-making, unpredictability, and high cognitive demand (Zaphir et al., 2025). These professionals are routinely required to make critical decisions under intense pressure, often while simultaneously interacting with complex systems and digital technologies (Rinkinen et al., 2024). One such system is the mobile data terminal (MDT), a device originally intended to enhance communication and streamline data documentation in prehospital settings (St John, personal communication, April 16, 2025). However, despite its intended purpose, there is anecdotal evidence that MDTs are not adequately designed for the specific needs of paramedics. Instead, these systems often prioritise data entry and documentation protocols over usability, leading to inefficient interactions during high-stress situations. This misalignment between system design and user needs likely contributes to increased cognitive load, which may negatively affect paramedic performance and overall well-being.

Although healthcare has seen substantial technological advancements, particularly in clinical decision-making support, diagnostics, and communication, there is anecdotal evidence regarding the limited focus on how interface design can be strategically leveraged to reduce mental burden in high-stakes, emergency contexts. The cognitive limitations of users in such environments are frequently overlooked in the design of digital systems, despite research that clearly illustrates the impact of stress on working memory, attention, and decision-making (McManus et al, 2022). Addressing this gap is critical, as cognitive overload can compromise both, provider safety and patient care outcomes.

This study examined the potential for redesigning the mobile data terminal (MDT) interface, drawing on secondary research to develop a design more attuned to the cognitive demands and real-world conditions experienced by paramedics. It also highlighted the issue of cognitive overload and its impact on EMS personnel, underscoring the importance of user-centred design in supporting their performance and well-being.

Chapter 1: Contextual Review

1.1 The Paramedic Space

There are various types of paramedics, such as critical care paramedics, intensive care paramedics, or advanced care paramedics. This research focused on critical care paramedics due to the nature of their work. Paramedics in this field are responsible for driving an ambulance while managing the MDT that includes the electronics patient report form (ePRF), information on an incident, communication to relevant parties and navigation, treating the patient, and handling communication and navigation independently. Critical care paramedics operate single operated ambulances provide prehospital care for patients involved in multi-trauma incidents. This section will provide some contextual background, outline the expectations for a critical care paramedic, and discuss how the role of a paramedic has changed over time.

The paramedic role, once narrowly defined within the confines of primary, emergency, and urgent care settings, has undergone significant transformation in response to evolving societal demands and employer expectations. Traditionally centred on providing acute care to the severely ill or injured, paramedics are now increasingly expected to function within what Hill and Eaton (2023, p. 45) describe as "non-traditional paramedic occupational spaces." This expansion has redefined the professional scope, necessitating new skill sets, greater adaptability, and a more comprehensive knowledge base. However, this broadened remit has also given rise to role stress, wherein externally imposed expectations conflict with individual understandings of the role, leading to a dissonance between perceived responsibilities and actual capacity (Hill & Eaton, 2023). Such misalignment is further exacerbated by the absence of structural clarity and organisational support, fostering both environmental and psychological strain among emergency medical services (EMS) personnel.

1.2 Critical Care Paramedics

The role of critical care paramedics remains under-documented, with limited research available to clearly define their scope, responsibilities, and working conditions. Wilkinson-Stokes (2021) offers one of the few comprehensive overviews, categorising various frontline paramedic roles across Australia and New Zealand. This includes distinctions in scopes of practice, qualifications, training pathways, and job titles used by different ambulance services. The once-common term "General Care Paramedic" has largely been phased out, with "Extended Care Paramedic" (ECP) now being the most widely adopted. Eight services across the region have implemented a version of the ECP role, with six, including St John New Zealand and Wellington Free Ambulance, using the exact title.

St John New Zealand defines critical care paramedics as highly trained professionals capable of delivering advanced medical interventions across a wide range of settings, from rapid response vehicles and helicopters to GP clinics and remote overseas locations such as the Pacific Islands and the Middle East (AUT Paramedic Career Sheet, 2022). These clinicians often operate solo, managing all aspects of care independently, from patient assessment and medication administration to vehicle operation.

Seven services across Australia and New Zealand use the title "Intensive Care Paramedic," with Ambulance Victoria employing the specific designation "Mobile Intensive Care Ambulance (MICA) Paramedic." This role closely aligns with St John's critical care paramedic profile (Wilkinson-Stokes, 2021). According to the Australian Paramedic College (2023), MICA paramedics are deployed in various types of emergency vehicles and possess advanced expertise in anatomy, pharmacology, and physiology. Their specialised training supports rapid clinical decision-making with minimal external consultation (Morgan, 2023).

Clearly defining and understanding the diverse roles and scopes of paramedics is vital to informing effective design interventions. However, ambiguity surrounding job titles, responsibilities, qualifications, and expected outcomes remains a significant barrier to prototyping and innovation in this field. Without clear definitions of these elements, designers lack the necessary information to develop solutions tailored to specific roles and tasks. This lack of clarity not only hinders designers but also contributes to the ongoing issues of overexertion and burnout among paramedics.

Paramedic work is inherently high-stakes, time-sensitive, and emotionally charged, characteristics that contribute to a demanding professional environment (Grigsby & Knew, 1988). These pressures do not merely influence operational efficiency but also have profound psychological implications (Lawn et al., 2020). As such, understanding the personal and occupational stressors faced by paramedics becomes a crucial next step. The following section will explore the detrimental effects of stress and burnout among paramedics, highlighting the impact on wellbeing. Understanding these effects is essential in identifying the underlying causes and reinforcing the need for targeted interventions within the profession.

1.3 Stress and Burnout

Stress affects individuals in different ways This section explores the complex and often unspoken impact of stress and burnout among paramedics. It examines how stress is experienced within EMS environments and introduces common personality traits observed in paramedics—traits that may influence how individuals perceive stress, cope with it, or seek support. In many cases, these personality factors can make it less likely for paramedics to report difficulties or ask for help, further reinforcing the need for proactive, systemic support. Both the immediate and long-term consequences of stress on individual wellbeing are discussed, alongside the broader implications for performance and safety.

Additionally, this section introduces the concept of cognitive load, what it is, how it operates, and how it manifests in high-pressure EMS contexts. Understanding the interaction between cognitive demands and stress is essential for identifying root causes of burnout and for designing targeted interventions that support paramedics' mental health, resilience, and professional effectiveness.

1.3.1 Stress in the Emergency Medical Environment

Emergency medical personnel often experience many sources of stress that may impact the ability of personnel to work effectively and efficiently. These challenges not only hinder performance but also contribute significantly to burnout syndrome, ultimately affecting the overall well-being of emergency medical service (EMS) personnel (Grigsby & Knew, 1988).

EMS departments face persistent challenges, including resource constraints, outdated infrastructure, escalating service demands, inequitable regulatory requirements, and limited technological advancement (Basnawi, 2023). These systemic limitations, when combined with the high expectations placed on EMS workers, create a work environment that is both physically and psychologically demanding. The cumulative impact of these pressures has been linked to increased rates of mental illness, psychological distress, and the physical manifestations of psychological injury (Lawn et al., 2020). Studies have reported widespread incidences of post-traumatic stress (PTS), depression, anxiety, and general psychological distress among paramedics (Petrie et al., 2018). In a comprehensive review, Lawn et al. (2020) found that emergency medical response work significantly affects the psychological, psychosocial, and physical health of EMS personnel. Observable symptoms, such as emotional outbursts, reduced tolerance for everyday interactions, irritability, self-isolation, and sleep disturbances, further highlight the toll this profession takes on individual well-being. These findings reinforce the growing concern that the current demands and systemic shortcomings within EMS contribute to a sustained decline in workforce health and EMS personnel wellbeing (Grigsby & Knew, 1988).

1.3.2 Managing Complex and Stressful Situations

Despite the EMS field being regarded as a highly stressful profession (Mason et al, 2020), many professionals in the field exhibit certain personality attributes that suggest a degree of psychological resilience, including the ability to detach from emotionally distressing experiences and utilise effective coping mechanisms (p. 281). Paramedics were typically found to score low on Neuroticism and Openness, while exhibiting high levels of Extraversion, Conscientiousness, and Agreeableness (Mason et al., 2020). These attributes have been analysed by Mason et al. (2020) through the lens of the Big Five personality framework (B-5), (DeNeve & Cooper, 1998). High ratings in extraversion, conscientiousness, and agreeableness align closely with traits desirable in caregiving professions—such as empathy, altruism, strong interpersonal skills, task management, and goal orientation. These traits contribute to effectiveness in high-pressure environments where both, technical competence and human compassion are required. Low neuroticism, associated with reduced experience of negative emotions, appears to provide a buffer against emotional distress. However, as DeNeve and Cooper (1998) caution, low neuroticism does not necessarily imply the presence of high positive affect (p. 220). Similarly, low openness may indicate reduced cognitive flexibility and a tendency toward rigidity in thought, which could influence how paramedics engage with complex or ambiguous situations.

As highlighted by Mason et al. (2020) and Deneve & Cooper (1998), the personality profile commonly found among paramedics appears to offer protective benefits against the emotional toll of their work, particularly through emotional regulation and task management. This pattern may reflect a coping mechanism shaped by the institutional limitations outlined in the previous, such as policy and systematic issues. This notion is further substantiated by the findings of Lockhart and Perrott (2024) who observed reluctance of EMS personnel to engage with supervisors, employee assistance programs, or peer and family support services. While there is no clear indication of distrust toward these resources, the hesitation appears to stem from deeper systemic issues rather than individual concerns. As such, there is a critical need to actively listen to paramedics' experiences and address the systemic issues they report (Lockhart and Perrott, 2024).

1.3.3 Coping Mechanisms and dealing with stress

Paramedics are known to adopt a range of coping mechanisms in response to the psychological demands of their work. These strategies typically include both problem-focused and emotion-focused approaches, a pattern that aligns with personality traits such as low neuroticism (Lockhart & Perrott, 2024). While this suggests a level of emotional resilience, it is important to recognise that paramedics often lack adequate social support (Grigsby & Knew, 1988). Despite the availability of formal support systems—such as supervisors, employee assistance programs, and peer or family support services—many paramedics decline to seek help through these channels (Lockhart & Perrott, 2024). This reluctance, potentially linked to cultural norms within the profession or personality traits such as self-reliance, may contribute to increased vulnerability to burnout and mental illness, even in individuals who appear emotionally stable, (Lockhart & Perrott, 2024).

Compounding these challenges is a high incidence of workplace violence experienced by EMS personnel. Boyle et al. (2007) report that 60% of paramedics globally have encountered some form of physical violence while on duty. This includes not only physical assaults but also property damage, intimidation, sexual harassment, and sexual assault. Additionally, between 21% and 78% have reported experiencing verbal abuse, further highlighting the volatile nature of the work environment. These statistics underscore the reality that the paramedic profession, while essential, is marked by significant occupational risk and persistent psychological strain (Boyle et al., 2007).

Despite the critical role paramedics play in healthcare delivery, the EMS work environment remains both physically and emotionally challenging. Additionally, EMS personnel tend to reject available support systems. The following section will examine the impact of these issues on the individual to understand short-term and long-term impacts of a high stress profession.

1.3.4 The Impact of Stress on People

Cognitive overload, as defined by the American Psychological Association (2018), refers to a "situation in which the demands placed on a person by mental work (the cognitive load) are greater than the person's mental abilities can cope with." This concept forms the foundation of Cognitive Load Theory (CLT), a psychological framework introduced by Plass et al. (2010), which seeks to explain cognitive and behavioural phenomena arising from instructional processes. The primary aim of CLT is to anticipate learning outcomes by considering the capacities and limitations of human cognition. Given this, CLT is particularly useful in high-pressure settings, such as emergency medical environments, where every decision counts, as it offers insight into how thoughtful design can help reduce mental strain.

CLT equips designers with the tools to identify and address sources of cognitive overload by categorising it into three types: intrinsic, extraneous, and germane load (Plass et al., 2010). Each type originates from different sources and impacts cognitive processing in distinct ways. According to Plass et al. (2010), intrinsic load is linked to the inherent complexity of the task itself, often determined by the number of interacting elements that need to be processed simultaneously. Extraneous load arises from poorly structured instruction or inefficient system design that imposes unnecessary cognitive effort. Germane load, on the other hand, is beneficial, it refers to the mental effort directed toward processes that foster learning and schema development, such as automation and internalisation of information (Plass et al., 2010).

In the context of emergency medical services (EMS), both intrinsic and extraneous cognitive loads are highly prevalent (Zaphir et al., 2025). Zaphir et al. goes on to explain that EMS personnel are routinely faced with complex, high-stakes situations that elevate intrinsic load, such as having to make rapid decisions using multiple sources of real-time information. At the same time, the unpredictable and dynamic nature of emergency scenarios, paired with ongoing problem-solving requirements, increases extraneous load. These cognitive demands not only impact immediate task performance but can also lead to longer-term stress and mental fatigue (Plass et al., 2010).

Unlike intrinsic and extraneous load, germane load supports optimal performance by enabling knowledge consolidation and more efficient task execution (Plass et al., 2010). In EMS settings, processes that encourage the automation of routine tasks could help free up cognitive capacity for more critical decision-making (Plass et al., 2010). Based on this understanding, it is reasonable to suggest that enhancing germane load through improved system design may help reduce the burden imposed by both intrinsic and extraneous load.

A clear understanding of these three types of cognitive load offers a valuable framework for assessing the challenges EMS workers face. By identifying and analysing the specific sources of cognitive strain, designers are better equipped to determine which aspects of tools, systems, or interfaces require improvement. The following section will delve deeper into how cognitive overload manifests in emergency medical settings and the factors that contribute to its development.

1.3.5 Emergency Medical Service (EMS) Cognitive Load

The emergency medical services (EMS) environment is inherently high-stress, and it has already been well established that prolonged exposure to such conditions negatively impacts paramedics and other EMS providers. This section examines in detail the detrimental effects of human error in EMS settings, errors that often arise as an unfortunate consequence of cognitive overload. It also explores the various contributing factors to cognitive overload in these environments. Understanding these factors is a necessary first step toward developing targeted strategies that can reduce and manage cognitive load, thereby enhancing both provider well-being and patient safety.

Human error in EMS can have significant consequences. As Zaphir et al. (2025) explain, decision-making under high stress, such as the types faced by paramedics, relies heavily on the individual's ability to process relevant information from multiple sources while simultaneously filtering out distractions. Given that EMS work frequently occurs in unpredictable, high-pressure environments, the cognitive demands placed on providers are substantial. However, the capacity to manage such load is inherently limited. Therefore, incorporating empirical research on cognitive load into EMS practice is essential.

Zaphir et al. (2025) identified several factors that influence cognitive load, including task complexity, physical exertion, professional experience, and equipment design. Their findings indicate that elevated cognitive load impairs clinical performance, leading to increased error rates (e.g., intubation mistakes or sharps injuries), delays in task execution, and overall reduced effectiveness (such as poor-quality compressions or airway management challenges). Furthermore, their research demonstrates a reciprocal relationship between cognitive load and emotional states: high cognitive load contributes to stress, anxiety, and burnout, which in turn further increase cognitive burden.

The study by Zaphir et al. (2025) emphasises that physical, cognitive, and emotional factors can either exacerbate or alleviate cognitive load. While multiple sources of load may accumulate, their impact can be mitigated through targeted interventions, such as minimising physical strain, simplifying tasks, employing emotional regulation strategies, and using well-designed equipment developed in consultation with frontline users.

The link between human error and cognitive overload in EMS, along with various contributing factors, highlights the need for targeted support. The work of Zaphir et al. (2025) identified specific issues within ambulances through preliminary research and consultations, particularly involving the communication device known as the mobile data terminal (MDT). The following section will examine the ambulance environment and key incidents, as this context plays a pivotal role in the MDT's redesign. A clear understanding of the hazards present within the ambulance setting is essential to inform and guide effective design solutions.

1.4 The Ambulance Safety and Accidents:

This section provides an overview of ambulance operations, common incidents involving emergency vehicles, and introduces the concept of a one-manned ambulance. Paramedics—including ambulance officers, emergency medical responders, and emergency medical technicians—play a vital role in emergency response and disaster management across the globe. These professionals are often the first point of contact in life-threatening situations, delivering critical interventions and stabilising patients before further medical care can be provided. The nature of their work is inherently high-risk, particularly due to the demands of emergency vehicle operations, which frequently place them in hazardous environments. As Mulvihill et al. (2025) emphasise, while paramedics are essential components of the healthcare system, they are also routinely exposed to significant occupational dangers.

Among the most pressing of these dangers are those associated with emergency driving. In Australia, Maguire et al. (2014) identified motor vehicle crashes as the leading cause of paramedic fatalities. Between 2000 and 2010, an average of one paramedic died and 30 were seriously injured every two years as a result of vehicle crashes. These incidents contribute to a paramedic fatality rate that is six times higher than the national average. These alarming figures underscore the occupational hazards and systemic safety risks inherent in emergency medical service operations.

Mulvihill et al. (2025) provide a comprehensive analysis of these incidents in a systematic review that applies a systems thinking framework, which conceptualises safety incidents as the outcomes of complex interactions within a broader sociotechnical system. This approach departs from the traditional focus on isolated human error or environmental conditions by emphasising the interconnectedness of factors contributing to risk.

While previous studies have typically examined elements such as road conditions, the situational context at emergency scenes, and driver behaviour, Mulvihill et al. (2025) argue that such perspectives often neglect broader systemic influences. Their findings highlight the importance of incorporating factors like organisational culture, supervisory practices, work policies and procedures, training standards, and regulatory environments into crash risk assessments. Furthermore, the study suggests that societal influences, including the role of social media use and digital distractions, should not be overlooked, as they can significantly shape behaviour and decision-making in high-stakes situations.

These concerns are particularly crucial when considering the emerging concept of the single operated ambulance. Given that motor vehicle crashes already pose substantial risks to paramedics operating in standard two-person teams (Mulvihill et al., 2025), it stands to reason that single-crewed ambulances, where the cognitive and operational burden falls entirely on one individual, may introduce even greater risks. The increased distractions and divided responsibilities inherent in one-manned operations could exacerbate the likelihood of critical incidents.

The next section explores the development and rationale behind the one-manned ambulance concept, setting the stage for a deeper examination of its implications for safety and system design.

1.4.1 Single Operator Ambulances

There is limited empirical evidence available regarding the implementation and effectiveness of ambulances operated by a single operator. This section explores a seminal article titled ‘Pre-hospital Cardiac Care in a Paramedical Mobile Intensive Care Unit,’ by Lewis et al. (1972). This provides insight into the origins and purpose of single-operator ambulances and offers a reasoned hypothesis on how these models have evolved into their present form.

Lewis et al. (1972) provide a foundational overview of the MICA model. Developed in the 1960s in California as a pilot program at Harbor General Hospital, the initiative aimed to optimise the use of existing paramedical personnel by enhancing their capabilities through specialised training and the integration of portable medical equipment. The primary goal of this model was to deliver advanced pre-hospital cardiac care efficiently and cost-effectively.

In its initial iteration, the one-manned MICA unit was staffed by firefighters who had undergone intensive paramedic training. These paramedics were authorised to perform life-saving interventions, such as cardiopulmonary resuscitation (CPR), while maintaining communication with physicians via radio for consultation and guidance. This approach enabled rapid response times and was praised for its economic efficiency, laying the groundwork for broader implementation of the MICA system in various EMS jurisdictions.

The success of this early model demonstrated the potential for a streamlined, resource-efficient approach to advanced pre-hospital care. It highlighted the value of equipping highly trained personnel with portable medical technologies to improve patient outcomes prior to hospital admission. These encouraging early outcomes contributed to the gradual global expansion of the one-person ambulance unit within EMS systems.

However, the iteration mentioned in this article by Lewis et al. (1972) and the contemporary iteration of the MICA model described by the Australian Paramedic College (2023) differ significantly. Current critical care or intensive care paramedics operate without real-time physician consultation. These professionals are now expected to independently make rapid, high-stakes decisions while concurrently managing multiple complex tasks, such as gathering patient histories, performing assessments, and administering a broad range of treatments (Morgan, L. 2023). The scope of paramedic practice has extended far beyond CPR and basic interventions to encompass advanced airway management, pharmacological therapy, and critical trauma care.

Based on the article explored above, it appears that the original design of the one-manned ambulance was feasible due to the relatively narrow scope of the paramedic role at the time. However, as the role has evolved, the expectations and clinical demands placed on paramedics have grown substantially—arguably beyond the operational capacity of a single individual in the field. This discrepancy between the initial design and current practice has led to many of the systemic challenges observed in modern paramedicine, including increased stress, decision fatigue, and heightened risk of clinical error.

Having explored the historical development and current implications of the one-manned ambulance, the next section turns to the medical data terminal (MDT). The MDT plays a critical role in EMS operations and is a central focus in discussions around ambulance and equipment redesign.

1.4.2 The Mobile Data Terminal (MDT)

The MDT is a tool implemented in contemporary ambulance operations. It facilitates real-time data capture, route planning, incident monitoring, and billing support. Within the pre-hospital care context, the MDT enables paramedics to digitally record essential patient care information, which can then be transferred directly to receiving hospitals during handover. This section explores the rationale behind the implementation of the MDT and highlights the company responsible for its development and ongoing support.

As outlined in the electronic Patient Report Form (ePRF) e-PASSPORT training booklet provided by St John New Zealand, the MDT, alongside the ePRF is a part of an ecosystem of a paperless documentation system. This system was designed to enhance patient care, improve clinical decision-making, and increase operational and financial efficiency. The information collected through MDTs plays a vital role in informing service planning and policy development within both St John New Zealand and the Ministry of Health. Given these high-level objectives, the accuracy and completeness of patient care records are of paramount importance.

St John New Zealand identifies Valentia Technologies as the provider of the MDT system. Valentia specialises in digital healthcare solutions, offering a range of services including cloud-based electronic health records, mobile practitioner platforms, and emergency care systems. Their MDT solution is supported by the Caremonx suite—an emergency care platform designed to streamline response times, enhance decision-making, and optimise data collection and management in high-pressure scenarios, as described on their official website.

The primary aim of the MDT is to improve communication and documentation, particularly concerning the patient report form. However, despite the system's potential benefits, frontline experience has revealed several challenges (St John, personal communication, April 16, 2025). The interface, while robust in theory, often proves inefficient in practice due to a steep learning curve and the volume of information required for documentation. These issues can detract from clinical efficiency and add to the cognitive burden already experienced by paramedics in high-stress environments.

To better understand how design can enhance the usability and functionality of the MDT, it is essential to examine each of its components in greater detail. Accordingly, the next section explores the ePRF more closely, with a focus on its integration into pre-hospital workflows and its implications for paramedic performance.

1.4.3 The Electronic Patient Report Form (ePRF)

The ePRF is a key component of the MDT system used in ambulance services. When an incident is initiated, an ePRF is automatically generated and pushed to the MDT alongside the incident location. The primary function of the ePRF is to facilitate the collection of critical information—including patient history, personal details, assessment findings, initial care provided, and estimated transport time. Developed as part of the broader shift toward a paperless system, the ePRF is intended to improve documentation practices while enhancing both operational and financial efficiency within emergency medical services (EMS).

This content has been removed by the author due to copyright issues.

