Efficiency meets **empathy:**

Technological **innovations** in the **patient registration** process at Central Military Hospital

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1 Plain language summary

This study examines how technological innovations can improve the patient registration process at the Central Military Hospital (CMH) in Utrecht. Patient registration is a crucial step in medical care, as it determines efficiency and impacts the overall patient experience. Currently, the registration process at CMH is manual, leading to waiting times, administrative burdens on staff, and occasional frustration among patients and staff. Additionally, privacy concerns arise as personal information is often discussed in an open reception area. Given increasing geopolitical tensions and the increased focus on military readiness, CMH faces growing pressure to ensure an efficient and scalable healthcare system that can accommodate evolving demands. This research explores solutions to streamline the process while maintaining a patient-centered approach.

Through qualitative research, including interviews with staff and patients, it became evident that digital solutions could enhance efficiency. However, given the hospital's military structure and emphasis on personalized care, a hybrid approach, combining digital tools with human interaction, is necessary.

The thesis identifies key technological solutions that could improve patient registration at CMH:

1. Enhanced digital patient portals: Expanding the functionality of the *'MyCMH'* portal would allow patients to book appointments online, update their information, and check in digitally before arriving at the hospital. This would reduce manual tasks for staff while improving accessibility for patients.
2. A digital queue management system: Implementing a system that provides real-time updates on waiting times would help optimize patient flow, reduce congestion at the reception, and improve overall efficiency.
3. Long-term innovations, such as artificial intelligence (AI) and facial recognition: While not immediately implementable due to regulatory and technical challenges, these technologies could further streamline the process in the future.

One of the main challenges CMH faces is its reliance on the IT[1] infrastructure of the University Medical Center Utrecht (UMCU), which limits its ability to independently implement new technologies. Any proposed solutions must therefore be compatible with existing systems. Furthermore, CMH's hierarchical decision-making structure, characteristic of military organizations slows down the adoption of innovation. Staff involvement in the initial stages of

[1] Information Technology

technological implementation is crucial to ensure smooth integration and acceptance of new systems. Training programs tailored to distinct levels of digital proficiency will also be necessary to ensure successful adoption.

The research concludes that technological innovations hold the potential to optimize patient registration at CMH by reducing inefficiencies, improving patient autonomy, and easing the workload of administrative staff. The most effective short-term solutions are enhanced digital patient portals and queue management systems, while AI-driven solutions offer promising possibilities overall.

To achieve these improvements, a phased approach to digital transformation is recommended, ensuring that new systems align with CMH's organizational culture and operational requirements. By strategically integrating technology while preserving human-centered care, CMH can enhance efficiency and strengthen its role as a modern military healthcare institution, particularly considering increasing security demands.

This research provides practical recommendations to guide CMH in implementing sustainable, future-proof registration solutions that improve both patient experience and hospital workflow.

2 Visual abstract

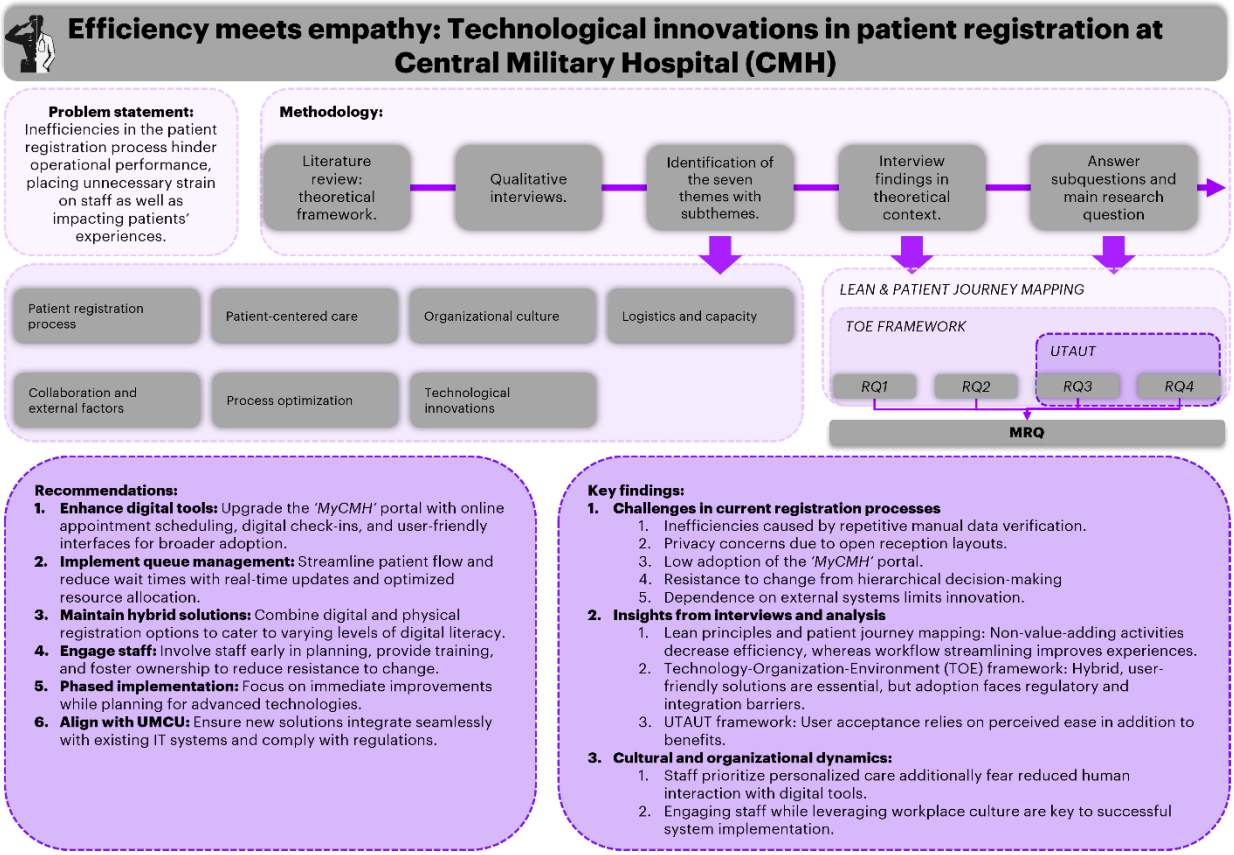


Figure 1 | Visual abstract technological innovations in patient registration at Central Military Hospital (CMH).

The research examines inefficiencies in the patient registration process at CMH while exploring technological innovations to improve workflows along with patient care. Using qualitative research in addition to the theoretical frameworks including Lean and UTAUT, the findings highlight the need for hybrid solutions, enhanced digital tools, next to cultural alignment to streamline processes and ensure sustainable improvements in military healthcare.

3 Abbreviations

ABBREVIATION	EXPLANATION
AI	Artificial Intelligence
CETC	Civil-Military Centre of Expertise for Trauma Care
CMH	Central Military Hospital
DGO	Dutch Healthcare Organization
DOSCO	Dutch Supporting Command
EPR	Electronic Patient Record
EU	European Union
GDPR	General Data Protection Regulation
GENAI	Generative Artificial Intelligence
IDR	Institute for Collaboration between Defense and Civilian Hospitals
HIT	Health Information Technology
HIX	EPR provided by ChipSoft
IT	Information Technology
MBB	Military Blood Bank
MIM	Medical Information Management
MRI	Magnetic Resonance Imaging
NATO	North Atlantic Treaty Organization
PESTLE	Political Economic Social Technological Legal Environmental analysis
PJM	Patient journey map(ping)
SMS	Short message service
SWOT	Strengths Weaknesses Opportunities Threats analysis
TAM	Technology acceptance model
TOE	Technology-Organization-Environment framework
UMCU	University Medical Center Utrecht
US	United States
UTAUT	Theory Acceptance and Use of Technology
VA	Veterans Affairs
WGBO	Wet op de geneeskundige behandelingsovereenkomst (Medical treatment agreement act)

Table 1 | Abbreviations together with explanations.

4 Introduction

The recent statement by NATO[2] Secretary-General Mark Rutte urged nations to mentally prepare for war (NOS, 2024), underscoring the growing urgency of global security challenges. In addition, the United States' (US) assertion, "For purposes of national security and freedom throughout the world, the ownership and control of Greenland is an absolute necessity," reflects an increased focus on strategic readiness in the face of geopolitical tensions (NBC News, 2024). These developments highlight how military preparedness is becoming a central priority in defense strategies as well as supporting institutions, including military healthcare. As operational readiness demands resilience at all levels, the military healthcare system must evolve to meet modern challenges while ensuring both efficiency and high-quality care (Centraal Militair Hospitaal 2023, 2023).

The Central Military Hospital (CMH) exemplifies this dual mission, balancing national defense imperatives with patient-centered healthcare (Centraal Militair Hospitaal 2023, 2023). With origins tracing back to the early 19th century, when the historic Karel 5 Military Hospital began treating military personnel, CMH builds on a long-standing tradition of providing specialized medical support to the armed forces (Grand Hotel Karel V, 2023). Today, CMH stands as a vital pillar within the Defense Health Organization (DGO), bridging demands of military operational readiness with the delivery of high-quality, human-centered care (Ministerie van Defensie, 2024). However, inefficiencies in CMH processes hinder operational performance, placing unnecessary strain on staff while also affecting patients' experiences.

As healthcare systems become increasingly complex, digitalization is no longer a luxury but a necessity. Westercamp et al. (2023) emphasize that "digitalization is essential for improving healthcare efficiency, ensuring resilience, and meeting rising expectations of patients and stakeholders." Recent additional investments in Defense, which highlight innovation as a core component of modernization efforts (Ministerie van Algemene Zaken, 2024), create new opportunities for CMH to benefit from advancements in digital transformation. However, while healthcare digitalization is widely explored in civilian contexts, limited research addresses the unique challenges faced by military healthcare systems (Alruwaili et al., 2023). This study contributes to closing this gap by analysing CMH's patient registration process through established frameworks, including Lean principles (Dammand et al., 2014), which focus on identifying inefficiencies while eliminating non-value-adding processes, and patient journey mapping (PJM) (Borycki et al., 2020), which visualises the end-to-end patient experience,

[2] North Atlantic Treaty Organization

identifying pain points coupled with areas for improvement. Additionally, the Technology-Organization-Environment (TOE) framework (Tornatzky & Fleischer, 1990) provides a structured approach for evaluating broader organizational and contextual factors affecting digital implementation. Finally, the Unified Theory of Acceptance and Use of Technology (UTAUT) examines potential technological solutions.

This research aims to enhance efficiency and accessibility in CMH's patient registration process by adopting innovative technologies that align with the hospital's operational standards as well as cultural values. It analyses the current patient registration process to identify inefficiencies and bottlenecks, gathers insights from staff and patients through a qualitative approach, benchmarks best practices from comparable institutions, assesses cultural implications of proposed innovations, and finally evaluates the feasibility of potential technological solutions.

The central research question guiding this study is: *To what extent can technological innovations optimize patient registration at the Central Military Hospital (CMH)?* To answer the main research question, four subquestions have been formulated:

1. What are the key challenges in the current patient registration process at CMH?
2. To what extent does organizational culture influence the adoption of technological innovations at CMH?
3. What are the criteria for evaluating technological innovations to improve the patient registration process at CMH?
4. Which technological solutions can address the identified challenges in patient registration at CMH?

The following chapters first explore CMH's strategic position, followed by theoretical frameworks to analyse challenges and opportunities. Finally, the study presents findings from qualitative interviews, discusses practical and societal implications, as well as provides recommendations for digital innovations to improve efficiency and user experience.

5 Strategic market position of CMH: Context, challenges, and opportunities

5.1 From past to present: CMH's evolution, mission, and modern challenges.

5.1.1 Background

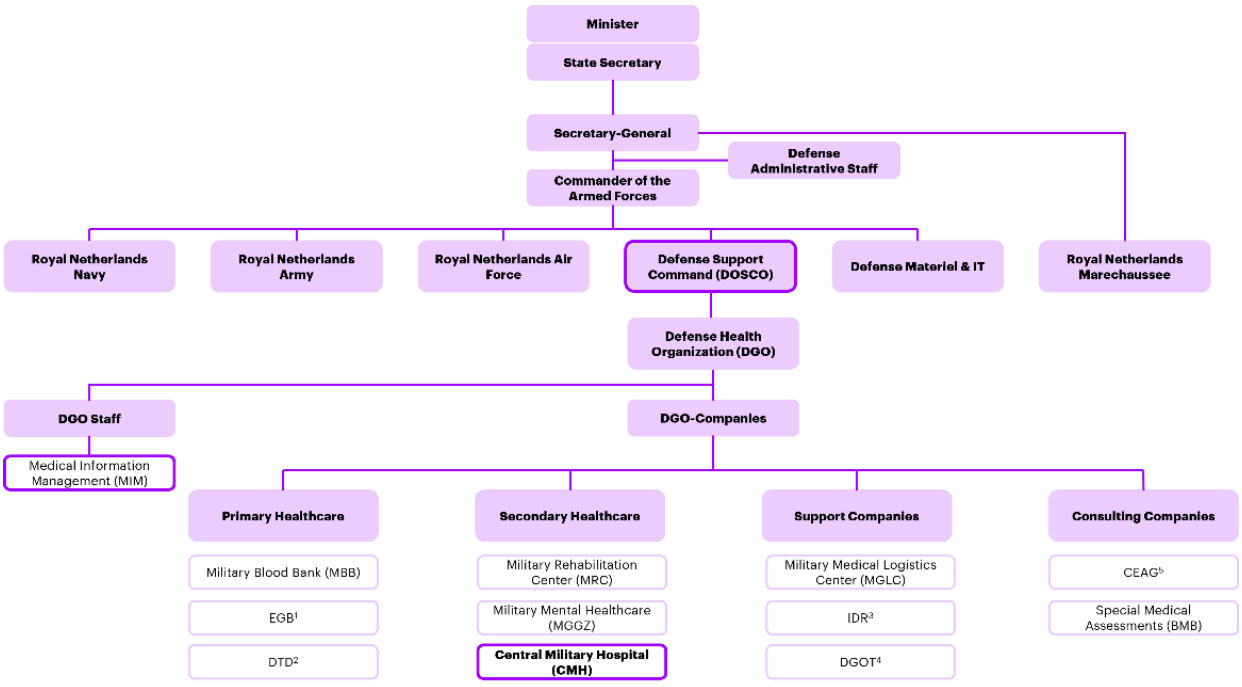
This chapter forms the foundation for understanding Central Military Hospital's (CMH) operational and strategic context. By linking this background to the research question, the chapter highlights the urgency for innovation and modernization at CMH. The insights demonstrated here serve as a guide for developing solutions tailored to CMH's specific context.

The CMH was established in 1991 in Utrecht, Netherlands, following the merger of military healthcare facilities, including the historic Karel 5 Military Hospital. Before its transformation into a five-star hotel, the Karel 5 complex served as a military hospital for years. Originally acquired by King Louis Napoleon in 1807, it began treating active military personnel in 1823 and continued to function as a hospital until 1990, when it was integrated into what is now the CMH (Grand Hotel Karel V, 2023). This consolidation aimed to centralize military medical services, ensuring specialized care tailored to the needs of the Dutch armed forces (Ministerie van Defensie, 2024). Over the years, CMH has evolved into a cornerstone of the Defense Health Organization (DGO), providing not only medical support but also contributing to operational readiness. This focus aligns with CMH's mission of delivering 'military care with a human touch,' emphasizing personalized, flexible in addition to reliable medical care.

5.1.2 Strategic role and operations

The CMH's strategic collaboration with University Medical Center Utrecht (UMCU) further strengthens its capabilities. The partnership facilitates shared use of 'calamiteitenhospitaal'[3], integration of medical expertise, and shared initiatives like the Civil-military Center of Expertise for Trauma Care (CETC), which aims to enhance trauma care through research and training. In addition to its clinical functions, CMH plays a significant role in repatriating injured personnel from missions abroad, underscoring its priority for the Dutch military healthcare system (Centraal Militair Hospitaal 2023, 2023). Besides CMH collaborates closely with civilian hospitals through the Institute for Collaboration between Defense and Civilian Hospitals (IDR)

[3] Calamity hospital



1. Primary Care Company. 2. Defense Dental Service. 3. Institute for collaboration between Defense and Affiliated Hospitals. 4. Defense Health Education and Training Center. 5. Coordination Center for Expertise in Occupational Health and Safety

Figure 2 | Organizational structure of the Dutch Ministry of Defense.

This figure illustrates the organizational structure of the Dutch Ministry of Defense, focusing on the role of DOSCO. The CMH operates under secondary healthcare within DGO, highlighting its integration within the broader defense healthcare system.

