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Interoperability and Usability of EHRs:

Healthcare professionals perspectives on Electronic Health Records and Digital Transformation

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ABSTRACT:
Electronic Health Records (EHRs) are central to the digital transformation of healthcare and are intended to support coordination, documentation, and access to patient information across healthcare settings. However, technical interoperability does not necessarily mean that exchanged information is usable in clinical work. This thesis examines how healthcare professionals experience the interoperability and usability of EHR systems in everyday practice.

The study employs a qualitative, interpretive approach, based on seven semi-structured interviews with healthcare professionals from Sweden and the United States. This analysis focuses on healthcare professionals' experiences with the findability, understandability, trustworthiness, and actionability of interoperable EHR information, as well as usability dimensions such as effectiveness, efficiency, satisfaction, and human-centeredness.

The findings show that EHR systems are deeply integrated into healthcare work, but that healthcare professionals still experience fragmented systems, workflow disruption, inconsistent access to information, and reliance on workarounds. At the same time, interoperable

information was perceived as beneficial for coordination, continuity of care, and access to patient information. The thesis concludes that interoperability only contributes to meaningful digital transformation when exchanged information is usable within clinical workflows and aligned with healthcare professionals' needs.

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1 Introduction

1.1 Background

Healthcare has become increasingly dependent on digital technologies for documenting, storing, exchanging, and using patient information (Barker et al. 2024; Shen et al. 2025). This development is often discussed under the broader concept of eHealth, which refers to the use of digital and information technologies to support healthcare services, health information, and healthcare delivery (Mangion & Piller, 2025). It is also increasingly connected to the emerging concept of Healthcare 4.0, which describes the digital transformation of making healthcare smarter through technologies, artificial intelligence, data-driven processes, the Internet of Things, and more integrated forms of healthcare delivery (Mangion & Piller, 2025) In this context, human-centred design (HCD) is important, and refers to an approach to system development where users, their tasks, and their work environments are considered throughout the design process (Harte et al. 2017). In eHealth, this is important because systems are more likely to be usable and meaningful in practice when they are designed around the needs and workflows of healthcare professionals (Yen & Bakken, 2012).

In this thesis, digital transformation refers to the integration of the digital technologies into healthcare work in ways that change how care is recorded, coordinated, and delivered (Tratkowska, 2019). Within this broader digital transformation of healthcare, Electronic Health Records are one of the most central healthcare information systems (HIS) used by healthcare professionals in everyday clinical work (Barker et al. 2024; Shen et al. 2025).

Electronic Health Records, commonly referred to as EHRs, are digital systems used to store and manage patient health information, including diagnoses, medications, test results, clinical notes, and treatment histories (Ehrenstein et al. 2019; Wang et al. 2023). EHRs were first created in the 1960's and have since undergone multiple iterations, upgrades, and widespread adoption worldwide (Atherton, 2011). They are intended to support documentation, coordination, decision-making, and continuity of care across healthcare encounters (Ehrenstein et al. 2019). As healthcare is often delivered across multiple departments, organizations, and care providers, the ability to access relevant patient information across systems has become increasingly important (Shen et al. 2025).

This is where Health Information Exchange (HIE) becomes relevant. HIE allows healthcare professionals to electronically access and securely share patient medical information, with the goal of improving the speed, quality, safety, coordination, and cost of care (Lum et al. 2025; Barker et al, 2024). The practical value of HIE depends not only on whether information can be technically exchanged, but also on whether healthcare professionals can use that information effectively in clinical work (Lum et al, 2025; Sarkar, 2022).

However, healthcare information systems are not implemented in the same way everywhere. Differences in funding, ownership, organizational priorities, national regulations, regional infrastructures, and local implementation strategies can result in different EHR systems being

used across healthcare settings (Kruse et al. 2016; Alzghaibi & Hutchings, 2025). This is evident in the wide variety of technologies used, including many outdated ones. For example, as of 2012, an estimated 63% of physicians were still using fax machines as their primary means of communication with one another (Reismann, 2017). These differences may contribute to interoperability problems, where systems are unable to exchange or use information smoothly across organizational and technical boundaries (Kruse et al. 2016; Li et al. 2021). Interoperability is therefore a central issue in the digital transformation of healthcare. In general terms, interoperability refers to the ability of information systems to exchange and use information across different systems, organizations, and contexts (Gliklich et al. 2019). In healthcare, interoperability is especially important because incomplete or inaccessible patient information may affect clinical decision-making, coordination, patient safety, and the efficiency of care (Li et al. 2022).

With that in mind, interoperability alone does not guarantee that exchanged information becomes useful in practice (Olakotan et al. 2025). Even when patient information is technically available, healthcare professionals may still experience difficulties finding it, understanding it, trusting it, or applying it in their workflow (Ehrenstein et al. 2019; Palojoki et al. 2024; Gierend et al. 2024; Sarkar, 2022). This means that interoperability should be understood together with usability. Usability concerns the extent to which users can achieve their goals with effectiveness, efficiency, satisfaction, and having elements of human-centered design, in a specified context of use (ISO, 2018). In an EHR context, usability is not only about whether a system has certain functions, but also about whether healthcare professionals can use those functions in real clinical conditions, including time pressure, interruptions, documentation demands, and complex patient needs (Olakotan et al. 2025).

For this reason, EHRs should not only be understood as technical systems, but as sociotechnical systems embedded in everyday healthcare work. A sociotechnical perspective emphasizes that the outcomes of health information technology depend on the interaction between technology, people, workflows, organizational routines, policies, and the broader clinical environment (Sittig & Singh, 2010). This perspective is important because digital transformation in healthcare does not occur simply by implementing new systems. It occurs when digital systems are meaningfully integrated into work practices, thereby changing how care is documented, coordinated, and delivered (Stoumpos et al. 2023).

Recent developments also show that EHR interoperability is not only an academic or organizational issue, but also a policy priority. For example, the European Health Data Space Regulation entered into force on 26 March 2025 and began a transition phase toward broader access to and exchange of European health data (European Commission, 2025). Its implementation includes phased rules from 2029 to 2035, underscoring the growing importance of shared electronic health data in healthcare policy.

Against this background, this thesis focuses on how healthcare professionals experience the interoperability and usability of EHR systems in everyday work. Rather than treating interoperability as only a technical issue, the thesis examines how exchanged patient information is perceived and used in practice.

1.2 Problem

Data interoperability is widely regarded as important for improving healthcare quality, efficiency, and safety because it enables patient information to move across systems and gives healthcare providers access to more complete health data, regardless of where the information was originally recorded (Alonge et al. 2024). And although EHRs and Health Information Exchange are intended to improve access to patient information, and recent research reports rising levels of interoperability (Barker et al. 2025), the practical use of interoperable health information remains challenging. The central problem addressed in this thesis is that technical access to patient information does not necessarily mean that the information is usable for healthcare professionals in clinical practice.