Figure 1: The Electronic Patient Report Form (ePRF) interface on the Mobile data Interface (MDT) (Source: St John, personal communication, April 16, 2025)

According to St John New Zealand's ePRF e-PASSPORT training handbook, the system was designed to support seamless information transfer and to promote real-time documentation. By integrating patient data, clinical observations, and treatment interventions into a single digital record, the ePRF enables more efficient communication between paramedics, emergency departments, and other healthcare providers. In doing so, it marks a significant shift in how pre-hospital care is recorded and shared, transitioning from a paper-based system to a fully digital, paper-free approach. The data captured through this system will enable St John and the Ministry of Health (MOH) to more effectively plan, evaluate, and implement changes across clinical, operational, and financial work practices.

However, despite these intended benefits, the ePRF system has notable limitations. The handbook reports that many paramedics experience a steep learning curve when first engaging with the platform. This complexity can act as a barrier to effective patient interaction, as paramedics may become more focused on inputting data into the system than engaging with the patient in their care. This not only impacts the quality of patient care but also contributes to increased cognitive load during already high-stress situations.

As outlined above, while the ePRF was developed to support documentation and communication, its current form introduces challenges that can undermine its core purpose. The insights gained from this analysis are crucial, as this thesis seeks to evaluate the functionality of the ePRF system, assess its impact on pre-hospital patient care, and identify opportunities to improve its usability, accuracy, and overall effectiveness. These findings will directly inform a redesigned interface aimed at supporting paramedics in the field without adding to their workload or compromising patient rapport.

To further inform this redesign process, it is essential to understand how data collection and analysis are approached within the broader healthcare system. The following section explores the design principles and data handling processes that underpin digital health technologies. This enables the identification of best practices for redesigning technology within medical environments.

1.5 Design Within the Healthcare System

Examining other examples of design within the medical context provides a clearer understanding of both the requirements and expectations when designing for healthcare systems. This section explores design practices in the medical field, identifying common challenges and examining how these can be addressed or mitigated through evidence-based approaches. It also includes a focus on the medical landscape in Aotearoa New Zealand, offering context for the current state of healthcare design in the country.

New Zealand's current health system has been described as "bloated" by Dr. Lester Levy, who was appointed Health Commissioner in September 2024 and tasked with reducing overspending within the sector (News, 2024). However, the emphasis on overspending may obscure more critical systemic issues contributing to the current state of healthcare. These include persistent workforce shortages, which—far from being unique to New Zealand—are a global challenge. These shortages exacerbate burnout, leaving healthcare workers overwhelmed and under-resourced.

Given these ongoing challenges, there is a clear need for innovation within the system. However, as previously mentioned, constraints such as limited budgets, insufficient capacity, and strict privacy regulations pose significant barriers to implementing innovative solutions in the healthcare sector.

In summary, New Zealand, like many other countries, lacks sufficient financial resources to meet the growing demands of its healthcare system. While this is not an isolated issue, there are strategies that can be employed to navigate these constraints. The following sections examine some of the core challenges associated with designing for the medical field and consider specific strategies adopted by systems such as the United Kingdom's National Health Service (NHS). The NHS, despite being one of the world's largest public health providers and frequently criticised for underfunding, has taken deliberate steps to create opportunities for innovation in the healthcare space.

1.5.1 Privacy Constraints

Designing for the medical sector requires navigating a highly regulated and resource-constrained environment. In Aotearoa New Zealand, these challenges are particularly pronounced due to systemic issues such as limited funding, workforce shortages, and stringent privacy protocols. Understanding these constraints is essential for designers seeking to contribute meaningfully to healthcare innovation.

A major impediment to innovation is the governance of patient data. According to Kelly and Young (2017), existing privacy frameworks have become excessively complex, rigid, and risk-averse, preventing data from being used effectively in clinical research and design. In addition, concerns around intellectual property often led to the abandonment of promising ideas before they can be developed or tested. My own experience with Hato Hone St John Ambulance exemplifies these barriers; their support for a design initiative was withdrawn due to unresolved privacy concerns. Such experiences illustrate how current data governance structures hinder collaborative efforts between designers and healthcare providers.

In summary, while innovation in healthcare design is urgently needed, its implementation is often constrained by regulatory, ethical, and institutional barriers. Privacy legislation and intellectual property concerns can restrict access to clinical environments and hinder the progression of potentially impactful ideas (Kelly & Young, 2017). These challenges are particularly pronounced in the New Zealand context, systemic underfunding, and limited capacity further complicate innovation efforts. Within the scope of this thesis, I have also encountered privacy-related challenges firsthand, underscoring the practical impact of these limitations on healthcare research and design.

The next section will build on this discussion by examining how technology can be leveraged to address cognitive overload in emergency medical settings, specifically through the concept of cognitive offloading

1.6 Cognitive Offloading with the Use of Technology

Technology has become an indispensable part of modern healthcare systems, with growing evidence supporting its ability to streamline processes and improve patient outcomes. In the context of Emergency Medical Services (EMS), where high-pressure environments and time-sensitive decision-making are prevalent, the integration of digital tools and interface design has shown promising results in enhancing performance and reducing error. This section explores the application of technology and interface redesign to mitigate cognitive overload, particularly in an EMS setting. The discussion builds toward the proposal of redesigning the Mobile Data Terminal (MDT) interface, presenting cognitive offloading as a practical intervention to support EMS personnel.

There is already substantial evidence demonstrating the positive role of technology in supporting healthcare delivery. Rinkinen et al. (2024) report various advancements in EMS systems, including improved prehospital medication delivery, the use of prehospital electrocardiograms (ECGs), and enhanced telecommunication between EMS and hospitals. These developments have not only supported faster, more accurate diagnosis and treatment but have also paved the way for further digital innovation in prehospital care.

An additional area of progress is the design of user interfaces for medical equipment. Liljegren et al. (2000) explored how redesigning the user interface of a volumetric infusion pump could reduce user error and improve efficiency. The team used field studies, evaluations of existing devices, and incident analyses to guide the development of a new interface, which was then tested for usability by nurses. Results showed a significant reduction in mode errors and decreased programming time, indicating that a well-designed interface could lessen the cognitive demand on users.

Crucially, Liljegren et al. (2000) concluded that human mental capacity is both limited and easily overwhelmed in high-stress environments. In such contexts, mental resources are best allocated to patient care rather than navigating complex or poorly designed equipment. This finding underscores the concept of cognitive overload, where the mental demands of a task exceed an individual’s capacity to manage them effectively. Their work provides a clear example of how thoughtful design can alleviate such overload and improve performance in clinical settings.

This line of thinking supports a proposal to redesign the Mobile Data Terminal (MDT) interface used in EMS. Like the infusion pump, the MDT is a critical tool that must be used efficiently under pressure. There is evidence of similar concerns have been documented in police forces using Mobile Computer Terminals (MCTs), a comparable technology to the MDT. Shahini et al. (2021) highlight the risk of in-vehicle distraction caused by these terminals, linking them to increased accident rates among officers. The study aligns with previous findings suggesting that in-vehicle technologies can divert attention, especially in high-stress situations, where cognitive capacity is already taxed. These parallels reinforce the urgency of evaluating and redesigning EMS tools such as MDTs to reduce mental strain and improve operational safety.

In summary, the application of digital technologies and user-centred interface design has already demonstrated substantial value in cognitive offloading, particularly in high-stakes environments. Studies by Rinkinen et al. (2024), Liljegren et al. (2000), and Shahini et al. (2021) all illustrate the importance of designing systems that align with the cognitive limitations of their users. These findings lay the foundation for proposing a redesign of the MDT interface with the goal of reducing cognitive overload and enhancing decision-making during emergency response. The next section will explore this idea further by introducing the concept of cognitive offloading, examining how technological solutions can be purposefully designed to reduce the cognitive burden on EMS professionals, specifically ambulance personal and ultimately improve their performance and wellbeing.

1.6.1 Cognitive offloading in an Emergency Medical Setting (EMS)

There is growing evidence of cognitive offloading within emergency medical service (EMS) environments. This section explores existing literature related to coping strategies aimed at supporting the psychological well-being of ambulance personnel, as well as training approaches intended to improve operational outcomes. While literature in this area is relatively scarce, due to the fast-paced and unpredictable nature of EMS work, this scarcity itself highlights the critical need for further investigation into this gap.

Lawn et al. (2020) present two categories of strategies for managing psychological distress among ambulance personnel: those that address the emotional toll of responding to critical incidents and those that target broader organisational issues. These approaches underscore the multifaceted nature of stress in EMS work and suggest that effective support must consider both individual and institutional dimensions. While organisational issues may require internal policy changes, programs focused on targeted training have shown promise. For instance, Von Vopelius-Feldt et al. (2023) found that outcome-focused training, combined with modern, well-designed equipment, led to improvements in performance within prehospital settings.

Another example illustrating the impact of training is provided by Simpson et al. (2023), who developed short workshops grounded in a theory of change model to improve paramedic responses for patients dying at home. These workshops were informed by rigorous research that identified effective strategies and necessary resources to achieve desired outcomes. However, it is important to note that both of these examples prioritise patient care and system efficiency, with relatively little focus on the mental health and well-being of EMS personnel themselves.

There are, however, efforts underway—such as those observed in Australian EMS training programs—that encourage new graduates to monitor and manage their own psychological health alongside their clinical responsibilities. Despite these advances, the field remains underdeveloped. As Reynolds et al. (2021) emphasise, more empirical research is needed to understand how best to support the mental well-being of those working in ambulance settings. Existing literature does acknowledge the cognitive overload frequently experienced by EMS workers, yet it often lacks depth in exploring how to systematically mitigate this burden.

In summary, evidence suggests that thoughtfully structured programs and comprehensive training can contribute to maintaining the psychological well-being of EMS personnel. However, there remains a significant gap in literature addressing sustained mental health support within this context. As previously noted, while program design and appropriate training are essential, they represent only one side of the equation. The effectiveness of EMS operations also depends heavily on the usability of the tools and technologies employed. For this reason, user interface and user experience (UI/UX) design, focused on aligning equipment with the needs and workflows of EMS professionals, will be examined in the following section.

1.7 UI/UX Design

User Interface (UI) and User Experience (UX) design have become central to the development of digital tools, particularly in fields where clarity, speed, and cognitive ease are crucial. As described by Hamidli (2023), UI/UX design is essential in creating effective and engaging digital products. These two distinct but interrelated concepts collectively shape the interaction between users and technology. UI focuses on the visual and interactive elements of a digital system, such as layout, typography, icons, and colour schemes, with the goal of making interfaces intuitive and visually accessible. UX, on the other hand, encompasses the entire user journey—from usability to emotional satisfaction—ensuring a smooth, meaningful experience that meets the needs and expectations of the user.

A product that is visually appealing, but difficult to navigate would frustrate users, as a seamless experience would not be achieved. In this research, UI/UX principles was used to inform the redesign of the MDT interface used in ambulances aiming to improve the usability of this system by integrating various digital tools currently employed by critical care paramedics into a single, cohesive platform. As suggested by Hamidli (2023), effective UI/UX not only enhances usability but also reduces unnecessary complexity, making technology more supportive during high-pressure tasks.

This integration is particularly important in emergency medical settings, where clinicians must manage complex, often simultaneous tasks under time-sensitive conditions. By applying UI/UX principles to streamline the MDT interface, this research seeks to improve interaction within the ambulance environment and reduce cognitive load during operations.

In conclusion, UI and UX design go beyond aesthetics or technical function—they are fundamental to how digital tools perform in real-world, high-stakes environments. Understanding the core principles of UI/UX provides a foundation for rethinking technology used by EMS personnel. The following section will explore how UI/UX design has been successfully applied in medical contexts, offering insights into its role in cognitive offloading and operational improvement within healthcare systems

1.7.1 UI/UX design in Medical Equipment

There is a growing body of evidence supporting the application of UI/UX design in medical settings to enhance communication, performance, and user satisfaction. Fleshman et al. (2016) investigated the implementation of a mobile data entry system for emergency medical technicians (EMTs) and a messaging system for charge nurses in emergency departments (EDs). The project addressed existing communication inefficiencies caused by verbal exchanges and human memory limitations. Their research followed a user-centred design process: it began with a review of existing literature, followed by user requirement analysis, data collection, interface design, and iterative prototyping. The outcome was a digital product that significantly improved efficiency and workflow for all involved users.

Such studies demonstrate the potential of UI/UX design to optimise digital tools in medical environments, particularly when tools are developed with direct user input and real-world constraints in mind. By grounding system development in actual user needs and behaviours, design outcomes are more likely to be effective and sustainable. In high-stress settings like EMS, where rapid decision-making and multitasking are constant, these improvements are not merely aesthetic—they are functional necessities that support better care delivery. A thoughtfully designed interface can facilitate faster data entry, reduce the likelihood of user error, and contribute to lower cognitive strain during critical tasks.

One strategy facilitated by improved UI/UX is cognitive offloading, which refers to the process of transferring mental workload onto external tools or systems. Grinschgl and Neubauer (2022) found that cognitive offloading can enhance task performance by accelerating information processing and reducing errors. In an EMS context, this can translate to fewer mistakes under pressure and quicker response times. Given its benefits, cognitive offloading likely supports psychological well-being by helping manage the intense information load and decision-making pressures typical in emergency settings.

However, Grinschgl and Neubauer (2022) also caution that cognitive offloading may come with trade-offs. Specifically, they note that consistent reliance on external systems for task execution can negatively affect long-term memory and hinder skill acquisition. In scenarios where digital systems are unavailable or malfunction, EMS personnel may struggle to perform critical tasks manually if their procedural knowledge has not been fully internalised. This suggests a need for balance—digital systems should be designed not only to offload cognitive load but also to reinforce learning through interaction and engagement.

In summary, UI/UX design within the medical and EMS domains demonstrates clear value in improving system usability and reducing cognitive burden. Successful examples, such as those by Fleshman et al. (2016), show that user-centred design can enhance communication and task performance. Cognitive offloading, when applied judiciously through well-designed interfaces, offers a promising strategy for both operational efficiency and psychological relief. Nonetheless, attention must be paid to the potential downsides of over-reliance on digital tools, particularly in high-stakes professions where procedural knowledge must remain accessible in all conditions. To further explore operational efficiency through user-centred design, it is essential to apply specific techniques from interaction design that support intuitive, streamlined workflows which will be discussed in the next section.

1.7.2 Progressive Disclosure and Hick's Law

To design a more effective MDT interface, it is essential to understand the theories that can reduce cognitive overload and improve user experience. Two key principles that inform this approach are Progressive Disclosure and Hick's Law. When combined thoughtfully, these concepts offer a framework for designing interfaces that are both intuitive and efficient for high-pressure environments like emergency medical services.

Progressive disclosure is a design technique that structures the presentation of information, so users receive only what is essential at each step (Spillers, 2025). This limits visual clutter and helps manage complexity by sequencing content across multiple screens. As described by Spillers (2004), a familiar example is Google Maps, where users first receive a high-level route overview, followed by step-by-step navigation instructions as they approach decision points. Additional details—such as traffic, alternate routes, or points of interest—appear only when relevant. In this way, users are not overwhelmed by too much information at once. Applying this technique to MDTs, where paramedics must process and input significant amounts of patient data under time constraints, could create a more focused and manageable interface. The progressive reveal of necessary fields, instructions, and options could streamline the data entry process while reducing mental load.

Complementing progressive disclosure is Hick's Law, which states that the time it takes to make a decision increases with the number and complexity of choices (Yablonski, 2022). In an MDT context, this principle can guide the simplification of menus and data fields, promoting faster decision-making. For example, implementing pre-populated fields based on frequent responses or common medical scenarios could help paramedics enter data more quickly and confidently. Instead of searching through dense menus, they would be met with streamlined, context-aware options that ease cognitive demands.

This alignment with simplicity is further reinforced by the design principle K.I.S.S. (Keep It Short and Simple). Originally developed by the U.S. Navy in the 1960s and widely adopted across different industries by the 1970s, K.I.S.S. encourages straightforward, minimal design that avoids unnecessary complexity (Soegaard, 2015). Systems work best when they are kept simple, and this is especially true for MDTs, where paramedics need quick access to essential functions. In high-pressure situations, a clean and easy-to-use interface is help and can improve outcomes by making sure nothing gets in the way of the task at hand.

In combining Progressive Disclosure with Hick's Law, a strong foundation is created for redesigning the MDT. These tools are not just theoretical; they offer concrete strategies to reduce cognitive load and improve user flow. By applying them, the redesigned system can become more intuitive, less overwhelming, and better suited to the fast-paced, high-pressure environment of emergency response. These techniques provide a pathway to create technology that actively supports paramedics rather than adding to the complexity of their work.

Chapter 2: Methodology

This study was guided by the research question: How can interface design principles be applied to support cognitive offloading and reduce mental workload in Emergency Medical Services (EMS) environments?

In response to the practical and institutional constraints encountered during the early stages of the project, the scope of the research evolved. Rather than conducting fieldwork involving operational paramedics, the project shifted to focus on the development of a design prototype informed by secondary research sources. These included existing literature on user interface design in high-stress environments, cognitive load theory, and precedents within emergency medical services (EMS). The insights derived from this research were then applied to the development of a concept prototype aimed at supporting cognitive offloading for EMS personnel, specifically through the redesign of the Mobile Data Terminal (MDT) interface.

The methodology and design process were structured in alignment with the Double Diamond framework, as defined by the Design Council UK. The Double Diamond is a visual model that represents the design and innovation process. It offers a clear and accessible way to describe the progression of any design project, regardless of the specific tools or methodologies employed. The model consists of four key stages: Discover, Define, Develop, and Deliver (The Double Diamond - Design Council, n.d.).

The Discover phase encourages a deep understanding of the problem, rather than relying on assumptions. This involves direct engagement with users and stakeholders to gain context-specific insights. The Define phase builds upon this understanding to clearly articulate the design challenge. In the Develop phase, a range of potential solutions are explored, often through co-design and creative experimentation. Finally, the Deliver phase involves iterative testing, refinement, and implementation of the most effective solutions. Chapters 3 and 4 of this study reflect these stages. Chapter 3 addresses the Discover and Develop phases, while Chapter 4 focuses on the Define and Deliver phases.

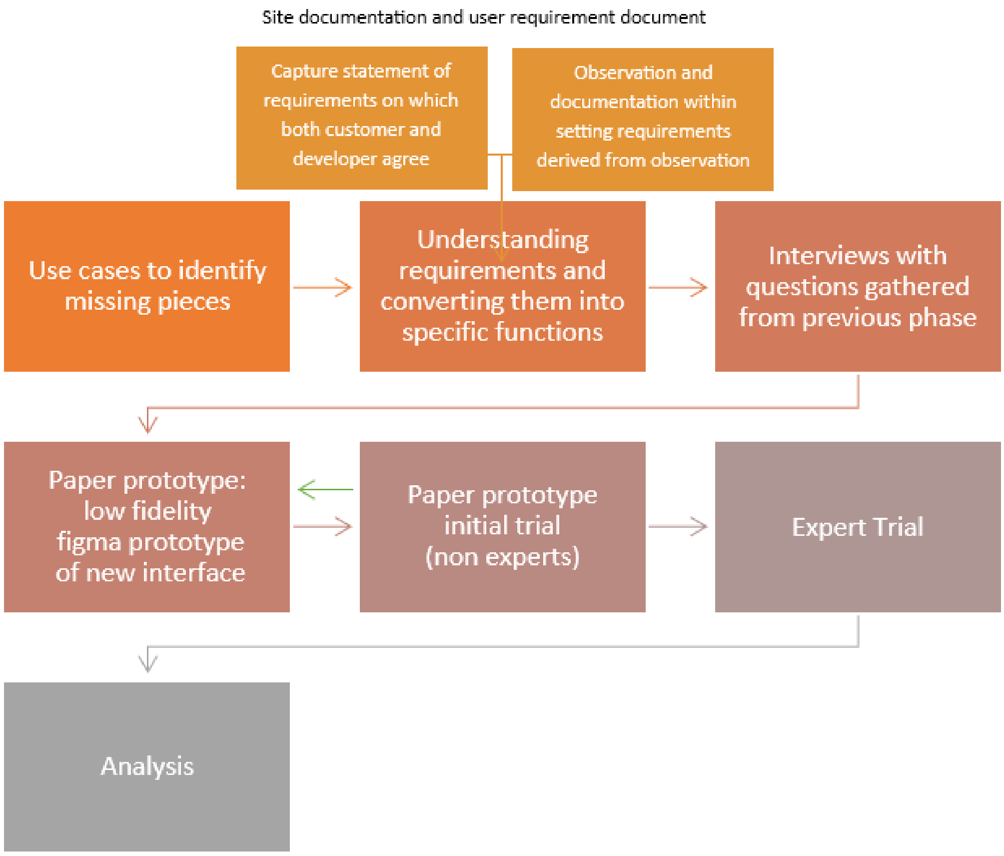

Figure 2: Planned methodology

2.1 The Discover phase

2.1.1 Case Studies

The initial phase involved analysing relevant case studies to establish a foundational understanding of existing research within the field. Gillham (2000) defined case studies as investigations rooted in real-world activities, best understood within their specific context. By examining past research related to healthcare technologies and interface design, this stage helped identify a gap in the literature that this study seeks to address.

2.1.2 Contextual Inquiry

The next phase employed Contextual Inquiry (CI), a qualitative method used to observe users in their natural working environment to understand tasks, behaviours, and systems. Privitera (2015) described CI as a systematic study of people, procedures, and environments, particularly useful in medical device development to uncover user needs and system constraints. In this study, CI was adapted to evaluate the current MDT interface. Instead of shadowing paramedics in the field, a training module available on campus was used to simulate interaction with the MDT. Walkthroughs would be conducted to assess functionality and inform the development of indicative interview questions for later stages.

2.2 The Define Phase

2.2.1 Defining Requirements

Following CI, the study moves to define the requirements for the redesigned MDT interface. This entailed semi-structured, open-ended interviews to capture user needs and challenges. A User Requirements Document (URD), as outlined by Coble et al. (1997), will be developed to prioritise and categorise system requirements. This phase will translate the observed and reported needs into functional criteria for the new interface design.

2.3 The Develop Phase

2.3.1 Prototyping

The next stage involved creating a low-fidelity prototype of the MDT interface using Figma, a digital prototyping tool. The prototype would be informed by the requirements established in the previous phase. This approach follows Martin et al. (2008), who advocate for paper and low-fidelity prototyping in early design stages to evaluate usability before committing to more complex development. The prototype would be tested through expert walkthroughs and followed by semi-structured interviews to assess usability, effectiveness, and alignment with the requirements.

2.4 The Deliver Phase

2.4.1 Reflection

The final stage involved a period of reflection. Baumer et al. (2014) define reflection as the critical evaluation of past experiences to gain deeper insights and enhance design outcomes. This reflective process will examine the study's findings, consider their implications for EMS interface design, and evaluate the researcher's personal development throughout the project.

The methodology outlined above integrates a range of user-centred research and design techniques to investigate the cognitive demands within emergency medical contexts and propose targeted design interventions. Through a structured application of case study analysis, contextual inquiry, requirements definition, prototyping, and reflection, the research is positioned to generate practical insights into the challenges faced by critical care paramedics. A project timeline is presented below (Table 1) to illustrate this process. Overall, the methodology establishes a strong foundation for data collection, analysis, and synthesis, ultimately supporting the development of a design solution that aligns with both user needs and contextual realities.