(Ministerie van Defensie, 2024). Furthermore, looking at the organizational structure (Figure 2) CMH is a part of DGO, which again falls under Defense Support Command (DOSCO), aligning its operations with the broader objectives of the Ministry of Defense (Ministerie van Defensie, 2024). The DOSCO provides essential logistical, medical, infrastructural, and facility management support to the Dutch Armed Forces, enabling operational units to focus entirely on their core tasks. Moreover, CMH collaborates with DGO-health institutions including the Military Blood Bank (MBB) as well as the Military recovery center (MRC). Internally, CMH is organized into clinical and outpatient care clusters, emergency preparedness units, along administrative support departments, ensuring efficient delivery of services by all 228 full-time staff (Centraal Militair Hospitaal 2023, 2023).

5.1.3 Challenges and outlook

In 2023, CMH treated over 15.500 military patients, conducted 1686 surgeries, as well as managed 1.211 day-care admissions. Thereby, CMH conducted more than 41.800 consultations, reflecting its substantial role in addressing the health needs of military personnel. Specialized services include the radiology department, which has recently upgraded its equipment to enhance diagnostic accuracy, and an operational pain clinic, which

has significantly reduced waiting times for chronic pain treatment (Centraal Militair Hospitaal 2023, 2023). At the same time, the hospital also supports a broader military healthcare objective, such as vaccinations, with over one thousand administered in 2023. CMH's efforts extend to providing advanced training and research opportunities, integrating clinical and operational medical practices, together with fostering collaborations with civilian healthcare institutions (Centraal Militair Hospitaal 2023, 2023).

Because of the above-mentioned mission, according to Centraal Militair Hospitaal 2023 (2023), CMH focuses on four strategic pillars. First, optimizing healthcare ensures alignment with military operational needs, achieved through extensive partnerships in addition to streamlined workflows. Second, CMH positions itself as a vital healthcare institution, enhancing its recognition among military personnel and civilian healthcare, while ensuring a holistic view of military health. Third, CMH aims to foster a welcoming hospital culture, prioritizing patient-centered care, staff well-being, additionally a sustainable workforce model. Finally, the hospital aspires to lead in military medicine innovation, through its CETC and collaborations with national as well as international partners. To summarize, these strategic objectives not only ensure that CMH meets healthcare requirements but also contribute to the broader field of military healthcare.

However, CMH faces challenges such as increasing demand for specialized care due to the complexity of military operations, the demand for more efficient patient registration and data processing, and the integration of innovative technologies while managing privacy and security concerns. NATO Secretary General Mark Rutte's recent call for nations to mentally prepare for potential war (NOS, 2024) emphasizes a critical role for CMH to maintain the health and readiness of military personnel.

This context raises questions about how The Netherlands can effectively accommodate large groups of military patients, particularly in times of conflict. Ensuring sufficient personnel, and logistical capacity, along with healthcare infrastructure is crucial for these demands. At the same time, the current reliance on paper-based information management from Role 1 (field care) to Role 4 (definitive care) presents significant limitations. Transitioning to integrated digital systems is essential for streamlining workflows and improving care coordination. To address these interconnected challenges, I believe CMH must invest in innovative technologies next to modern care models while strengthening collaborations.

The anticipated 7% organizational growth of CMH by 2025, driven by rising national security demands and an expanded budget, adds another layer of complexity (Centraal Militair Hospitaal 2023, 2023). Furthermore, the partnership with UMC Utrecht presents logistical and

strategic challenges, particularly in managing shared resources, personnel, and responsibilities. These factors mark the obligation for a forward-looking approach to ensure CMH remains agile and effective in handling both current and future healthcare demands (Centraal Militair Hospitaal 2023, 2023). Besides, internal along external analysis serves as the foundation for this research to create a deep understanding of the organization and its operational context.

5.2 Navigating the external landscape: A PESTLE perspective

The CMH operates as a unique institution, combining military and healthcare services under the Dutch Ministry of Defense. Political, Economic, Social, Technological, Legal, and Environmental (PESTLE) analysis provides a comprehensive framework for examining external factors influencing military healthcare (Figure 3) (Akman, 2020). Additionally, by understanding external factors the analysis underlines challenges and opportunities relevant to CMH's modernization efforts.

5.2.1 Political factors

To begin with political factors, CMH operates within the structured and hierarchical framework of the Dutch Ministry of Defense, where healthcare priorities are closely tied to national defense strategies. Decisions concerning resource allocation emphasize military readiness and the health of active-duty personnel. This alignment accentuates CMH's critical role in supporting the operational fitness of serving military personnel, while also preparing for emergencies or crises (Defensie Ministerie Van Financiën - Rijksoverheid, 2022).

Geopolitical tensions further determine CMH's responsibilities. For instance, NATO commitments and military engagements in regions such as Eastern Europe can potentially lead to increased demand for specialized care. As mentioned above, the declaration of NATO Secretary General Mark Rutte, stresses the value of increased investment in defense capabilities (NOS, 2024). Additionally, CMH's collaboration with UMCU introduces political and operational complexities, particularly as it balances its dual role as a military healthcare provider and a civilian partner. This partnership requires CMH to navigate distinct governance structures, and operational priorities together with cultural expectations (Ministerie van Defensie, 2022). A shift in focus towards '*Hoofdtaak 1*'[4] would necessitate accommodating large-scale military patient care beyond CMH's current facilities (Centraal Militair Hospitaal 2023, 2023). Such a shift would require deeper integration with civilian healthcare institutions,

[4] The constitutional task of protecting national and allied territories

compliance with civilian regulations, and robust collaboration to ensure seamless and high-quality care during a crisis (Centraal Militair Hospitaal 2023, 2023).

5.2.2 Economic factors

While CMH operates within the financial constraints of the Ministry of Defense, where healthcare funding competes with broader defense priorities such as weapons modernization and cyber defense, the recent annual increases in defense budgets present new opportunities (Centraal Militair Hospitaal 2023, 2023). These additional funds, if allocated to DGO, could enhance CMH's capacity for technological investments or infrastructure improvements. In collaborative settings like the CMH-UMCU partnership, resource sharing still demands detailed cost-benefit analysis to maximize the impact of these investments. At the same time, rising operational costs, driven by inflation as well as technological advancements, continue to pose challenges (Centraal Militair Hospitaal 2023, 2023). This financial environment stresses the need for CMH to pursue cost-efficient solutions while ensuring that long-term strategic investments in innovation and modernization are not compromised.

5.2.3 Social factors

As for social factors, CMH's patient demographic consists exclusively of active-duty personnel, resulting in a younger population than the average civilian patient group (Ashman et al., 2020). As indicated by initial interviews (Interview findings in theoretical context), the ageing workforce within the military healthcare system could pose a significant challenge, leading to potential recruitment gaps and skill shortages. Cultural dynamics within a military environment are a considerable influence (Hartmann et al., 2009). Hierarchical structures and command-driven communication can hinder open dialogue. As described by Bisel et al. (2012), the 'Hierarchical mum effect' refers to team members' reluctance to challenge or disagree with supervisors, often resulting in silence or vague responses. Moreover, societal trends, such as increasing patient expectations for digitalization and user-friendly healthcare services, also pressure CMH to modernize its systems and adapt to evolving patient needs (Köbe & Bohnet-Joschko, 2022). These social factors underscore the significance of CMH ensuring that its healthcare services are tailored to the specific needs of active military personnel.

5.2.4 Technological factors

Furthermore, technological innovation allows CMH to enhance efficiency, patient experiences, together with interoperability cooperation with civilian healthcare providers. Digital

registration systems, telemedicine platforms[5], and AI-powered diagnostics represent transformative tools for streamlining operations and expanding care access. However, integrating these technologies is challenging since hospitals have shown significant resistance to change (Gopal et al., 2018). Furthermore, close collaboration with UMCU requires CMH to utilize the same Electronic Patient Record (EPR) system, HiX, developed by ChipSoft. This dependency significantly restricts technological innovations, as any innovative solutions must be compatible with and integrated seamlessly into the HiX system (Centraal Militair Hospitaal 2023, 2023). Despite these constraints, UMCU has already initiated Artificial Intelligence (AI) pilot projects aimed at reducing administrative workloads, such as AI-generated patient communication in addition to predictive analytics for appointment management. These initiatives provide CMH with an opportunity to explore similar AI-driven efficiencies, either in collaboration with UMCU or as an independent innovation within the constraints of HiX (Harmsen, 2024).

Despite these limitations, HiX offers advantages, including standardized care processes, reduced management workload, and access to the latest EPR updates. Moreover, uniform registration across hospitals facilitates better data exchange, critical for improving coordination between CMH and civilian healthcare providers (Elektronisch Patiëntendossier HiX, n.d.). However, adopting and integrating modern technologies within the HiX framework also requires addressing critical challenges, such as ensuring robust cybersecurity measures. This is particularly valuable given the sensitive nature of military medical records next to the heightened risks associated with data breaches (Ministerie van Defensie, 2022).

5.2.5 Legal factors

CMH operates within a stringent legal framework that governs military healthcare, data protection, and patient confidentiality (Ministerie van Defensie, 2022). Compliance with the General Data Protection Regulation (GDPR) is essential, particularly in its collaborative efforts with civilian institutions like UMCU, where data-sharing agreements must be precisely managed (Ministerie van Defensie, 2022). CMH's dual role operations also create legal complexities regarding shared liability, contractual obligations, and jurisdictional overlaps. Navigating these legal guidelines requires robust compliance mechanisms, such as deploying security experts by Medical Information Management (MIM) and clear agreements with civilian partners to safeguard operational integrity and patient rights.

[5] Remote healthcare services

5.2.6 Environmental factors

Sustainability initiatives within the Ministry of Defense significantly determine CMH operations, aligning with broader societal and governmental commitments to climate change mitigation (Ministerie van Defensie, 2024). Measures such as energy-efficient infrastructure, waste reduction strategies, minimized paper usage, and adopting green technologies are becoming integral to the hospital's operational planning. These efforts support (inter)national climate goals in addition to enhancing CMH's ability to operate efficiently.

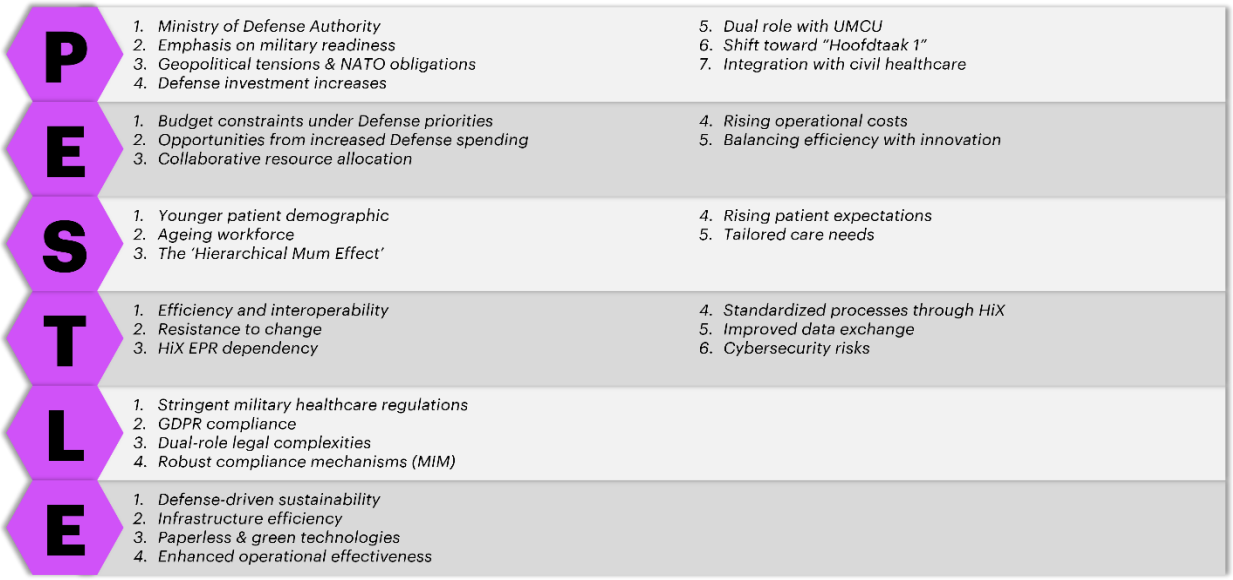


Figure 3 | PESTLE analysis on CMH.

This PESTLE analysis identifies Political, Economic, Social, Technological, Legal and Environmental factors impacting CMH. It underscores challenges such as defense priorities compliance requirements, and technological dependency while identifying opportunities like sustainability initiatives or collaborative resource allocation to align military healthcare with evolving.

In short, Figure 3 provides an overview of all PESTLE elements relevant to CMH. The PESTLE analysis marks external factors influencing the modernization of CMH. Politically, the CMH operates within national defense priorities and is impacted by geopolitical tensions, increasing demand for specialized care. Economically, budget constraints compete with defense priorities, although rising defense budgets can create opportunities for technological advancements. Socially, a younger patient demographic next to growing expectations for digitalization drives the demand for modern solutions. Technological innovation is limited by dependencies on systems like HiX. Whereas legal compliance, particularly with GDPR, and collaboration with civilian partners require careful coordination. Environmentally, sustainability initiatives align with broader societal goals, emphasizing energy-efficient

operations. Together, these factors provide a framework for aligning innovation with CMH's dual role in defense and healthcare.

5.3 Internal dynamics uncovered: SWOT insights

A SWOT analysis provides a structured framework to evaluate CMH's internal strengths and weaknesses, alongside external opportunities, and threats (Gürel, 2017). This analysis serves as the foundation for the identification of growth areas, as visualized in Figure 4, and incorporates insights derived from academic sources, researcher's observations coupled with interview insights, which will be discussed in detail later in this thesis.

5.3.1 Strengths

1. Specialized military healthcare expertise: The CMH focuses exclusively on active-duty military personnel, offering tailored healthcare that ensures quick recovery and operational readiness (Centraal Militair Hospitaal 2023, 2023).
2. Strategic collaboration with UMCU: A close partnership with UMCU enhances access to advanced medical expertise and resources, including shared facilities like Magnetic Resonance Imaging (MRI) and personnel (Centraal Militair Hospitaal 2023, 2023).
3. Dedicated infrastructure for military needs: The CMH operates as a 'one-stop-shop,' ensuring efficient care delivery, specialized military health solutions, and integration across the military healthcare chain (Centraal Militair Hospitaal 2023, 2023).
4. Operational flexibility: The hospital's capacity to manage crises, such as the train disaster response (Centraal Militair Hospitaal 2023, 2023) through the Calamiteitenhospitaal, highlights its readiness to manage emergencies. However, this flexibility has limitations, particularly in scenarios involving a sustained influx of patients, where the hospital's capacity could be quickly exceeded.
5. High patient satisfaction: A consistently high patient satisfaction score (9.1/10 in 2023) accentuates its quality of care and patient-centered approach (Centraal Militair Hospitaal 2023, 2023).
6. Commitment to education and research: The CMH invests in the training of military healthcare professionals and supports research through initiatives like CETC, ensuring continuous knowledge development and innovation (Centraal Militair Hospitaal 2023, 2023).
7. Quality assurance: Successfully passing Qualicor audits reflects a strong commitment to maintaining ambitious standards in safety, hygiene, and patient care.

5.3.2 Weaknesses

1. Limited scale and capacity: Based on the researcher's own observations, CMH's small size restricts its ability to provide substantial support during large-scale disasters or wartime scenarios. This limitation also impacts its efficiency and flexibility in implementing significant or costly changes, as smaller institutions can face challenges in justifying and managing extensive investments in innovation or infrastructure.
2. Budgetary constraints: As a part of the Ministry of Defense, CMH faces financial pressures from competing priorities such as weapons modernization and cybersecurity investments. These constraints limit the hospital's ability to invest (Centraal Militair Hospitaal 2023, 2023).
3. Dependence on existing systems: As discussed in the interviews, reliance on the HiX system restricts the hospital's ability to innovate or adopt alternative technologies.
4. Resistance to change: Hierarchical structures and deeply ingrained protocols can create cultural resistance, delaying the adoption of modern technologies or processes such as digitalization or telemedicine (Bisel et al., 2019).
5. Complex regulatory environment: Operating under strict defense policies and civilian healthcare regulations adds layers of complexity to CMH's operations. Compliance with GDPR and other data protection regulations is particularly challenging (Ministerie van Defensie, 2022).
6. Low independence: Based on the researcher's own observations in addition to interview findings, CMH's reliance on its partnerships with UMC and ChipSoft represents internal constraints. This dependence limits CMH's ability to independently explore and adopt alternative systems or technological innovations. As a result, the hospital's capacity to adapt to changing needs is restricted, potentially decreasing flexibility and innovation.