Previous research shows that EHRs can support documentation, coordination, and decision-making, but they may also create new challenges related to usability, workflow disruption, documentation burden, information overload, and fragmented information practices (Olakotan et al. 2025; Holmes et al. 2021). These challenges are especially important in healthcare because clinicians often work under time pressure and need accurate, relevant, and trustworthy information to make decisions (Gierend et al. 2024).

Problems related to EHR interoperability and usability have persisted despite decades of digital development in healthcare. While EHRs and HIE systems are intended to improve access to patient information, previous research indicates that healthcare professionals may still face challenges due to fragmented systems, workflow misalignment, and limited usability (Shen et al. 2025; Kruse et al. 2016). These problems may appear in several ways. Healthcare professionals may need to search across multiple systems, manually request information from other organizations, interpret data in unfamiliar formats, verify information through informal communication, or rely on paper, fax, or other workarounds when digital exchange is insufficient (Kim et al. 2017). In such cases, interoperability may exist at a technical level, but still fails to support clinical work in a meaningful way.

This creates a gap between the promise of digital transformation and the everyday experiences of healthcare professionals. EHRs and HIE are often promoted as tools to improve efficiency, safety, coordination, and quality of care. However, if healthcare professionals cannot easily find, understand, trust, or act on exchanged information, then the expected benefits of interoperability may not be realized.

The problem is therefore not only whether EHR systems are interoperable, but whether interoperability becomes usable in practice. This thesis refers to this as usable interoperability. Usable interoperability means that exchanged information is not only transferred between systems, but is also available in a form that healthcare professionals can locate, interpret, rely on, and apply in their work.

This problem is important because poor interoperability and poor usability can affect both healthcare professionals and patients. For healthcare professionals, these issues may create extra work, frustration, documentation burden, inefficient routines, and workarounds. For patients, these factors may contribute to delayed access to information, repeated tests, incomplete clinical histories, or increased risks in treatment decisions (Li et al. 2022; Tummers et al. 2021). Therefore, understanding healthcare professionals' perceptions of interoperable EHR use is important for evaluating whether digital transformation in healthcare is actually supporting clinical work. In this context, usability concerns whether a system is easy to learn, efficient, effective, and satisfying to use (Plass, 2026; Windlinger & Tuzcuoglu, 2021). When

EHR systems are perceived as usable, they are more likely to be integrated into everyday clinical routines, indicating a digital transformation not only at a technical level but also in practice (Olakotan et al. 2025; Vial, 2019).

Existing research has addressed EHR adoption, interoperability, usability, and digital transformation in healthcare. However, there is still a need for greater understanding of how healthcare professionals experience these issues together in everyday practice. In particular, more attention is needed on how interoperability and usability shape whether EHR use becomes part of routine clinical work, whether professionals develop workarounds, and whether they perceive digital systems as beneficial or burdensome.

1.3 Purpose

The purpose of this thesis is to examine how healthcare professionals experience the interoperability and usability of EHR in their everyday work. The thesis focuses on how healthcare professionals perceive the practical use of exchanged patient information, particularly whether the information is findable, understandable, trustworthy, and actionable, and whether the systems used to access it are effective, efficient, satisfying, and designed around users' needs. By focusing on healthcare professionals' experiences, the thesis seeks to contribute to a better understanding of how EHR systems support or hinder clinical work in practice. The purpose is not to evaluate one specific EHR system, vendor, country, or healthcare organization. Instead, the thesis aims to explore broader experiences of EHR interoperability and usability among healthcare professionals who work with digital patient information.

1.4 Aim

The aim of this thesis is to analyze how healthcare professionals experience usable interoperability in EHR systems and how these experiences shape their clinical work. More specifically, the thesis aims to examine how healthcare professionals perceive the findability, understandability, trustworthiness, and actionability of exchanged patient information. It also aims to analyze how these experiences influence clinical routines, workarounds, and perceived benefits of EHR use. By doing so, the thesis seeks to understand how EHR interoperability and usability contribute to, or limit, digital transformation in healthcare practice.

1.5 Research Questions

The research questions that this Thesis seeks to answer are:

RQ1: How do healthcare professionals perceive the usability of interoperable EHR information in clinical work?

RQ2: How do these experiences shape clinical routines, workarounds, and perceived benefits of EHR use?

1.6 Delimitation

This thesis focuses on healthcare professionals as users of EHR systems, rather than on a specific professional role, healthcare organization, system vendor, or national healthcare context. The thesis also does not focus on patient privacy legislation, such as HIPAA or GDPR, except where respondents raise such issues in relation to their everyday experience of EHR use. EHR systems vary considerably between countries, regions, organizations, and clinical settings, and the technical infrastructure surrounding interoperability may differ depending on local regulations, implementation strategies, and system design. However, the purpose of this thesis is not to evaluate one specific EHR system or compare national healthcare systems. Instead, the focus is on how healthcare professionals perceive interoperability and usability in their everyday work across different EHR environments. Since the study concerns user experiences of working with digital patient information, the specific system, organization, or geographical location is considered less central than the professionals' perceptions of how well information can be accessed, exchanged, and used in practice. The inclusion of respondents from both Sweden and the United States is therefore treated as a way to capture broader experiences of EHR use, rather than as a basis for country-specific comparison. For this reason, the thesis approaches EHR interoperability and usability as issues relevant to healthcare professionals in general, while acknowledging that local systems and institutional contexts may shape individual experiences.

In this thesis, the term EHR is used to refer to the overarching concept of digital systems that store, manage, and enable access to patient health information. While a distinction is sometimes made between Electronic Medical Records (EMRs) and EHRs, where EMRs are often understood as records used within a specific healthcare organization and EHRs as broader records intended to support information sharing across care settings, this thesis treats the two terms as interchangeable. This choice is motivated by the study's empirical context, in which interview respondents use the term EMR to refer to systems and practices within the broader scope of EHR interoperability. In other words, respondents' references to EMRs are interpreted as referring to digital patient record systems within the wider EHR landscape. Therefore, for consistency and analytical clarity, the term EHR is used throughout the thesis unless directly quoting or referring to respondents' own terminology.

2 Literature and Theory

2.1 Electronic health (eHealth)

Electronic health, often referred to as eHealth, is a broad concept that describes the use of information and communication technologies in relation to health services, health information, and healthcare delivery. The concept has been defined in several ways across the literature, reflecting its interdisciplinary character and the fact that it encompasses both technological and organizational aspects of healthcare. In their systematic review of published definitions, Oh et al. (2005) show that e-health is commonly associated with health services and information supported by Internet-related or digital technologies.

More recent literature also emphasizes that eHealth should not be understood only as the introduction of digital tools. Shaw et al. (2017) argue that eHealth involves different modes of interaction among people, health professionals, and health data, thereby changing how health services are organized, accessed, and experienced. This makes eHealth relevant not only as a technological phenomenon, but also as a transformation of healthcare practices.