Timeline	Thesis Schedule	Design Schedule
Feb 2024- June 2024	Thesis Abstract Literature review	Investigating leverage points History Identifying a Gap
June 2024- July 2024	Methods Methodology	Case Studies
July 2024- Aug 2024	Research Design Literature review	Ethics Expert opinions
Aug 2024 – Sept 2024	Results/ Findings	Designing/preliminary prototype Exploring ideas and theories User interface prototype
Nov 2024 – Dec 2024	Discussion	Testing through simulation
Jan 2025 – March 2025	Conclusion Implications	
March 2025 – May 2025	Conclusion Introduction Formatting	

Table 1: Planned Timeline

Chapter 3: Documentation of Research

3.1 Pre-Project Consultation: Investigating the Scope

3.1.1 Identifying the Problem

The initial phase of this project focused on identifying a tangible and relevant problem within the emergency medical services (EMS) sector. With close family and friends working in emergency services, I was compelled to explore this area after observing their persistent exhaustion and the pressures they routinely faced. This prompted a personal reflection: there must be a more effective way to support those on the frontlines. Acknowledging the limitations of addressing systemic issues all at once, the decision was made to focus on a specific, manageable aspect that could yield meaningful impact.

This pursuit led to a consultation with a senior paramedic lecturer at Auckland University of Technology (AUT), which provided valuable insights into the operational realities of paramedic work. A brief observation of the Echo vehicle, a single-crew ambulance designed for critical care paramedics as seen in Figure 5, further highlighted the overwhelming presence and disorganisation of in-vehicle technology. Amid these findings, attention was drawn to the Mobile Data Terminal (MDT), a key digital interface used by paramedics during emergency response. The MDT emerged as a focal point for investigation due to its functional importance and potential for improvement. Consequently, the objective became to critically assess the usability of the current MDT system and identify opportunities for redesign, with the broader aim of reducing cognitive load and enhancing workflow efficiency in high-stakes EMS contexts.

3.1.2 Key Insight: Complexity and Disorganisation

Firsthand observation of the ambulance environment, particularly the communication technology in use, revealed a surprising degree of complexity. The Mobile Data Terminal (MDT), as pictured in Figures 6 and 7, emerged as a system in urgent need of improvement. The volume of disjointed technologies embedded within the vehicle presented a significant opportunity to streamline processes and enhance efficiency.

This realisation prompted a deeper reflection on how to approach the redesign process. I began exploring relevant case studies and examining similar interface redesigns to better understand what design strategies were effective in comparable healthcare and emergency settings. While the project was immediately compelling from a UI/UX standpoint, the scale and complexity of the problem felt daunting. It became clear that meaningful progress would require not only design knowledge but also direct access to expert insights.

From the outset, collaboration emerged as a critical component of this research. Engaging with critical care paramedics was essential for understanding both the broader context of the Echo ambulances and the specific limitations of the MDT system. These collaborations were intended to elicit in-depth feedback regarding the pain points experienced while using the MDT in real-world scenarios. Particular areas of concern included unintuitive navigation, excessive on-screen information, and redundant steps within the interface—all of which were perceived to contribute to cognitive overload and hinder timely decision-making during emergencies.

This investigative process laid the groundwork for the development of more intuitive and user-centred design solutions. Furthermore, it reinforced the importance of including paramedics as participants in the research, both to inform the design process and validate the effectiveness of the redesigned interface.

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Figure 3: Single operated ambulance (Echo vehicle) (Source: St John, personal communication, April 16, 2025)

Figure 4: Location of Mobile Data Terminal (MDT) in ambulance

Figure 3: Closeup of the Mobile Data Terminal (MDT) interface

3.2 Consulting St. John for Participation and Resources

In order to access the necessary resources and recruit participants for this research on paramedic cognitive load and the redesign of the Mobile Data Terminal (MDT) interface, contact was initiated with St. John. The objective of this outreach was to establish a formal partnership and secure a contractual agreement that would provide access to relevant resources and facilitate participant recruitment. This collaboration was intended to support the study's aims by ensuring the involvement of appropriate stakeholders and access to real-world EMS environments.

Initially, the plan for Phase One was to conduct interviews with critical care paramedics to gain an in-depth understanding of their experiences with the mobile data terminal (MDT) and the associated cognitive demands. The insights gathered during this phase were intended to inform the development of a prototype, which would then be tested during Phase Two. However, the recruitment process proved significantly more challenging than anticipated. In Auckland, there are only eight critical care paramedics, and their highly variable and demanding schedules made it difficult to secure interview times.

Ultimately, St John formally withdrew its support for the project, citing concerns around staff shortages and privacy. This decision represented a considerable setback for the research, given that St John is the sole operator of the MDT system in real-world ambulance contexts and retains ownership of the interface itself. Following their withdrawal, the only recommendation offered by St John was to shift the focus of the study to the Paramedicine Department at Auckland University of Technology (AUT). This would involve the use of their MDT training tablets and potentially interviewing academic staff or subject-matter experts instead of frontline paramedics.

This development necessitated a complete reconsideration of the research design. The loss of access to operational users and the authentic field setting fundamentally altered the scope and direction of the study, requiring a methodological pivot to accommodate the new constraints. For details of the full process, please refer to Appendix F.

3.3 Rethinking the Approach

With my supervisors' support, I decided to adjust the scope of my research. Instead of frontline paramedics, I would focus on interviewing AUT paramedicine educators and other field experts. I would also continue using the AUT MDT training tablets to interact with and prototype the interface.

While this shift was not part of my original plan, it ultimately opened up new perspectives. By speaking with educators and system experts, I gained deeper insights into cognitive load and interface design, perspectives that may not have emerged from frontline interviews alone.

In hindsight, losing St. John's support forced me to adapt and be more resourceful. That shift not only allowed me to continue my research ethically and practically, but it also added strength and dimension to the project that I had not anticipated from the outset.

3.4 Changing the Plan

Recruiting participants for my research was one of my biggest concerns. Fortunately, AUT has a Paramedicine Department, and many qualified professionals were accessible through public sources. Initially, I was unsure whether to involve students or lecturers, so I reached out to a senior paramedic lecturer for advice. He pointed out that involving students would raise complex ethical concerns and recommended focusing on recruiting AUT staff instead.

3.4.1 Figuring out Recruitment

As I approached the data collection phase, I met with my supervisors on September 4th, 2024, to refine my research design. We agreed to pivot toward a case study approach, focusing on expert participants while maintaining semi-structured interviews and prototype testing. The same senior paramedic lecturer who had previously helped with recruitment ideas was going to assist with participant outreach. However, he went on research leave just as I was finalising my ethics application, completely derailing that plan.

We briefly considered involving master's students from AUT, but the additional ethics requirements for student participation made that route too complex. Ultimately, we decided it would be best to recruit experienced AUT clinical staff, including extended care and critical care paramedics. These individuals had the right professional background and familiarity with the vehicles and MDT interface, and recruiting them via public channels also simplified the ethics approval process.

3.4.2 Moving Forward

Although shifting my recruitment strategy was not part of the original plan, it actually streamlined the overall process. I no longer needed institutional approval for participant access, which made the ethics process considerably easier in terms of approval and logistics.

3.5 Challenges in Participant Recruitment

Following the receipt of ethics approval, I initiated the process of recruiting participants through publicly available sources, including AUT's Expert Search and LinkedIn. The aim was to interview paramedicine experts to gather insights into how the Mobile Data Terminal (MDT) interface could be improved. However, I encountered a series of challenges early on that necessitated a reassessment of my recruitment strategy.

3.5.1 Reaching out to Participants

To begin the recruitment process, I reached out to potential participants by sending emails through publicly available contact information and via LinkedIn profiles. Additionally, I revisited my literature review to refine my interview questions. Drawing on prior discussions and notes, I sought to develop a set of structured yet open-ended questions that would facilitate the collection of valuable insights relevant to the redesign of the MDT. Despite these efforts, after two weeks of outreach, I received no responses. The majority of experts were either unavailable due to the commencement of the semester or chose not to respond, which raised concerns about how to ensure a sufficient sample size for my research.

3.5.2 Understanding Paramedic Roles

A particularly valuable insight emerged from a senior paramedic lecturer who reviewed my participant information sheet. He made an important distinction between Extended Care Paramedics (ECPs) and Critical Care Paramedics (CCPs). ECPs primarily manage low-acuity patients with complex medical conditions, aiming to treat them outside of hospital settings in order to alleviate pressure on emergency departments. In contrast, CCPs respond to high-acuity situations, such as trauma from motor vehicle accidents, multi-system injuries, and out-of-hospital cardiac arrests (OHCA).

This distinction prompted me to reconsider the structure of the electronic patient report forms (ePRFs) used within the MDT system. Instead of maintaining a uniform form layout, the system could automatically adjust the form based on the paramedic's role, whether ECP, CCP, or standard paramedic, by identifying the user's login ID. This would allow for a more tailored approach that would cater to the specific needs of each role. However, due to time constraints within the project, I chose to focus exclusively on CCPs, as they were the primary group of interest in my original research plan. Expanding the scope to include ECPs would require a different methodological approach, which was not feasible given the timeline.

3.5.3 The Struggles of Recruitment

I initially believed that AUT's Expert Search tool would simplify the recruitment process. However, most lecturers I contacted either stated that they were too busy or did not respond at all. I also attempted to reach out via LinkedIn, but this approach yielded no responses.

In an effort to expand my recruitment strategy, I explored other potential databases, such as hospital records and the paramedic council database. However, these resources were not publicly accessible, a decision that was understandable given the need for privacy protections. The paramedic council's database, which allows searches based solely on registered numbers, proved to be ineffective for broad recruitment purposes.

With no responses to my initial outreach, I sought advice from a senior paramedic lecturer at AUT. He recommended recruiting participants through social media platforms, noting that individual paramedic providers may be reluctant to engage due to concerns about negative exposure or potential professional risk. This further highlighted how valuable institutional support from St John would have been, not only for access to participants and resources, but also for legitimising the research in the eyes of potential participants.

3.5.4 Pivoting to Secondary Sources

Due to the issues with participant recruitment I pivoted to alternative recruitment strategies, including seeking assistance from the Australasian College of Paramedicine to post a study advertisement via their social media platforms. While this approach initially seemed promising, I soon discovered that engaging with Australasian paramedics would require an ethics amendment and approval from the College's research committee, both of which involved delays that were incompatible with my project timeline.

Consequently, I made the decision to pivot the study toward a secondary research approach. Although this shift limited the scope of data collection and eliminated the possibility of user testing, it allowed the research to continue within the project constraints. The focus turned to synthesising existing literature, system documentation, and informal observations to inform a speculative redesign of the MDT interface. This meant that the final prototype would serve as a conceptual proposal rather than a tested and validated solution.

Additional attempts to access relevant technical information and training resources, such as contacting Valentia Technologies and seeking access to internal St John course materials, also met with limited success. These efforts underscored the broader issue of gatekeeping within emergency medical services. The highly controlled nature of system documentation and training content presents a significant barrier for external researchers and designers. Without access to these materials or to end users, it becomes difficult to fully understand or improve upon existing systems.

Nevertheless, the challenges encountered have offered valuable insights into the realities of conducting research in restricted and specialised fields. The experience has emphasised the importance of adaptability and highlighted systemic issues that limit innovation. While the final design proposal cannot claim empirical validation, it draws upon best practices in user experience design and available contextual knowledge to offer a well-informed vision for improving MDT usability.

Chapter 4: Documentation of Design

4.1 Exploring Training Tablets

When exploring the MDT (Mobile Data Terminal) training tablets available at AUT, my goal was to understand how paramedics use these devices, what information needs to be entered, and the standard workflows followed in the field.

To start, I captured images and videos while navigating through various tabs and buttons on the training tablet. However, I quickly realised that I did not understand what most of the interface elements meant. The layout was confusing, and it was not clear what each button did or how the system was supposed to function in a real-world scenario.

One major issue that stood out was the navigation. I believed it lacked intuitiveness and required constant switching between tabs, with no split-screen or multi-tasking capability. This made it difficult to view or input multiple types of information at once. I also thought that turning some on-screen functions into physical buttons might improve usability by freeing up screen space and enhancing speed. Additionally, the navigation system did not compare well to modern tools like Google Maps, it lacked features like voice guidance, which could be useful for paramedics who need to focus on driving while receiving updates.

Another challenge was understanding how paramedics actually use the MDT in practice. Randomly clicking through tabs was not enough, I needed to understand the correct sequence for inputting information. I also realised I had gaps in knowledge around other technology used alongside the MDT. During earlier consultations, I had seen paramedics using walkie-talkies and personal phones, but it was not clear whether those tools were standard issue or personal choices.

To address these gaps, I began searching for more resources. I found training manuals and even an available lecture on the MDT. I reached out to a senior paramedicine lecturer to request access, hoping these materials would help me build a clearer understanding of how the system is actually used in the field.

Overall, my first impression of the training tablet was that it was more complex than it needed to be. If its primary purpose is to support efficient, accurate data entry and navigation during high-pressure emergency responses, the interface should be much more streamlined and intuitive. I aimed to develop a clearer understanding of the MDT’s functionality and to begin exploring design improvements that could reduce cognitive load for paramedics, with the intention of informing future research and training initiatives.

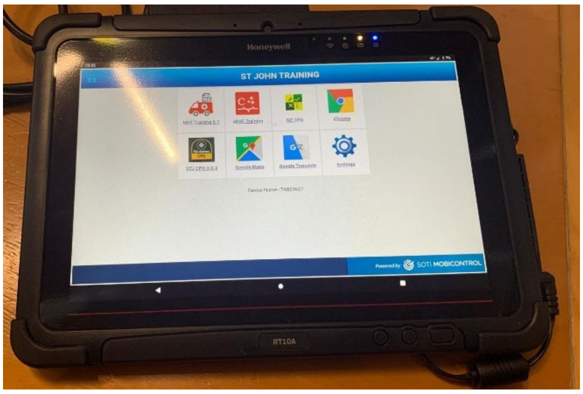

Figure 6: Starting the MDT, front page of interface

Figure 7: Back of the MDT. There is no communication or camera function on the device itself

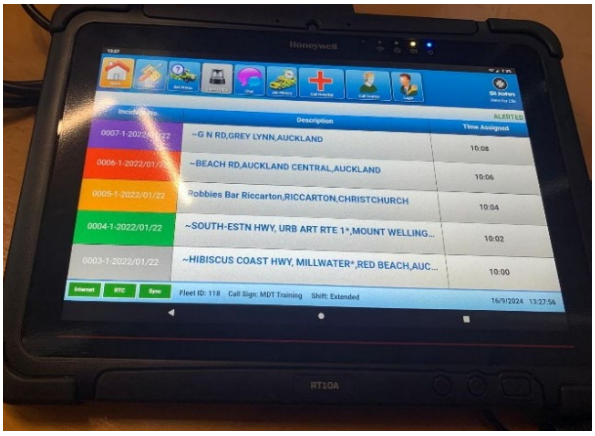

Figure 8: Job navigation page

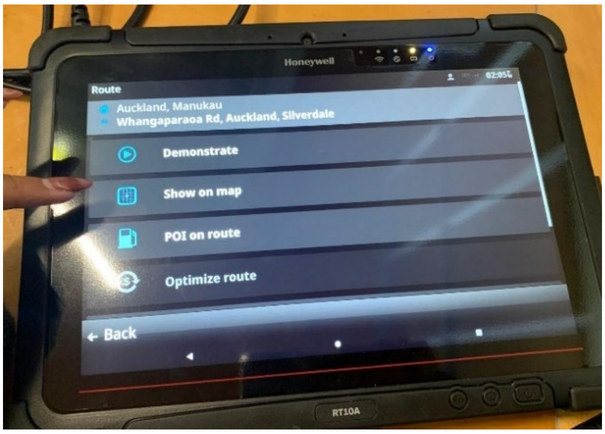

Figure 9: Map navigation, powered by Google Maps

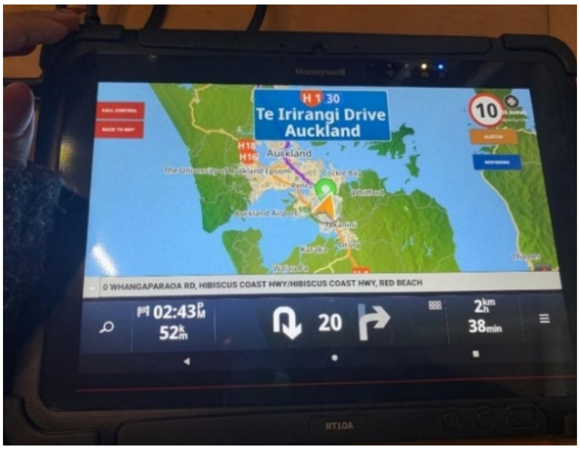

Figure 10: Navigation page

4.2 Blueprinting the MDT Process

In an effort to better understand how Mobile Data Terminals (MDTs) function in real-world emergency scenarios, I began exploring publicly available content. I focused on a combination of ride-along footage and training module videos available on YouTube (Eugene Springfield Fire, 2024; Williamson Fire/Rescue, 2018; OlatheFire, 2024), to observe how emergency responders interact with these devices during active duty.

My approach was fairly straightforward: ride-along videos provided insight into how first responders used MDTs in the field, while training modules offered a structured overview of how the systems were intended to be used. From these observations, I began to map out a rough service blueprint, as seen in Figure 14, outlining key steps, decision points, and touchpoints in the MDT workflow. This helped me develop a preliminary understanding of the user journey and gave me a clearer picture of the interface's role in supporting emergency services.

However, the majority of publicly available content focused on MDT systems used in fire trucks, rather than ambulances. Although some of these devices offered an "ambulance mode," they did not accurately represent the unique workflows or contextual demands faced by paramedics. As a result, the insights I gathered felt overly generic and lacked the specificity I needed to inform ambulance-centric interface design.

Despite this shortcoming, the exercise was still worthwhile. It helped me identify recurring interface patterns, system bottlenecks, and usability issues that could inform future design iterations. For instance, I began thinking critically about ways to simplify navigation and streamline data entry, particularly in time-critical situations. However, to build a truly relevant and actionable blueprint, I needed access to resources tailored specifically to ambulance MDTs.

I raised this issue during a project meeting, where I mentioned the limitations of the online training material I had been reviewing. In response, a senior paramedic lecturer at AUT informed me that official ambulance-specific training videos were available internally and connected me with the appropriate contact to access them. Once obtained, these materials were expected to offer deeper insights into the real-world use of the MDT by paramedics, thereby informing and enhancing the accuracy and relevance of my service blueprint as the project progressed.

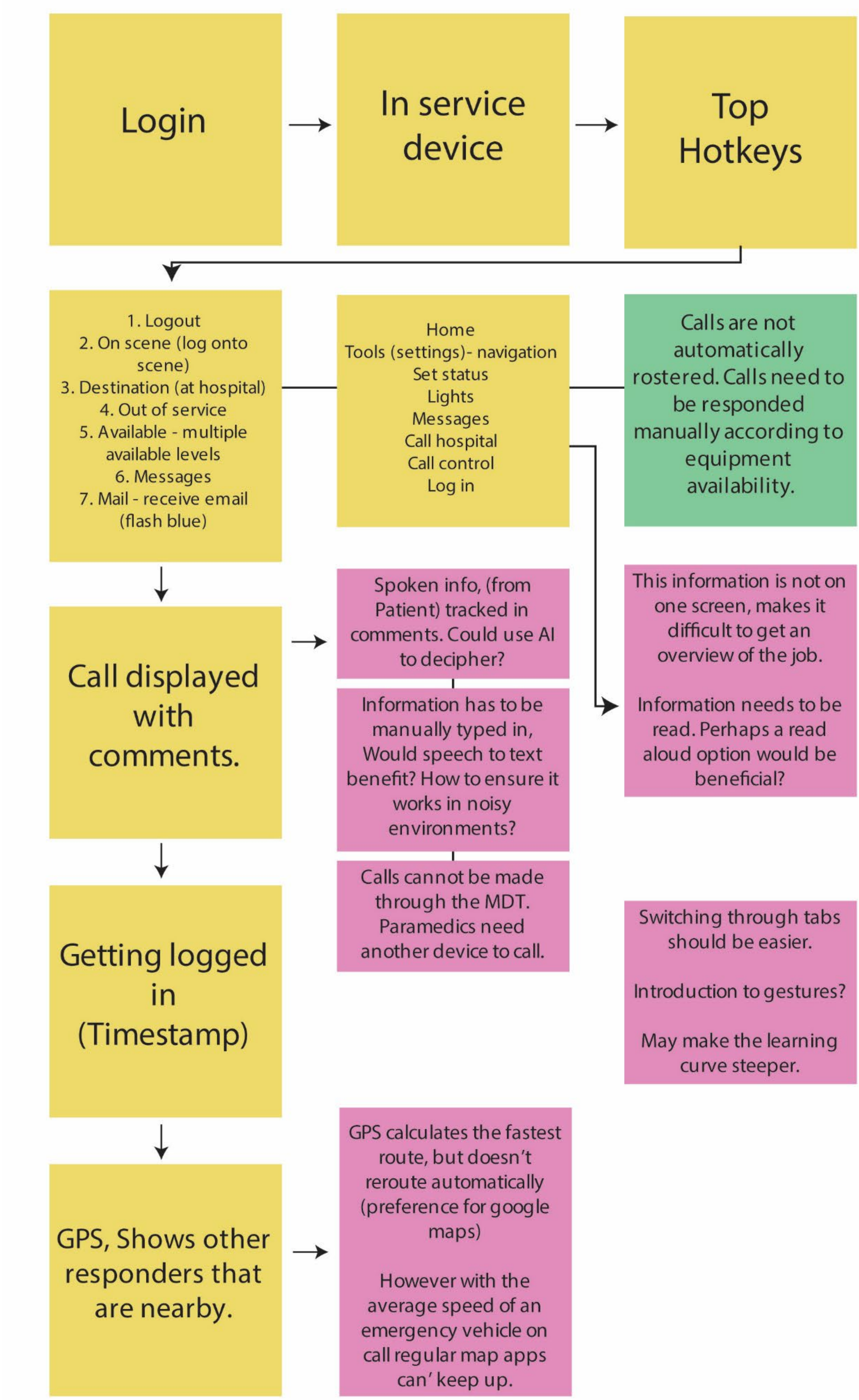

Figure 11: Preliminary blueprinting of the Mobile data Interface (MDT)

4.3 Exploring the ePRF Training Module

4.3.1 Understanding the MDT and its Challenges

Exploring the ePRF (electronic Patient Report Form) training module provided a clearer understanding of how the MDT (Mobile Data Terminal) interacts with the system. While some points are documented and used within sections 4.3 to 4.5, more comprehensive notes are found in the appendices (see Appendix A). As shown in Figures 12 and 13, the module includes information about the technology available in the ambulance and outlines a workflow that offers insight into the operation of the MDT. It reveals several significant issues, primarily around the currency and usability of the training materials. The most recent documented update dates back to 2016, meaning that any changes or improvements made to the MDT system since then are not reflected in the current documentation. This lack of updated material may create a knowledge gap for users and raised questions about the reliability and relevance of the training resources.

Without current documentation, users, especially new or less experienced staff, may struggle to understand how to use newly implemented features or workflows. This gap prompted several critical questions: What are the exact processes supported by the MDT? Which functions are essential versus optional? And more importantly, what changes could be made to enhance usability and efficiency?