5.3.3 Opportunities

1. Geopolitical tensions: As identified during the researcher's analysis, geopolitical tensions can lead to increased defense budgets, providing CMH with opportunities to secure funding for innovation and modernization. This enables investments in advanced medical technologies and infrastructure to enhance operational efficiency and readiness.
2. Expansion of technological integration: As noted through the researcher's observations, CMH holds the opportunity to leverage advancements in healthcare technologies, such as artificial intelligence (AI), telemedicine, and digital registration systems, to enhance patient care and operational efficiency both within the hospital as

well as across the broader operational chain of the armed forces. This includes improving the transfer of medical information for injured patients from mission or conflict zones to The Netherlands, ensuring continuity of care and better coordination. These innovations could support more streamlined processes and better collaboration with civilian healthcare institutions like UMCU.

3. Strengthening civil-military partnerships: CMH's collaboration with UMCU provides access to an increased range of expertise, resources, and technologies. This partnership could be further expanded with for instance training programs and research initiatives (Centraal Militair Hospitaal 2023, 2023). Additionally, UMCU's ongoing AI pilot projects aimed at reducing administrative workload present an opportunity for CMH to explore similar innovations, either through collaboration or independent implementation (Harmsen, 2024).
4. Sustainability as a strategic asset: By aligning with broader sustainability initiatives from the Ministry of Defense, CMH can implement green technologies, decrease surgical waste, and reduce energy consumption. While these efforts may require initial investments as well as process adjustments, they not only support national climate goals but position the hospital as a forward-thinking institution, enhancing its operational efficiency together with its long-term reputation (Ministerie van Defensie, 2024).
5. Specialization in niche healthcare areas: Based on findings from the researcher's own evaluation, CMH's focus on military healthcare creates an opportunity to develop expertise in specialized fields such as trauma care or rehabilitation. This specialization could position CMH as a knowledge hub and center of excellence in these areas, attracting talent, partnerships as well as funding.

5.3.4 Threats

1. Geopolitical tensions: From the researcher's perspective, while increased defense budgets driven by geopolitical instabilities may provide resources, they also bring risk of overburdening CMH's staff and facilities due to fluctuating demands for military healthcare. On the other hand, these challenges create a compelling case for modernizing systems and processes to enhance efficiency as well as resilience.
2. Dependency UMCU: The researcher highlighted that close collaboration with UMCU poses a significant threat to CMH's independence. Reliance on shared resources, expertise, and infrastructure, including personnel, could create vulnerabilities.
3. Vendor lock-in: The researcher noted that CMH's reliance on the HiX EPR system, supplied by ChipSoft, limits its technological flexibility. The dependency creates a

potential vendor lock-in, restricting the hospital's ability to adopt alternative or innovative technologies without significant costs or disruptions.

4. Budgetary constraints: CMH faces financial pressure from the Ministry of Defense, as healthcare funding competes with other defense priorities. Economic downturns or shifting government priorities could increase budget limitations (Centraal Militair Hospitaal 2023, 2023).
5. Regulatory and compliance risks: Operating under strict regulations, CMH faces risks associated with data breaches, legal challenges, or failures in maintaining compliance, which could harm its reputation along with its operations. These risks are increasing due to the growing frequency and sophistication of cyberattacks targeting healthcare institutions (World Health Organization, 2024). Strengthening cybersecurity measures is essential to safeguarding sensitive medical data and maintaining operational integrity.
6. Ageing workforce: As observed by the researcher, within the military organization, the ageing workforce poses a challenge in attracting as well as retaining new talent. This could lead to expertise gaps that weaken CMH's operational excellence.
7. Sustainability as a threat: Meeting climate targets and operating in resource-constrained environments will require additional investments in infrastructure and processes (Ministerie van Defensie, 2024).

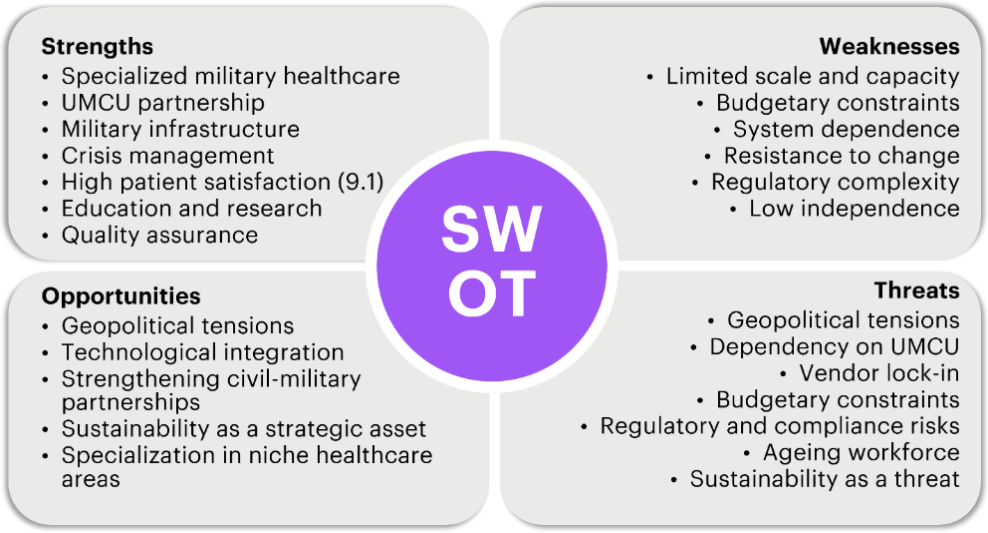


Figure 4 | SWOT analysis on CMH.

This SWOT evaluates CMH's internal strengths and weaknesses alongside external opportunities and threats. Strengths include specialized military healthcare and strong partnerships, while weaknesses underscore capacity and regulatory challenges. Opportunities lie in technological integration with threats such as geopolitical tensions and budgetary constraints impacting future operations.

The SWOT analysis identifies critical internal and external factors determining the CMH's operational landscape. Strengths include specialized military healthcare expertise, strong partnerships with UMC, additionally high patient satisfaction, underscoring the hospital's readiness as well as commitment to quality care. However, weaknesses such as limited capacity, reliance on HiX, or resistance to change can hinder innovation. Opportunities exist in leveraging increased defense budgets, technological advancements, or sustainability initiatives to enhance operational efficiency coupled with specialization in niche healthcare areas. Conversely, threats such as geopolitical tensions, budgetary constraints, vendor lock-in, next to regulatory challenges underscore the need for strategic resilience. Addressing these dynamics is vital for CMH's ongoing modernization next to fulfilling its dual mission in the military and healthcare context.

5.4 Mapping key players: A stakeholder perspective

Stakeholder analysis is a critical component in understanding dynamics that influence CMH's operational and strategic decisions. This analysis identifies key stakeholders involved in patient registration processes, their level of interest and influence, and their specific role in determining the hospital systems (Table 2) (Grim & Chan, 1995).

Organization	Interest	Power	Role
Internal stakeholders			
CMH management	High: Strategic oversight and resource allocation.	High	Drives decision-making, aligns processes with strategic goals and ensures operational readiness.
CMH reception staff	High: Efficiency in workflows and patient satisfaction.	Low	Key implementers of patient registration systems and contributors to operational improvements.
CMH medical staff (Doctors, Nurses)	High: Ensuring high-quality care and efficient processes.	Medium	Users of clinical systems and key stakeholders in integrating patient care with operational systems.
Medical information management (MIM) (Administrative, IT)	Medium: Supporting operational continuity.	High (niche)	Provide essential support for IT systems, patient records, and day-to-day administration. MIM determines which information management changes are implemented.
Military patients	High: Access to efficient and high-quality care.	Low	The experience of primary users of CMH services determines the hospital's reputation. CMH seeks to enhance

			patient influence through initiatives such as the establishment of a patient panel, providing a structured platform for feedback and engagement.
External stakeholders			
Dutch politics	Medium: Balancing public healthcare needs with defense priorities.	High	Influences budget allocation for the Ministry of Defense and sets the regulatory framework for healthcare and defense integration.
Ministry of Defense	High: Ensuring military readiness and efficient use of resources.	High	Allocates funding to CMH, sets strategic priorities, and ensures alignment with defense objectives.
Defense supporting commando (DOSCO)	Medium: Operational support and alignment with defense strategies.	High	Provides logistical, medical, and infrastructural support to the CMH, ensuring the hospital can focus on delivering medical care to military personnel coupled with maintaining operational readiness.
Defense Health Organization (DGO)	High: Coordination of military healthcare policies.	High	Supervises CMH operations and integrates healthcare with broader defense goals.
UMC Utrecht (UCMU)	Medium: Shared infrastructure and expertise.	Medium	Partner in medical research shared resources, and process integration.
NATO and international military organizations	Medium: Standardization and readiness in military healthcare.	Medium	Influence through NATO healthcare standards and operational requirements.
Influencers and collaborators			
Accenture Data&AI experts	High: Enabling technological advancements.	Medium	Support innovation through consulting on digital transformation and AI-driven solutions.
ChipSoft (HiX software vendor)	High: Maintaining and developing ERP systems.	High	Provides the technical backbone for patient data management and integration.

Other civilian healthcare providers	Medium: Best practices and benchmarking.	Low	Serve as comparative benchmarks for operational and technological innovation.

Table 2 | Stakeholder analysis.

The table outlines key internal and external parties impacting CMH operations. Internal stakeholders focus on management and implementation together with patient care. Yet, external stakeholders, like the Ministry of Defense, influence policy and resources. Partners like Accenture or ChipSoft drive technological innovation.

The stakeholder analysis, in Table 2, identifies internal along external parties influencing strategic and operational processes at CMH. Internal stakeholders, such as management, reception staff, and medical personnel, play a direct role in daily operations and are critical to the implementation of innovations like digital patient registration. External stakeholders, including the Ministry of Defense, DOSCO, and UMCU, have a strategic and logistical influence, determining CMH's alignment with broader defense objectives. Patients, while having limited formal power, are key to the success of CMH's services. Additionally, technology partners such as ChipSoft and Accenture provide essential support for innovation and modernization. This analysis highlights the roles and interests of key stakeholders, providing valuable insights to guide the development of this thesis and its recommendations.

5.5 Bridging insights to research: A concluding perspective

This internal and external analysis provides a comprehensive understanding of CMH's dual role, balancing healthcare delivery with operational readiness for active-duty personnel. While partnerships, particularly with UMC Utrecht, enhance CMH's capabilities, they also introduce challenges such as resource dependency and shared responsibilities.

The external analysis, guided by the PESTLE framework, identifies critical factors shaping CMH's strategic environment. Politically, CMH operates in a defense-driven landscape influenced by regulations and geopolitical tensions. Economically, it faces budgetary constraints due to competing defense priorities. Socially, challenges such as workforce aging and recruitment gaps must be addressed. Technologically, advancements offer opportunities for modernization but are constrained by reliance on systems like HiX. Legally and environmentally, CMH must balance innovation with compliance and sustainability goals.

The internal SWOT analysis accentuates CMH's strengths in specialized military care, strategic partnerships, and crisis readiness, alongside weaknesses such as budgetary limitations, resistance to change, and technological dependencies. Opportunities lie in leveraging modern technologies, expanding partnerships, and specializing in areas like trauma care.

However, threats such as vendor lock-in, regulatory risks, and geopolitical instability require strategic resilience.

Patient registration emerges as a critical component of CMH's operational efficiency, directly influencing patient satisfaction and data accuracy. This analysis reinforces the earlier identified need to modernize these processes through innovative tools. These modernizations offer opportunities to streamline workflows and reduce administrative burdens. This not only enhances CMH's efficiency but also strengthens its role in meeting broader defense healthcare objectives.

By integrating these findings, this analysis lays the foundation for exploring how technological innovations, tailored to CMH's organizational culture, can optimize patient registration processes. These insights guide the development of practical and impactful recommendations aligned with CMH's unique context and strategic goals.

6 Theoretical foundations: Exploring key concepts

This literature review provides the theoretical foundation to address the research question: *To what extent can technological innovations optimize patient registration at the Dutch Military Hospital (CMH), considering the influence of organizational culture?* By exploring the intersection of digital transformation, healthcare improvement, and organizational dynamics, this review aims to establish a comprehensive framework for analysing challenges and opportunities within CMH's patient registration process.

The review begins by examining digitalization in healthcare, highlighting the potential and barriers to adopting technology in a complex environment. Then, patient journey mapping (PJM) is introduced as a tool for understanding user needs and enhancing patient-centered care. Next, Health Information Technology (HIT) is explored. Followed by Lean principles are then explored to identify inefficiencies and streamline workflows. The Technology Organization Environment (TOE) framework provides insights into the technical, organizational along environmental factors shaping technology adoption. Additionally, the Technology Acceptance Model (TAM) next to the Unified Theory of Acceptance and Use of Technology (UTAUT) offers perspectives on behavioral and cultural dimensions of implementing modern technologies. Finally, the review examines technological solutions available for patient registration in hospitals. Together, these concepts form an integrated framework to evaluate and optimize patient registration processes at CMH.

6.1 Transforming military healthcare through digital innovation

The digitalization of healthcare is reshaping the industry, offering significant advantages such as enhanced patient outcomes, cost efficiency, and improved decision support systems (Tresp et al., 2016). Nevertheless, the adoption of digital health innovations is hindered by barriers, including resistance from both healthcare providers and patients, infrastructural limitations, and concerns related to usability and self-efficacy (Lyanna et al., 2022). In hospital settings, additional challenges such as increased workload, extensive training requirements, resistance to organizational change, and interoperability issues further impede effective implementation and adoption (Cresswell & Sheikh, 2013). Despite these obstacles, digital transformation in healthcare holds considerable promise, including the development of a participatory healthcare ecosystem that enhances patient experiences, optimizes clinical outcomes, and empowers healthcare professionals (Pillay, 2019). Emerging trends, such as continuous health monitoring through wearable devices and increased patient engagement with their health

data, underscore the potential for a more integrated and patient-centered approach to care (Tresp et al., 2016).

Moreover, technology can improve efficiency by enabling staff to complete tasks more quickly and oversee larger workloads (Hebert, 1998). Besides, it leads to the addition of new tasks and services (Hebert, 1998). These shifts reshape roles and responsibilities, primarily through the integration of modern technologies rather than fundamental changes to the system's structure (Sætra & Fosch-Villaronga, 2021). Notably, despite concerns among employees about job security, digitalization rarely leads to job loss, as research indicates it allows staff to focus on value-adding tasks rather than being made redundant (Hernnäs, 2020). This highlights the opportunity to tackle fears by demonstrating that innovation enhances roles rather than replaces them. Successful implementation relies on strong leadership, mobilizing support, guiding staff through the transition, fostering active participation, and tailoring solutions to local needs (Hansen & Norup, 2017). While digitalization can streamline processes, it can also impact job satisfaction and reduce the amount of time staff spend interacting with patients (Hebert, 1998). These complexities accentuate the relevance of balancing efficiency with the human aspects of care, ensuring that innovations support both staff and patients at every level (Sætra & Fosch-Villaronga, 2021). Addressing these challenges requires thoughtful design approaches that place patient coupled with their needs at the core of technological solutions.

6.2 Designing healthcare around the patient

Patient-centered design principles are integral to developing healthcare technologies that prioritize usability and functionality. By involving patients throughout the development process, user-centered design ensures solutions are accessible and effective for diverse populations, addressing a common gap in healthcare technology adoption (Dabbs et al., 2009; Wolpin & Stewart, 2011). Incorporating human factors principles can help resolve usability challenges, particularly for non-standard user groups such as older adults or individuals with limited digital literacy (Gibbons et al., 2014). These principles are especially relevant to patient registration processes, where ease of use and inclusivity are critical for widespread adoption and improved patient experiences (Franklin & Myneni, 2018).

Patient journey mapping (PJM) is an emerging methodology in healthcare aimed at visually representing and analysing patients' experiences throughout their care processes. This approach identifies gaps in care, and enhances continuity, while reducing inefficiencies, such as prolonged wait times (Borycki et al., 2020). By creating visual, narrative, or descriptive maps, PJM provides a comprehensive overview of patient interactions with healthcare systems and providers (Bulto et al., 2024). PJM has been applied in military hospitals, such as the Rabat

Military Hospital, located in Morocco, to align processes with national guidelines while optimizing workflow efficiency (Jabbar et al., 2017)

PJM is particularly valuable for the integration digital technologies into patient care. It helps healthcare professionals, patients, as well as policymakers understand the patients' digital ecosystem, to evaluate how technological tools can enhance their journey (Borycki et al., 2020). For instance, its application in emergency departments has demonstrated improvements in communication in addition to patient experiences, with patients reporting better clarity (VandenBerg, et al., 2021).

Despite its promise, PJM remains underutilized in healthcare settings. Wider adoption of this method could significantly improve healthcare delivery by addressing inefficiencies while fostering more patient-centered care (Joseph et al., 2020). Besides, its ability to guide integration of innovative technologies into healthcare practices underscores its potential as a critical tool for advancing patient outcomes (Joseph et al., 2020). Leveraging such tools enhances patient experiences and lays a foundation for integrating broader technological innovations in healthcare systems.