The importance of e-health lies in its potential to improve healthcare delivery by increasing accessibility, supporting communication, enabling new forms of monitoring and documentation, and improving the availability of health information. da Fonseca et al.'s (2021) systematic review describes eHealth as a set of technologies used through digital and Internet-based means to provide healthcare services and improve quality of life. In this thesis, e-health is therefore understood as the broader digital context in which electronic health records, interoperability, and digitally mediated clinical work are situated.

2.2 Electronic Health Records (EHRs)

Electronic Health Records are among the central technologies in e-health. An EHR is a digital collection of health-related information about an individual, including clinical documentation, diagnoses, medications, test results, and other data generated across healthcare encounters. Wang et al. (2023) describe EHRs as collections of digitalized information about an individual's health and emphasize that they are not only used to store clinical information but also serve as a foundation for clinical research and data-driven healthcare.

The importance of EHRs comes from their role in making patient information available to healthcare professionals, supporting documentation, coordination, and decision-making. Modi et al. (2022) describe EHRs as electronic records of patient health information created during one or more encounters in healthcare settings. Similarly, Shen et al. (2025) state that EHRs facilitate accessibility and sharing of patient data among healthcare providers, which can contribute to more coordinated and efficient care.

However, the value of EHRs depends on how well they fit clinical work. While EHRs can improve access to patient records, coordination, e-prescribing, documentation, and reporting, their benefits are often limited by usability problems, workflow misalignment, and interoperability issues (Makhni et al. 2026) . Makhni et al. (2026) note that although EHRs offer several potential benefits, many clinicians perceive that these systems have not yet reached their full potential, partly due to usability challenges. Therefore, EHRs should not only be understood as digital repositories of patient information, but also as sociotechnical systems that influence clinical work routines, communication, and decision-making.

2.3 Digital Transformation in Healthcare

Digital transformation refers to organizational change enabled by digital technologies. Vial (2019) defines digital transformation as a process in which digital technologies trigger significant changes to an organization's properties through combinations of information, computing, communication, and connectivity technologies. This definition is useful because it shows that digital transformation is not simply the adoption of technology, but a process that changes how organizations create value, organize work, and respond to new technological possibilities.

In healthcare, digital transformation has become increasingly important because digital technologies are now embedded in many core areas of healthcare delivery, including EHRs, telemedicine, decision support, patient portals, and digital communication systems. Kraus et al.'s (2021) systematic literature review shows that digital transformation in healthcare is a growing research area and that digital technologies are connected to operational efficiencies, stakeholder relationships, and new forms of healthcare organization. Stoumpos et al. (2023) similarly argue that digital transformation in healthcare is linked to technology acceptance and the use of digital technologies to benefit healthcare systems and society.

Within this broader transformation, EHRs are especially important because they are often the core digital infrastructure through which clinical information is documented, retrieved, exchanged, and reused (Shen et al. 2025). However, the transformative potential of EHRs depends on whether information can be shared across systems and remain useful in clinical work. This makes interoperability a central condition for digital transformation in healthcare. Li et al.'s (2022) systematic review shows that EHR interoperability can positively influence patient safety, reduce safety events, reduce costs, and contribute to time savings and improved clinical workflows.

Usability is also important because it shapes whether digital systems become embedded in work routines. Olakotan et al.'s (2025) scoping review shows that EHR usability issues contribute to documentation burden and disruption of clinical workflows. When EHRs are usable, interoperable, and aligned with clinical workflows, they are more likely to support routinization, meaning that they become integrated into everyday clinical processes rather than remaining external or additional tasks (Mishuris et al. 2019; Olakotan et al. 2025).

The relationship between interoperability, usability, and outcomes can also be seen through the literature on workarounds. Workarounds occur when users adapt, bypass, or compensate for system limitations in order to complete their work. Blijleven et al. (2022) show that EHR workarounds affect organizational workflows and care-service outcomes, including patient

safety, effectiveness, and efficiency. Friedman et al. (2014) further distinguish between temporary and routinized workarounds, where routinized workarounds become taken for granted as part of regular workflow. This is important for the thesis because workarounds can indicate that a digital system has been incorporated into work, but not necessarily in the intended or beneficial way.

Digital transformation in healthcare does not occur simply because digital systems are implemented. It occurs when digital technologies become embedded in organizational routines, thereby changing how work is performed (Tratkowska, 2019). In the context of EHRs, interoperability is a prerequisite because it enables information to move across systems and organizational boundaries. However, interoperability alone is not sufficient. Exchanged information must also be usable, clinicians must be able to find, understand, trust, and act upon it within their workflow. Usability then influences the outcomes of digital transformation, including whether the system becomes routinized in work processes, whether users develop workarounds, and whether benefits such as efficiency, coordination, and improved decision-making are realized.

In this thesis, digital transformation is therefore understood as a sociotechnical process in which EHRs and interoperability reshape clinical work. Interoperability is treated as a condition for making information available across systems, usability as the condition for making that information clinically workable, and outcomes as the observable effects in work routines, workarounds, and perceived benefits.

2.4 The Context of EHR

Healthcare professionals' interaction with digital systems is heavily shaped by the context in which those systems are used. This includes the clinical setting, workload, time pressure, interruptions, staffing levels, local routines, policies, and available training or support (Vehko et al. 2019; Moy et al. 2021). This matters because EHR systems are used in complex work environments where healthcare professionals multitask, move between patients, document care, review information, and coordinate with other professionals. Therefore, whether an EHR system supports clinical work depends not only on the technology itself, but also on how well it fits the tasks, environment, and routines in which it is used (Yen & Bakken, 2012; Mishuris et al. 2019).

This contextual view is important because health information systems are not just technical tools. HIS can be understood as sociotechnical subsystems in healthcare that include data and information processes, as well as the human and technical actors involved in them (Winter et al. 2023). This means that EHR systems are embedded in work practices, professional roles, organizational structures, and clinical responsibilities.

To motivate why context and everyday work matter, the thesis draws on a sociotechnical systems perspective. A healthcare-focused version is the sociotechnical model by Sittig and Singh (2010), which highlights that outcomes depend on multiple interacting dimensions such as hardware and software, people, workflows, processes, and organizational policies, which explains the importance of the relationship between these aspects and why the need for having some alignment is good.

2.5 Usable Interoperability of EHR

Interoperability is commonly defined as the ability of information systems to exchange and use information, including health information, across organizational and technical boundaries (Lehne et al. 2019; Li et al. 2022). However, for interoperability to affect frontline work routines, exchanged information must become clinically usable, not merely technically transferable. This distinction is supported by Ehrenstein et al. (2019), who describe interoperability as comprising several stages: sending, receiving, finding, and, eventually, using data. It is also reflected in Everson et al.'s (2025) concept of "ideal interoperability," defined as external information being available, easy to find, and easy to compare or reconcile within the EHR.