To investigate, I adopted a multi-step approach. I began by reviewing the training manual in detail, taking notes to highlight key processes, system features, and noticeable gaps in information. While the manual included a FAQ section and documentation of the initial system update, it lacked references to subsequent changes, leaving me uncertain about what updates, if any, had occurred since.

These issues suggest a broader need to simplify and clarify the documentation process. If the ePRF is too lengthy or unintuitive, it discourages accurate and complete data entry. This opened up opportunities for design interventions, potentially including the use of AI to assist with auto-filling, summarising, or validating entries.

Although I now had a foundational understanding of how the MDT operates, several questions remained unanswered, particularly regarding its feedback mechanisms. While the manual references "feedback," it did not clarify how this feedback is gathered, where it is stored, or how it is used to inform future updates. It was also unclear whether feedback includes usability suggestions from frontline users or is limited to technical issues such as software bugs and system crashes.

Overall, my exploration of the training module highlighted a critical disconnect between the intended use of the MDT and its application in real-world practice. Bridging this gap is essential not only for improving usability but also for supporting the cognitive and emotional demands placed on paramedics in high-pressure environments.

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Figure 12: The ambulance and its technology. The ePRF system is connected to the ambulance ecosystem. Future devices aim to be connected wirelessly connected to each other to provide medical centres a more comprehensive report (Source: St John, personal communication, April 16, 2025

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Figure 13: The MDT and ePRF workflow, as outlined in the ePRF Passport. The image illustrates the essential elements present within the ePRF system and provided a useful framework for identifying the core components that should be incorporated into the redesigned prototype. (Source: St John, personal communication, April 16, 2025)

4.3.2 Frustrations with Outdated Materials

One of the most persistent challenges I faced in this research was the outdated nature of the available training materials. Initially, I had planned to compare the current MDT interface against the version described in the official training manual. However, without a documented update history or changelog, this comparison became speculative. The absence of up-to-date documentation suggests that users may be relying on legacy instructions or assumptions, potentially leading to inefficiencies, errors, or misunderstandings in the field.

To better understand how the system may have evolved, I conducted a side-by-side analysis, comparing my own images of the MDT training tablet with the instructions and interface descriptions outlined in the manual, a preview seen in Figure 14 below. This process aimed to highlight visual or functional discrepancies that might indicate undocumented updates. While this analysis provided some insights, it also emphasised just how difficult it is to trace changes without formal documentation or version control.

To dig deeper, I reached out for expert input. A senior paramedic lecturer connected me with a paramedic lecturer who confirmed that comprehensive MDT training materials are not publicly accessible. While downloadable modules do not exist for general use, I was informed that physical training manuals are available to staff. These include technical terminology, system abbreviations, and step-by-step explanations of basic interface navigation. In addition, there is an official 18-minute MDT training video produced by Hato Hone St John. However, access to this module is restricted to the lecturer space and not available to external researchers.

This lack of transparent, up-to-date, and publicly accessible training materials highlights a broader issue in digital tool adoption within emergency services. Without standardised or current documentation, staff may not be fully informed about how to use the MDT effectively, especially when new functions are introduced. This raises further questions about how training is delivered, how updates are communicated, and whether feedback from users is meaningfully integrated into system revisions.

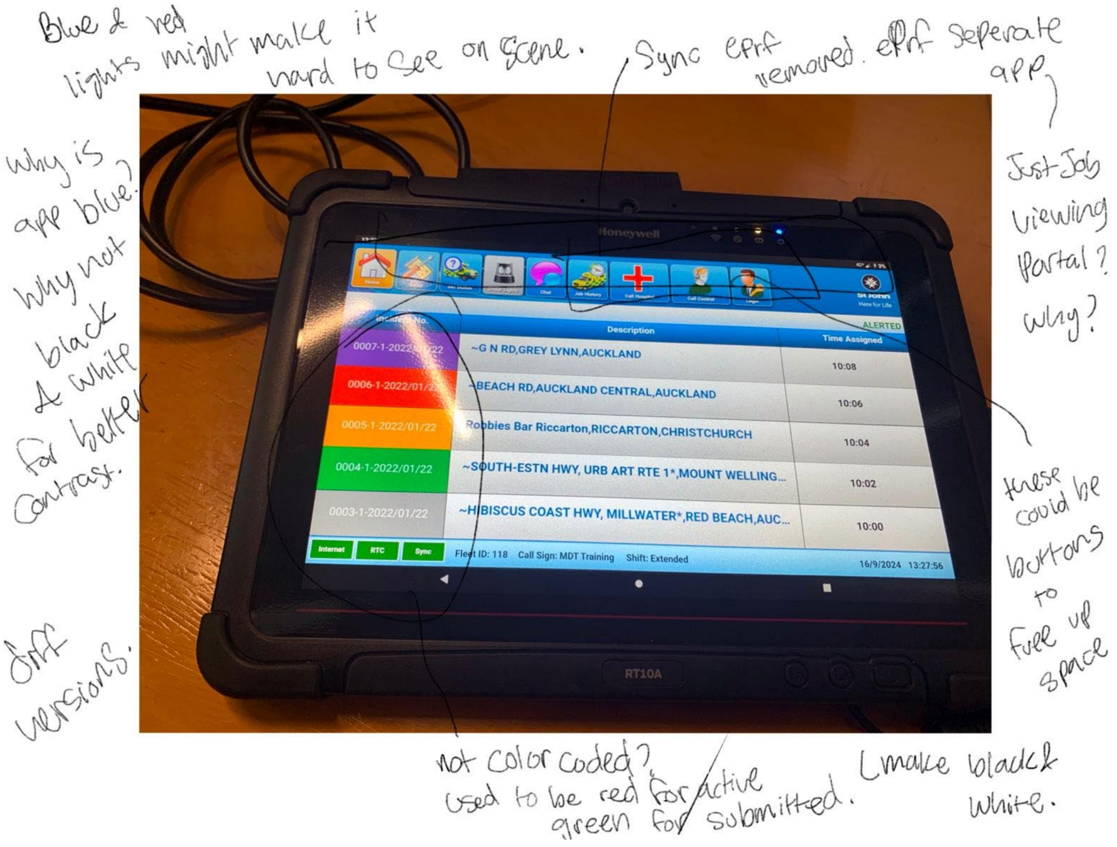

Figure 14: Evaluation of the Electronic Patient Report Form (ePRF) using a training MDT with the latest version of the software from AUT. The notes highlight how different the software that is shown in the ePRF passport looks compared to this version

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Figure 15: This is the quick navigation page, an overview of all the sections that need to be completed for submission of the ePRF. There are certain sections that are either split into two sections or duplicated, adding more steps to the process making it more complex, hence contributing to cognitive load. (Source: St John, personal communication, April 16, 2025)

4.3.3 Access Limitations and Delays

My attempts to access more recent MDT training materials were delayed by the end-of-year academic schedule. Due to final assessments and the subsequent school shutdown, I was unable to review the physical training manuals or the Hato Hone St John training module until the following year. In early January, I finally gained access to these resources, only to find that the information remained outdated. The last documented amendments dated back to 2016, with no indication of further updates or changes since then.

This discovery raised a critical concern: although MDTs likely receive regular software updates, there is no publicly available documentation outlining what these updates included. Without this information, users may be left unaware of new features, bug fixes, or interface improvements, potentially limiting their ability to adapt to changes and fully utilise the device's functionality.

This experience exposed a major gap in the accessibility and transparency of MDT documentation. While I had a working understanding of the interface and its core features, many questions remained about how the system evolved over time and how user feedback was captured and actioned. To address these gaps, I planned to investigate whether any internal feedback reports or update logs existed, and whether these documents reflected real-world usability concerns or focus primarily on technical performance (e.g., system crashes, software errors).

In parallel, I continued to compare the current MDT interface, through training tablet exploration and imagery, with the outdated training materials, to identify discrepancies and undocumented changes.

These comparisons helped highlight where critical documentation is missing and where users may be operating under outdated assumptions.

Ultimately, ensuring that paramedics and clinical staff have access to clear, comprehensive, and current training materials is essential for reducing cognitive load and improving the efficiency and safety of field operations. Improving the feedback loop between MDT users and system developers could also contribute to more targeted and responsive updates, enhancing the overall usability of the platform.

4.4 Comparing Training Modules and Prototyping

4.4.1 Understanding the Evolution of the Training Module

As outlined in the preceding section, 4.3.2, I compared the current MDT interface with the ePRF e-Passport, a training manual published by St. John (personal communication, April 16, 2025). This section provides a detailed analysis of the differences between the two. My aim was to determine whether updates to the module improved usability or introduced new challenges. By analysing the content of both versions side-by-side, I was able to identify key differences and track the progression of design and functionality. This process helped clarify whether the changes were intentional improvements or unstructured modifications without a clear rationale.

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Figure 16: Old menu buttons (Source: St John, personal communication, April 16, 2025)

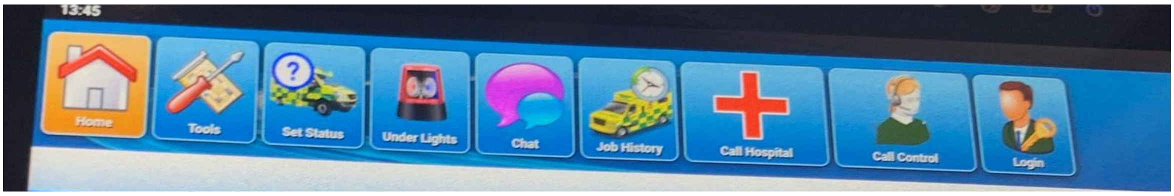

Figure 17: Current menu buttons

One of the most noticeable differences was the repositioning of certain buttons, as seen in Figures 16 and 17. While this may seem minor, such adjustments typically indicate a newer version of the software. It suggests the developers made deliberate updates—potentially in response to user feedback or technical requirements—but the reasoning behind these changes was unclear. Altering the layout can have significant implications for usability, particularly for users accustomed to the original design. I began to question the motivations behind these decisions: were they driven by evidence, or were they arbitrary?

This led me to think critically about the changes, not just accepting them as improvements, but evaluating whether they enhanced the user experience. Understanding the rationale (or lack thereof) behind these changes became essential for informing my own design decision making process during the design and prototyping stages.

4.4.2 Evaluating Usability and Design

Despite updates in the newer version of the MDT, the interface still appeared to be poorly designed. The ePRF e-Passport acknowledged that the system presented a steep learning curve and failed to adequately address the cognitive load challenges I had previously identified. While some elements had been rearranged, the interface remained cluttered and visually overwhelming, with limited improvements in usability. This prompted me to consider how I might prototype a more effective version, focusing on clarity, accessibility, and minimal visual noise, particularly under low-light conditions common in emergency settings. I explored design factors such as colour contrast, font size, button placement, and the visibility of critical information. By role-playing various emergency scenarios, I evaluated how these elements impacted usability and efficiency in real-world contexts. Through this process, I also identified broader systemic issues, including inconsistencies in how patient information is collected and recorded. For example, medications self-administered by patients must be typed manually under an “other” category, suggesting a need for more intuitive and standardised data entry options. These design shortcomings not only hinder usability but may also compromise the accuracy and completeness of patient records, ultimately affecting the quality of care provided.

4.4.3 Key Insights

Several elements of the MDT interface require refinement (see Table 2 for a summary). One instance is the "sync ePRF" function, a process that is undertaken when paramedics need to synchronise an ePRF case prior to submission, for instance, to allow the Clinical Desk of the receiving hospital to access and review the documentation (St John, personal communication, April 16, 2025). This button appears to have been rendered redundant, as reports are now required to be submitted for audit purposes regardless. It is possible that this function has since been automated. Additionally, the interface’s heavy reliance on colour makes it visually overwhelming, while the use of images reduces text size, they could help identify critical elements like alerts. A better balance between text and visuals was needed, and switching the navigation bar to buttons could enhance usability. For better visibility, the design should prioritise black and white, using colour sparingly to highlight critical information, such as active versus inactive cases. Furthermore, the ePRF app’s separation from the main MDT system creates inefficiencies—patient information should be integrated into the primary system. Improving readability with high-contrast, bold text and optimising navigation with clearer traffic information would also likely enhance the user experience. Expanding GPS and LTE broadband access inside the UCC could improve GPS/AVL services, ensuring ambulances take the most efficient routes, incorporating real-time traffic and weather updates.

Current MDT interface issues	Suggested improvements
The “sync ePRF” function creates unnecessary extra step	This function can be automated
Visually overwhelming interface due to use of colour	Interface can be primarily black and white with colour used to highlight critical elements
Balance between text and visuals	Use of images
Navigation bar	Certain functions can be buttons for ease of access
ePRF app is separated from main MDT interface	They can be one interface
Navigation is slow and inefficient	GPS and LTE broadband services can be used to improve the system

Table 2: A summary of current MDT interface issues and suggested improvements

These inquiries were intended to be central to the planned interviews, where I aimed to gather expert opinions to understand the reasoning behind the design choices. Additionally, by testing different settings and role-playing various scenarios, I would have been able to ensure that my prototype addressed the real-world needs of paramedics. This process would have provided valuable insights into the challenges of designing an effective training module and underscored the importance of considering user experience from the outset. These insights would have then been applied to help refine my prototype.

A key focus of my process was applying my contextual understanding of the ePRF system, along with my expertise as a UI/UX designer, to simplify a complex process and create a more efficient user experience.

Using the insights gained from the training module, I documented the structure of each section, detailing the type of information required and how it was presented. Based on this understanding, I developed a detailed blueprint of the form and proposed several changes aimed at improving usability. Where possible, I simplified user actions by introducing auto-filled fields and dropdown menus to minimise manual input and reduce user effort. I also integrated gesture-based navigation, allowing users to move seamlessly between sections with minimal interaction. This design decision was informed by the goal of reducing cognitive load and streamlining the workflow.

Additionally, I applied key design principles such as Hick's Law (Mads Soegaard.,2015), reducing decision-making time by limiting visible options—and progressive disclosure (Spillers, F.,2025), which involves presenting only necessary information at each stage to avoid overwhelming the user.

4.4.4 Design Improvements and Prototype

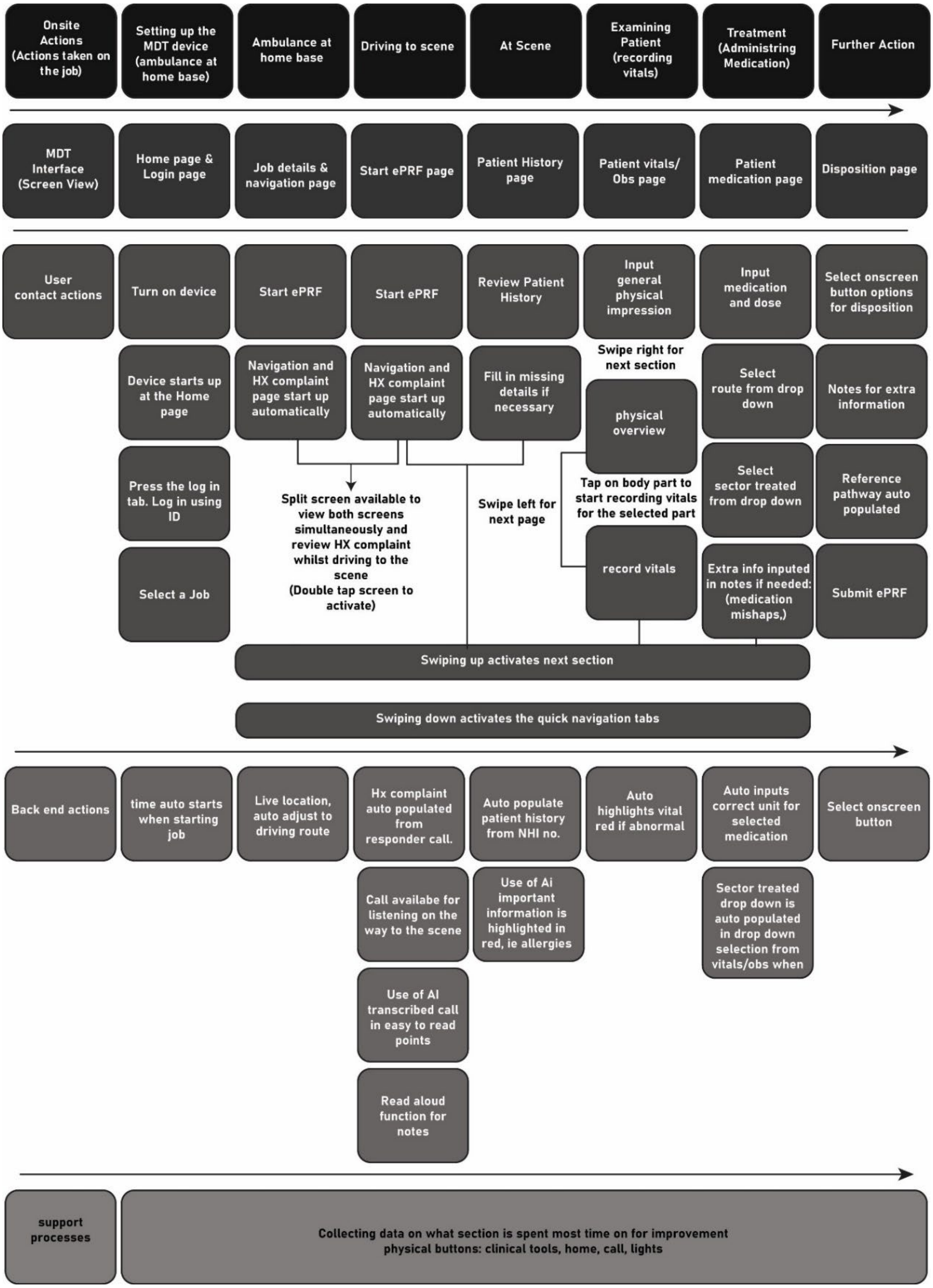

Figure 18: Service blueprint of created Interface

As part of the redesign process, I began by blueprinting and sketching individual pages based on the structure and content available in the current ePRF training module, as pictured in Figures 18 and 19. This module served as a foundational guide, providing insight into the various sections of the electronic Patient Report Form and the types of information each section captures. By mapping out the interface in this way, I was able to establish a clear visual and functional framework to build upon.

Drawing from both the contextual review and my professional experience in UI/UX design, I aimed to simplify the complexity of the current system and propose a more user-friendly solution. I applied human-centred design principles to the high-pressure, time-sensitive context of emergency medical services, to make the system more efficient, and accessible for its users. Using the training module as a reference, I reviewed the existing structure and identified opportunities for improvement. I then created a comprehensive blueprint and translated these insights into refined sketches, as pictured in figures 20 to 27. Actions that previously required multiple steps were streamlined using auto-filled fields and dropdown menus, significantly reducing the amount of manual data entry required. To further enhance navigation, I incorporated gesture-based interactions that allow users to move between sections fluidly, minimising physical effort and saving time.

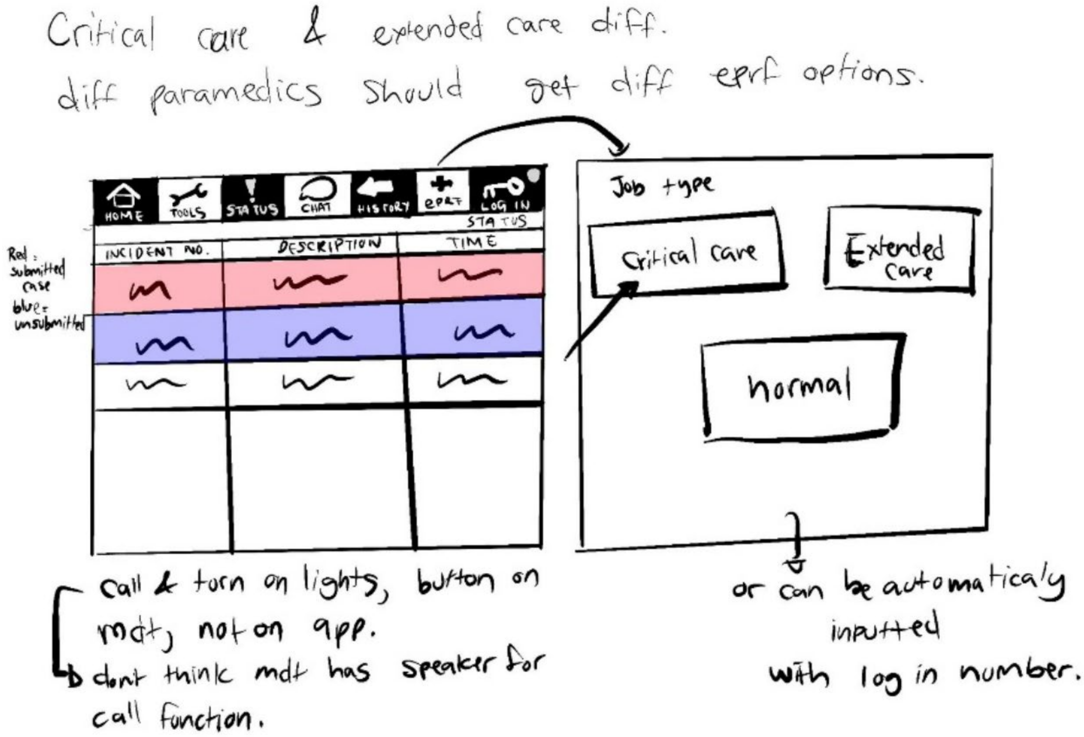

Figure 19: I explored the potential of having different a selection of different versions of the ePRF catered to specific roles. Exploring the potential of having some of the onscreen buttons as physical ones, and other physical amnesties needed.

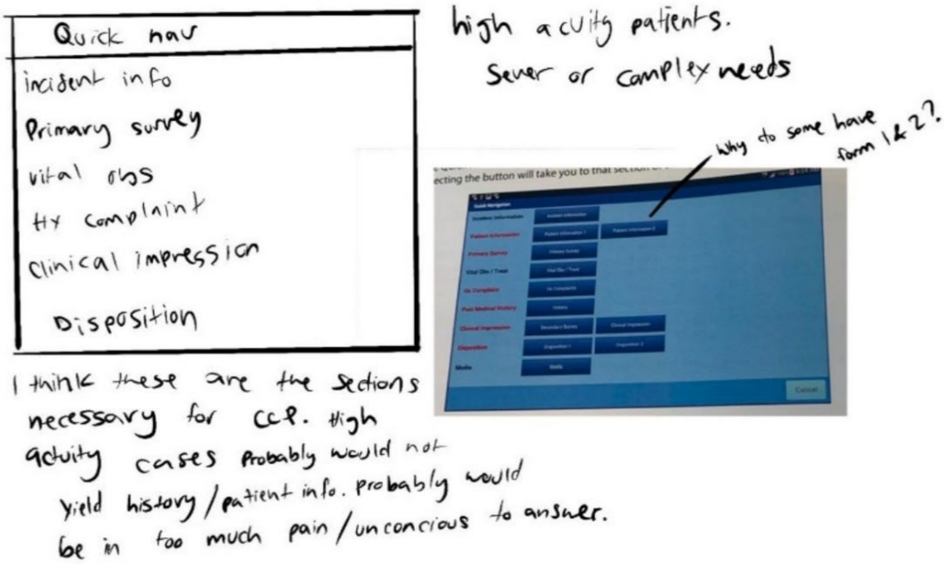

Figure 20: I explored the quick navigation page and the sections that can be consolidated. Considering the best order of sections for critical care paramedics.