6.3 Health Information Technology in modern military healthcare

Health Information Technology (HIT) refers to a broad range of technologies used in healthcare to manage and exchange health information, with the goal being to improve quality and efficiency (Zeng et al., 2009). It includes electronic health records, data analytics, telemedicine[67], but also digital tools that improve communication and patient engagement (Gomathy et al., 2023). Implementing HIT can streamline administrative processes, enhance communication, and improve patient care (Okolo et al., 2024). However, successful adoption requires addressing ethical considerations, patient privacy, and regulatory compliance (Okolo et al., 2024).

Effective HIT implementation requires robust change management strategies. Key components include clear communication of objectives, active collaboration among stakeholders, and empowerment of healthcare professionals to adopt and utilize modern technologies effectively (Mekanontchai, 2009). However, despite considerable investments, the rate of HIT adoption in hospitals remains low, hindered by a range of strategic, organizational, technical, and social barriers (Cresswell & Sheikh, 2015). Therefore, the

6

[7] Remote healthcare services

implementation of HIT can be complex, additionally needs comprehensive planning and support mechanisms to achieve full adoption.

According to Cresswell & Sheikh (2015), emerging trends in HIT emphasize greater patient involvement through online accessible medical records, integration of smart devices, and advancements in system interoperability. These innovations aim to create more cohesive and patient-centered healthcare ecosystems. However, HIT should not be viewed as a standalone solution but rather as an enabler that supports broader healthcare redesign efforts (Cresswell & Sheikh, 2015). Continuous evaluation and iterative refinement are essential to ensure that HIT systems adapt to the evolving needs of healthcare providers and patients, driving sustainable improvements in healthcare delivery (Yen et al., 2017).

As mentioned above, the critical role of HIT in modern healthcare lies in its ability to address systemic inefficiencies and improve overall hospital quality (Okolo et al., 2024). Achieving these outcomes requires overcoming the outlined barriers through strategic, well-supported implementation efforts (Cresswell & Sheikh, 2015). This is particularly relevant in complex environments, such as military healthcare systems, where HIT could serve as a foundational element for integration and modernization of hospital processes (Woody, 2020). To complement these advancements, adopting structured methodologies like Lean can further enhance efficiency by streamlining workflows or reducing waste (Dammand et al., 2014).

6.4 Applying Lean principles in military healthcare

As mentioned above the Lean model is a systematic and effective approach to process improvement, originally developed for manufacturing but now widely adopted in healthcare, education, and other sectors (Tilfarlioğlu, 2017; Martin, 2021). Its objective is to maximize value by identifying and eliminating non-value-adding activities, thereby streamlining workflows, and enhancing efficiency (Liker, 1997). In healthcare, Lean has been instrumental in tackling key operational challenges such as reducing patient waiting times, increasing process efficiency, and minimizing unnecessary staff movement within facilities (Dammand et al., 2014). Tools such as Kaizen events and Value Stream Mapping are particularly transformative, providing structured methodologies for identifying inefficiencies, standardizing procedures, and fostering a culture of continuous improvement (Bošnjak & Bošnjak, 2020; Dammand et al., 2014).

Successful Lean implementation in hospitals requires leadership support, active engagement from staff, and sufficient resources to sustain change (Dammand et al., 2014). Moreover, Lean's core principles, prioritizing patient needs, establishing and maintaining clear operational standards, and continuously refining processes, align seamlessly with the goals of modern

healthcare organizations (Weiss, 2019). Beyond operational improvements, Lean fosters employee satisfaction by empowering teams to contribute actively to organizational enhancements, creating a culture of ongoing development and shared responsibility (Tilfarlioğlu, 2017; Weiss, 2019; Liker, 1997).

Lean's adaptability extends to military healthcare, as demonstrated in Brazil, where Lean practices at a military treatment facility resolved organizational misalignments, improving workflow coordination and operational efficiency (Seraphim et al., 2010). Similarly, a Veterans Affairs medical center in the US adopted Lean methodologies to optimize emergency department operations, achieving significant reductions in waiting times compared to other facilities (Vashi et al., 2018). These examples underscore how Lean enhances healthcare delivery in both civilian and military contexts.

Crucially, Lean addresses both operational inefficacies as well as establishes a robust foundation for adopting advanced technologies like HIT. By standardizing processes and fostering a culture of continuous improvement, Lean creates stability and consistency in workflows, which are essential for the successful integration of innovative solutions. For instance, methodologies like Value Stream Mapping enable identification of inefficiencies as well as key parts of operational processes, creating a stable operational foundation to implement innovations (Dammand et al., 2014). Furthermore, Lean's emphasis on employee engagement can reduce resistance to change, ensuring improved implementation of modern technologies (Wackerbarth et al., 2015). Therefore, Lean can empower healthcare organizations to optimize their operations while building the resilience and adaptability needed to embrace future advancements in technology and patient care. Expanding on these approaches, the TOE framework offers a broader perspective by analysing contextual factors that influence technological adoption.

6.5 The TOE framework for technological adoption

The Technology-Organization-Environment (TOE) framework, developed by Tornatzky & Fleischer (1990), provides a panoramic view through which the adoption of modern technologies within an organization can be analysed (Baker, 2011). As demonstrated in Figure 5, the framework posits three key contextual domains - technology, organization, and environment – that significantly influence an organization's decision to adopt and implement technology. By dissecting factors within these domains, the TOE framework offers a structured approach to understanding varied drivers and barriers to technological innovation (Ahmadi et al., 2015; Baker, 2011). Building on the discussion Grundfest et al. (2012) state that, the context

of a military hospital complexifies these factors, given the intersection of healthcare with strict security protocols, and hierarchical organizational factors.

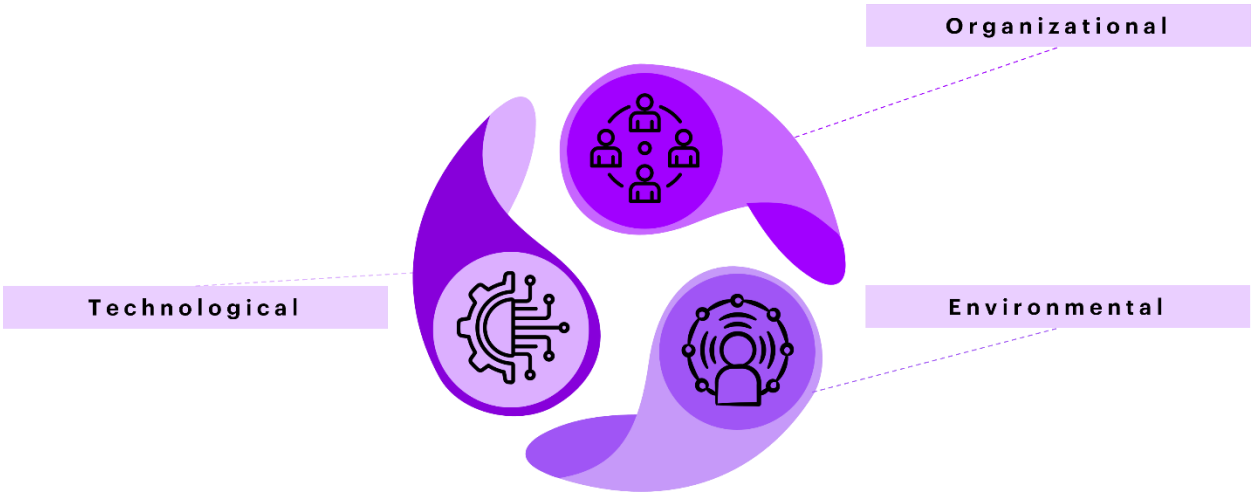


Figure 5 | TOE framework for technological innovation decision-making.

The figure represents the TOE framework, underscoring the interconnected factors influencing innovation adoption at CMH. These dimensions, technology-organization-environment, guide the analysis of challenges and opportunities.

6.5.1 The technological context

Starting with the technological context encompasses all technologies available to an organization, including both technologies currently in use and those available on the market (Baker, 2011). Organization existing technologies play a critical role in determining the scope and speed at which technological change can be introduced (Baker, 2011). According to Baker (2011), these existing technologies establish a foundational limit, by setting constraints on the extent of change an organization can undertake.

As reported by Gurol-Urganci et al. (2013) external innovations can lead to three types of internal change, namely incremental, synthetic, or discontinuous changes. Incremental change introduces new features or versions of existing technologies, whereas it represents the least amount of risk associated with change. An example is the implementation of automated SMS or e-mail hospital appointment reminders within existing scheduling systems, reducing missed appointments and improving operational efficiency with minimal disruption to staff workflows. This small enhancement has been shown to increase patient adherence and satisfaction without requiring significant changes to the hospital's administrative processes (Gurol-Urganci et al., 2013).

While synthetic changes demonstrate a moderate level of change, they combine existing ideas or technologies in a novel manner (Baker, 2011). To illustrate, a synthetic change in hospitals

is the adoption of telemedicine to enable remote consultations. This integration expands access to care, particularly for remote or mobility-challenged patients, by repurposing current technologies to enhance patient experience without a complete system overhaul (Greenhalgh et al., 2016).

Finally, discontinuous change also referred to as radical innovation, stands for significant departures from current technology of processes (Baker, 2011). Such as the adoption of robotic surgery systems, which introduces a fundamentally innovative approach to conducting surgeries compared to traditional methods. This technology, which enables minimally invasive procedures with enhanced precision, requires significant shifts in training, equipment, and workflows altering surgical practice (Herron et al., 2016). Thus, each type of technological change presents varying levels of disruption and opportunity, requiring organizations to carefully assess their resources and readiness to integrate these innovations within their existing systems and workflows.

6.5.2 The organizational context

The organizational context in the TOE framework involves characteristics and resources within a firm, including its structure and internal communication processes, which together shape adoption as well as the implementation of innovations (Baker, 2011). In hospitals, this context is particularly defined by the complexity of healthcare delivery, regulatory requirements along a highly interdependent structure among departments and professionals (Damanpour & Schneider, 2008). Key factors such as hospital size, resource availability, and alignment of organizational roles and responsibilities are critical in determining the capacity for change (Baker, 2011). For instance, large hospitals may have greater resources for adopting innovations, yet smaller hospitals may benefit from closer, more flexible communication across departments, allowing for quicker decision-making and responsiveness to change (Damanpour & Schneider, 2008).

Besides, linking mechanisms within an organization, such as interdisciplinary teams or informal communication networks are instrumental in promoting innovation (Westover, 2024). By coordinating input across departments, these structures can enable hospitals to integrate modern technologies more effectively, ensuring they align with clinical workflows along with patient care requirements. Besides, as Baker (2011) notes, decentralized and flexible organizational structures that encourage lateral communication and adaptable roles significantly support the initial stages of adoption, allowing for rapid innovation and experimentation.

On the other hand, according to Baker (2011), the organizational context, including structure and processes, plays a critical role in the adoption as well as implementation of technological innovations. Stable well-defined organizational frameworks can support the alignment of innovative technologies with existing safety standards in addition to regulatory requirements. Centralized structures, as discussed within the TOE framework, can facilitate uniform application of innovations across the organization.

Finally, resource availability, or slack, provides organizations with the necessary flexibility to support technological change. However, especially hospitals resource allocation is frequently limited, with priorities such as patient care and compliance competing with technological investments (Taye & Assefa, 2022). Consequently, hospitals must carefully balance these priorities to foster an organizational context that encourages innovation.

6.5.3 The environmental context

The environmental context in the TOE framework encompasses external factors such as industry structure, technology service providers, and regulatory requirements, which determine an organization's ability to adopt innovations (Baker, 2011). Previous research by Marques et al. (2011) states that competitive pressure is a powerful driver of IT[8] adoption and diffusion. In a hospital setting the environmental context is determined by regulatory standards and market dynamics that influence technology use and innovation in healthcare (Ramdani et al., 2019).

For instance, the regulatory environment in healthcare often mandates stringent privacy and data protection measures, such as compliance with the General Data Protection Regulation (GDPR) in the EU, which can constrain hospitals' flexibility in adopting certain digital solutions (Vest & Kash, 2012). Additionally, the market for EPR systems in the Netherlands is dominated by a limited number of vendors, such as Epic and ChipSoft's HiX. This oligopolistic market structure discourages competitive innovation and makes it challenging for hospitals to switch systems, as transitions are both costly as well as complex (Figure 5) (Wang, 2016).

6.6 Understanding technology adoption in military healthcare: Insights from TAM and UTAUT

The challenges outlined in the digitalization of healthcare underline the need for robust theoretical models in understanding and addressing barriers to technology adoption. The Technology Acceptance Model (TAM), initially developed by Davis (1989), is one of the most prominent frameworks for understanding user acceptance of information systems (Surendran,

[8] Information Technology

2012). TAM is built upon two central constructs: perceived usefulness, the extent to which an individual believes that using a technology will enhance their performance, and perceived ease of use, which reflects the degree of effort required to use the system. Both constructs influence attitudes toward use and subsequently determine behavioral intentions, which drive technology adoption (Davis, 1993). Research consistently demonstrates that perceived usefulness has a stronger influence on behavioral intentions compared to perceived ease of use, with perceived usefulness being approximately 50% more impactful in determining actual system usage (Davis, 1993).

TAM has been applied in a wide range of domains, including e-services, mobile data systems, self-service technologies, and e-learning platforms (Chen et al., 2012). The model has undergone various refinements and extensions to improve its explanatory power, with researchers introducing new variables, moderators, and mediators to account for contextual differences (Malatji et al., 2020). While TAM has been validated, it is not without limitations. For example, the model struggles to quantify observed behaviors, particularly in settings where direct measurement is challenging. Additionally, TAM does not explicitly consider external factors such as financial costs, organizational support, or structural constraints, which can significantly affect technology adoption (Malatji et al., 2020). Despite these limitations, TAM remains a foundational framework due to its simplicity and adaptability across diverse contexts.

In healthcare, TAM has been instrumental in studying patient acceptance of online registration systems, which aim to streamline administrative processes and enhance patient experiences. Studies have shown that perceived usefulness and perceived ease of use are significant predictors of patients' attitudes toward mobile and online registration platforms (Lai et al., 2015). Moreover, behavioral intention, a key intermediary variable, has been found to significantly influence the actual use of these systems (Rumana, 2020). For instance, patients are more likely to adopt systems they perceive as easy to use and beneficial in terms of saving time or improving the registration process. However, despite potential benefits, adoption rates remain low. Dinata et al. (2020) reported that only 8% of patients used an online registration system, highlighting barriers such as insufficient awareness, limited accessibility, and perceived complexity. To address these challenges, hospitals are advised to prioritize usability improvements, expand platform availability, and invest in patient education initiatives (Rumana, 2020; Dinata et al., 2020).

In addition to TAM, the Unified Theory of Acceptance and Use of Technology (UTAUT) has emerged as a robust model for predicting user acceptance in healthcare and other fields. UTAUT incorporates constructs such as performance expectancy, effort expectancy, social

influence, and facilitating conditions, offering a wider perspective for understanding technology adoption. In healthcare, UTAUT has been used to study a range of innovations. For example, it has been employed to predict patient adoption of hospital mobile applications (Badra Al Aufa et al., 2020) and Emergency Department wait-time websites, demonstrating its applicability in both patient-facing and operational contexts (Jewer, 2018).

For healthcare professionals, a modified version of UTAUT has been applied to examine the adoption of Electronic Medical Record (EMR) systems by physicians. This adaptation increased the model's explanatory power, accounting for 44% of the variance in behavioral intentions compared to 20% in the original UTAUT (Venkatesh et al., 2011). Similarly, UTAUT2 has been used to explore the adoption of mobile health applications in Jordanian hospitals, emphasizing the value of factors such as time savings and improved administrative efficiency (Alazzam et al., 2018). Research further demonstrates that UTAUT can account for up to 70% of the variance in behavioral intentions, compared to around 40% for TAM, demonstrating its superior predictive power (Venkatesh et al., 2011).

These findings demonstrate the adaptability and value of both TAM and UTAUT in healthcare settings. However, while TAM provides a streamlined approach to studying technology acceptance, UTAUT's broader framework is particularly well-suited for understanding the complex interplay of user perceptions, and organizational context next to external factors in technology adoption. UTAUT’s inclusion of constructs like social influence and facilitating conditions makes it a more comprehensive choice for examining adoption in the unique dual role environment of military hospitals.

This broader applicability, coupled with its higher predictive power, is why UTAUT is selected for this study. It allows for a detailed analysis of how technological innovations can be successfully adopted.

6.7 Innovations in patient registration processes

Moving on to patient registration technologies, patient registration has evolved significantly with the adoption of modern technologies aimed at enhancing efficiency and patient satisfaction (Lulejian & Cantor, 2018). Traditional manual check-in remains a widespread practice but can lead to inefficiencies such as long queues and increased administrative burden (Hosseini et al., 2024). To address these challenges, hospitals have introduced digital solutions (Lulejian & Cantor, 2018).