In this thesis, we therefore use usable interoperability as a bridge between technical interoperability and clinical work routines. Rather than treating interoperability solely as data exchange, we operationalize it through four user-facing conditions that determine whether exchanged information can realistically support clinical work: whether the information is findable, understandable, trustworthy, and actionable.

2.5.1 Findability

Findability refers to whether clinicians can quickly and reliably locate relevant external information within their workflow. This is a necessary condition for usable interoperability because exchanged information cannot support clinical work if users cannot identify where it is, whether it exists, or how to retrieve it. Ehrenstein et al. (2019) explicitly include finding as one of the stages of interoperability, alongside sending, receiving, and using data. Empirical HIE research also shows that navigation and retrieval problems limit use. Patel et al. (2025) found that clinicians encountered unclear layouts, difficult navigation, and task-irrelevant data when using HIE technologies, and recommended features such as searching, sorting, filtering, and fewer navigation steps.

2.5.2 Understandability

Understandability refers to whether exchanged information can be interpreted correctly and with sufficient context. This is closely related to semantic interoperability, which concerns whether the meaning of exchanged information is preserved across systems. Palojoki et al. (2024) state that semantic interoperability aims to support the availability and use of patient data across diverse EHRs without loss of meaning, and that its development is tied to creating usable, computable data from heterogeneous medical information. In this thesis, understandability therefore captures the practical user-facing outcome of semantic interoperability. Healthcare professionals must be able to make sense of external information despite differences in format, terminology, documentation practices, and source systems.

2.5.3 Trustworthiness

Trustworthiness refers to whether clinicians can rely on exchanged information enough to use it in clinical reasoning or decision-making. A central part of this is provenance, meaning knowing where the data came from, how it was produced, whether it has been modified, and how current it is. Gierend et al. (2024) define provenance as the origin and history of data and argue that provenance supports interpretability, reliable collaboration, and data sharing. Sembay et al.'s (2023) systematic review also shows that provenance management is an important topic in health information systems and is connected to broader challenges of interoperability and data management. In clinical work, a lack of trust may lead healthcare

professionals to manually double-check external information, reducing the practical value of interoperability under time pressure (Gierend et al. 2024).

2.5.4 Actionability

Actionability refers to whether exchanged information supports a meaningful next step, such as decision-making, medication reconciliation, avoiding duplicate tests, improving handoffs, or coordinating care. This dimension reflects the idea that interoperability creates value only when exchanged data can be turned into information that supports action (Ehrenstein et al. 2019). Sarkar's (2022) review is explicitly framed around transforming health data into actionable information and describes HIE as a basis for health data interoperability. Empirical studies also show that HIE use is closely tied to workflow and task needs. For example, Unertl et al. (2012) found that HIE use varied by site, role, workflow, and information need, indicating that the usefulness of exchange depends on how well it supports actual clinical work.

2.6 EHR Usability

To understand how clinicians experience EHR use, this thesis uses the ISO 9241-11 definition of usability, the extent to which specified users can achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use (ISO, 2018). This definition is useful because it treats usability as context-dependent rather than as a general property of an interface. In other words, an EHR function is not usable simply because it exists or because information is technically available; it is usable when specific clinicians can use it to accomplish specific clinical goals under real working conditions.

This contextual understanding is especially important in health information technology. Yen and Bakken (2012) review approaches for evaluating health IT usability and show that usability can be assessed through several complementary methods, including ISO-based understandings of effectiveness, efficiency, and satisfaction. Their review supports the approach taken in this thesis because it emphasizes that usability evaluation should account for the relationship between users, tasks, systems, and environments. In this way, EHR usability should not be studied only as an isolated interface issue, but as something shaped by clinical tasks and work settings.

In this thesis, EHR usability is therefore understood as the practical ability of clinicians to use EHR functions and exchange information in ways that support clinical work. This is particularly relevant for interoperability, because exchanged information only becomes valuable when clinicians can locate it, interpret it, trust it, and apply it within their workflow.

2.6.1 Effectiveness

In ISO terms, effectiveness concerns whether users can achieve their intended goals accurately and completely (ISO, 2018). In an EHR interoperability context, this means that clinicians should be able to accomplish clinical tasks that depend on external information, such as locating relevant data from another organization, understanding the patient's previous care, reconciling medications, or using external information in decision-making (Yen & Bakken, 2012; Snyder et al. 2024).

This dimension is supported further by Yen and Bakken's (2012) review of health IT usability evaluation methods, where effectiveness is treated as one of the established dimensions used to assess whether health IT systems support users in completing their tasks. Their review strengthens the use of effectiveness in this thesis by showing that usability evaluation should consider whether users can perform meaningful tasks within the relationship between user, system, task, and environment. If an EHR function does not support the clinical task that the user is trying to complete, then it may be technically available but still ineffective in practice. Task-Technology Fit also supports this reasoning, as Goodhue and Thompson (1995) argue that technology is more likely to improve performance when its capabilities align with the tasks users need to perform. In this thesis, effectiveness therefore captures whether interoperable EHR information actually helps clinicians complete their work, rather than merely being present in the system.

2.6.2 Efficiency

Efficiency concerns the resources required to achieve a goal, such as time, effort, attention, and cognitive load (ISO, 2018). In EHR use, inefficiency may appear as excessive clicking, unclear navigation, repeated logins, duplicate documentation, fragmented views, or the need to manually compare conflicting information (Poissant et al. 2005). These issues are especially important in clinical work, where time pressure and high information density are common.

Yen and Bakken's (2012) review of health IT usability evaluation methods also supports efficiency as an established usability dimension, since usability is commonly assessed not only by whether users can complete tasks, but by the resources required to complete them in a specific work context. Their review strengthens the use of efficiency in this thesis by emphasizing that health IT usability must be evaluated in relation to users, tasks, systems, and environments.

2.6.3 Satisfaction

Satisfaction refers to the user's subjective experience of using the system (ISO, 2018). In EHR contexts, this may include confidence, frustration, perceived burden, perceived usefulness, or trust in the interaction (Unni et al. 2017). Satisfaction matters because clinicians' experiences influence whether they continue to rely on a system, avoid it, or develop alternative ways to complete their work.

DeLone and McLean (2003) help motivate satisfaction as an important aspect of information system evaluation because they treat user satisfaction as a central way of assessing how users experience a system and the value it provides. In this thesis, satisfaction is therefore not treated as a superficial preference, but as an important usability dimension that indicates how EHR usability is experienced.

2.6.4 Human-Centred Design

Human-centered design is included as a complementary usability perspective because it shifts attention to the system's design approach. While ISO 9241-11 defines usability through effectiveness, efficiency, and satisfaction in a specified context of use, it describes human-centered design as a related concept and an important approach to interactive system development based on understanding users, tasks, and environments, involving users

throughout the design process, and evaluating and refining design solutions iteratively (ISO, 2018).