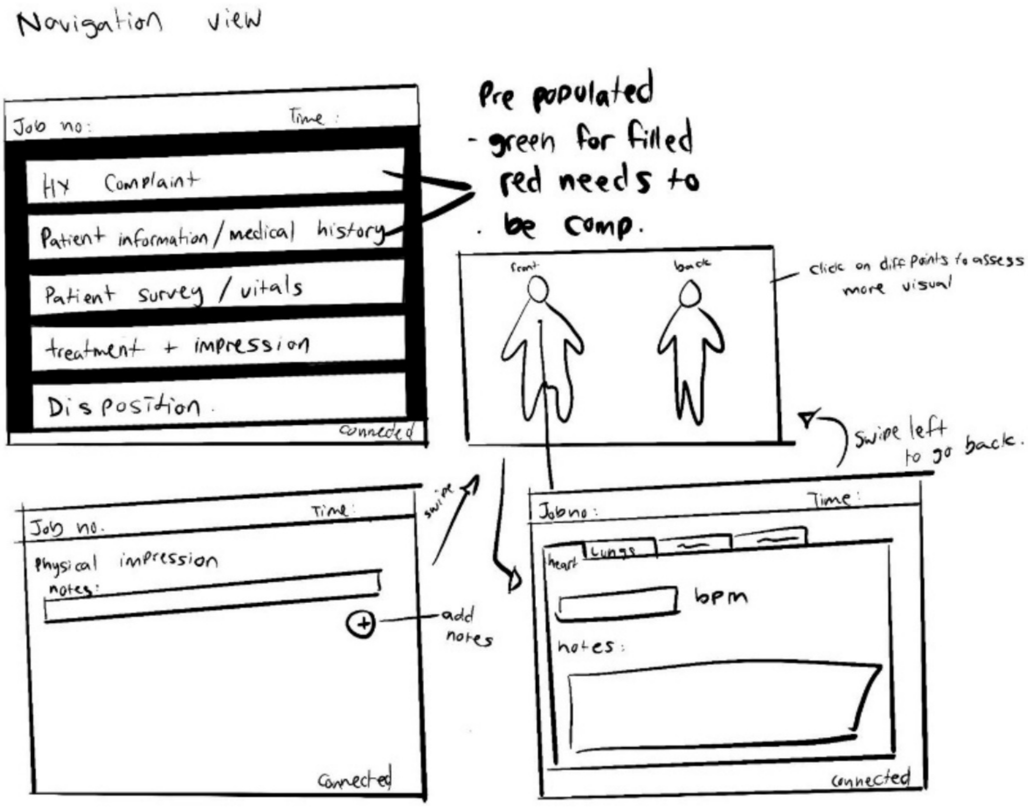

Figure 21: When visualising the navigation overview page, I aimed to maximise contrast to support clarity and usability under pressure. This led to the use of white boxes on a black background, which helps to clearly separate and define each section, reducing the risk of accidental input in high-stress environments. A similar approach was applied to the treatment page, where I incorporated more visual elements to improve comprehension and tap accuracy. Additionally, gesture-based navigation was introduced—allowing users to swipe left or right to move between pages—further supporting intuitive and efficient interaction.

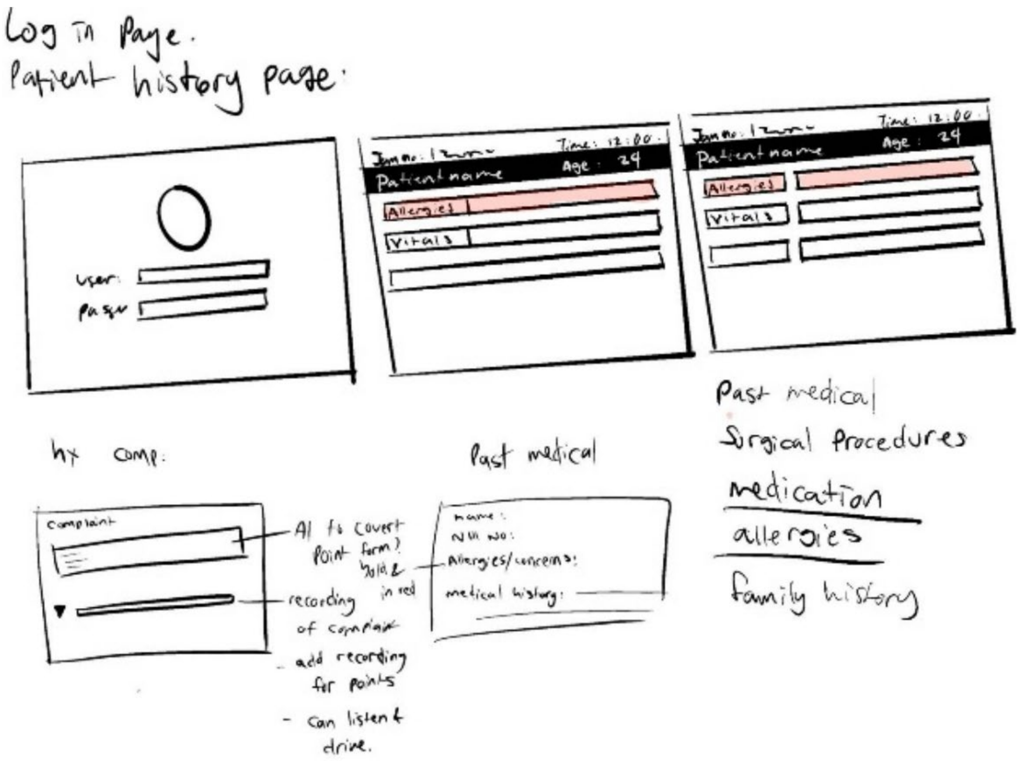

Figure 22: I explored elements for the login page and patient history page. Using the same principles as Figure 22 to keep it high contrast.

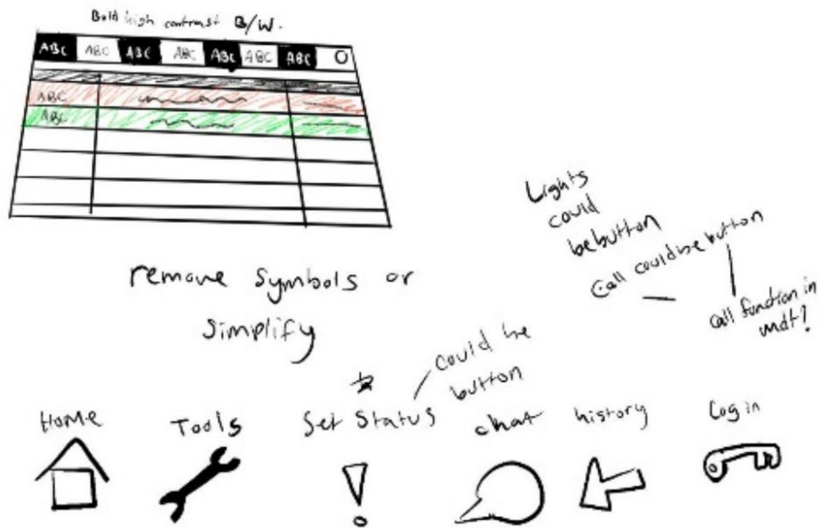

Figure 23: Simplified icons to make it easier to read. Smaller details get lost. Icons should be easy to identify and understand in fast paced environment.

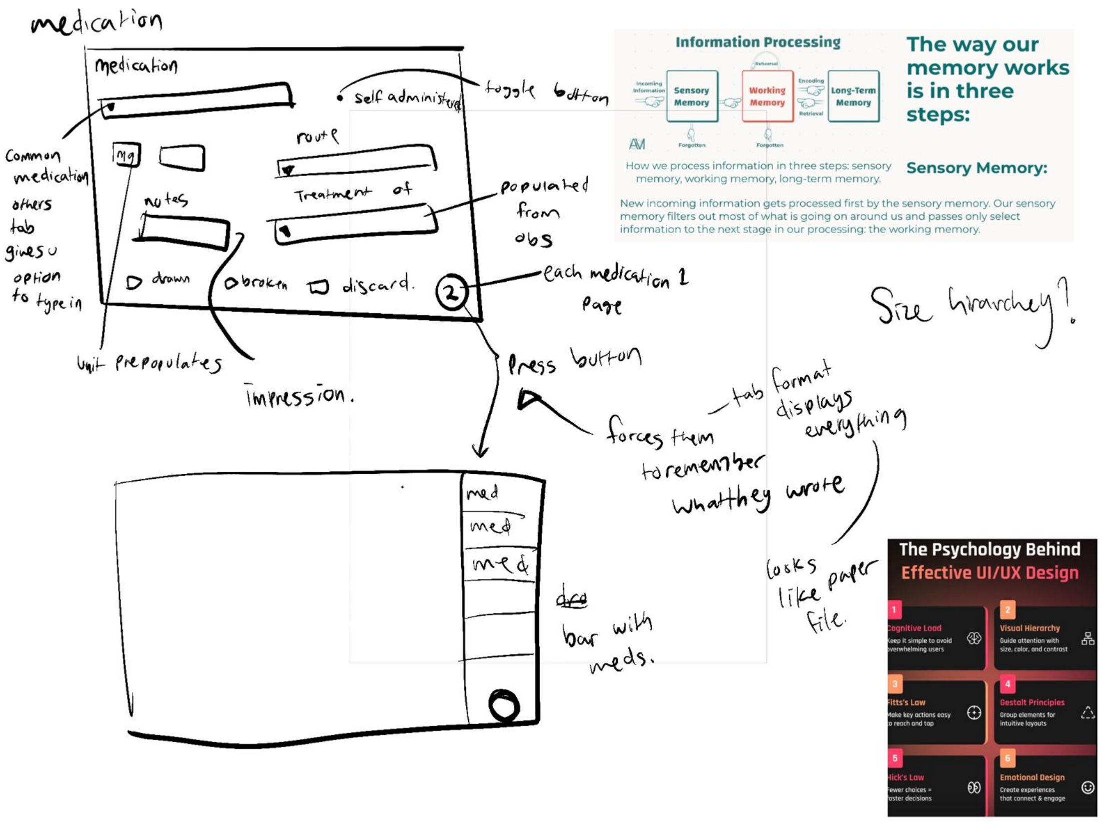

Figure 24: I explored the layout of the medication page, with consideration given to key UI/UX design principles. The aim was to incorporate all necessary elements without overwhelming the user.

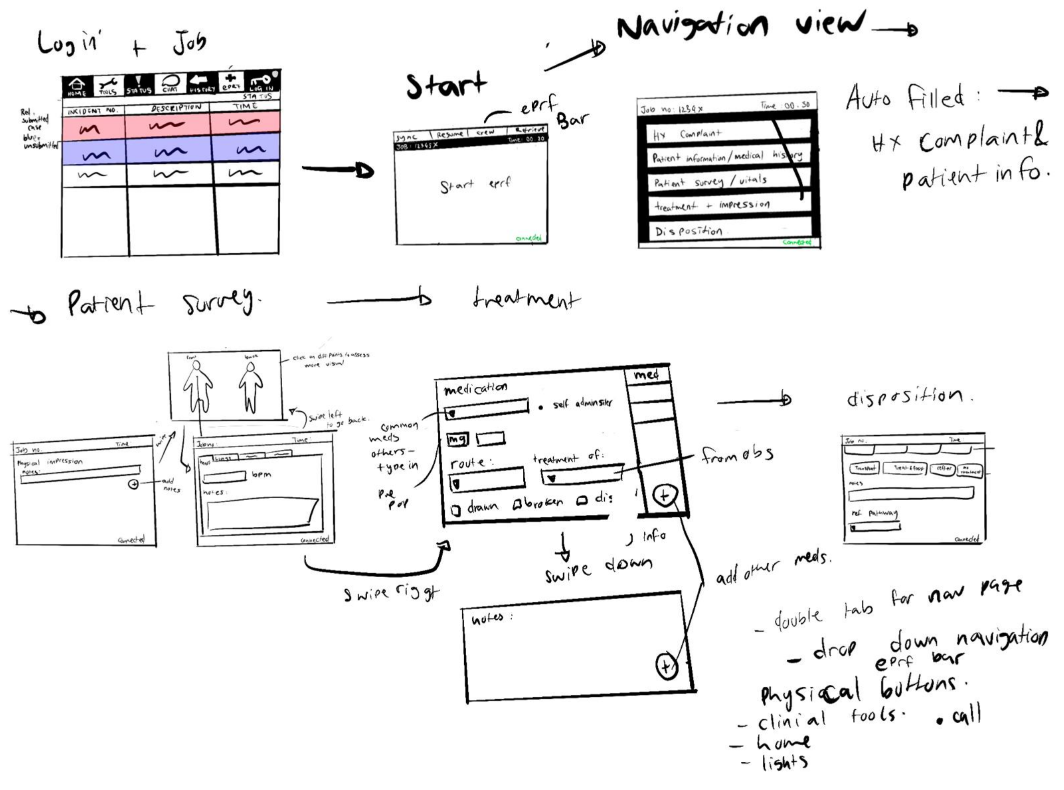

Figure 25: Visually mapping out the blueprint allowed me to lay out all interface pages and examine how they connect, ensuring the overall flow made logical sense. This process involved identifying which elements function as physical buttons and how users navigate between sections.

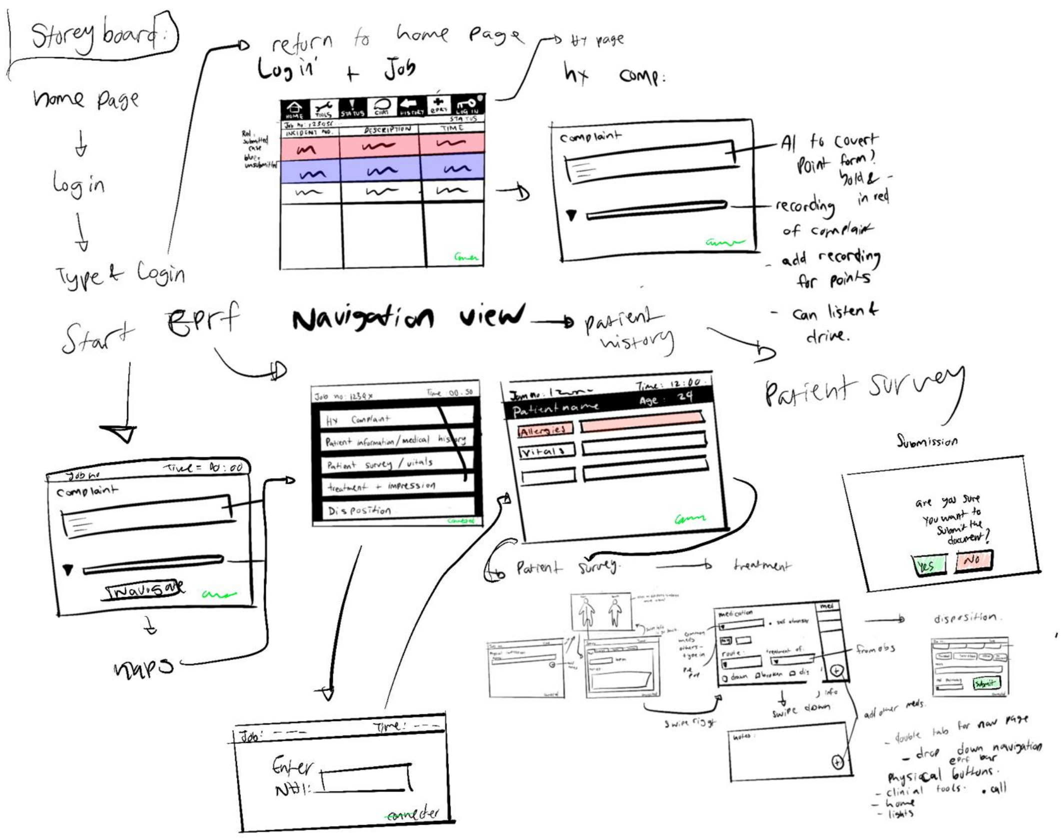

Figure 26: Mapping out the interface as a storyboard allowed me to visualise how the entire system could be presented in video format as part of my design showcase. This process also enabled me to add or remove pages that disrupted the overall flow and user experience.

Hick's Law (Yablonski, J. 2022) helped guide the decision to limit on-screen options, while progressive disclosure ensured that only the most relevant information was presented at any given time. Together, these techniques helped structure each page in a way that supports clear, logical progression without overwhelming the user.

Another important change involved the hardware. Key on-screen functions were relocated to physical hardware buttons. Features such as Lights On, Call, and Toolkit were identified as essential tools that would benefit from more immediate access. By assigning these actions to permanent physical buttons on the device as pictured in figure 28, users can activate them more quickly and reliably, especially in high-stress or fast-moving situations. Additionally features such a speaker and microphone was added to for calls on the device to make it a comprehensive communication interface.

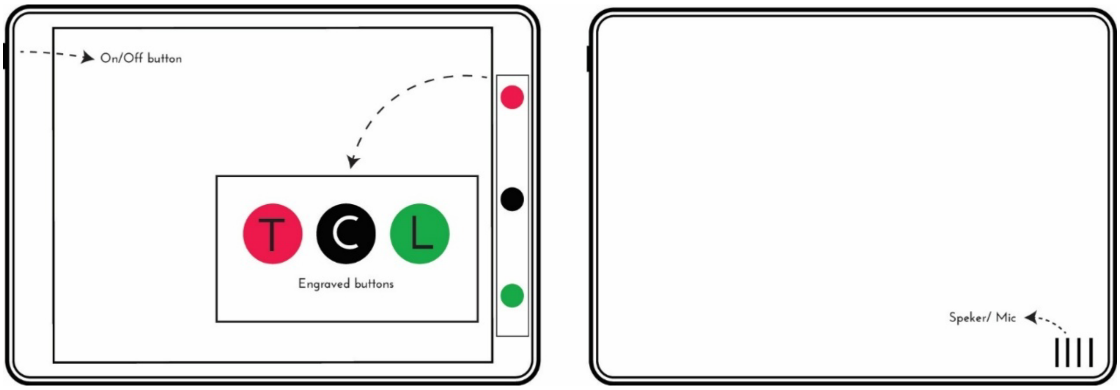

Figure 27: Tablet with physical buttons and speaker/microphone for voice communication

The proposed changes should improve usability by reducing unnecessary complexity, increasing speed of access, and improving the overall user experience. Some features, such as gesture-based navigation, may require a short learning curve; however, with consistent use, these gestures are likely to become second nature and enhance workflow efficiency. The next step in the design process involved translating the blueprint into a high-fidelity prototype using Figma. This prototype finalised the visual design, interactive elements, and user flow, serving as a foundation for future usability testing and further development. This final stage ensures that the redesigned ePRF system is not only functional but also tailored to the needs of its users.

4.5 Figma Prototyping

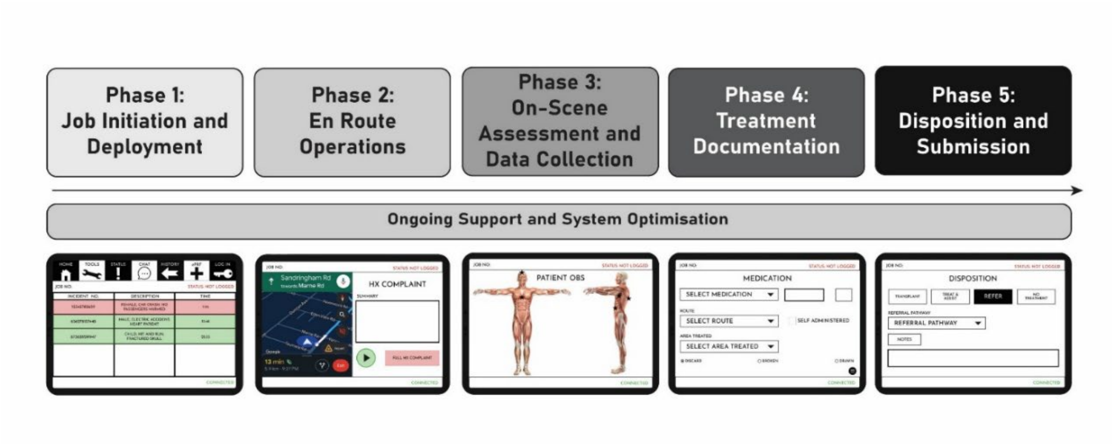

Figure 28: Journey of the interface

Using the initial sketches and the structural blueprint as a foundation, a functional prototype in Figma was developed, an outline of this is pictured in figure 30. This phase involved translating static visual concepts into an interactive digital format. Variations in layout, line weight, and typography were explored to refine the visual hierarchy and ensure clarity.

During this process, certain elements from the original blueprint were adjusted. These changes were made to improve logical flow and enhance user experience, which became more apparent once the design was visualised in an interactive format. Creating the prototype allowed me to fully engage with the interface for the first time. This hands-on interaction provided valuable insight into the flow and usability of the design, enabling final refinements to ensure a cohesive and intuitive experience.

While the prototype uses elements of human centred design, I acknowledge that usability testing with relevant participants would have provided critical feedback and potentially revealed further opportunities for improvement. However, due to previously noted constraints, this step could not be undertaken. Future steps would involve conducting usability testing to validate assumptions and inform any necessary refinement

4.5.1 Line Weight

I experimented with varying line weights to create a high-contrast visual style that maintained clarity without overwhelming the layout, as shown in Figures 30 to 33. Line weight 6 as illustrated in Figure 30, offered the optimal balance, bold enough to provide emphasis while remaining spatially unobtrusive. For secondary details—such as icon elements, non-interactive components, prepopulated fields, and visually subordinate elements—line weight 3 was used, as illustrated in Figure 31. This choice aimed to preserve subtlety and visual precision. In contrast, line weight 1 pt, shown in Figure 32, was discarded due to its lack of visibility and tendency to blend into the background. Line weight also played a key role in establishing visual hierarchy. As illustrated in Figure 33, heavier lines were used to draw attention to critical interface elements, such as the summary section that requires user focus. In other areas, line weight was applied to emphasise input fields, effectively guiding users to the locations where information needs to be entered.

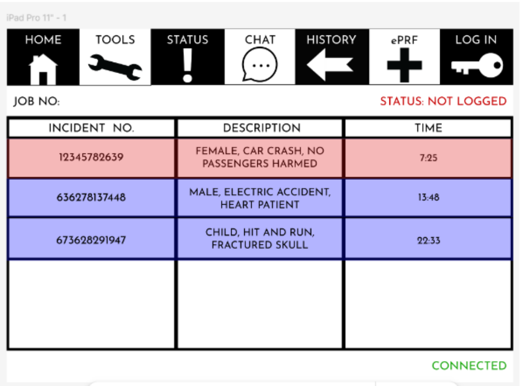

Figure 29: Experiment with 6pt line weight, the ideal line weight.