Online check-in through mobile apps and web platforms allows patients to register remotely, reducing waiting times and streamlining administrative processes (Pratama et al., 2022). For

example, web-based outpatient registration systems have been demonstrated to enhance user convenience and improve workflow efficiency (Wijaya et al., 2023). Another alternative, self-service kiosks enable patients to independently complete their check-in process. These kiosks have proven effective in busy hospital environments, where they help manage patient flow and reduce staff workload (Loukili et al., 2024). Moreover, contactless authentication using face recognition has been proposed as a hygienic alternative to traditional methods, achieving 94% accuracy in initial tests (Tay et al., 2021). However, they can pose challenges for patients with limited digital literacy or accessibility needs, highlighting the significance of inclusive design (Jones, 2009). Manual systems, while less efficient, remain crucial in situations where digital infrastructure is lacking or for patient groups who prefer face-to-face interactions. These systems can be incorporated into hybrid models that combine manual and digital approaches to serve diverse patient populations (Xie et al., 2020).

Finally, in military hospitals, patient registration technologies face unique challenges and opportunities. According to a study on Pekanbaru Military Hospital offline registration processes caused significant bottlenecks, resulting in long waiting times and inefficiencies. The implementation of a mobile-based registration system tailored for military hospital needs significantly reduced these issues by providing online registration, real-time queue updates along seamless access to patient records. The system's success was proven by an 84% user satisfaction rate, demonstrating its effectiveness in military healthcare environments (Saputra et al., 2024).

In addition, (Generative) AI[9] is transforming healthcare administration and patient care. In patient registration, AI can automate data collection, minimize errors, while enhancing overall efficiency (Sumathi & Jeyalaksmi, 2022). In clinical environments, it analyses real-time patient data to anticipate health issues, in addition to creating personalized treatment plans (Voola et al., 2024). Moreover, Generative AI (GenAI) streamlines administrative tasks such as form completion or EPR documentation, freeing healthcare providers to focus on patient care (Falak, 2023). While AI offers substantial advantages in both administrative efficiency as patient care, its implementation must carefully address challenges to ensure optimal functionality and safeguard patient experiences (Voola et al., 2024).

[9] Artificial Intelligence (AI) is a broad term for technologies that analyse data and make decisions. Generative AI (GenAI) is a subset that creates new content, such as text, images, or predictions, based on learned patterns.

7 Methodology

This chapter provides a detailed overview of the research methodology, including the research design, data collection methods, sampling strategies, along analysis techniques employed in this study (Figure 6). Given that patient registration processes at CMH involve both operational inefficiencies next to cultural dynamics, this research required an approach that captures complex interactions on top of perspectives.

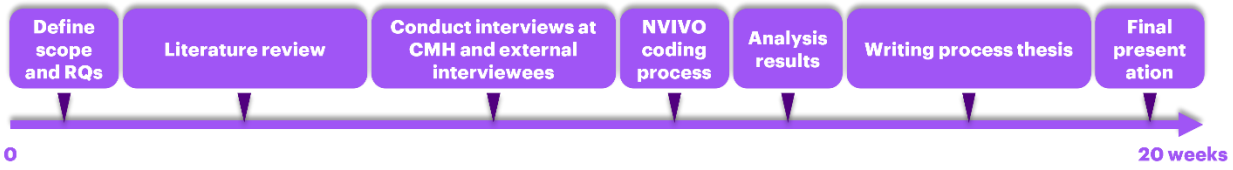


Figure 6 | Research and writing timeline.

This timeline illustrates the research process, from defining the scope and research questions (RQs), conducting the literature review to interviews, data analysis using NVIVO, as well as authoring the thesis, culminating in the final presentation. It outlines the structured approach taken to achieve the research objectives.

7.1 Research design

A qualitative research design was selected as the primary methodological approach, as it enables an in-depth exploration of human experiences, and institutional practices while capturing social dynamics (Cresswell & Poth, 2018). Unlike qualitative research, which focuses on numerical data in addition to statistical analysis, qualitative research is suitable for context-dependent aspects, such as organizational culture or technological adoption (Cresswell & Poth, 2018). This approach allows researchers to collect rich descriptive data that provides deeper insights into stakeholder perspectives, and resistance to change, coupled with the broader implications of digital transformation. Whereas, due to the exploratory nature of this study, semi-structured interviews and thematic analysis were employed to capture diverse viewpoints from CMH staff, patients, and external stakeholders. These methods facilitate a nuanced understanding of challenges in the patient registration process besides help to identify organizational factors that influence the adoption of modern technologies.

7.2 Data collection

7.2.1 5.4.1 Ethical considerations

The study adhered to strict ethical guidelines to ensure confidentiality and data security. Informed consent was obtained from all participants before the interviews (Appendix B:

Informed consent), in addition, data was anonymized to protect identities. All digital and physical data were securely stored.

To ensure objectivity while minimizing bias, questions were carefully phrased neutrally, avoiding any leading formulations. A standardized interview guide (Appendix A: Interview guide) provided consistency across all sessions, reducing variability in responses. Where necessary, participant validation was sought to clarify responses while ensuring an accurate representation of their perspectives. These measures contributed to the reliability as well as validity of the findings, ensuring that insights were captured as objectively as possible.

7.2.2 Semi-structured interviews

Data were gathered through semi-structured interviews, lasting between 10 and 50 minutes. These interviews followed a predefined guide (Appendix A: Interview guide) aligned with the research objectives. Topics included registration workflows, procedural inefficiencies, privacy concerns, and digital transformation opportunities. Open-ended questions encouraged participants to share their experiences and insights comprehensively. Besides the interviewer conducted the *'Five Why'* method to uncover the root causes of identified challenges (Serrat, 2017). Each interview concluded with participants being thanked and provided with an opportunity to offer additional remarks or clarifications.

7.2.3 Sampling

A combination of purposive and snowball sampling techniques was employed to ensure the inclusion of relevant and diverse perspectives (Nyimbili & Nyimbili, 2024). Purposive sampling targeted individuals directly involved in or impacted by patient registration processes, such as reception staff, patients, management next to external stakeholders. Snowball sampling extended participant recruitment through referrals, enabling access to broader viewpoints Nyimbili & Nyimbili, 2024). The sample size was guided by the principle of data saturation, ensuring comprehensive coverage of the research themes (Ness & Fusch, 2015). Whereas data saturation was considered achieved when no new themes or insights emerged from subsequent interviews.

7.2.4 Study Population

The study population included individuals aged eighteen and above who were engaged in or affected by CMH's patient registration processes. In total seventeen participants were interviewed, representing key stakeholder groups:

- Reception staff: Operational insights into registration workflows.
- Patients: Experiences with the existing registration system.

- Management: Strategic perspectives on procedural inefficiencies.
- External stakeholders: Comparative insights from other healthcare organizations.

Table 5 in Appendix C: Details of interviewees provides a detailed overview of the participants, including their roles, interview dates as well as durations.

7.3 Data Analysis

Thematic analysis, assisted by NVIVO software (Version 15), was conducted to analyse interview data systematically. Thematic analysis was selected for its flexibility and effectiveness in identifying patterns or themes across qualitative data (Cresswell & Poth, 2018). The analysis followed these steps:

1. Familiarization: Transcripts were reviewed multiple times to build a thorough understanding of the data.
2. Coding: Descriptive codes were applied to text segments, capturing key ideas or observations.
3. Theme development: Related codes were grouped into broader themes that aligned with the research questions.
4. Interpretation: Themes were interpreted to derive insights into CMH's registration process in addition to its organizational culture.

NVIVO facilitated data management and visualization, ensuring a rigorous analytical process. The resulting themes are discussed in the results section.

7.4 Framework integration to address the main research question

Figure 7 illustrates the conceptual framework used in this study to address the main research question (MRQ) and the corresponding subquestions (RQ1-RQ4). The framework integrates four theoretical approaches: Lean principles (Dammand et al., 2014), patient journey mapping (PJM) (Borycki et al., 2020), TOE framework (Tornatzky & Fleisher, 1990), and UTAUT (Venkatesh et al., 2003), to provide a comprehensive analysis of the challenges together with associated opportunities in the patient registration process at CMH.

Lean principles were used to identify inefficiencies along with non-value-adding tasks in workflows, while PJM provided detailed insights into patient interactions with CMH's registration process. Together, these frameworks form the analytical foundation of this study. The TOE framework was applied to RQ1 and RQ2 analysing broader organizational, technological, as well as environmental factors influencing the patient registration process.

This structured approach highlights the role of organizational culture, external dependencies, and contextual challenges in digital transformation.

Furthermore, the UTAUT framework was used to evaluate feasibility as well as user acceptance of proposed technological solutions (RQ3 and RQ4). By evaluating performance expectancy, effort expectancy, social influence as well as facilitating conditions, this framework enabled a detailed assessment of potential innovations. The findings from each subquestion (RQ1-RQ4) contribute to answering the MRQ providing insights into challenges, cultural dynamics, evaluation criteria, as well as potential solutions for optimizing the patient registration process at CMH. The layered structure of the framework reflects how these approaches interconnect to ensure a holistic and methodologically robust analysis.

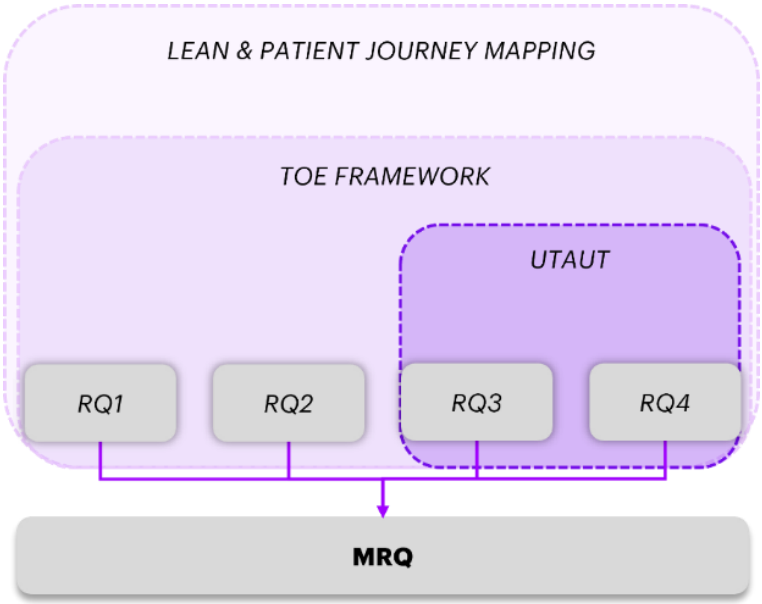


Figure 7 | Framework integration to address the main research question.

This framework visualises how Lean and patient journey mapping, alongside the TOE and UTAUT models, guide the answering of the subquestions (RQ1-RQ4) to address the main research question (MRQ). It integrates theoretical approaches to analyse in addition to improving patient registration processes at CMH.

8 Interview findings in theoretical context

The section covers findings from the analysis of the patient registration process at CMH. Using the patient journey map (PJM) together with Lean principles, inefficiencies, and key challenges were identified. Thematic analysis was conducted on the data collected through semi-structured interviews, resulting in seven overarching themes, each with related sub-themes that reflect challenges and opportunities within the CMH context (Figure 8). These themes form the foundation for applying the Technology-Organization-Environment (TOE) framework to determine requirements and organizational context for potential solutions. Finally, the Unified Theory of Acceptance (UTAUT) is used to evaluate these solutions against identified requirements, ensuring feasibility and alignment with user needs. Together, these analyses provide a structured and evidence-based pathway to optimize the patient registration process.

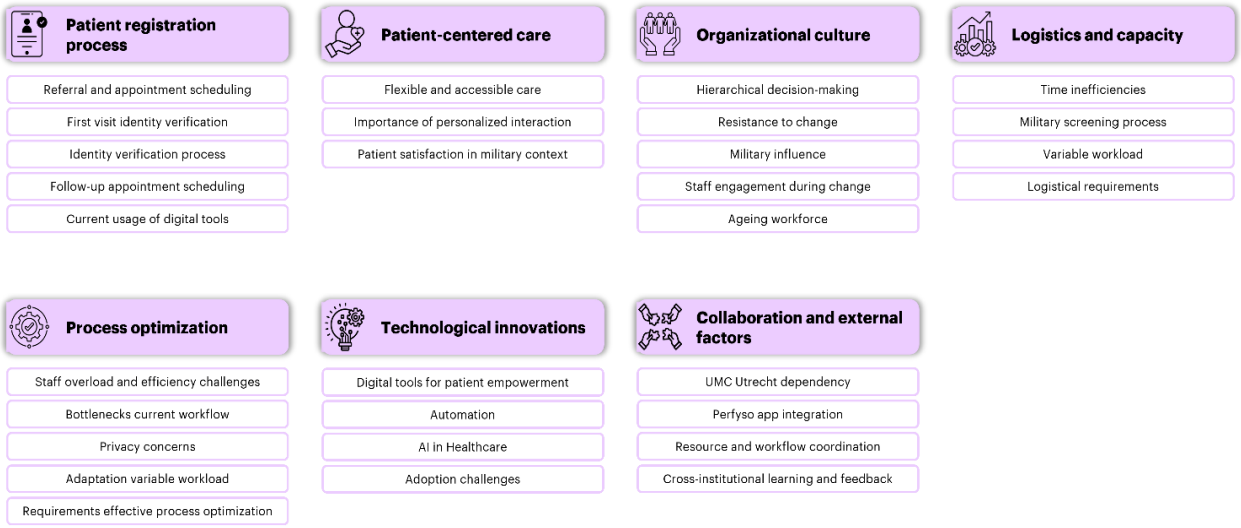


Figure 8 | Interview themes and subthemes.

This figure categorizes the key themes next to subthemes identified in the research. It shed light on critical

areas such as the patient registration process, patient-centered care, organizational culture, logistics, process optimization, technological innovations, and external collaboration. These themes provide a comprehensive foundation for analysing and addressing inefficiencies in CMH's patient registration workflow.

8.1 Lean: Value stream mapping reception desk activities

The application of Lean principles within healthcare provides a structured methodology to enhance value-added activities while eliminating inefficiencies. Originally developed for manufacturing, Lean methodology has been widely adopted in healthcare settings to streamline processes, reduce waste, and improve overall efficiency (Weiss, 2019). At CMH,

Lean principles are employed to analyse reception desk processes using a Value stream map (Figure 9). This map categorizes reception desk activities into value-adding and non-value-adding tasks, providing actionable insights for process optimization. The insights gained from the Lean analysis serve as a foundation for developing the PJM, which offers a deeper exploration of patient interactions and is discussed in the next chapter.

8.1.1 Non-value-adding activities

The analysis of CMH's registration process shed light on activities that do not directly contribute to patient value. These include tasks such as manually sorting emails, repetitive telephone calls, redundant verification steps next to the reliance on manual data re-entry. A staff member emphasizes these challenges:

"Currently, any changes to patient details must be made over the phone, which limits flexibility for both staff and patients." – Reception staff member C.

A staff member stresses the burden of these inefficiencies: *"At peak times, I do not get to my other tasks. I am just registering patients, managing their orders after consultations, and then registering the next one. It is a cycle that leaves no time for anything else." – Reception staff member C.*

Patients also recognize inefficiencies in the current system. For instance, one patient shares their frustration with the scheduling process: *"I had to personally call CMH to make my appointment, which was time-consuming. I had to wait a month before seeing the doctor." – Patient B.*

Moreover, another patient mentions: *"When I arrived, I had to provide my ID and answer a series of questions to verify my details. It felt thorough but redundant." – Patient C.* These examples illustrate how manual as well as time-intensive workflows can create unnecessary delays and reduce overall efficiency.

8.1.2 Value-adding activities

Conversely, value-adding activities in the registration process are those that directly enhance patient experiences while supporting CMH's mission of providing high-quality military healthcare. These activities include assisting patients with queries, scheduling appointments, and managing laboratory results while ensuring compliance with legal requirements.

A staff member states the significance of maintaining a smooth appointment management system: *"To minimize long waiting times for follow-up appointments, I often schedule two or three additional appointments right after the first one." – Reception staff member A.*

Similarly, patients express their appreciation for personalized support: *"I received a call from CMH after my referral, and they collaborated with me to find a suitable date for the appointment. The process was quite smooth." – Patient C.*

These value-adding activities align closely with CMH's strategic goals of operational readiness and patient-centered care. The Value stream map (Figure 9) provides a clear overview of non-value-adding and value-adding activities. By visualizing these tasks, CMH can identify areas for improvement together with prioritizing changes that maximize patient value while reading administrative burdens on staff. For instance, automating non-value-adding tasks, such as redundant verification steps, could free up staff to focus on more critical, value-adding activities. Whereas the insights gained from this analysis (Figure 9), form the backbone for the patient journey map discussed below.