This is relevant because EHR interoperability is not only a technical issue. Exchanged information may be available in the system, but it still fails to support clinical work if the design does not reflect clinicians' information needs, workflows, responsibilities, and time constraints (Kalsy et al. 2024). Yen and Bakken's (2012) review of health IT usability supports this view by emphasizing that usability should be evaluated through the relationship between users, tasks, systems, and environments. Human-centered design, therefore, strengthens the thesis's theoretical foundation by showing why usable interoperability depends on designing for the clinical context rather than merely enabling technical data exchange.

In this thesis, human-centered design is used as a supporting lens for understanding EHR usability. It helps explain why interoperable information must be integrated into workflows in a way that clinicians can actually use.

2.7 Outcomes

The outcome dimension captures what happens when interoperable EHR use is introduced into clinical work. This is important because digital transformation in healthcare does not occur simply when digital systems are implemented, but when they become embedded in organizational routines and change how work is performed (Vial, 2019; Tratkowska, 2019). Outcomes are therefore needed to evaluate whether interoperable EHR use contributes to practical change in clinical work, rather than only representing technical adoption.

This thesis does not treat outcomes as technical performance measures, but as practical effects in everyday work. Three outcomes are emphasized: routinization, workarounds, and perceived benefits. Together, these outcomes make it possible to examine whether interoperability and usability support meaningful digital transformation in clinical practice, or whether they instead become associated with extra work, informal adaptations, and limited practical value.

2.7.1 Routinization

To explicitly capture routinization, this thesis draws on Normalization Process Theory (NPT). NPT explains how new technologies, ways of acting, and ways of working become routinely embedded in everyday practice (May et al. 2009). This is useful because it shifts the analysis away from adoption as a one-time event and toward the ongoing work required to make a new practice normal, shared, and sustainable.

In the context of EHR interoperability, routinization means that clinicians do not experience interoperable information exchange as an exceptional or additional activity. Instead, the use of external information becomes incorporated into ordinary clinical work, such as reviewing patient histories, preparing consultations, coordinating across organizations, reconciling medication, or making decisions. NPT is therefore helpful because it directs attention to whether interoperability is actually integrated into workflow, rather than simply implemented as a technical capability.

For this thesis, the key assumption is that interoperability only contributes to digital transformation when it becomes part of routine work. If clinicians have to leave their ordinary

workflow, search in separate systems, verify information manually, or treat external information as extra work, then interoperability may exist technically without being normalized in practice.

2.7.2 Workarounds

Workarounds are included as an outcome because they reveal mismatches between EHR design and clinical work. In EHR research, workarounds are commonly understood as user-created ways to address limitations, misfits, or constraints in the system. Blijleven et al. (2022) show that EHR users develop workarounds when mismatches arise between the workflows designed into the EHR and the workflows used in practice. Their review also shows that workarounds can affect patient safety, quality of care, and efficiency.

Workarounds are important because they are not only signs of resistance or misuse, but also of innovation. They can also serve as practical coping strategies that help clinicians complete their work despite system limitations. However, they may also pose risks if they lead to unstable information practices, duplicate documentation, informal communication channels, or the bypassing of safety procedures. Blijleven et al.'s (2017) earlier work shows that EHR workarounds can affect organizational workflows, patient safety, and the effectiveness and efficiency of care.

More recent IS research further strengthens this point. Van Offenbeek et al. (2024) show that workarounds and system misfits can reinforce one another over time: workarounds may temporarily solve a problem, but they can also aggravate the underlying mismatch between the EHR system and professional work practices. In this thesis, workarounds are therefore treated as a key signal that usability and/or usable interoperability may be insufficient to support routine, embedded use.

2.7.3 Benefits

To ground the benefits dimension theoretically, this thesis draws on the concept of net benefits from the DeLone and McLean (2003) IS Success Model. In their model, net benefits refer to the value or impact that an information system produces for users, organizations, or other stakeholders. This concept is useful for this thesis because it allows benefits to be understood as the practical value that EHR systems and interoperable information create in clinical work.

In this thesis, benefits are understood as practical and clinician-facing outcomes rather than abstract organizational performance indicators. This is also consistent with EHR interoperability research. Li et al.'s (2022) systematic review examines how EHR interoperability affects patient safety and other dimensions of care quality in healthcare settings, showing that interoperability is commonly evaluated in relation to safety, quality, costs, time savings, and workflow effects.

The benefits dimension, therefore, captures whether interoperable EHR use is perceived to create value in clinical work. From an IS Success perspective, benefits are not expected to arise solely from interoperability. They depend on whether the system and information are of sufficient quality, whether clinicians use the system, and whether the user experience is satisfactory enough to support continued reliance.

2.8 Literature Synthesis and Research Gap

Existing research has examined EHRs, interoperability, usability, and digital transformation in healthcare from several perspectives. Previous studies show that EHRs and Health Information Exchange can improve access to patient information, support documentation, strengthen coordination, and contribute to clinical decision-making. Interoperability has also been associated with potential benefits such as improved patient safety, reduced duplicate work, time savings, and more efficient healthcare delivery (Li et al. 2022; Barker et al. 2024; Shen et al. 2025). These studies show that interoperable EHR systems are important for the broader digital transformation of healthcare.

At the same time, existing research shows that implementing EHRs and interoperable information exchange does not automatically lead to improved clinical work. EHRs may create or reinforce challenges related to usability, documentation burden, workflow disruption, information overload, and fragmented information practices (Holmes et al. 2021; Olakotan et al. 2025). Healthcare professionals may still need to search across several systems, interpret information from unfamiliar formats, verify external information manually, or rely on informal communication and workaround practices when digital systems do not fit clinical workflows (Kim et al. 2017; Blijleven et al. 2022). This suggests that the value of EHR interoperability depends not only on whether information can be exchanged, but also on whether it can be used effectively in everyday clinical practice.

A recurring issue in previous research is therefore the difference between technical interoperability and what this thesis refers to as usable interoperability. Technical interoperability concerns whether systems can exchange information, while usable interoperability concerns whether the exchanged information can actually support clinical work. Research on interoperability has increasingly emphasized that exchanged information must be available, findable, understandable, and usable within clinical workflows in order to create value (Ehrenstein et al. 2019; Everson et al. 2025). Similarly, usability research in health information technology emphasizes that system use must be understood in relation to users, tasks, systems, and environments (Yen & Bakken, 2012). Together, these perspectives suggest that interoperability and usability should not be studied separately when the focus is on healthcare professionals' everyday work.

There is also a need to better understand the outcomes of interoperability that are usable or unusable in everyday work. Existing research shows that EHR systems can become embedded in routines, but also that poor alignment between systems and clinical work can lead to workarounds (Blijleven et al. 2022; Friedman et al. 2014). Workarounds are especially important because they may indicate that healthcare professionals are adapting to system limitations in order to complete their work. While some workarounds may help professionals cope with inefficient systems, they may also create risks related to documentation quality, communication, patient safety, and continuity of care. This means that routinization and workarounds are useful indicators of whether interoperable EHR use is becoming integrated into clinical work, in intended or unintended ways.