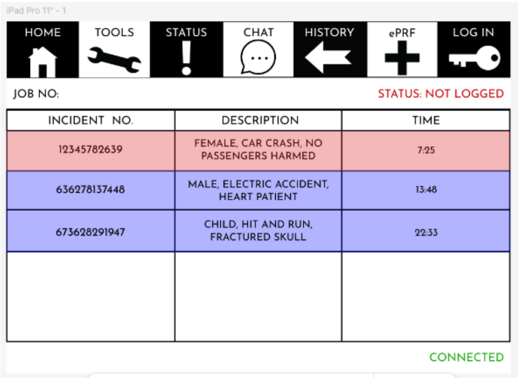

Figure 30: Experiment with 3pt line weight, the ideal line weight for finer details.

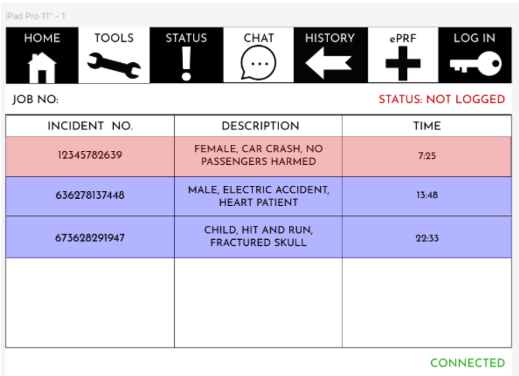

Figure 31: Experiment with 1pt line weight

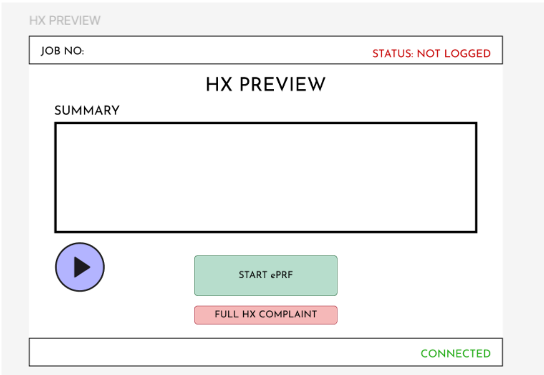

Figure 32: Highlighting relevant fields using line weight.

4.5.2 Visual Hierarchy

I experimented with the orientation and placement of elements to ensure actions followed a logical sequence, as depicted in Figures 34 and 35. For example, the task of recording patient vitals was positioned before note-taking, consistent with the structure of the original interface, with the layout structured to reflect this order and support a natural workflow. I also explored different layout configurations to determine the optimal number of elements per page. In line with the principle of progressive disclosure, I opted to place the notes section on a separate page to reduce visual clutter and maintain user focus for the medication page as illustrated in figures 36 to 38. Most user actions were streamlined through the use of dropdown selection boxes, in accordance with Hick's Law, which helped minimise cognitive load and facilitate decision-making.

While similar to the previous layout, as shown in Figures 39 to 41, the disposition section kept the notes on the same page. This decision was based on the simplicity of the two preceding actions, recording through buttons, a drop-down selection box and then finally typing. The first two elements involve relatively simple actions that do not require significant cognitive effort. Therefore, in my view, placing the notes on the same page does not overwhelm the user, hence does not impose additional cognitive load, making it unnecessary to separate them.

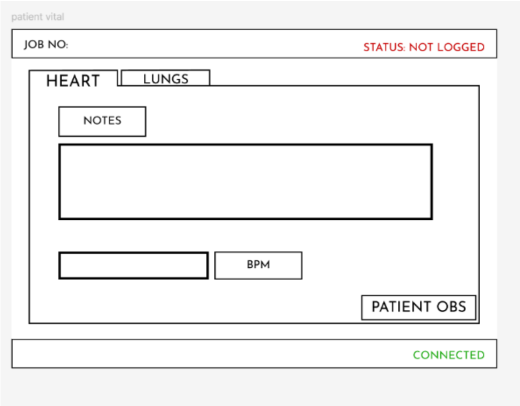

Figure 33: I experimented with the orientation of the patient observations layout, which was aimed at achieving a logical sequential flow. However, this configuration does not represent the correct sequence.

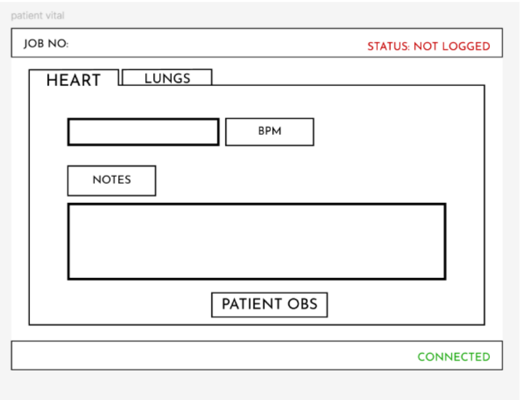

Figure 34: I experimented with the orientation of the patient observations layout, which was aimed at achieving a logical sequential flow. This configuration represents the correct sequence.

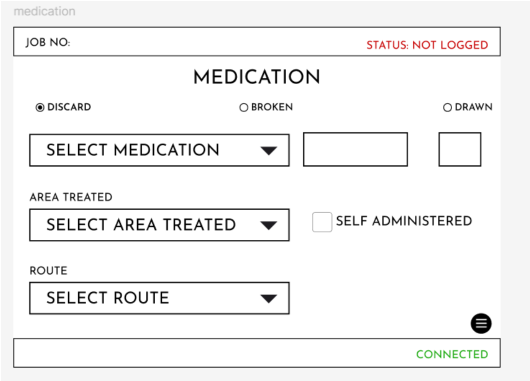

Figure 35: I experimented with the orientation of the medication layout, aimed at achieving a logical sequential flow without visually overwhelming the user. In this version, the notes section is not included on the same interface page.

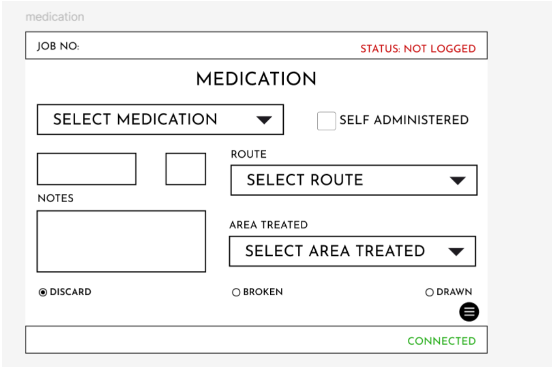

Figure 36: I experimented with the orientation of the medication layout, aimed at achieving a logical sequential flow without visually overwhelming the user. In this version, the notes section is included on the same interface page.

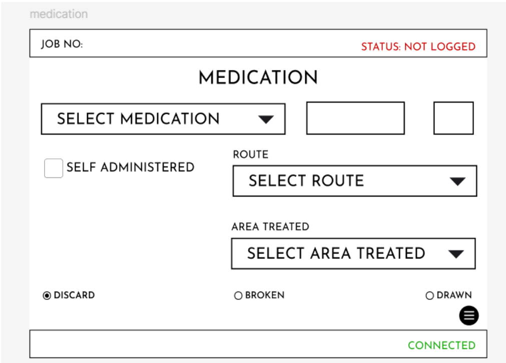

Figure 37: I experimented with the orientation of the medication layout, aimed at achieving a logical sequential flow without visually overwhelming the user. In this version, the notes section is not included on the same interface page. The layout follows a different order, which does not make effective use of space or supports intuitive orientation.

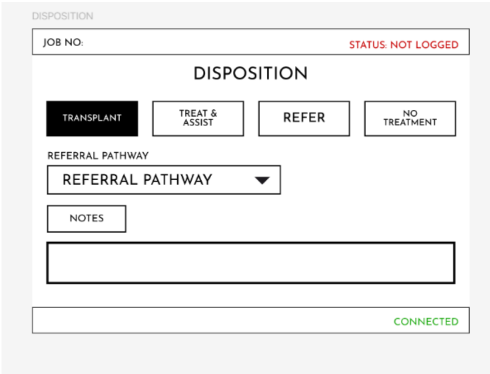

Figure 38: I experimented with the orientation of the disposition layout, aimed at achieving a logical sequential flow without visually overwhelming the user. In this version, the notes section is included on the same interface page.

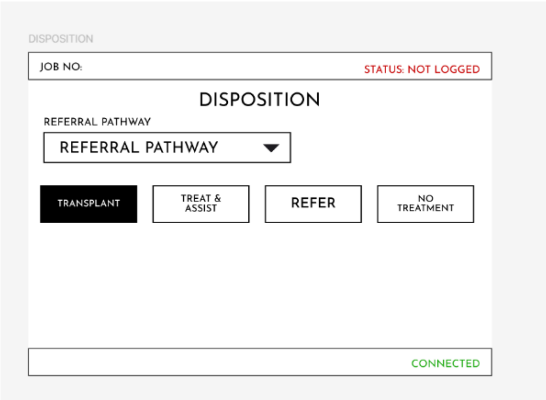

Figure 39: I experimented with the orientation of the disposition layout, aimed at achieving a logical sequential flow without visually overwhelming the user. In this version, the notes section is not included on the same interface page.

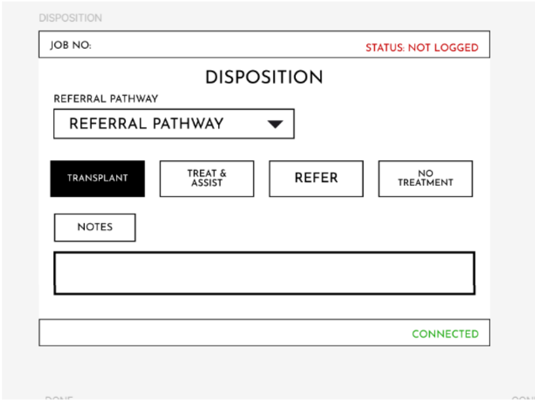

Figure 40: I experimented with the orientation of the disposition layout, aimed at achieving a logical sequential flow without visually overwhelming the user. In this version, the notes section is not included on the same interface page. The layout follows a different order, which does not make effective use of space or support intuitive orientation.

4.5.3 Colour and Contrast

I tested both colour and black-and-white imagery to determine the best option for visual contrast, as shown in Figures 43 to 48. The interface page was specifically designed to function as a clear visual aid, helping users quickly identify which aspect of patient observations was being recorded. The image needed to stand out from the background, and the interactive points had to contrast effectively with the image itself. While the black-and-white version blended into the background, it did offer stronger contrast for the stars, visual indicators of specific points on the body for patient examination. Users can tap these points to select the corresponding area. However, the combination of a coloured image with black stars provided superior overall contrast and visual clarity compared to the other trials tested.

I also explored different colourways, as shown in Figures 49 to 51, ultimately selecting green and red at 30% opacity to highlight text fields. This approach created a softer visual effect that enhanced readability without overwhelming the user. It is less harsh, bright, and distracting than full-opacity text boxes, allowing users to clearly read the black text displayed within. A solid red text at 100% opacity was used to draw stronger attention when necessary, e.g., for abnormal vital signs (either dangerously low or high), connectivity problems, login errors, recorded allergies, or any other information requiring immediate attention. To maintain visual consistency, the same red and green tones were applied at full opacity for the text. This colour treatment contrasts effectively with the otherwise black-and-white interface, ensuring that highlighted elements stand out clearly.

To further enhance contrast and improve readability, I employed a checkerboard layout alternating between black and white sections, as illustrated in Figure 52, with Figure 53 serving as a reference example without contrast. This layout effectively differentiates content areas and enhanced overall visual clarity

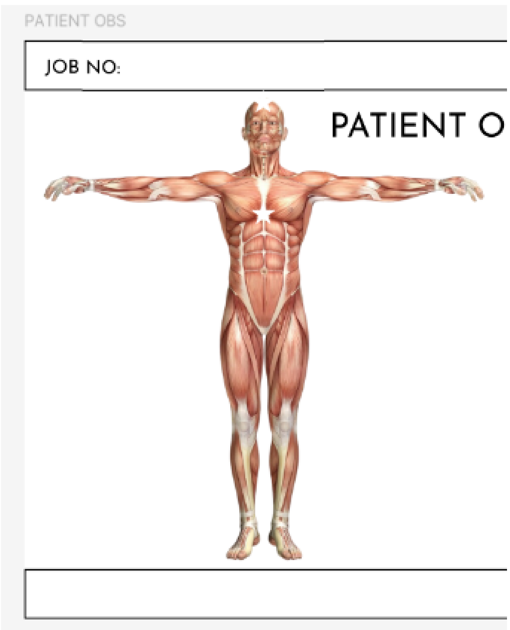

Figure 41: Colour and contrast experiment 1

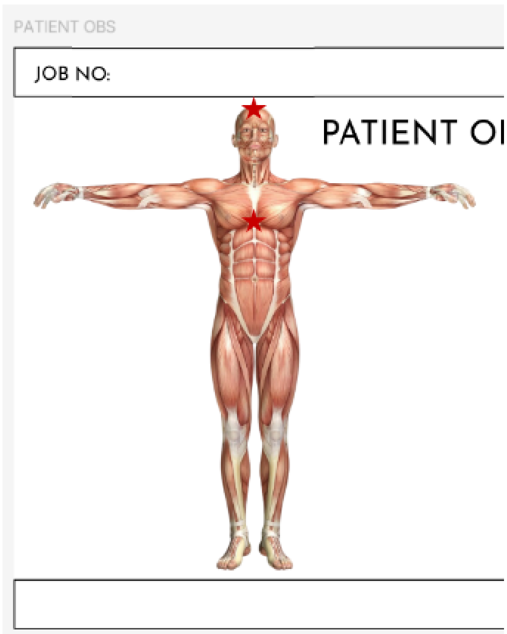

Figure 42: Colour and contrast experiment 2

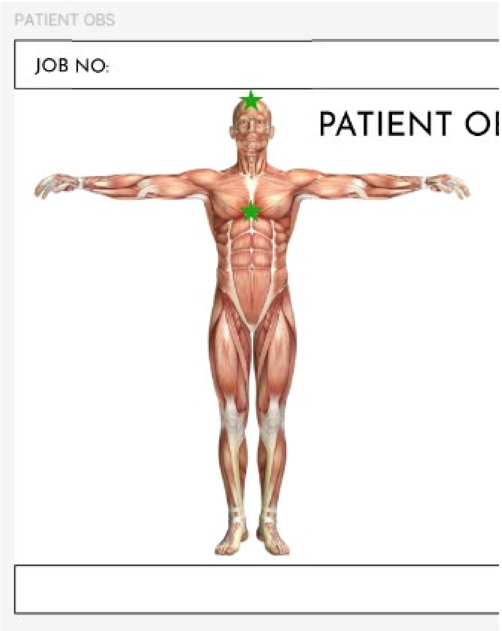

Figure 43: Colour and contrast experiment 3

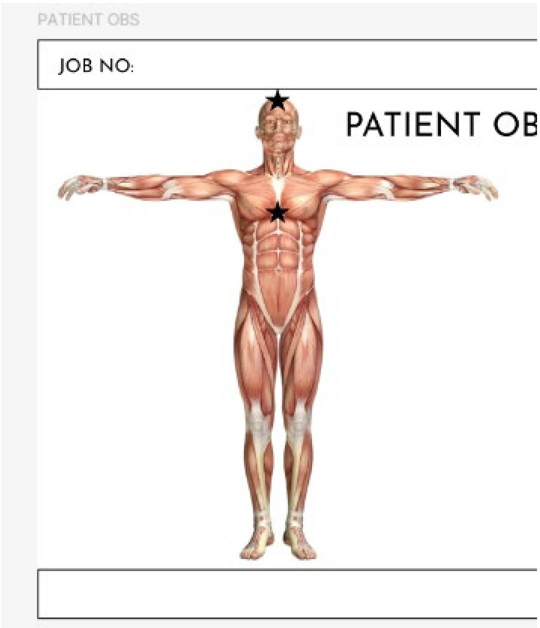

Figure 44: Colour and contrast experiment 4

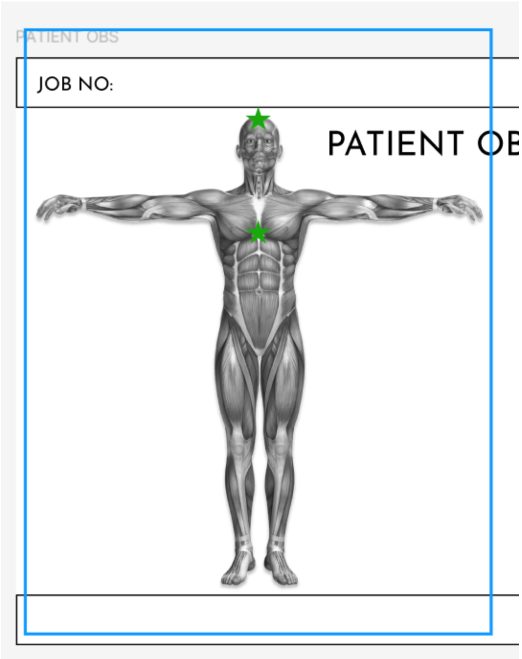

Figure 45: Colour and contrast experiment 5

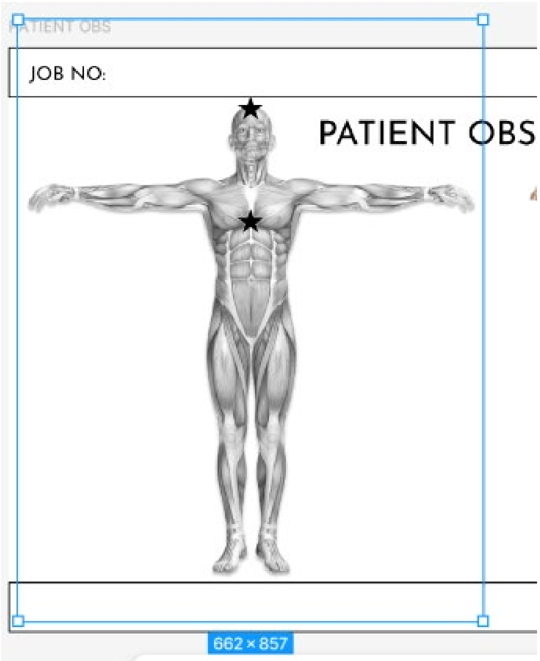

Figure 46: Colour and contrast experiment 6

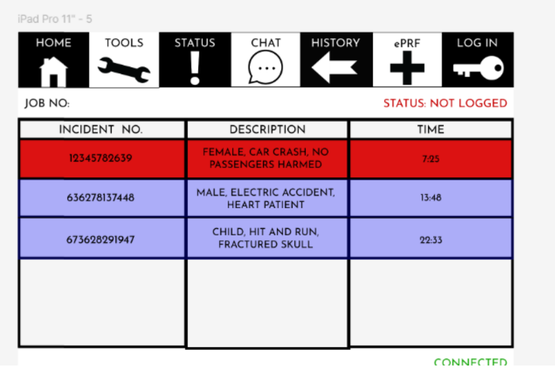

Figure 47: I experimented with the colour scheme of the menu layout, aimed at using colour to highlight information. In this case, blue indicates resolved cases and red indicates unresolved ones. However, the red is overly harsh and compromises the readability of the text.

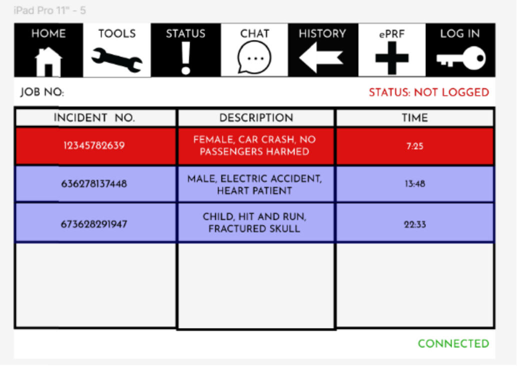

Figure 48: I experimented with the colour scheme of the menu layout, aimed at using colour to highlight information. In this case, blue indicates resolved cases and red indicates unresolved ones. However, the red is overly harsh and compromises the readability of the text even with white text.

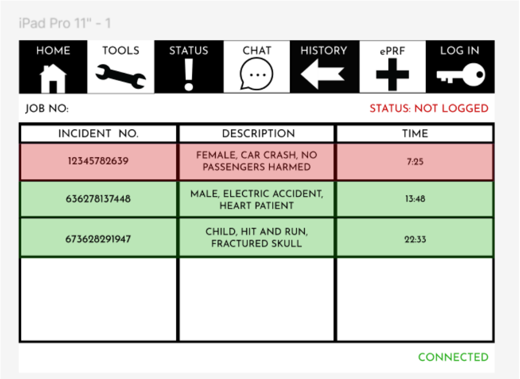

Figure 49: I experimented with the colour scheme of the menu layout, aimed at using colour to highlight information. In this case, green indicates resolved cases which I think is a better fit and red indicates unresolved ones. Both colours are not visually harsh and do not compromise the readability of the text.

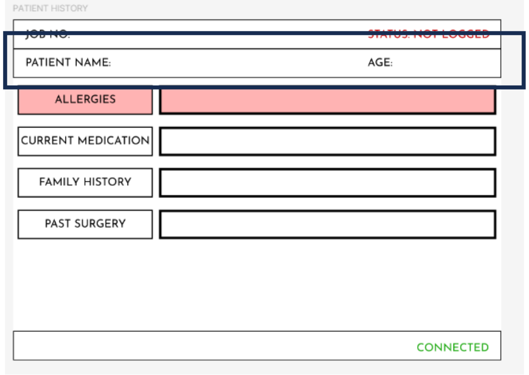

Figure 50: I experimented with the colour scheme of the patient history layout, aimed at maintaining high contrast across the interface. In this case, the use of an all-white background fails to provide sufficient contrast between different sections of the page.

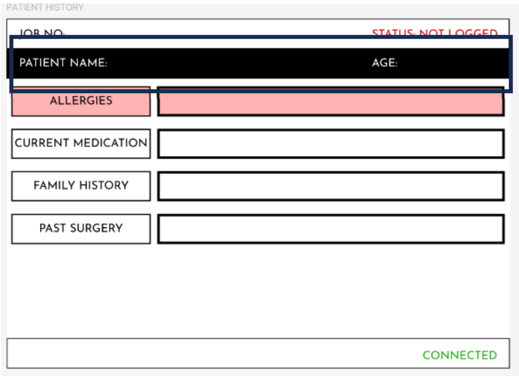

Figure 51: I experimented with the colour scheme of the patient history layout, aimed at maintaining high contrast across the interface. In this case, the use of black and white interchangeably provides sufficient contrast between different sections of the page.

4.5.4 Type

The selection includes a variety of type styles, such as sans-serif, serif, and slab serif, to explore different visual qualities. I chose fonts that I believed would offer good readability and compared them against one another to assess their suitability for the interface. Compared to other common free for use fonts available, it offered clear readability in both uppercase and lowercase formats, making it a suitable choice for the interface. In experimenting with typography, as seen in Figure 54, I selected Josefin Sans for its clean, sans-serif design. Its lack of decorative details made it straightforward and easy to read. These fonts were selected because they are publicly available and included by default in Figma as part of the Google Fonts library.

Figure 52: Exploration of various type styles to compare their visual qualities and readability. Fonts were selected based on legibility and assessed for their suitability within the interface.