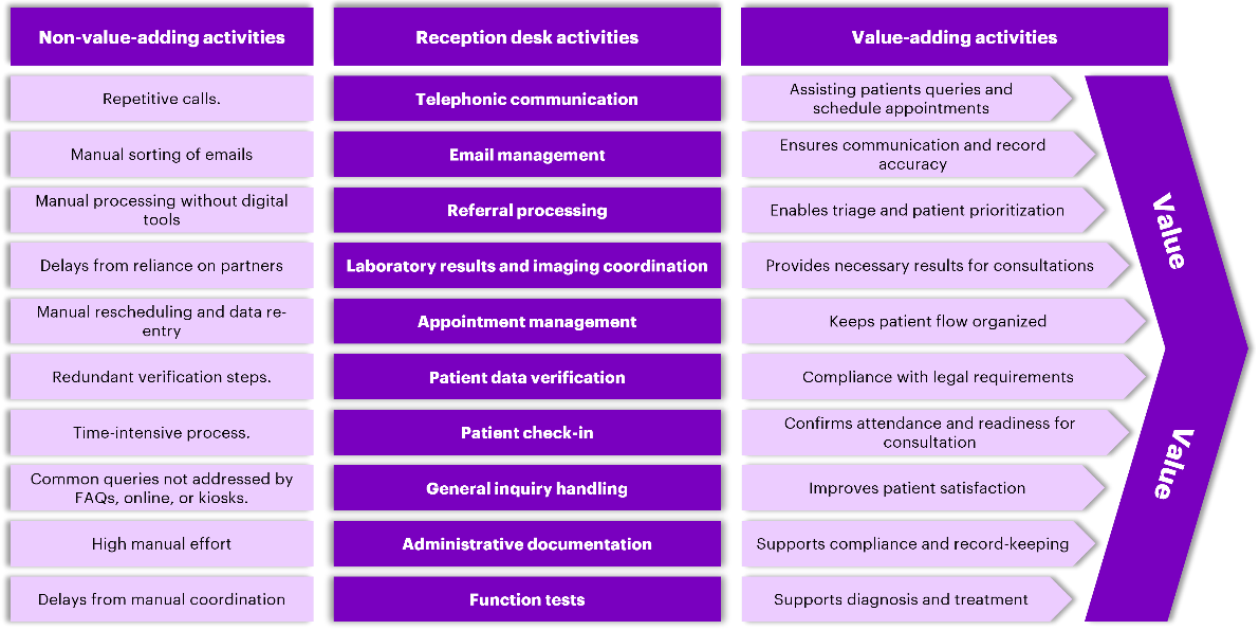


Figure 9 | Value stream mapping reception desk activities CMH.

This figure distinguishes between non-value-adding and value-adding activities in reception desk activities. It highlights inefficiencies including redundant manual tasks while displaying activities that enhance patient care and operational efficiency, emphasizing opportunities for streamlining workflows and increasing value.

8.2 Insights from patient journey mapping

As previously discussed, Lean methodology forms the foundation for the PJM at CMH. The PJM visualises patients' interactions with CMH, segmented into key phases: appointment booking, pre-appointment preparation, arrival and check-in, consultation, post-consultation besides data updates. Each phase points out opportunities, pain points along with the associated

emotions of patients and staff, offering a holistic view of the registration process as can be seen in Figure 10.

This tool is not only instrumental in uncovering inefficiencies but also sheds light on areas where technological innovations can enhance patient experience and operational workflows. Furthermore, PJM serves as a foundational guide for analysing CMH's processes, offering critical insights that will inform the broader framework for optimization explored in subsequent chapters.

8.2.1 Appointment booking phase

This phase encompasses the scheduling of medical appointments at CMH. Patients are either contacted by the reception staff or proactively make their own appointments. The process is primarily manual whereas it depends on phone communication, which can introduce delays during peak times.

A reception staff member notes: *"First we receive referrals, which allow us to let the medical specialists review patient information before contacting them to arrange the appointment."* – *Reception staff member A*.

However, this manual method can lead to patient dissatisfaction, particularly among those unable to make calls during standard business hours. A military trainee shares their experience: *"I found it difficult to call during my shifts since I rarely have breaks."* – *Patient D*.

8.2.2 Pre-appointment preparation phase

In this stage, patients receive confirmation of their scheduled appointments as well as any preparatory instructions. Despite the use of SMS[10] and email reminders, the process remains inconsistent in ensuring clarity for all patients. One patient appreciates the efficiency of reminders saying: *"I received an SMS reminder for my appointment, which was very helpful and reassuring."* – *Patient A*. Nevertheless. Others report confusion regarding the overall communication, with a common remark being: *"Confusion on what to bring or where to go"* – *Reception staff member C*.

8.2.3 Arrival and check-in phase

Upon arriving at CMH, patients are required to complete identity verification at the reception desk, a process mandated by Dutch healthcare laws to ensure compliance with the *'Wet op de geneeskundige behandelingsovereenkomst'* (WGBO). Although staff strive to make the check-in process seamless, patients find the procedure redundant. A patient comments: *"When I*

[10] Short Message Service

arrived, I had to provide my ID and answer a series of questions to verify my details. It felt thorough but redundant." – Patient C. Privacy concerns also emerged during this phase due to the open layout of the reception area. A staff member mentions: *"We try to verify personal details discreetly, but the open reception area sometimes makes patients uncomfortable." – Reception staff member C.*

8.2.4 Consultation phase

During consultation, patient interact with medical professionals for diagnoses or treatment. This phase typically receives high satisfaction scores due to CMH's emphasis on personalized care. One patient expresses confidence stating: *"This hospital is incredibly flexible. You can quickly schedule an appointment compared to civilian hospitals, where patients often face long wait." – Patient A.*

However, the demand for consultations together with tight schedules can lead to challenges. As noted by a reception staff member: "On busy days, around 40 patient's check-in at my desk." – Reception staff member A.

8.2.5 Post-consultation phase

After their consultation, patients schedule follow-up appointments or receive medical advice on further steps. While patients appreciate the convenience of scheduling follow-ups immediately, others encounter difficulties. A staff member explains: *"To minimize long waiting times for follow-up appointments, I often schedule 2 or 3 additional appointments right after the first one." – Reception staff member A.*

8.2.6 Data update phase

This phase involves updating patient information or records to reflect changes in health status or personal details. Currently, this process relies on manual methods, requiring patients to call or visit CMH in person. A staff member states: *"Currently, any changes to patient details must be made over the phone, which limits flexibility for both staff and patients." – Reception staff member C.* These inefficiencies accentuate the need for integrated digital solutions to streamline workflows and enhance data accuracy.

8.2.7 Summarizing patient journey map results

The PJM in Figure 10 reveals both strengths as well as areas for improvement in the registration process. Each phase emphasizes a balance between personalized care and operational challenges, reflecting CMH's commitment to patient-centered service delivery within the military healthcare context. However, inefficiencies such as reliance on manual workflows, limited use of digital tools, and recurring privacy concerns point out the urgency for targeted

innovations. By addressing these issues, CMH can better align its operational processes with its strategic goals of flexibility and high-quality care. To further explore the potential for optimization the next chapter will apply the TOE framework. This framework provides a structured analysis of factors influencing the adoption of technological innovation at CMH, considering its unique military context and culture.

Phases	Appointment booking	Pre-appointment preparation	Arrival and check-in at CMH	Consultation	Post-consultation	Data updates
User actions, tasks and activities	• Digital referral letter is shared. • Schedule appointment (phone call) • Verification of patient data	• Patients receives an appointment confirmation and reminder by mail or SMS.	• Patient enters asks where to go. • Checks-in at the clinic specific reception desk. • Identify is verified • Patient is seated in waiting area.	• Patient attends consultation or receives treatment.	• Patient schedules follow-up appointment. • Patient receives updates about test results, prescriptions, or referrals.	• Patient updates personal information (e.g., address, insurance). • Patient fills out questionnaires.
Emotion, thoughts and feelings	• Patient is frustrated when delays occurs. • Patient is relieved when appointment is scheduled. • Staff is stressed during peak times.	• Patient is anxious about forgetting documents or forgetting appointment.	• Patient frustrated with waiting and long process. • Patient is nervous about the upcoming consultation.	• Patient has confidence or reassurance if the consultation is successful.	• Patient is relieved after receiving results. • Patient has confusion if further steps are not clear.	• Patient feels convenience if the process is smooth. • Patient experience frustration if it requires too many steps/time.
Painpoints	• Wait times on the phone. • Only available during business hours. • Limited flexibility in available slots.	• Confusion on what to bring or where to go. • Communication on different channels. • Reliance on phone-based processes.	• Lack of privacy during check-in. • Insufficient efficiency • Queues at reception desk. • Staff unable to complete other tasks.	• Potential delays in the consultation schedule. • Limited time. • No-show military patients.	• Unclear where to find what information. • Unclear follow-up steps.	• Complex data update processes. • Security concerns. • Limited use of digital tools. • Manual process.
Opportu-nity	• Implement features to plan appointments online. • Implement a digital tools	• Simplify communication • Online overview of appointments. • Provide a virtual tour.	• Introduce additional options to check-in. • Reduce administrative burden.	• Improved resource allocation. • Post-consultation summaries. • Live waiting cues.	• Enhance portal to allow easy access. • Provide real-time notifications for test results.	• Enable secure updates via portal. • Reminders to update data. • Offer online questionnaires.
Touch-point	• Phone (call center).	• Email reminder. • Confirmation letter or call.	• Enter hospital. • General reception. • Clinic desk.	• Interaction with healthcare provider.	• Clinic-specific desk.	• Phone. • Clinic-specific desk.

Figure 10 | Patient journey map of the registration process.

This figure outlines the patient journey at CMH across six phases, detailing user actions, emotions, pain points, in addition to opportunities for improvement. It highlights key challenges like delays, inefficiencies, as well as communication gaps while proposing solutions to enhance the overall experience.

8.3 Technology-Organization-Environment framework

To address the challenges identified in the patient journey at CMH and explore viable pathways for innovation, this chapter employs the Technology-Organization-Environment (TOE) framework. Developed by Tornatzy and Fleisher (1990), the TOE framework is widely recognized for its ability to analyse factors influencing technological adoption in organizations. It considers three key dimensions: the technological, organizational, and environmental contexts.

By applying this framework, the chapter aims to provide a structured analysis of how CMH can leverage technological solutions to optimize its patient registration process. The framework is particularly relevant given CMH's unique dual role as both a healthcare provider as well as a military institution, where technological integration must align with strict operational protocols, hierarchical structures, in addition to the overarching objectives of the Ministry of Defense.

8.3.1 Technological dimension

The technological dimension at CMH encompasses critical challenges and opportunities that determine the adoption of technological innovation in the patient registration process. These factors include the limited adoption of digital tools, privacy concerns, integration requirements with existing systems, as well as the need for hybrid and user-friendly solutions.

One of the primary limitations in the current technological setup is the underutilization of digital tools. For instance, while the 'MyCMH' portal and SMS reminders are available to patients, their adoption remains questionable.

"Patients can use the 'MyCMH' portal to view appointments or send e-consults, but they must actively log in to access these features." – Reception staff member D. This underlines the obligation for more accessible and intuitive digital interfaces that encourage broader adoption among patients.

Another significant barrier is the lack of privacy in the current patient registration layout. The registration process occurs at the reception desk, as mentioned in the PJM, where patients are required to discuss personal information in an open environment. This setup raises concerns among both staff and patients about the lack of confidentiality. As one patient observes: *"In the waiting area, you can hear people discussing personal matters at the desk. That is uncomfortable, and privacy is an issue." – Patient F*. Such concerns underscore the necessity of evaluating technological systems to enhance privacy while aligning patient expectations.

Moreover, CMH faces challenges in managing patient queues during peak hours. The absence of an effective queue management system can result in delays and inefficiencies, placing additional strain on reception staff. A staff member elaborates on this issue: *"Some mornings can have eighteen patients, while others only two. The variability makes it unpredictable." – Reception staff member D*. This highlights the pressing demand for technologies that streamline patient flow and reduce bottlenecks.

Besides, CMH operates under technological constraints due to its reliance on HiX EPR. Any technological solutions must integrate seamlessly with HiX, which limits the hospital's

flexibility to explore alternative systems. A representative from the Perfyso app notes: *"If you want to change something in the current EPR system, you must coordinate with UMC Utrecht. You cannot take a completely different direction because we remain tied to one system."* This dependency marks the significance of ensuring compatibility with existing infrastructure when proposing technological innovations.

Despite these challenges, CMH recognizes the potential of hybrid systems that combine digital and physical solutions to cater to diverse patient needs. This approach ensures inclusivity for patients with varying levels of digital literacy, as a MIM staff member notes: *"You must always maintain a hybrid situation, including a host to assist those who need support."- MIM staff member.*

In addition, any proposed technological solutions must prioritize accessibility, particularly for those less familiar with digital technologies. This is critical for ensuring widespread adoption and minimizing resistance. An Accenture Data & AI expert emphasizes this point by stating: "F*or me, using an app is fine, but for people over 50, relying on apps and chatbots can be overwhelming."* Designing intuitive systems that cater to all is thus essential for the success of any innovation.

Lastly, while innovations such as AI-powered tools present significant opportunities for CMH, they must be carefully implemented to complement existing processes without overwhelming staff or patients.

"Introducing AI assistance for tasks like drafting reports or managing patient data could significantly improve efficiency." – Accenture Data & AI expert.

However, implementing AI requires careful consideration of ethical and technical challenges: *"In theory, HiX could integrate with external AI systems, but this raises trust and security concerns that need to be addressed. – ChipSoft expert.*

In summary, the technological factors influencing the optimization of patient registration at CMH focus on addressing existing inefficiencies, ensuring seamless integration with current systems, and designing hybrid, user-friendly solutions (Figure 11). By overcoming these challenges, CMH can employ technological innovation to enhance patient experiences and operational efficiency.

8.3.2 Organizational factors

The organizational dynamics at CMH play a critical role in determining of technological innovation for patient registration. These factors include hierarchical decision-making,

resistance to change, administrative burden, and the challenge of balancing efficiency with personalized care.

A key organizational challenge at CMH is its hierarchical decision-making structure, rooted in its military context. This structure slows the process of innovation adoption, as multiple layers of approval are required before any change can be implemented. Leadership maintains strong control over decisions, leaving limited room for input or initiatives from frontline staff.

"Change here is slow because everything is decided from the top, and by the time it reaches us, there is little flexibility. It is hard to embrace something when you are not part of the decision-making process." – *Reception staff member A*. This underlines the significance of inclusive decision-making to address these concerns.

The administrative burden on reception staff further complicates efforts to introduce technological innovations. Staff manage multiple manual tasks, including patient check-ins, appointment confirmations, and record updates, leaving little room for strategic activities. As reception staff member C states: *"At peak times, I do not get to my other tasks. I am just registering patients, overseeing their orders after consultations, and then registering the next one. It is a cycle that leaves no time for anything else."* Streamlining these processes through automation could alleviate workload pressures and improve overall efficiency.

Additionally, CMH faces challenges associated with an ageing workforce, which can slow adoption of modern technologies. Older staff members may require additional training and support to navigate digital tools effectively. A MIM staff member acknowledges this dynamic: *"The staff here are slightly older, and that affects how quickly people adapt to changes."*

Finally, CMH's commitment to personalized care adds complexity to adoption of innovations. Staff emphasize the need to maintain human interaction, even as digital tools are introduced. As patient F states: *"Digital tools should support, not fully replace, human contact."* This again underscores the commitment to hybrid solutions that integrate technology without compromising personal connections.

Despite challenges associated with hierarchical decision-making along with resistance to change, staff at CMH express satisfaction with their work environment and consistently describe CMH as a positive as well as rewarding place to work. As one staff member states: *"I would absolutely recommend CMH as an employer."* – *Reception staff member D.*

In summary, the organizational factors at CMH, such as hierarchical decision-making, resistance to change, and administrative overload, define the hospital's readiness to adopt technological innovations (Figure 11). Addressing these factors requires strategies that engage

staff, provide targeted training, and balance technological efficiency with the organization's values of personalized care.

8.3.3 Environmental factors

Finally, the environmental factors affecting CMH are influenced by its dependence on external partners, regulatory frameworks, and cross-institutional coordination. These factors create both constraints as well as opportunities for implementing technological innovations.

A significant aspect of CMH's environmental context is its dependency on UMCU for IT infrastructure next to system upgrades. This reliance limits CMH's autonomy in pursuing independent technological solutions and therefore aligns its innovation trajectory with decisions made by its partner institution. A staff member emphasized how CMH was required to adopt the HiX 6.3 upgrade following UMCU, stating: *"UMC decided to upgrade to HiX 6.3, and we had to follow suit. We did not have a choice in the matter."*

This reliance on the HiX system also creates a potential vendor lock-in scenario, where CMH's flexibility to explore alternative or innovative technologies is severely restricted. The mandatory alignment with ChipSoft's system infrastructure makes it costly as well as challenging to adopt different solutions.