The research gap addressed in this thesis is therefore the need for a more integrated understanding of how healthcare professionals experience interoperable EHR information as usable or unusable in everyday clinical practice. While previous research has examined EHR interoperability, usability, and digital transformation separately, less is known about how these issues interact from the perspective of healthcare professionals. This thesis addresses that gap

by examining usable interoperability through two connected lenses. First, it studies whether exchanged patient information is findable, understandable, trustworthy, and actionable. Second, it examines whether the process of accessing and using this information is effective, efficient, satisfying, and aligned with users' needs. Together, these dimensions are used to analyze how healthcare professionals' experiences shape clinical routines, workarounds, and perceived benefits of EHR use.

This gap also motivates the conceptual framework used in this thesis. The framework connects interoperability, usability, and outcomes in order to study not only whether information is exchanged, but whether exchanged information becomes clinically workable. Interoperability is treated as the condition that makes information available across systems, usability as the condition that makes this information useful in practice, and outcomes as the observable effects in healthcare professionals' routines, workaround practices, and perceived benefits. This makes the framework suitable for examining digital transformation in healthcare as a sociotechnical process, where the success of EHR interoperability depends on how digital information is experienced and used in everyday clinical work.

2.9 Conceptual Summary

This subchapter contains a table that has compiled the key concepts for this study and presents them in a clear and concise manner.

Table 2.1 Summary of Concepts

Concept	Key Points	Source
Findability	- Aspect of usable interoperability - Information must be easy to locate in the EHR.	Ehrenstein et al. 2019
Understandability	- Aspect of usable interoperability - Information must be interpretable and retain its clinical meaning.	Palojoki et al. 2024
Trustworthiness	- Aspect of usable interoperability - Healthcare professionals must be able to rely on the information's source, accuracy, and currency.	Gierend et al. 2024
Actionability	- Aspect of usable interoperability - Information must support clinical decisions or next steps.	Sarkar 2022

Effectiveness	- Aspect of usability - Healthcare professionals can successfully complete the intended task.	ISO 2018
Efficiency	- Aspect of usability - Healthcare professionals can complete the task with reasonable time, effort, and cognitive load.	ISO 2018
Satisfaction	- Aspect of usability - Healthcare professionals experience the system as acceptable, useful, and not overly frustrating.	ISO 2018
Human-centered design	- Connected aspect of usability - system design should be based on users, tasks, workflows, and context.	ISO 2018
Routinization	- Aspect of outcomes - EHR use becomes embedded in everyday clinical work.	May et al. 2009
Workarounds	- Aspect of outcomes - Healthcare professionals bypass or adapt the system when it does not fit workflow.	Blijleven et al. 2022
Benefits	- Aspect of outcomes - EHR use creates practical value such as coordination, safety, efficiency, or better decisions.	DeLone & McLean 2003 Li et al.'s 2022

2.10 Model of Conceptual Framework

The conceptual framework developed for this study is presented in Figure 2.9. The model illustrates how the digital transformation of EHRs is understood through the context of use, where interoperability influences usability and contributes to outcomes such as workarounds, routinization, and perceived benefits.

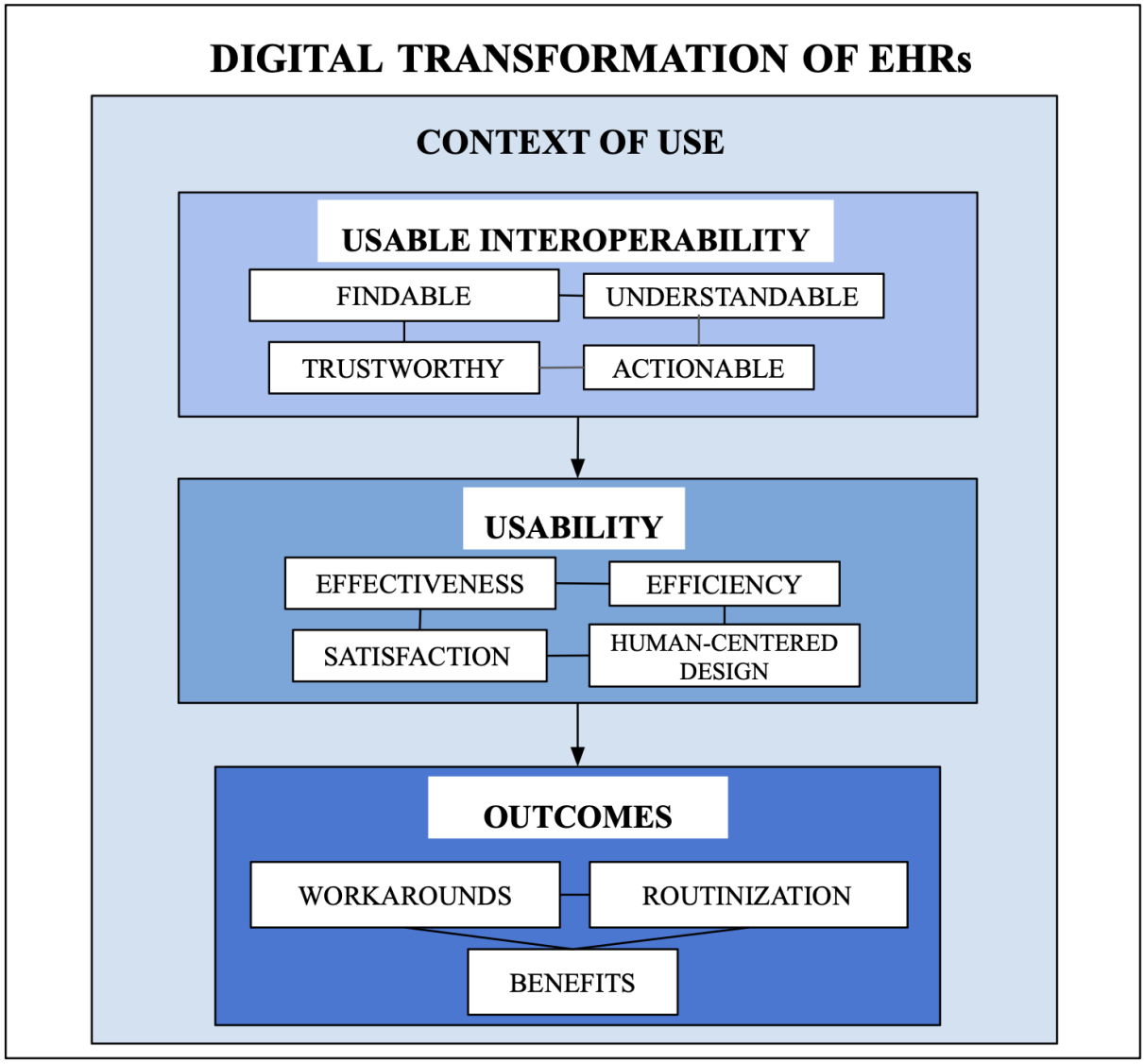

Figure 2.1 Model of Conceptual Framework

3 Method

This chapter explains and motivates the methodological choices for this research. The design is tailored to generate an in-depth understanding of how healthcare professionals use and experience the systems they work with. The chapter, therefore, sets out the research philosophy and approach, explains the data collection and analysis, outlines how research quality is ensured and addresses ethical considerations.