4.5.5 The Redesigned Interface:

This section compares key pages from the original interface—sourced from St John, personal communication (16 April 2025)—with the redesigned version. The changes were informed by a desire to create a cleaner, less cluttered interface that enhances usability. The homepage, previously overwhelmed with job information, was restructured into a simplified linear table format, as illustrated in Figures 54 and 55.

Initially, I questioned the purpose of the original blue background and speculated that it might have been intended to enhance visibility under ambulance lighting conditions. To explore this, I conducted a basic usability experiment by flashing red and blue lights in a dark room while viewing the original interface on a tablet. The test revealed that the device's backlighting rendered the interface largely unaffected by ambient light colour.

As a result, I opted to switch the background to white, which simplifies the visual design and improves contrast. This change also enhances the visibility of critical interface elements—for example, fields highlighted in red to indicate connection issues or invalid inputs stand out more clearly against a white background (see Figure 59). On the medication pages (Figures 56 and 57), many input fields were redesigned as dropdown menus, now prepopulated with data from other sections—such as the patient's clinical impression—to reduce manual entry and support faster decision-making.

Furthermore, new features such as overlay menus (see Figure 60), accessible at any stage of interaction, and automation tools were introduced to streamline workflow—both of which were absent in the original interface.

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Figure 53: The original interface navigation/ home page. (Source: St John, personal communication, April 16, 2025)

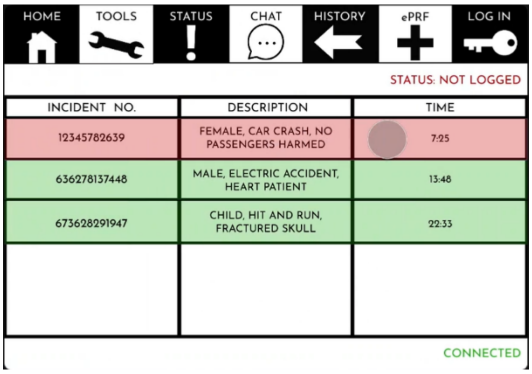

Figure 54: The redesigned interface navigation/ home page.

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due to copyright issues.

Figure 55: The original interface medication page. (Source: St John, personal communication, April 16, 2025)

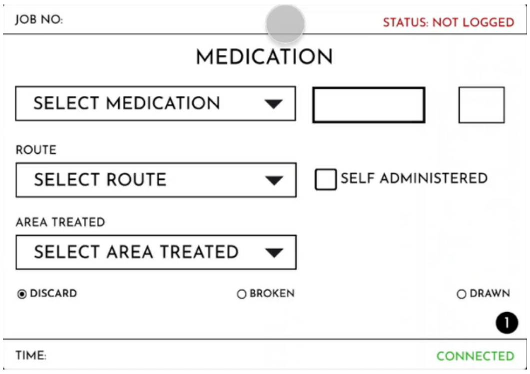

Figure 56: The redesigned interface medication page.

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removed by the author
due to copyright issues.

Figure 57: The original interface clinical impression. (Source: St John, personal communication, April 16, 2025)

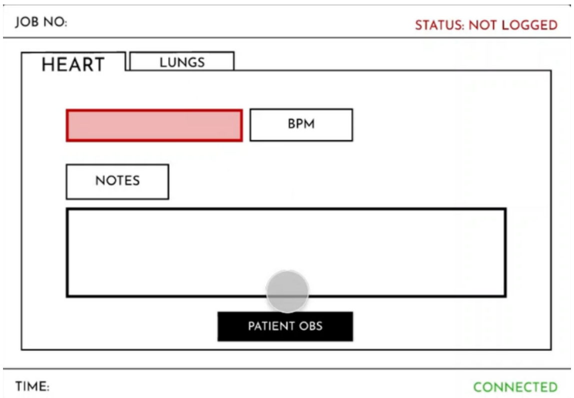

Figure 58: The redesigned interface clinical impression page.

Figure 59: The redesigned interface disposition page with the navigation dropdown overlay

Chapter 5: Discussion

This research set out to understand how the Mobile Data Terminal (MDT) used by paramedics in New Zealand could be redesigned to reduce paramedics cognitive load while attending to the fast paced and high stress environment of emergency responses. Through expert insight and secondary resources, this study presents a reflection on interface design in high-pressure environments, synthesised with findings from relevant literature. This chapter reflects on the design outcomes of a proposed MDT interface for paramedics in New Zealand and situates them within existing literature and practice-based insights. The research aimed to reduce cognitive load and improve workflow alignment through thoughtful interface design. However, the process revealed complex and sometimes conflicting dynamics between technological capability, user needs, and institutional constraints.

Several core themes were identified in the study and are explored in this chapter. First, the tension between the MDT's current linear documentation model and the highly interruptive, non-linear nature of paramedic workflows is examined. Second, the need for adaptable systems that respect both standardisation and contextual variability is discussed. Third, the interface's role in reducing cognitive burden through visual hierarchy and progressive disclosure is explored. Fourth, the chapter considers how automation must be carefully balanced with user trust and control in high-stakes environments. Fifth, the physical and emotional context in which the MDT is used in often unstable, fast-paced, and stressful environments that introduce unique ergonomic and design challenges.

Additionally, the chapter reflects critically on the barriers faced during this research, particularly around participant access and perceived institutional risk aversion—and considers what these obstacles reveal about innovation in protected domains like emergency medicine. It concludes by considering broader implications for interface design and research methodology in constrained, high-responsibility fields.

5.1 Designing an MDT Interface

In the rapidly evolving landscape of emergency medical services (EMS), the need to align digital tools with the dynamic, high-stakes realities of field operations is becoming increasingly urgent (Basnawi, 2023). This section of the research further explores the design and functionality changes intended to enhance utility and responsiveness to real-world paramedic workflows. Central to this discussion is the tension between structured digital systems and the inherently non-linear, unpredictable nature of emergency response work.

Throughout this project, I aimed to develop a more usable and coherent version of the MDT interface. The original design featured many buttons and sections that lacked clear purpose, appearing as though they had been added without meaningful consideration of workflow or context. Rather than feeling intentionally designed, the interface gave the impression of being assembled haphazardly, with users expected to adapt to its flaws. While this may have allowed basic functionality, it significantly hindered efficiency, especially in a system used daily.

This kind of design neglect can be perceived by users as a reflection of institutional disregard for their working conditions. When essential tools are poorly designed, it not only impedes job performance but also contributes to a sense of undervaluation. Such systemic barriers have the potential to drive paramedics out of the profession (Beldon & Garside, 2022).

My background in design enabled me to focus on reducing friction within the system. Drawing on experience in app and website development, as well as established UI/UX principles, I prioritised clarity, accessibility, and user-centred functionality. The most valuable aspect of the process was consistently adopting the perspective of the end user thinking through each step from the standpoint of a paramedic in the field. This empathetic approach informed all design decisions, with the goal of easing their interaction with the system at every stage.

5.1.1 Structure vs Reality

The existing MDT system is predicated on a sequential task flow, initiating, completing, and closing cases in a fixed order, which may be an issue considering paramedic work is inherently non-linear, characterised by frequent interruptions, shifting environmental conditions, and fluctuating patient care priorities (Carter & Thompson, 2015). This incongruity increases the risk of errors and cognitive fatigue, as systems fail to accommodate the fluidity of real-world scenarios. Supporting literature by Grigsby & Knew (1988) indicates that emergency environments are inherently high-stakes, time-sensitive, and emotionally charged, which exacerbates these risks when systems lack flexibility.

To mitigate these challenges, the redesigned interface incorporates features that aim to bolster interruption resilience. Notably, the interface allows users to pause, skip, and resume documentation seamlessly through features such as gesture-based commands, which enable users to navigate back and forth with ease, and an overlay dropdown navigation pane that facilitates jumping between sections at any stage. These design choices support the fragmented and often unpredictable nature of paramedic duties. As identified by Carter and Thompson (2015) in their paper Defining the Paramedic Process. Their work attempts to define a process of care suited to the unique demands of the profession, underscoring the need for flexible and adaptive interface solutions. Additionally, the navigation pane, aims to allow EMS personnel to prioritise tasks based on situational demands rather than adhering to a rigid sequence. These design decisions aim to address the unique demands associated with the paramedic profession, specifically, by enabling flexibility to accommodate the dynamic nature of their work and processes.

Another prominent challenge was reconciling the need for standardised procedures with the requirement for situational adaptability. While legal and procedural frameworks demand consistency, the diverse experience levels of paramedics and varying work environments necessitate flexible systems. There appears to be a prevailing frustration with the current MDT's rigid workflow logic, a sentiment echoed in literature that advocates for user-adaptive systems accommodating diverse work styles. Reay et al. (2018) describe decision-making by paramedics as a fluid, iterative process. In response, the new design introduces user-driven navigation, flagging options, and configurable input fields, enabling varied documentation patterns without compromising data integrity.

The redesign of the MDT system intends to represent a shift towards accommodating the complex realities of paramedic work. By introducing features that enhance interruption resilience and allow for user adaptability, it was intended that the system aligns more closely with the dynamic nature of emergency medical services. This underscores the importance of designing digital tools that meet procedural standards and support the nuanced demands of field operations, ultimately contributing to improved efficiency and patient care outcomes (Carter & Thompson, 2015).

Looking ahead, the next section will discuss the visual and functional hierarchy of the redesigned MDT system that I have created. These changes aimed to streamline essential user tasks and improve system adaptability. This supports the ongoing shift towards more intuitive and effective digital tools in emergency medical services.

5.1.2 Managing Cognitive Load through Visual and Functional Hierarchy

In the realm of EMS, the cognitive demands placed on paramedics are substantial, often exacerbated by complex and information-dense digital interfaces (Zaphir et al., 2025). By redesigning the MDT interface to incorporate visual and functional hierarchy, this project aims to reduce cognitive burden through a simplified layout and prioritised content structure, thereby improving the efficiency and effectiveness of paramedic workflows. This section outlines the design techniques implemented to achieve this goal, drawing on established principles of human-computer interaction and cognitive psychology.

Spillers, F. (2025) discusses user overwhelm caused by excessive information and introduces the concept of progressive disclosure as a means to manage cognitive load. This technique has been utilized in the redesigned interface to improve user experience and reduce cognitive strain.

Progressive disclosure involves revealing information in a staged manner, presenting only what is necessary at a given time, thereby mitigating information overload (Spillers, F. 2025). Additionally, the chunking technique, as described by Yablonski, J. (2024), was employed. Chunking groups related information into manageable units, which aids in memory retention and recall. By visually emphasising high-priority fields and nesting secondary details, the redesigned interface enables paramedics to focus on the most critical information first, minimising distractions from less relevant data.

The two design techniques, progressive disclosure and chunking were intended to collectively contribute to improved decision-making by minimising the cognitive load associated with information processing. By structuring information in a manner that aligns with human cognitive capabilities, the new interface design intended to reduce the need for paramedics to retain large volumes of information in working memory, thereby decreasing the likelihood of errors and cognitive fatigue (Yablonski, J. 2024). This approach is particularly pertinent in high-stress environments where rapid and accurate decision-making is paramount (Zaphir et al., 2025).

The redesign of the interface, grounded in principles of user-centred design and aims to address the challenges associated with cognitive overload in paramedic practice. By simplifying the interface and prioritising content, the system aims to enhances usability and supports more efficient workflows.

Building upon these improvements, the subsequent section will explore the integration of automation and user feedback mechanisms. These elements aim to further streamline operations, reduce manual workload, and enhance the adaptability of the system to meet the diverse needs of EMS personnel.

5.1.3 Automation and the User

In the endeavour to enhance efficiency within emergency medical services (EMS), automation, through functionalities such as autofill, smart defaults, and predictive prompts, has been implemented to ease the documentation burden placed on paramedics. Nevertheless, Grinschgl and Neubauer (2022) caution against excessive reliance on automation as a means of mitigating cognitive load, citing potential detriments to cognitive functions such as learning and memory. While their concerns underscore the risks associated with overdependence on automated decision-support, I believe automation remains appropriate when applied to specific aspects of the workflow, provided it is implemented with due care and consideration.

Given the prominence of automation, the absence of features designed to alleviate cognitive load within the interface suggests a concerning lack of consideration for personnel. Medical design often prioritises patients over staff. However, I believe greater emphasis should be placed on creating user-friendly technologies that support staff, rather than expecting them to cope with poorly designed systems. Conversations with St John suggest that their research teams primarily focus on supporting clinical studies, which tend to centre around patient outcomes. Similarly, Rinkinen et al. (2024) highlight technological advancements in prehospital healthcare delivery—yet the emphasis remains on patient-facing improvements, with comparatively less attention paid to the needs of frontline personnel.

Building upon this foundation, the subsequent section will explore the design considerations that concern stressful and emotionally charged environments in which paramedics operate. Understanding and accommodating the psychological and emotional demands of emergency response work are crucial for developing interfaces that support resilience, decision-making, and overall well-being among EMS personnel.

5.2 Barriers to Participatory Research

This section explores the significant barriers encountered in paramedicine research, from the perspective of this research project, particularly in relation to participant recruitment. The challenges faced in securing participants during this study may reflect broader, systemic issues within the field of paramedicine research. Individual paramedics seemed or may have been hesitant to participate due to concerns about liability and reputational risks, while organisations cited issues such as privacy concerns, political considerations, and limited resources. Hato Hone St John, though initially supportive of this research, and presenting a potential pathway to recruitment, contributed further complications through its lengthy approval and changing procedures and timelines. As a result, the user-testing phase was ultimately abandoned. This obstacle is an example of the barriers present within paramedicine research (Basnawi, 2023). These challenges provide valuable insights into the importance of fostering a conducive environment for innovation.

Despite what appeared to be initial interest and enthusiasm by several individuals in various leadership roles at different departments. Along with extensive consultation process to design the research approach to involve the appropriate user expertise and subsequent ethics approval, this study faced considerable barriers in participant recruitment. Individual paramedics declined to participate due to perceived risks, including potential liability or reputational damage. Organisations cited privacy, political considerations, and limited capacity. While the Australasian Paramedics Association offered a possible pathway, its long approval timeline and uncertain outcomes led to the decision to drop the user-testing phase.

This may reflect wider challenges in paramedicine research. As noted in recent literature, there exists a fragmentation between academic and operational stakeholders, with limited resources and a lack of research that may be impeding progress (Maguire et al., 2014). I believe there should be policy frameworks in place that facilitate innovation while safeguarding patient data and operational sensitivities.

The challenges associated with participant recruitment, alongside the systemic barriers identified in this study, underscore the necessity for a comprehensive approach to addressing these issues. The fragmentation between academic and operational stakeholders, limited resourcing, and the absence of a robust research culture—as discussed by Ross et al. (2023) in Barriers and Enablers to Paramedicine Research in Australasia—contribute to the stagnation of research progress within paramedic services. Ross highlights the prevailing negative perceptions towards research and participation in research within the paramedic space, further compounding the issue. A significant disconnect persists between stakeholders and the provision of essential resources, such as funding, time, training, dedicated roles, and access to data—all of which are major impediments to advancing paramedicine research. Addressing these and other professionalisation barriers requires the development, adoption, and implementation of a coordinated paramedicine research agenda for Australia and New Zealand. Such frameworks must aim to streamline approval processes, foster collaboration, and cultivate a research-oriented culture across the profession.

5.3 The Challenge of Encouraging Innovation

Innovation plays a pivotal role in addressing the persistent challenges faced by healthcare systems. Without active support and encouragement, innovation risks being stifled, leaving inefficiencies entrenched and systems resistant to meaningful progress. This section explores key barriers to innovation in the healthcare sector, while also highlighting enabling frameworks and strategies that can promote a more adaptive and forward-looking environment.

Kelly and Young (2017) present the NHS Challenge Prizes as a compelling example of structured innovation support. These prizes incentivise localised problem-solving while facilitating the national scaling of successful ideas through funding, recognition, and visibility—critical factors in converting ideas into implementable solutions. Similarly, the NHS Clinical Entrepreneur Programme (Kelly and Young, 2017) empowers clinical staff to develop innovations grounded in their lived experience of healthcare delivery. With access to mentorship, funding, educational resources, and professional networks, clinicians are well-placed to devise interventions that align with operational realities, thus reducing resistance to implementation.

To understand how innovations transition from research into practice, it is important to consider the field of implementation science. According to Bauer and Kirchner (2020), implementation science is the systematic study of methods that promote the integration of evidence-based practices into routine healthcare. It addresses two core processes: identifying barriers and facilitators at multiple contextual levels (e.g., individual, organisational, systemic) and designing implementation strategies that enhance adoption. Importantly, it is estimated to take 17–20 years for clinical innovations to be fully integrated into practice, and fewer than 50% of innovations ever achieve widespread use (Bauer & Kirchner, 2020). These figures highlight how individual attitudes, organisational behaviours, and the passage of time can dilute the original intent behind innovations—underscoring the need for more agile and responsive systems.

Despite such initiatives, resistance to change remains a formidable barrier to innovation, as identified by Kelly and Young (2017). Organisational inertia, risk aversion, and cultural rigidity often impede the adoption of new technologies and practices. However, Van Den Hoed et al. (2022) offer a framework for overcoming these challenges through four critical enablers of innovation readiness in healthcare organisations: a strategic orientation towards innovation, an organisational climate that supports experimentation, leadership that champions innovation, and sustained commitment across all levels of the organisation. Embedding these principles into healthcare culture could ease the path toward adopting technologies that ultimately benefit staff and patients alike.

Barriers to innovation in healthcare reflect those found across other sectors and can be grouped into four main categories: economic, technical, organisational, and social (Pakulska & Religioni, 2023). Within these categories, specific issues include a lack of managerial incentives to pursue innovation, limited stakeholder awareness of the benefits of new technologies, and deep-rooted mistrust in IT systems. Successful innovation thus demands more than technical deployment; it requires a profound cultural shift. Sony et al. (2023) argue that healthcare professionals must be meaningfully supported to engage with innovation, which calls for transparent communication, structural investment, and a reimagining of traditional work patterns. This reinforces the importance of cultivating a culture that values adaptability, curiosity, and continuous learning.

Kelly and Young (2017) further note that limited funding opportunities for emerging technologies continue to pose significant barriers. However, mechanisms such as the UK's Enterprise Investment Scheme (EIS) help mitigate this by offering tax incentives that attract investment and entrepreneurial talent. Additionally, the growing healthcare-focused angel investment and venture capital market—supported by both government and private actors, indicates a more mature innovation ecosystem. Academic institutions also contribute meaningfully through initiatives like Entrepreneur First, which guides deep-tech concepts from ideation to commercialisation.

Collectively, these insights emphasise that fostering innovation in healthcare requires more than isolated initiatives or financial incentives. It necessitates coherent policy frameworks, leadership commitment, scientifically grounded implementation strategies, and a culture that embraces adaptability and change across all levels of the system. In this context, New Zealand could benefit from adopting similar models to those seen internationally, particularly in light of the Pae Ora (Healthy Futures) Act, which outlines a commitment to embracing modern technologies and fostering innovative approaches to healthcare delivery (Ministry of Health, 2024).

Establishing innovation pathways tailored to New Zealand's unique healthcare context—such as national innovation challenges or clinical entrepreneurship programmes—could support the development and integration of locally relevant solutions. While innovation funding is available through entities like the Ministry of Business, Innovation and Employment (MBIE), such funding is broad in scope and not specifically targeted at clinical innovation. The Health Research Council of New Zealand (HRC) provides a more focused avenue, with its Gateway portal serving as the primary government-affiliated platform for healthcare-specific research funding, contract management, and expert peer review.

In addition, the government's New Zealand Health Research Strategy (2017–2027) sets a bold vision: that by 2027, New Zealand will have a world-leading health research and innovation system which, through high-quality research, enhances the health and wellbeing of all New Zealanders. If this vision is realised, it may provide stronger structural support for clinical innovation and help accelerate the integration of evidence-based solutions into practice across the national health system

In conclusion, the research presented above underscores the critical role of innovation in enhancing healthcare delivery and improving patient outcomes. Although it often faces obstacles such as funding limitations and resistance to change, support from larger institutional bodies, through structured programmes, public-private partnerships, and targeted investment, may help overcome these challenges.

5.4 Implications for Future Innovation

This section considers the dual realities of designing for paramedicine: the considerable potential for innovation and the persistent structural limitations that constrain it. This research revealed that, despite significant opportunities to enhance paramedic interfaces through the application of established user experience (UX) design principles, such enhancements have largely not been implemented, though the reasons for this remain unclear. Perhaps the development of such technologies was exposed to systemic barriers that prevented an effective development of the technology. These barriers could include institutional restrictions, data governance concerns, and entrenched cultural dynamics that may inhibit meaningful participatory design. Together, these factors define a complex landscape where the promise of design-led innovation is tempered by the practicalities of limited access and organisational resistance.

This study highlights both the potential and the limitations of designing in the paramedic space. On one hand, there are clear opportunities to improve paramedic interfaces by applying well-established UX principles. On the other, there may be deep structural barriers, both institutional and cultural, that limit meaningful participatory design.

In an ideal scenario, research in this field would be supported through formal partnerships between researchers and healthcare institutions. Access to training environments, simulated clinical scenarios, and anonymised or non-sensitive MDT data can significantly enrich the research process, resulting in more robust findings and higher-quality prototypes. I believe that the absence of structural support continues to limit the depth and impact of research efforts.

This study has investigated the redesign of MDT interfaces for paramedics in New Zealand, with the aim of reducing cognitive load and making the digital interface easier to use, intuitive and more efficient. Through design interventions such as service design workflows, visual hierarchy, user-controlled automation, and improved physical usability, the proposed interface aims to offer a more contextually appropriate and cognitively supportive experience for EMS personnel.

The research demonstrates that successful interface design in high-stakes environments must extend beyond basic functionality to include adaptability, user trust, and sensitivity to the complex conditions in which these systems are deployed. Crucially, such design efforts also require strong organisational backing (Van Den Hoed et al., 2022; Bauer & Kirchner, 2020). Future innovation in this domain will depend not only on thoughtful design practices but also on policy reform, cross-sector collaboration, and a sustained commitment to cultivating a research-oriented culture within emergency services. Without these systemic changes, the transformative potential of design in paramedicine will remain unrealised—an opportunity that is both urgently needed and, without intervention, frustratingly out of reach.

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Appendices

ePRF Passport notes

Case Initiation:

The system begins with a job number pop-up, which serves as the unique identifier for each case. This identifier helps track all patient interactions throughout the case's lifecycle, from initial assessment to handover to a healthcare facility.

Offline Functionality: The app offers a manual job initiation feature for situations where there is no internet connectivity. This allows paramedics to begin data entry even when the MDT is offline, which is critical in remote areas or during temporary network outages.

Sync ePRF:

The Sync ePRF function ensures that data entered into the system is transmitted to a central server. This is particularly useful for hospital viewing when multiple clinical teams need access to real-time updates on a patient's status, treatment, and interventions.

Retrieve ePRF:

In the event of a data entry interruption, the Retrieve ePRF feature allows paramedics to recover and re-enter data that has not been submitted or has been mistakenly lost.

Manage Crew:

The Manage Crew function tracks the crew members assigned to each case. This allows for detailed documentation of which paramedics attended the patient, including their roles in providing treatment. This is important not only for clinical purposes but also for legal and regulatory compliance.