Another critical factor, which arose during the interviews, is the complexity of regulatory requirements, particularly the GDPR, which governs the handling of sensitive medical data. These regulations impose strict standards for data privacy and security, making adoption of digital systems more challenging. Compliance with such frameworks ensures the protection of patient information but also adds layers of complexity to any technological innovation.

Benchmarking against civilian healthcare institutions provides CMH with opportunities for learning and process improvement. Insights from Berman Clinics, for instance, reveal alternative approaches to administrative and operational workflows. At Bergman Clinics administrative tasks are split between the front office, which oversees physical patient interactions, and the back office, which manages appointment preparations. A Bergman Clinics representative explains: *"At Bergman Clinics, the front office manages all physical tasks, while the back office manages appointment preparation, ensuring physicians have all necessary information before consultations."* Such practices could inspire CMH to explore more efficient configurations for patient registration processes.

Additionally, the integration of systems and workflows with external partners presents logistical challenges. CMH staff frequently coordinate with UMCU to access imaging results and other shared resources, which can be time-consuming and prone to delays. As one

reception staff member describes: *"We often need to call UMC to check if an MRI has been completed or if results are available."* Another staff member shares a similar experience: *"Yesterday I needed an actual signature from a UMC physician. I had to physically walk to UMC to get it."* These examples stress the obligation for streamlined communication.

In summary, CMH's environmental context is characterized by dependencies on external institutions, regulatory obligations, and the need for efficient cross-institutional coordination (Figure 11). While these factors present challenges, they also shed light on opportunities for collaboration and learning from civilian healthcare systems to optimize workflows as well as embrace technological innovations.

8.3.4 Summarizing TOE framework findings

To summarize, the application of the TOE framework reveals critical factors influencing the adoption of technological innovation at CMH, visualized in Figure 11. The technological dimension underscores the need for user-friendly hybrid solutions that seamlessly integrate with existing systems like HiX while addressing inefficiencies such as manual workflows or privacy concerns. Organizationally, CMH faces challenges related to hierarchical decision-making, and resistance to change, besides administrative burdens, which must be mitigated through inclusive strategies, staff training, while maintaining a balance between efficiency and personalized care. Environmentally, CMH's reliance on external partners, regulatory constraints besides the inter-institutional coordination points out both dependencies as well as opportunities for process optimization and cross-sector learning.

By addressing these challenges while leveraging identified opportunities, CMH can position itself to implement technological innovation that aligns with its dual role as a military healthcare institution. These findings form the foundation for the next steps in the evaluation of specific solutions with the UTAUT framework.

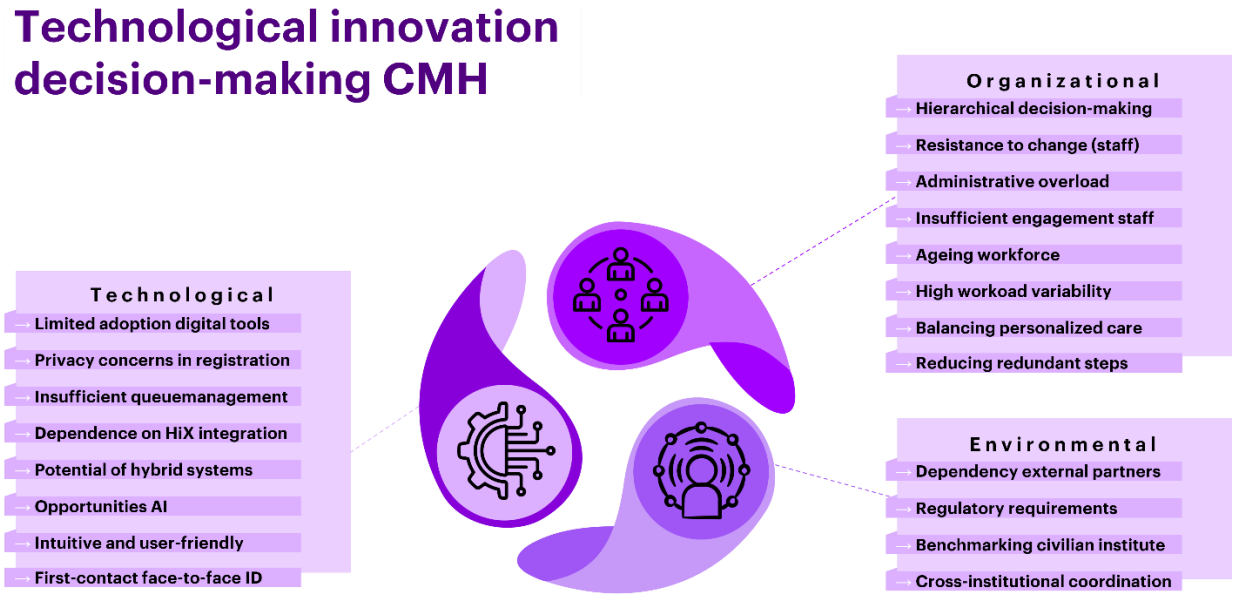


Figure 11 | Technological innovation decision-making at CMH.

This figure illustrates the factors influencing technological innovation decision-making at CMH across the earlier mentioned three dimensions: technological, organizational, and environmental. It points to challenges including limited digital adoption, hierarchical decision-making along external dependencies, while identifying opportunities like hybrid systems, AI integration, and cross-institutional collaboration to enhance processes.

8.4 The UTAUT framework to CMH interview results

To optimize the patient registration process at CMH, the findings from the Lean analysis, PJM and the TOE framework can be evaluated using the Unified Theory of Acceptance and Use of Technology (UTAUT). This theoretical framework provides a structured approach to understanding feasibility as well as alignment of potential solutions with user needs, emphasizing key factors such as performance expectancy, effort expectancy, social influence, and facilitating conditions (Tugiman et al., 2023). This will be further discussed when answering sub-question 4.

8.4.1 Performance expectancy

The analysis shed light on opportunities to enhance the effectiveness along efficiency of the patient registration process through technological innovation. Automating non-value-adding tasks, such as redundant verification steps and manual data entry, could significantly reduce administrative burdens on staff while improving the patient experience. For instance, digital check-ins and queue management systems could streamline workflows, and minimize delays while offering patients greater autonomy in managing their appointments and records. Addressing privacy concerns, particularly in the reception area, through self-service kiosks or

digital alternatives, could enhance patient trust in addition to satisfaction score, demonstrating tangible benefits of technology in improving operational performance.

8.4.2 Effort expectancy

Whereas, ease of use is critical for the adoption of modern technologies, as evidenced by the limited uptake of existing tools such as the '*MyCMH*' portal. The findings suggest that these tools, while functional, lack intuitive interfaces and user-friendly design necessary to encourage widespread adoption. Hybrid solutions supported by staff for patients with lower digital literacy or simplified app interfaces could cater to diverse needs of the patient population. Notably, CMH's patient demographic consists of active military personnel, resulting in a younger and more digitally proficient population compared to civilian healthcare settings. Furthermore, targeted training programs for older staff members would ensure that new systems are accessible and manageable, reducing resistance to change while enhancing operational efficiency.

8.4.3 Social influence

Moving on, social, and cultural dynamics at CMH play a significant role in influencing attitudes toward technological adoption. The hierarchical decision-making structure within the organization has been identified as a barrier to staff engagement, as personnel feel excluded from innovation processes. This lack of involvement undermines their sense of ownership as well as openness to new systems. An example of this is the recent implementation of the HiX upgrade, where staff is not entirely aware of the reasoning behind the change, leaving them unaware of the benefits for CMH. This disconnect further decreases acceptance and reinforces resistance to modern technologies. Additionally, patients and staff emphasize the value of preserving personalized interactions within the healthcare experience. This suggests that hybrid solutions, which balance technological efficiency with human-centered care, would align more effectively with the expectations next to the values of CMH's stakeholders.

8.4.4 Facilitating conditions

Finally, the organizational and environmental context at CMH presents both constraints as well as opportunities for the implementation of technological innovations. The hospital's reliance on UMCU for IT infrastructure limits its autonomy but ensures alignment with broader systems like HiX. This dependency necessitates solutions that are seamlessly compatible with existing platforms while addressing CMH's requirements. Privacy and regulatory compliance, particularly concerning GDPR, also demand careful consideration in the design of modern technologies to maintain trust and security. Furthermore, the variability of workloads at CMH

points out the need for flexible systems that can adapt to fluctuating patient volumes and ensure consistent efficiency during peak periods.

8.4.5 Evaluating potential solutions using UTAUT constructs

The UTAUT framework is applied to assess feasibility as well as alignment of proposed technological solutions with CMH's patient registration needs (Table 3). Each solution was evaluated based on performance expectancy, effort expectancy, social influence, and facilitating conditions. Table 3 summarizes key findings, highlighting the relative strengths and limitations of each option.

Solution	Performance expectancy	Effort expectancy	Social influence	Facilitating conditions
Self-service kiosks	Moderate	Moderate	Moderate	Moderate
Enhanced patient portals	High	High	High	Moderate
Queue management systems	High	High	High	Moderate
External app check-in	Moderate	High	Moderate	Low (greater autonomy but lacks HiX integration)
Face recognition check-in or AI tool	High (future)	High	Moderate	Low (current regulatory barriers)

Table 3 | UTAUT-based evaluation of patient registration solutions.

This table evaluates potential technological solutions for CMH using the UTAUT framework, assessing performance expectancy, effort expectancy, social influences along with facilitating conditions. It highlights strengths and limitations of options like self-service kiosks, enhanced patient portals, or advanced technologies.

Enhanced patient portals together with queue management systems scored highest in feasibility and alignment with CMH's operational needs. While self-service kiosks and external apps provide benefits, they face limitations in functionality and integration. Face recognition together with AI tools demonstrates strong long-term potential but is hindered by regulatory as well as developmental challenges. These findings inform subquestion three whereas they provide a basis for further analysis in the next chapter.

9 Discussion and conclusion

This chapter examines the extent to which technological innovations can optimize the patient registration process at CMH. To provide a structured discussion and conclusion, subquestions are addressed first, offering insights into key challenges, organizational influences, as well as the feasibility of technological solutions. The answers to these subquestions form the basis for addressing the main research question. Furthermore, findings are situated within broader theoretical and practical contexts to assess their implications for CMH's patient registration system.

9.1 Subquestion 1: What are the key challenges in the current patient registration process at CMH?

The patient registration process at CMH is slowed down by significant inefficiencies in their workflows, including repetitive data verification and phone-based appointment scheduling, which create substantial administrative burdens for staff, particularly during peak periods. These inefficiencies result in delays, wait times, as well as dissatisfaction among patients, who report usability issues together with limited awareness of digital tools like the *'MyCMH'* portal.

Privacy concerns also arise due to the open layout of the reception area, compromising confidentiality while decreasing patient trust. Additionally, CMH's reliance on external systems, such as the EPR managed by UMCU, limits its autonomy to implement tailored technological solutions, further complicating innovation.

Cultural and organizational factors, such as a hierarchical decision-making structure next to emphasis on personalized care, slow technological adoption along with reducing staff engagement. Broader contextual factors, including budgetary constraints and sustainability goals, further shape CMH's priorities but were not directly addressed in this study. The next subquestion will explore how CMH's organizational culture, including its hierarchical decision-making structure alongside an emphasis on personalized care, impacts the adoption of new technologies.

9.2 Subquestion 2: To what extent does organizational culture influence the adoption of technological innovations at CMH?

The organizational culture at CMH significantly affects the adoption of technological innovations, determined by its dual role as a military and healthcare institution. The hierarchical decision-making structure, a key characteristic of CMH's culture, slows innovation adoption by requiring multiple layers of approval, which reduces staff engagement as well as

ownership. This lack of inclusion contributes to resistance to change, particularly among older employees, who in addition may require additional training or support to adapt to new systems.

Besides, CMH's emphasis on personalized care shapes its approach to technology adoption, as staff and patients value human interaction while expressing concerns about digital tools undermining this aspect of care. This preference underlines the demand for hybrid solutions that balance technological efficiency with personalized patient experiences.

Despite these barriers, CMH's positive work environment creates opportunities to foster innovation. By involving employees early in the design and implementation processes of new systems, the hospital can enhance engagement while reducing resistance. Additionally, CMH's dual obligations as a military institution require adherence to strict operational standards, adding complexity to the selection as well as implementation of technologies.

In summary, while hierarchical structures additionally pose resistance to change, CMH's strong emphasis on personalized care, in addition to its positive organizational culture provides a foundation for successfully adopting technological innovations.

9.3 Subquestion 3: What are the criteria for evaluating technological innovations to improve the patient registration process at CMH?

The evaluation of technological innovations for CMH's patient registration process is guided by six key criteria. First, solutions must address operational inefficiencies by automating non-value-adding tasks, mentioned in subquestion one, to reduce staff workloads yet enhance patient autonomy. Second, accessibility is critical to ensure adoption among staff and patients, necessitating intuitive interfaces along with hybrid options to accommodate users with varying digital proficiency. Third, seamless integration with the HiX EPR system is essential to maintain data consistency while avoiding disruptions. Compatibility with the broader IT framework shared with UMCU is equally significant for smooth implementation. Fourth, compliance with privacy and security regulations, particularly GDOR, is vital given the sensitivity of military medical data. Technologies should address privacy concerns by providing secure alternatives for patient interactions. Fifth, proposed solutions must align with CMH's organizational culture, which emphasizes personalized care. This requires technologies that enhance efficiency without compromising human interaction. Involving staff in the evaluation of new systems can foster ownership and reduce resistance to change. Finally, solutions must demonstrate cost-effectiveness in addition to scalability, ensuring they can adapt to future demands, such as increased patient volumes during crises, without imposing unsustainable financial burdens.

9.4 Subquestion 4: Which technological solutions can address the identified challenges in patient registration at CMH?

The identified challenges in CMH's patient registration process can be addressed through technological solutions, each targeting specific inefficiencies. Enhanced patient portals emerge as the most promising option. Expanding the functionality of the existing *'MyCMH'* portal to include online appointment scheduling, digital check-ins, and seamless data updates can streamline workflows in addition to improving patient autonomy. Additionally, reducing reliance on phone-based communication will alleviate administrative workload.

To ensure widespread adoption, a user-friendly interface is crucial, allowing patients to complete check-ins effortlessly. However, as the system would require patients to scan their self-required QR code, either on a tablet or another device, CMH must invest in the necessary hardware infrastructure at the reception area. Implementing hybrid options will also be essential to accommodate patients who are less digitally proficient, ensuring inclusivity.

Queue management systems complement enhanced portals by optimizing patient flow during peak times. These systems provide real-time updates on waiting times yet help reduce administrative burdens by improving resource allocation. However, their impact is limited to managing patient flow whereas it does not address broader challenges like data updates, making them a complementary rather than standalone solution.

Self-service kiosks, integrated with the HiX Mobile Patient app, offer another option to streamline check-ins while reducing congestion at the reception desk. Patients could use the app to check in from home, receive a code, and finally confirm their arrival via a kiosk in the waiting room. However, the long-term viability of kiosks is uncertain, given UMCU's preference for upgrading to newer technologies, suggesting CMH must evaluate whether kiosks align with its strategic trajectory.

Advanced innovations such as facial recognition technology present significant long-term potential for contactless check-ins, enhancing security. However, developmental, or regulatory barriers currently limit their feasibility. Similarly, external app-based or GenAI could provide flexible customizable solutions but face challenges with HiX integration next to privacy concerns, making them less suitable in the short term.

9.5 Main research question: To what extent can technological innovations optimize patient registration at the Central Military Hospital (CMH)?

Based on the answers to the subquestions, the following answer to the main research question can be formulated. Technological innovations have significant potential to optimize the patient registration process at CMH by addressing inefficiencies, enhancing patient autonomy, and reducing administrative burdens on staff. Key challenges include manual, time-intensive workflows, low adoption of existing digital tools, and privacy concerns at the reception desk, which together strain resources while impacting patient satisfaction.

Whereas a phased digital transformation strategy is crucial for optimizing CMH's patient registration process. Given the complexity of healthcare IT systems, a step-by-step approach ensures smoother implementation in addition to higher adoption rates. Enhanced patient portals combined with queue management systems present the most feasible, minimally disruptive short-term solution, streamlining workflows on top of improving resource allocation while maintaining CMH's commitment to personalized care. These technologies empower patients to manage appointments more independently while also reducing pressure on staff during peak times. In the long term, advanced solutions such as facial recognition technology or AI tools hold significant potential but require further development, along with strategic planning to address integration, scalability along compliance challenges.

CMH's organizational culture significantly influences the adoption of these technologies. Hierarchical decision-making in addition to resistance to change among staff can slow implementation, but early staff engagement coupled with targeted training can leverage CMH's positive work environment as a foundation for innovation. Furthermore, all solutions must align with CMH's dual mission as a healthcare provider as well as a military institution, integrating seamlessly with existing systems and adhering to privacy regulations.