3.1 Research Philosophy

This research is based on the idea that to understand information systems in healthcare, it is important to understand how they are actually used and experienced in day-to-day work. In the case of EHRs, they are not only technical tools, but they are also part of how staff document care, find and share information, coordinate with others, and make decisions. Because of this, the research problem is not primarily about whether the system works on paper, but about what it is like to work with it in practice, the challenges people encounter, and how system use affects work routines and collaboration. This is why the study takes an interpretive, qualitative perspective that focuses on meaning, context, and people's experiences rather than seeking a single, universal answer (Patton, 2015).

From an ontological point of view, the study asserts that what is real about HIS's includes both the system itself and its integration into work. The same system can be experienced differently depending on role, unit, responsibilities, and situation. For example, what counts as good documentation or enough information may vary between professions, and staff may develop different ways of working around system limitations. This means the study needs to allow for more than one reality, since experiences are shaped by context and by how people understand and use the system. This aligns with constructivist thinking in qualitative research, which emphasizes how meaning is shaped in everyday practice (Patton, 2015). At the same time, the study recognizes that there are real constraints shaping work, such as time pressure, access rules, and poorly communicating systems. The point is not to ignore these constraints, but to understand how people deal with them in practice.

From an epistemological point of view, the study asserts that useful knowledge about HISs can be built by listening to people who use them and by exploring their experiences and interpretations. This type of knowledge is hard to capture through numbers alone, because it often involves organization-specific routines, individual judgment calls, and work that is not visible in formal procedures. For that reason, the study fits better with qualitative inquiry than with a purely quantitative approach. It is closer to qualitative logic because it focuses on how things happen and what they mean in context, rather than measuring how often something happens or testing predefined cause–and–effect relationships (Patton, 2015).

An overview of qualitative inquiry frameworks (Patton, 2015) indicates that this research primarily aligns with interpretive traditions concerned with experience and meaning. A phenomenological angle is relevant because the research focuses on what it is like for staff to work with information systems and on how they experience these systems in their daily tasks. A hermeneutic view is also relevant because healthcare work often involves interpreting information in records and understanding its meaning in a specific situation. In addition,

systems and complexity thinking are useful for viewing healthcare organizations as connected environments in which information practices in one place can affect work elsewhere (Patton, 2015).

Overall, this philosophical position gives a clear foundation for the next section. Since the study aims to understand experiences, meanings, and work practices around HIS's, it makes sense to adopt a qualitative approach that can capture those perspectives in a detailed, realistic way.

3.2 Research Approach

This study used a qualitative research approach to explore HIS in the form of electronic health records from the perspective of those who work with them. It was conducted using a qualitative approach because the research problem concerns understanding how these systems are experienced and used in practice, rather than what they are supposed to do. In healthcare, EHRs are closely tied to daily routines, coordination between roles, and decisions made under time pressure. That kind of knowledge is difficult to capture with surveys alone or with predefined categories (Recker, 2021).

The research also took an interpretive approach, learning from participants' descriptions and examples and building an understanding of patterns across different experiences. The goal was to identify how people make sense of system-supported work, what they see as helpful, what they find challenging, and how information systems shape or are shaped by workflows. This supports a qualitative inquiry as a way to study complexity, context, and meaning, in which we, as researchers, sought to understand the world from the participants' point of view and then interpret what those experiences suggest more broadly (Patton, 2015).

Qualitative research allowed for flexibility without losing focus, because the overall purpose can stay the same while the specific emphasis becomes clearer through early contact with the empirical setting. The approach therefore supports a sensible way of working: starting with an open but clearly motivated focus, learning how the system is used in practice, and then narrowing the study based on what appears most important to staff and most suitable to the research question.

Another reason this approach was appropriate is that a smaller sample can still yield strong insights if participants are selected for their direct experience of the phenomenon and can provide detailed examples. Qualitative designs are often built around information-rich cases, where the goal is to learn a great deal from a small number of well-chosen participants rather than to generalize from large numbers (Patton, 2015). This logic aligns with the research, as it enabled us to explore real experiences with EHRs and gain valuable insights.

A qualitative, interpretive approach was the best match for this research because it supports the kind of knowledge the research aims to develop: a grounded understanding of how electronic health records are used and experienced in everyday work, and what that means for the people using them.

3.3 Data Collection Methods

Empirical data was collected exclusively through 7 semi-structured interviews with healthcare professionals who use EHRs as part of their daily work. The first interview was considered a pilot, during which we added broader questions to better understand the topic; we also asked meta questions to get honest feedback on the study's focus. A Pilot is also a good way to test and improve the interview guide before the main data collection (Bell et al. 2022). We decided that the content from the Pilot was useful, the questions asked were essentially the same for the rest of the interviews, where the respondent is referred to as Respondent 1, and the empirical data was processed in the same way as for the later interviews. When possible, which it was for 6 out of the 7 interviews, both researchers were present, with the reason being that it would help us ask better questions and also give a more nuanced interpretation of the answers, and this is a recommended practice by Bell et al. (2022). Interviews were chosen because they allow participants to explain what they do, why they do it that way, and what kinds of situations make system use easier or harder. Since the research is about everyday work practices around information systems, interviews are useful for capturing details that are not always visible in formal process descriptions, such as informal routines, workarounds, or how the professionals judge whether information is reliable and usable. Qualitative interviewing is a strong method for understanding experiences, meanings, and practical reasoning in context (Patton, 2015).

The empirical settings were different hospital, clinical, and emergency environments where staff routinely document, retrieve, and share information through digital systems. The main requirement is that respondents have had regular contact with EHRs in a manner related to information handling and exchange. Because this research is focused on how healthcare professionals perceive the interoperability and usability of EHRs in a general sense, not in regard to any specific system, geographic location, or type or brand of system, these factors were not taken into consideration for this study.

Because hospital environments can be sensitive and time-constrained, interviews were scheduled to fit the respondents' schedules to minimize disruption. In preparation, basic context about the setting, such as general workflows and the types of systems in use, was explored, so that clearer follow-up questions could be asked and to understand the examples participants give. It was important to be prepared, enter the field respectfully, and pay attention to how context shapes the data we collected (Patton, 2015).