Group PTS:

The Group PTS feature is used to group multiple patients together under a single Patient Transport Service (PTS) case. This function reduces administrative work, ensures patients are billed collectively, and prevents errors where patients are billed separately when they should be grouped. However, this feature currently requires manual input, which can lead to errors or omissions.

Interface Design

The ePRF application is designed to ideally be user-friendly, with intuitive navigation and clear categorization of patient information. The application has been structured to reflect the natural flow of clinical assessment, from patient intake to intervention, and finally to handover to receiving healthcare providers.

Menu Tabs:

The main interface consists of five key menu items, which include options for starting a new case, syncing or retrieving ePRFs, managing crew members, and grouping patients for billing purposes. These tabs essential, they are pretty straightforward and provide easy access to essential functions.

Visual Indicators:

The system uses color-coded indicators to convey the connectivity status. A green light shows that the MDT is online, while red indicates offline status. Similarly, submitted jobs are marked in blue, while unsubmitted jobs are shown in red, providing a visual cue to the user regarding the status of their documentation.

Data Entry and Management

Vital Signs and Treatment Documentation

The Vitals Obs/Treat section plays a crucial role in patient care documentation, as it records vital signs such as heart rate, blood pressure, oxygen saturation (SpO2), respiratory rate, and temperature. This section ensures that paramedics have immediate access to essential patient data, allowing for informed decision-making during treatment.

Critical Data Fields:

The ePRF system enforces data completeness by highlighting missing or incomplete fields in red text. For example, if a paramedic starts entering a particular vital sign, the system flags the entry as a compulsory field. This ensures that all critical data is recorded.

Data Entry Protocols:

The system prompts paramedics to enter the date and time of each measurement. While the manual entry of this data ensures accuracy, it may be time-consuming during high-pressure situations. Some users have suggested that the system could benefit from auto-population of time stamps based on the moment a vital sign is entered, reducing the need for manual input.

Medication Administration

Medications administered to patients are logged in a separate section, where paramedics input medication name, dosage, administration time, and the paramedic's ID for legal documentation. However, certain features could be optimized:

Self-Administered Medication:

At present, self-administered medications must be manually recorded in the notes section under "Others." This is an inconvenience and leads to a lack of standardization. A dedicated section for self-administered medications would streamline this process and enhance the accuracy of patient medication histories.

Discarded Medications:

The app includes a prompt for recording discarded medications. Paramedics are required to input their ID number and signature when medications are discarded. This process is important for accountability and inventory management but could be simplified to reduce time spent on administrative tasks.

Patient Grouping and Billing

The Group PTS feature, designed for billing purposes, allows paramedics to group patients under a single transport case. While the feature is essential for accurate billing, it currently requires manual input. This could be automated through the use of NHI numbers or patient identifiers to reduce errors and administrative workload.

Usability and User Experience

Interface Usability

The ePRF interface is generally well-organized, but it is not without its challenges, particularly for new users:

Learning Curve:

There is a learning curve for paramedics transitioning from paper-based to digital forms. Although the interface is designed to be intuitive, it requires practice to become comfortable navigating between different sections (e.g., clinical observations, patient history, medication administration).

Navigation and Workflow:

Experienced users may develop their own preferred workflows, skipping between sections rather than following a strict sequence. This flexibility can improve efficiency once the system is well understood but may result in inconsistent data entry.

Automatic Data Population:

Vital signs, medication entries, and patient information could be auto-populated based on prior entries or external systems (e.g., patient records), minimizing manual input and reducing errors.

Enhanced Sync Functionality:

The Sync ePRF feature could be enhanced by providing a pop-up reminder when submitting the ePRF to ensure data is synchronized just before submission, minimizing the risk of data loss.

Offline Data Entry Improvements:

The system could be optimized to allow for more seamless data entry in offline modes, ensuring that paramedics can continue to record patient information without disruption. Features such as local storage backups and automatic sync upon reconnect could be integrated to improve reliability.

Data Security and Privacy Concerns

Security of Patient Data

Given the sensitive nature of patient information, data security and privacy are paramount. The ePRF system complies with national healthcare privacy regulations, ensuring that patient data is encrypted both during transmission and at rest. However, further enhancements in data access controls and auditing capabilities could strengthen the system's security.

Access Control:

Access to ePRF records is restricted based on user roles (paramedics, clinicians, administrators), but there could be additional layers of authentication for higher-security functions, such as modifying case data.

Audit Trails:

The system should maintain a comprehensive audit trail of all user interactions with the system, logging changes made to patient records for accountability and transparency.

The ePRF system has demonstrated significant benefits in terms of improving the documentation, communication, and efficiency of patient care in the pre-hospital setting. However, there are several areas that warrant further attention:

Automating Patient Grouping: The grouping of patients under PTS could be automated using patient identifiers, reducing the administrative burden.

Streamlining Medication Entry: Introducing a dedicated field for self-administered medication would improve the accuracy of medication logging.

Improving Offline Functionality: Enhancing offline capabilities and reducing the reliance on internet connectivity will ensure uninterrupted care, especially in remote areas.

User Training and Support: Comprehensive training and intuitive design will reduce the learning curve for new users and enhance the overall user experience..

Auckland University of Technology Ethics Committee (AUTEC)

10 March 2025

Stefan Marks
Faculty of Design and Creative Technologies

Dear Stefan

Re Ethics Application: **25/9 Towards a Safer and Healthier Work Environment: Exploring the Impact of User Interface Design with Technology on Stress Reduction for Emergency Medical Service (EMS) Personnel**

Thank you for your responses to AUTEC's conditions.

Your ethics application has been approved for three years until 10 March 2028.

Non-Standard Conditions of Approval

1. In the Information Sheet please also include LinkedIn as a place where potential participants were identified.

Non-standard conditions do not need to be submitted to or reviewed by AUTEC unless requested but must be completed before commencing your study.

Standard Conditions of Approval

1. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC.
2. All public facing documents must have the AUTEC approval number and be of a high standard of spelling and grammar. Dates on the Information Sheet(s) and Consent Form(s) must be consistent.
3. Any amendments to the project must be approved by AUTEC prior to being implemented.
4. A progress report is due annually on the anniversary of the approval date.
5. A final report is due at the expiration of the approval period, or, upon completion of project.
6. Any serious or adverse events must be reported to AUTEC, this includes unforeseen issues that might affect continued ethical acceptability of the project.
7. AUTEC grants ethical approval only. You are responsible for obtaining management permission for access from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

The application number and title need to be referenced on all correspondence related to this project.

All forms are available online http://www.aut.ac.nz/research/researchethics

For any enquiries, please contact the Secretariat at ethics@aut.ac.nz
(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat
Auckland University of Technology Ethics Committee

Cc: Bfy1222@autuni.ac.nz; Stephen Reay

TE WĀNANGA ARONUI
O TĀMAKI MAKAU RAU

Participant Information Sheet

Date Information Sheet Produced:

4 November 2024

Project Title:

Towards a Safer and Healthier Work Environment: Exploring the Impact of User Interface Design with Technology on Stress Reduction for Emergency Medical Service (EMS) Personnel

Hello, I am Shreya Pradeep a Masters student in Creative Technologies. This research will contribute to my completion of this degree.

My background is in service design, graphics and UI/UX and am passionate about working with people and designing solutions accordingly. This research topic is close to my heart. I come from a family of doctors and other medical practitioners, and I have seen the mental strain that working in a high-pressure field like emergency medical services can have on a person.

Thank you for expressing interest in participating in this research.

What is the purpose of this research?

The purpose of this research is to explore redesign opportunities in the emergency medical service space, specifically for personnel working in this area as it related to their wellbeing. Through this research I aim to reduce cognitive load on critical care paramedics while driving to emergencies and using the mobile data terminal (MDT),by redesigning the interface of the MDT present in Eeco Ambulances.

I would like to conduct interviews with extended care paramedics to examine their experiences and the factors that may affect their cognitive load when using MDTs while responding to emergencies. I would then take that information to prototype a new interface that paramedics may test and provide feedback.

This research will contribute to my completion of the Masters in Creative Technologies at AUT; and the findings of this research may be used for academic publications and presentations.

How was I identified and why am I being invited to participate in this research?

Potential participants were identified through the public domain, AUT website, according to their relevant experience in EMS settings and having extended care paramedic experience Through email, I have invited you to participate in my research. Interested parties will contact me back with a signed consent via email. To ensure participation is truly voluntary, each participant may withdraw from the study if they wish. Is the researcher I reinforce the voluntary nature of the research. Participants may elect in for the subsequent second stage.

Participants must be Extended Care Paramedics or Emergency medical service (EMS) personnel who work at AUT or are employed in emergency medical service space living in Auckland, and able to engage in an interview in English.

How do I agree to participate in this research?

Should you wish to participate in this research, you must return a signed consent form. This form will be sent to you via email by me. Once you have returned a signed consent form, I will take this as your acceptance of this invitation to participate.

Your participation in this research is voluntary (it is your choice) and whether you choose to participate will neither advantage nor disadvantage you. You can withdraw from the study up until your data begins to be analysed. If you choose to withdraw from the study, then you will be offered the choice between having any data that is identifiable as belonging to you removed or allowing it to continue to be used. However, when data analysis begins, the removal of your data may not be possible.

What will happen in this research?

Participants will engage in an interview with me. Interviews may take 45 minutes – 1 hour. Interviews will be undertaken in person or online. There will be time for myself and the participant to get to know one another. I will also repeat key information about the project and the participants' rights, and the participant can ask any questions they may have. Interviews will involve a predetermined set of open-ended questions, as well as ad-hoc, follow-up questions. The content of the interview will focus on the participants' experience with the current MDT.

The interviews will be audio-recorded and later transcribed (written out verbatim) by me, with the participants' consent. Participants will be given pseudonyms and any identifiable information about them or anyone they may talk about during their interview will be removed.

I will then analyse the transcripts. This will involve exploring similarities and differences in participants' experiences and summarising key themes that have arisen across participants' transcripts. Once I have analysed the transcripts, I will write up a results section to capture the findings and will include de-identified quotes from participants' transcripts. The findings will be used to support the redesign of a prototype MDT.

Should participants opt in for the ongoing stages, participants would be contacted for the follow up interview to provide feedback on an interface prototype. This stage may take 45 minutes – 1 hour. Interviews will be taken in person at AUT. There will be time allotted for me to repeat key information about the project and the participants' rights, and the participant can ask any questions they may have. Interviews will involve a predetermined set of questions, as well as ad-hoc, follow-up questions. The content of the interview will focus on the participants' experience with the new MDT interface, how they feel about it and if it addresses all the concerns and issues brought up in the initial round of interviews.

Participants have the option to participate in either one or both stages of the research.

Once the research project is complete and has received a final grade, I will provide a summary of the research to participants who indicate on the consent form that they wish to receive this summary. The research may be used for academic presentations and publications in the future.

What are the benefits?

I hope participants find the research process enjoyable. This study aims to identify usability issues with the communication system, specifically the mobile data terminal (MDT). Additionally, I seek to understand how technology and equipment impact paramedics while exploring solutions to enhance EMS systems, processes, and technologies, particularly regarding the use of the MDT in ambulance vehicles. Additionally, the study aims to fill a gap in the literature regarding the wellbeing of EMS personnel. As noted by Reynolds et al. (2021), there is a pressing need for more research into this area, given the unique challenges faced by EMS workers and the nature of their roles. This research shows the need for more exploration. It also helps to understand EMS workers' wellbeing.

How will my privacy be protected?

Participants' interview transcripts and audio recordings, and consent forms, will be stored securely. Data will be stored on a password-protected AUT OneDrive that is only accessible to myself and my supervisors (Stefan Marks, and Stephen Reay). Participants will be given pseudonyms and any information that could be used to identify them or anyone they may discuss within their interview will be removed from their transcripts. Any quotes that are used in the findings of the research will not contain any identifiable information. All research data (e.g., transcripts, audio recordings) will be destroyed six years after the research has concluded as per AUT's data management guidelines.

What are the costs of participating in this research?

Participation in this research will cost participants 45 minutes – 1 hour of their time for each stage of the research, depending on interview length and location.

What opportunity do I have to consider this invitation?

Participants have two weeks (14 days) from the date they receive this information sheet to consider this invitation to participate. If I have not heard back from a participant after one week, I will send a follow-up email. They will then have one week to consider from the date the follow-up email is sent.

Will I receive feedback on the results of this research?

Once the research is complete and has received a final examination grade, I will email a summary of the findings to participants who have indicated they wish to receive this material on their consent form.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Primary Supervisor, Dr Stefan Marks, stefan.marks@aut.ac.nz.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, ethics@aut.ac.nz , (+649) 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Shreya Pradeep: bfy1222@autuni.ac.nz

Project Supervisor Contact Details:

Primary Supervisor, Stefan Marks, stefan.marks@aut.ac.nz.

Secondary Supervisor, Stephen Reay, stephen.reay@aut.ac.nz

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Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.

TE WĀNANGA ARONUI
O TĀMAKI MAKAU RAU

Consent Form

Project title:

Towards a Safer and Healthier Work Environment: Exploring the Impact of User Interface Design with Technology on Stress Reduction for Emergency Medical Service (EMS) Personnel

Project Supervisor: ***Stefan Marks & Stephen Reay***

Researcher: ***Shreya Pradeep***

- I have read and understood the information provided about this research project in the Information Sheet dated 11/10/2024 and agree to be a part of this research.
- I have had an opportunity to ask questions and to have them answered.
- I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.
- I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study, up until the researcher begins analysing my data, without being disadvantaged in any way.
- I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once my data begins being analysed, removal of my data may not be possible.
- I agree that I meet the following participant criteria: Participants must be emergency service personnel driving a one manned Ambulance (example: Eeco ambulance) living in Auckland, and able to engage in an interview in English
- I wish to be contacted to participate in the second phase (prototype trial) of the research.

Yes○ No○

- I wish to receive a summary of the research findings (please tick one):

Yes○ No○

Participant's signature: ....

Participant's name: .... Participant's Contact Details (if appropriate):

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Date:

Approved by the Auckland University of Technology Ethics Committee on type the date on which the final approval was granted AUTEC Reference number type the AUTEC reference number

Note: The Participant should retain a copy of this form.

TE WĀNANGA ARONUI O TĀMAKI MAKAU RAU

Email Invitation Stage 1

Dear xxxx

I hope this email finds you well,

I am contacting you to invite you to participate in a short interview as part of a Master of Creative Technologies research project at AUT (Auckland University of Technology).

The purpose of this research is to identify and address usability issues with the communication system, specifically the Mobile Data Terminal (MDT), in order to improve EMS systems, processes, and technologies. My focus is on enhancing the effectiveness of the MDT in ambulance. Through this research I aim to reduce cognitive load by redesigning the interface of the mobile data terminal (MDT) present in Eeco Ambulances.

I am interested in conducting a series of interviews with extended care paramedics to investigate their use of the MDT and what factors make these difficult to use when on the job.

More information regarding the research is available in the participant information sheet attached for more information.

If you are interested, please send a reply to bfy1222@autuni.ac.nz , and we can organise a date to meet in person or online via Teams. Please also feel free to reach out and discuss any questions or concerns you have about the research.

Thank you for your time,
Shreya Pradeep

Approved by the Auckland University of Technology Ethics Committee on *type the date final ethics approval was granted*, AUTEC Reference number *type the reference number*.

St Johs Recruitment and Ethics Process

Initial Contact and Discovery Phase

On June 14th, 2024, I contacted a manager at St. John with support from a senior paramedic lecturer at Auckland University of Technology (AUT), who facilitated the introduction. This initial outreach was instrumental in helping me gradually identify the appropriate stakeholders within the organisation to engage with for my research. I provided a summary of my master's project and asked for an online meeting to discuss potential access to necessary resources and participant recruitment for my study. Despite follow-up attempts over the following two weeks, I did not receive a response.

On July 5th, 2024, I was informed that my initial request had been forwarded to the St John Operations Team. At this stage, a research assistant was appointed to support the process. By July 10th, I was in direct communication with the Head of Operations, and within two weeks, we convened virtually to discuss the aims of my research and my academic background. During this conversation, I was advised that the Mobile Data Terminal (MDT) interface falls outside the jurisdiction of the Operations Team, whose responsibilities focus primarily on physical equipment. I was subsequently referred to Valentia Technologies, the software provider responsible for the MDT system, for further inquiry. The meeting also highlighted potential concerns regarding intellectual property (IP), particularly in relation to interface design, though it was suggested that the front-end interface may be publicly accessible. In addition, patient privacy was identified as a significant issue due to the sensitive health data stored within the MDT system; a concern that echoes the broader ethical and legal considerations outlined in Chapter One.

Despite these challenges, I remained optimistic about potential collaboration. The Operations Team connected me with a Digital and Data Business Partner to further explore the technical and design aspects of the MDT. In parallel, I was informed by the Research and Insights Manager that training tablets were available through AUT, which could be used to simulate MDT use in a driving context. This presented a promising alternative for the usability phase of the study, enabling realistic testing while mitigating privacy concerns. As discussions continued, I focused on refining my methodology, preparing my ethics application, and addressing the queries raised by the Operations Team in anticipation of gaining full access and institutional support for the next stages of the project.

Ethics Consultation

In response to the concerns raised by St. John, I arranged a meeting with an AUT Ethics Officer and my supervisors to gain clarity on how to proceed. The primary aim of the consultation was to understand how to address the ethical, logistical, and institutional challenges affecting my research and to determine how best to structure my ethics application moving forward.

Two-Stage Ethics Application

One of the most important outcomes of this meeting was the decision to submit my ethics application in two distinct stages. The first stage would focus on interviews and data collection, while the second would involve prototyping and usability testing of the MDT interface. The Ethics Officer recommended using flexible language such as "ongoing stages" in the participant consent forms. This approach would reduce the need for re-consenting participants if further stages were added later, ultimately streamlining the process and minimising delays.

Addressing Patient Privacy

Patient privacy was a significant concern raised by the St. John Operations Team, particularly due to the sensitive data stored on the MDT. To avoid the risk of a privacy breach, it was suggested that any visible patient data be blurred in demonstrations or that I request access to a training MDT, which does not store real patient records. These solutions would allow me to study the interface without compromising confidentiality or ethical standards.

Managing Conflict of Interest

A further issue involved potential conflicts of interest. Paramedics affiliated with AUT were not permitted to participate, which was especially limiting given that there are only eight critical care paramedics in Auckland. To ensure that participation was entirely voluntary and free from institutional influence, I was advised not to reach out to potential participants directly. Instead, interested individuals would need to contact me of their own accord. This ensured that St. John's involvement in the project would not influence recruitment.

Establishing Safety Protocols

The consultation also addressed the importance of safety protocols for both participants and myself as the researcher. Given the unpredictable and high-pressure nature of emergency medical work, I was encouraged to carefully consider interview locations, timing, and contingency plans in the event that a participant had to leave unexpectedly. Although the possibility of a ride-along was discussed, it presented too many logistical and safety challenges to pursue. What stood out during this discussion was the emphasis on protecting not only participants but also my own well-being—a reminder that prompted some personal reflection on the risks and responsibilities involved.

Accessing Resources

We also discussed the practical considerations related to accessing the Echo vehicle and MDT interface, which are owned by St. John. Several logistical questions emerged during this part of the conversation, including:

- How would I gain physical access to the Echo vehicles?
- Would interviews take place at a central location, or would I travel to participants?
- How could I ensure that participants were off-duty during sessions?
- What if a participant was called away in the middle of an interview?
- What steps could I take to ensure that participants felt safe and comfortable throughout the research process?

Following the consultation, I felt I had a clearer roadmap for navigating the ethical complexities of my project. However, the challenges also became more apparent. The limited participant pool, combined with restrictions around AUT-affiliated staff and the sensitivity of the data involved, made recruitment feel uncertain. The additional safety and logistical concerns added another layer of complexity to my planning.

What made the biggest impression on me was a comment from my supervisors highlighting that the ethical protocols were as much about protecting me as they were about protecting participants. That realisation brought a new level of awareness to the risks involved and, at times, left me questioning whether I was prepared for everything this research might demand.

Nonetheless, I understood that moving forward without support from St. John would significantly compromise the project, especially given their ownership of the MDT system and their access to critical care paramedics. With this in mind, I remained determined to push through the challenges. The consultation ultimately provided essential guidance for structuring my ethics application, addressing privacy concerns, and designing an approach that prioritised the safety and autonomy of everyone involved. With the support of the Ethics Officer and my supervisors, I left the meeting feeling more confident and better equipped to tackle the road ahead

Losing St. John’s Support

In August 2024, I received confirmation that St John would not be supporting my research. Their decision was primarily driven by concerns regarding patient privacy, internal capacity constraints, and broader political considerations. This posed a significant setback to the project, as I had been relying on their support to access two core components of my study, both the critical care paramedics and the Mobile Data Terminal (MDT) interface. St John holds the intellectual property for their backend systems and possesses in-depth knowledge of the MDT, while all critical care paramedics are contracted exclusively through the organisation. Without their endorsement, gaining access to these key participants and technical resources became extremely difficult.

Despite months of emails, follow-ups, and careful planning, I found myself back at square one. I had hoped that the longstanding relationship between AUT and St John might facilitate collaboration, but that proved unsuccessful. This rejection left me grappling with a fundamental question: how do I now recruit participants and move forward with the research?

Navigating and understanding the MDT Interface

Despite the setback, I still needed to better understand the MDT interface to move forward with designing my study. I returned to St. John with a more refined set of research questions, aiming for clarity on how to gain access to the MDT device itself. My initial request went through the Research Assistant and was passed along to the Digital and Data Business Partner. However, due to ongoing capacity issues, I did not hear back for over a month, until August 13th, 2024.

Eventually, I managed to schedule a meeting with the Clinical Digital Product Manager. In this conversation, I learned that while my research could not go into production, they were open to supporting it as a creative project. I also discovered that the current MDT system was more limited than I had assumed. It functions primarily as a job information receiver and does not integrate communication tools like walkie-talkies, the kind of multi-functionality I had initially hoped to explore. Additionally, since St. John was already allocating budget and attention to redesigning the back of the ambulance, there were no resources available to support changes to the MDT interface.

Privacy Issues and Alternative Solutions

Privacy concerns continued to be a major barrier. Because MDTs store sensitive patient data, the idea of a ride-along was ruled out entirely. However, the Clinical Digital Product Manager offered a helpful workaround in the form of using AUT’s MDT training tablets. These are dummy devices pre-loaded with fake patient data, which meant I could still study and test the interface without breaching any privacy protocols. This access proved to be an unexpected breakthrough.

The Final Blow

At this point, my Phase One plan was to conduct interviews with critical care paramedics to understand their experience with the MDT and the cognitive demands it creates. These insights would inform the design of a new prototype, which I planned to test in Phase Two. However, recruitment turned out to be more difficult than expected. Not only are there only eight critical care paramedics in Auckland, but their unpredictable schedules made it hard to arrange interviews. Eventually, St John formally declined to support my research any further. Their only suggestion was to shift focus to the Paramedicine Department at AUT, using their MDT training tablets and possibly interviewing academic staff or experts in the field instead. This development forced me to completely rethink my research approach. Losing St John’s support was a major setback, particularly because they own the MDT interface and are the only organisation using it in active, real-world ambulance settings.