In conclusion, technological innovations can improve CMH's patient registration process by automating repetitive tasks, enhancing patient and staff experiences, and increasing overall operational efficiency. The extent of this optimization depends on CMH's ability to address cultural and organizational barriers, prioritize user-friendly solutions, while strategically planning for both immediate as well as long-term advancements.

9.6 Comparison with existing literature

This study identifies significant inefficiencies in CMH's patient registration process, rooted in organizational culture along with workflow challenges. Similar issues are well-documented in

other healthcare institutions, particularly in military high-pressure environments, accentuating the significance of aligning technological innovations with organizational as well as cultural dynamics.

Military healthcare systems face delays in implementing modern technologies due to hierarchical decision-making structures. This is consistent with findings by Hartmann et al. (2009), who identified rigidity in hierarchical systems as a barrier to fostering innovation. Similarly, the U.S. Veterans Affairs (VA) medical system has encountered difficulties in adopting digital tools due to bureaucratic constraints in addition to staff resistance to change (Vashi et al., 2018). These parallels reflect challenges observed at CMH, where centralized structure limits flexibility while slowing technological adoption.

CMH's emphasis on personalized care mirrors a broader trend in healthcare institutions, which strive to balance efficiency with patient-centered approaches. As Franklin and Myneni (2018) note, technological solutions must complement human interaction rather than replace it to gain acceptance among staff and patients. This preference for hybrid solutions is a recurring theme across healthcare contexts.

When compared to civilian hospitals, CMH faces additional constraints due to its dependence on UMCU's IT framework, which restricts autonomy in exploring alternative solutions. In contrast, civilian institutions, such as Bergman Clinics in The Netherlands, benefit from more flexible decision-making structures, enabling faster implementation of queue management systems or digital portals. Similarly, other military hospitals, like Rabat Military Hospital in Morocco, have successfully applied Lean methodologies and patient journey mapping to optimize workflows, achieving measurable improvements in efficiency or patient satisfaction (Jabbar et al., 2017).

While these challenges are not unique to CMH, its dual role as a military healthcare institution amplifies their impact. Insights from similar organizations emphasize the significance of hybrid solutions that balance technological efficiency with human-centric care. Inclusive decision-making as well as targeted training programs are critical for overcoming barriers and fostering innovation. By learning from both military and civilian healthcare systems, CMH can strategically position itself to address these challenges and strengthen its capacity to deliver high-quality, patient-centered care.

9.7 Critical reflection on research

This study provides valuable insights into inefficiencies in CMH's patient registration process while evaluating the potential of technological innovations to address these challenges.

However, limitations must be acknowledged. The small sample size may not fully capture the diversity of experiences within CMH, limiting the generalizability of findings. On the other hand, the principle of data saturation was applied to ensure that all relevant insights were thoroughly captured. Additionally, reliance on qualitative data, while insightful, restricts the ability to quantify inefficiencies or the impact of proposed solutions. Quantitative measures, such as time studies or satisfaction surveys, could enhance future research.

Further constraints arise from CMH's dependence on external systems like HiX as well as alignment with UMCU IT policies, which limit the hospital's autonomy in implementing tailored solutions. Cost considerations were also not explicitly addressed, creating a gap in the practical feasibility of recommendations. While advanced technologies like GenAI were mentioned, their potential remains unexplored due to the study's scope. Meanwhile, UMCU has already initiated an AI pilot aimed at reducing administrative burdens (Harmsen, 2024).

9.8 Societal and practical impact

This study marks significant implications for CMH besides broader discussions on healthcare digitalization. Addressing inefficiencies in the patient registration process enables CMH to enhance operational efficiency and better fulfill its dual role as a healthcare provider and military institution. Solutions like enhanced patient portals and queue management systems streamline workflows, and reduce administrative burdens, besides improving patient satisfaction. For staff, these technologies reduce manual workloads, fostering greater efficiency and job satisfaction.

The societal impact extends beyond CMH, particularly in demonstrating how digital transformation can enhance both operational readiness along patient-centered care in military healthcare. By optimizing its processes, CMH can serve as a model for other military hospitals, addressing the global need for healthcare systems to balance efficiency with personalized care. Additionally, given the increasing geopolitical uncertainties along with potential military threats (NOS, 2024), maintaining an efficient, resilient healthcare system within CMH is essential for ensuring readiness in crises. Improved patient registration processes contribute to a more agile healthcare response.

From a societal perspective, there is a growing expectation for public institutions, including military hospitals, to modernize as well as improve service delivery (Köbe & Bohnet-Joschko, 2022). Efficient patient-friendly healthcare aligns with broader societal demands for accessible well-organized public services. This research fills a critical gap, as a structured analysis of CMH's patient registration process was previously lacking. By identifying inefficiencies in addition to potential improvements, this study has contributed to CMH's

awareness of its internal processes, enabling improved informed decision-making for future optimization.

Hybrid solutions, which preserve human interaction in patient interactions, align with the broader trend of prioritizing patient-centered care. This approach ensures inclusivity, providing accessible solutions for users with varying levels of digital proficiency. However, challenges such as privacy concerns as well as regulatory compliance, particularly with GDPR, must be addressed through a strategic implementation approach.

In conclusion, this study underscores the societal and practical relevance of optimizing CMH's patient registration process. By adopting targeted technological innovations, CMH can enhance efficiency, improve patient experiences, and strengthen its readiness in times of political and societal challenges, while contributing to advancements in healthcare digitalization.

9.9 Suggestions for future research

This study provides a comprehensive understanding of challenges as well as opportunities in optimizing CMH's patient registration process. Despite the above-mentioned limitations, this research provides a solid foundation for addressing challenges in CMH's patient registration process. However, further research is needed to address the remaining questions besides supporting successful implementation of proposed solutions.

First, future research should examine the scalability of proposed technologies, particularly in scenarios with increased patient volumes during crises. While this study focused on routine operations, exploring adaptability under extreme conditions through simulation-based analysis could provide valuable insights. Second, a detailed cost-benefit analysis is necessary to evaluate the financial feasibility of the proposed solutions. Future studies should assess initial investments, maintenance costs, and potential savings to enable CMH to prioritize technologies with the highest return on investment. Third, real-world testing through pilot implementations is essential to evaluate user adoption as well as satisfaction among patients and staff. Longitudinal studies tracking the impact of these solutions over time could also inform continuous improvement efforts while highlighting potential adjustments. Finally, emerging technologies such as GenAI need further exploration. AI-driven systems could automate complex scheduling tasks, and assist with patient queries, together with enhanced data security. Research into these innovations can help CMH stay ahead of technological trends as well as strategically plan for future advancements. UMCU has already launched AI pilot projects focused on reducing administrative workloads, such as AI-assisted patient

communication in addition to predictive analytics for appointment management (Harmsen, 2024).

These initiatives offer valuable insights that CMH could leverage, either by expanding its collaboration with UMCU or by independently implementing AI-driven solutions tailored to its operational requirements. In conclusion, future research should prioritize scalability, cost-effectiveness, real-world implementation, and emerging technologies. Addressing these areas will equip CMH with the insights needed to make informed decisions while achieving long-term success in optimizing its patient registration process.

9.10 Concluding thoughts

This research demonstrates that technological innovations have significant potential to optimize CMH's patient registration process by addressing inefficiencies, aligning with its organizational culture, while improving both patient and staff experiences. Implementing enhanced patient portals and queue management systems can deliver immediate operational improvements, while strategic planning for advanced technologies ensures long-term success.

Beyond practical recommendations, this study accentuates broader themes relevant to both military and civilian healthcare systems. It underscores the significance of addressing organizational culture in adopting modern technologies while emphasizing the need for user-friendly as well as inclusive solutions. These findings contribute to global discussions on healthcare digitalization, particularly in complex organizational contexts.

In conclusion, optimizing patient registration is not solely a technical challenge but a strategic opportunity for CMH to strengthen its operational readiness and leadership in military healthcare. By adopting the proposed solutions as well as addressing identified barriers, CMH can position itself as a model institution that effectively combines innovation with its dual mission of delivering high-quality care besides supporting the national defense.

10 Recommendations

To optimize the patient registration process at CMH, the following targeted recommendations are proposed:

1. Enhance the *'MyCMH'* patient portal: Expand its functionality to include online appointment scheduling, digital check-ins, and seamless data updates. Simplify the interface, integrate mobile compatibility, while providing hybrid options with on-site support to ensure inclusivity for less digitally proficient users. Pilot testing with patient groups can help refine usability before full implementation.
2. Implement queue management systems: Introduce queue management systems to streamline patient flow during peak periods. Leverage the data generated by these systems to improve scheduling as well as resource planning for long-term efficiency.
3. Explore advanced technologies: Conduct, phased pilot testing of advanced solutions, such as facial recognition or GenAI tools. Feasibility studies should evaluate scalability, cost-effectiveness, and user acceptance, addressing integration as well as regulatory challenges. Collaboration with UMCU's AI initiatives could provide valuable insights into best practices as well as implementation barriers.
4. Adress organizational and cultural barriers: Foster change management strategies by involving frontline staff early in the process of new systems. Develop tailored training programs to support staff in adapting to digital tools, reducing resistance while promoting a sense of ownership.
5. Adopt a phased digital transformation strategy: Start with short-term solutions like enhanced portals or queue management systems, while strategically planning for long-term innovations. Collaboration with UMCU is essential to align modern technologies with the broader IT infrastructure. Periodic evaluations should assess progress in addition to allowing iterative improvements.

By implementing these recommendations, CMH can enhance operational efficiency, patient autonomy, in addition to staff satisfaction. These changes will not only address immediate inefficiencies besides position CMH as a leader in military healthcare innovation.

11 Reflection

As the concluding chapter of my thesis, I want to take a moment to reflect on the past five months, a period filled with growth, learning, and discovery. Last September I started my internship at Accenture, motivated to explore whether consultancy was the right path for me and to gain first-hand experience in a large international corporate environment. What followed was a time of intense learning along with personal development.

From the start, I had the opportunity to take ownership of my internship experience and tailor it to my interests and goals. This autonomy required me to be assertive and initiative-taking, particularly in seeking out opportunities or assignments. It was both challenging and rewarding to "talk my way in," and this experience sharpened my skills in presenting myself and understanding my professional aspirations.

One of the highlights of my internship was contributing to RFPs (Requests for Proposals) alongside Gé Jacobs, an inspirational manager at Accenture. He entrusted me with significant responsibilities, allowing me to grow professionally and personally. Besides, I would like to thank Jasper Kras for his extensive mentorship, I learned valuable lessons, such as the value of setting boundaries and saying no when tasks became overwhelming. Moreover, navigating the initial stages of my thesis research presented its challenges. Especially determining my topic as well as narrowing the scope of my research questions proved to be particularly difficult. Jasper's guidance was instrumental in helping me find my way into CMH next to framing my research effectively. This process taught me the significance of clarity and focus in tackling complex problems. I would also like to thank Bart Verkade from Utrecht University for his supervision and valuable feedback during my thesis. His insights helped me structure my research questions and keep an academic perspective throughout the process.

The interview phase of my research was another key learning moment. Resistance among CMH employees often made it challenging to secure interviews along with meaningful results. This iterative process required persistence as well as adaptability, skills that I now recognize as crucial for my future career.

One of the most pivotal moments presented itself during Christmas when my laptop broke down, and I lost all my coded interview data. Despite the frustration as well as the pressure of this setback, I managed to stay calm and recode the data, completing the task with focus and determination. This experience taught me resilience next to the ability to remain calm under stress, qualities that I will carry forward in my professional life.

Looking back, I am proud of the focus, dedication, and enthusiasm I have brought to this thesis. This project has allowed me to dive deeply into a subject that I am enthusiastic about. I passionately believe that hospitals, like CMH, must transform in the coming years, and I am grateful for the opportunity to contribute to this critical discussion.

The past few months I have learned a lot, and I look forward to applying the lessons I have learned as I take the next steps in my career. It was especially rewarding to hear that the H&PS team values my contributions and would like me to stay on, which reinforces my interest in continuing in this field.

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13 Appendix A: Interview guide

This appendix contains the interview guides used during this research, detailing the questions and themes explored to gather qualitative insights from various stakeholders involved in or impacted by the patient registration process at CMH. Most questions were identical across all interviewees to ensure consistency, with minor adaptations based on expertise and relevance.

13.1 General questions (asked to all participants)

1. Can you briefly introduce yourself and your role?
2. What do you consider the biggest challenges for CMH?
3. How do patients make an appointment? What kind of agreements are involved?
4. How can a patient change their data?
5. What does the patient registration process at CMH currently look like?
6. What do you think of digitization in healthcare, and to what extent do you consider it necessary?
7. What kind of features should an improved registration solution have?
8. How are changes in work processes normally communicated to employees?
9. How does the information exchange between CMH and other hospitals or care providers work? Are there any areas for improvement?
10. Have you seen best practices at other hospitals that CMH can learn from?

13.2 Specific questions per stakeholder group

The table below provides an overview of the specific questions asked per stakeholder group (Table 4).

STAKEHOLDER GROUP	ADDITIONAL QUESTIONS
ACCENTURE DATA&AI EXPERT	What are the biggest digitalization challenges in military hospitals? When is an app preferable over a web-based solution? What role can AI play in improving patient registration and planning? What implementation strategies ensure successful adoption?
CMH PHYSICIAN	How does 'Hoofdtaak 1' influence potential solutions?
CMH STAFF	what steps are involved in the registration process on the backend? Are there other administrative processes that could be digitized?
EXTERNAL HEALTHCARE PROVIDERS	How have you arranged the patient registration process in your organization? What bottlenecks do you experience, and how have you addressed them?
HIX EXPERT	How does CMH use HiX?

	What are the integration possibilities with external systems, such as kiosks or mobile apps? What are the constraints and opportunities for HiX in improving patient registration?
PATIENT	How did you make an appointment, and what was your experience with it? What would make the registration process more convenient for you?
PERFYSO APP REPRESENTATIVE	What are the functionalities and goals of the Perfyso app? Is there a link with HiX, and would integration be possible?

Table 4 | Stakeholder specific questions

13.3 Ethical considerations and closing questions

At the beginning of each interview, participants were informed about the study's purpose and provided informed consent (Appendix B: Informed consent). All interviews concluded with:

1. That brings us to the end of the interview. Do you have any questions or additional remarks? Thank you for your time and insights.
2. Participants were also asked whether they could recommend others for participation in the study.

14 Appendix B: Informed consent

This appendix includes the informed consent used in this study, outlining the purpose of the research, confidentiality measures, next participant rights to ensure ethical compliance and transparency:

You have been invited to participate in a study on the innovation of patient registration processes in the Central Military Hospital (CMH) in Utrecht. This research is conducted based on interviews.

As a participant, I hereby declare that I have been informed about the purpose and methods of this research. I was informed that:

- My data will be processed completely anonymously, and all information that can be traced back to me will be deleted.
- The audio recording of the interview will be destroyed after the analysis.

Furthermore, as a participant, I declare that:

- I voluntarily participate in this research.
- The results of this interview may be used in a report or presentation.
- I permit the interview to be recorded via a voice recorder or the recording function of Microsoft Teams.

As a researcher, I declare that I will answer any questions to the best of my ability and will provide further oral explanations about the nature and purpose of the research.

PARTICIPANT NAME	RESEARCHER NAME
DATE	DATE
SIGNATURE PARTICIPANT	SIGNATURE RESEARCHER

15 Appendix C: Details of interviewees

This appendix contains a detailed table of interviewees. This overview supports the transparency as well as the replicability of the study (Table 5).

I- NUMBERS	INTERVIEWEE ROLE	DURATION	INTERVIEWER
I-1	Bergman Clinics representative	50 minutes	Pleun Herder
I-2	ChipSoft expert	25 minutes	Pleun Herder
I-3	CMH management	40 minutes	Pleun Herder
I-4	CMH physician	30 minutes	Pleun Herder
I-5	Data & AI expert	50 minutes	Pleun Herder
I-6	MIM staff member	30 minutes	Pleun Herder
I-7	Patient A	15 minutes	Pleun Herder
I-8	Patient B	10 minutes	Pleun Herder
I-9	Patient C	15 minutes	Pleun Herder
I-10	Patient D	15 minutes	Pleun Herder
I-11	Patient E	10 minutes	Pleun Herder
I-12	Patient F	15 minutes	Pleun Herder
I-13	Perfyso app representative	30 minutes	Pleun Herder
I-14	Reception staff member A	30 minutes	Pleun Herder
I-15	Reception staff member B	25 minutes	Pleun Herder
I-16	Reception staff member C	25 minutes	Pleun Herder
I-17	Reception staff member D	40 minutes	Pleun Herder

Table 5 | Overview of interviewees