3.3.1 Selecting Respondents

Participant selection was affected by multiple factors, one being their roles and experience, which were relevant to the research focus, meaning they had to be working with EHRs more or less daily or have significant experience with EHRs. Age, position, and location were not part of our analysis or scope of this study, so those factors were not used in deciding who to interview. After data collection was finished, there was a good spread of age, position, and location in the data. The selection of participants was also affected and conducted through social connections to ensure accessibility. This means there was a clear element of convenience sampling combined with purposive sampling. Purposive sampling is central in qualitative designs, where the aim is to select information-rich participants who can provide useful insight into the phenomenon (Patton, 2015). The goal was to conduct 6–10 interviews, which balances depth with feasibility. A pilot interview was conducted early in the process to test the interview guide, understand how participants naturally discuss the topic, and refine questions to better fit the healthcare context. After 7 interviews, we decided to conclude the data collection. We felt

confident that clear themes had been identified and, for the most part, aligned with previous research and that we had also discovered other valuable findings to discuss, meaning that additional interviews would have diminishing returns for the value of this study.

Table 3.1 List of Respondents

Respondent	Field	Title	Location	Appendix
R1	Hospital Care Team	Senior Resident	Illinois, USA	2
R2	Nursing	Director of Clincal Education	Tennessee, USA	3
R3	Primary Care	Primary Care Phsycician	California, USA	4
R4	Emergency Medical Services	EMT	Oregon, USA	5
R5	Eye Care	Optometrist	Ohio, USA	6
R6	Emergency Medical Services	Advanced EMT	Vermont, USA	7
R7	Oncology	Attending/Specialist	Uppsala, Sweden	8

Table 3.2 Interview Details

Respondent	Date	Communication Channel	Duration	Appendix
R1	16 April 2026	Zoom	40 Min	2
R2	27 April 2026	Zoom	39 Min	3
R3	28 April 2026	Zoom	43 Min	4
R4	4 May 2026	Zoom	37 Min	5
R5	5 May 2026	Zoom	41 Min	6
R6	7 May 2026	Zoom	43 Min	7
R7	24 April 2026	Zoom	42 Min	8

3.3.2 Interview Guide

The interview guide was, as mentioned, semi-structured, meaning it included core topics but allowed for flexibility, such as follow-up questions to what participants brought up. This was important because the details of EHR use may differ across roles and departments, and it is valuable to capture those differences without losing the main focus. Questions covered how participants use the systems in daily work, how they find and share information, what makes

information trustworthy or uncertain, what kinds of problems occur, and how staff adapt when the system does not support the work well. The questions are also designed to capture respondents' perceptions of all relevant concepts established in Chapter 2 of this thesis.

Table 3.3 Interview Guide

	Introductory Questions
1	How are you doing?
2	What is your role?
3	How long have you been doing that?
4	Do you enjoy it?
	General HIS
5	Do you use computer systems in your role?
6	What are some examples of types of systems that you interact with?
7	Do the systems you interact with change?
8	Are you happy with having to use those systems (or specific system)
9	What type of systems are you not happy to use?
10	Where does interoperable/external information come up in your work?
11	What is the primary form of communication among colleagues?
	Context
12	In what situations is it easiest vs hardest to use external/interoperable info?
13	What policies, training, or support affect how you use it?
	Usability
14	Effectiveness: When you use it, can you usually accomplish what you’re trying to do?
15	Efficiency: How much time/effort does it take to get what you need? What slows you down most?
16	Satisfaction: How does using it generally feel? helpful, frustrating, stressful, reassuring?
17	User centered design: Do you feel like the system was designed for you and with your work in mind?
	Interoperability

18	Findable: How easy is it to find the specific external information you need, when you need it?
19	Understandable: When you find it, is it clear enough to interpret quickly?
20	Trustworthy: When do you trust external/interoperable info, and when do you double-check it?
21	Actionable: Does it let you take the next step in care, or do you still need to call/message someone?
	Workarounds
22	When it doesn't work well, what do you or your colleagues do instead?
23	What are the consequences of those workarounds?
	Routinization
24	Is using interoperable/external info a normal part of your routine, or does it feel like extra work?
25	Has your use changed over time?
	Outcomes
26	Have interoperable systems changed how care is coordinated?
27	Has it changed decisions or outcomes?
28	Overall: Does this feel like a "digital transformation" in care, or mostly just digitization/digitalization? Why?
	Closing/Improvements
29	If you could change one thing about the system/feature, what would you change first, and why?
30	What improvement would make the biggest difference for your daily work?
31	What improvement would most improve patient care or coordination with others?
32	If you were advising the people who design/manage it, what's the one message you'd want them to hear?
33	Is there anything important we didn't cover?

3.4 Data Analysis Methods

The data analysis was carried out in a structured yet flexible way, with the goal of finding clear patterns in how healthcare professionals describe EHRs in healthcare and how these systems shape their daily work. Since the empirical material came from semi-structured interviews, the analysis needs to handle rich and detailed text. A theme-focused approach was used, where the interviews guided what became important, while we still kept the analysis connected to the research purpose. This fits well with qualitative analysis as something that moves between careful organization of the data and thoughtful interpretation of its meaning in context (Patton, 2015).

The main mode of analysis was deductive, although it contained elements of inductive analysis. That means the analysis did start with a preliminary set of categories into which the data was sorted into. Although some codes and themes were generated from what was actually said during the pilot interview. Theory was used as a guide for our established concepts rather than a strict framework. In practice, this meant theory helped us stay aware of relevant ideas that often matter in information systems and healthcare contexts, such as coordination, information quality, trust, accountability, or workflow. These ideas helped us ask better follow-up questions during the interviews and interpret patterns later, but they still allowed for new or unexpected themes to emerge from the material.

The analysis began with the transcription of the interviews. Each transcript was first transcribed with the help of Sunet Scribe, which is an AI tool that has been approved by the university to use. Part of the transcription process involved cleaning up the AI-generated transcript, as it for example had difficulty identifying the speaker and struggled with punctuation sometimes. As a result, this process became part of the familiarisation with the material. It was a good opportunity to review the interviews and get a refreshed sense of what participants were saying as a whole, and short notes were taken on first impressions, recurring issues, and interesting examples. After that, the coding process started. A set of codes were established, as shown in Table 3.4 below. Coding was the step in which parts of the text were labeled to keep track of what the data is about. It began with open coding, meaning to create simple codes that stayed close to the participant's wording and the concrete situation they describe (Recker, 2021). The goal at that stage was to capture what was happening in the data without overthinking it too early. As more interviews were coded, the codes were then compared across transcripts, and similar codes were grouped together.

Once the full set of codes was established, the process moved into a more focused stage where the codes were organized into broader categories. For example, several codes might relate to trust in information, missing data, or difficulties in passing information between units. By clustering codes into categories, themes could be identified that capture patterns across participants while still preserving important differences between roles or settings. The next step was data reduction, involving reviewing and refining the themes by returning to the transcripts and ensuring each theme is supported by data and is clearly defined (Recker, 2021).

Throughout the analysis, "memos" were used to document decisions and reflections. This helped keep track of, for example, why certain codes were created, how themes developed over time, and how the interpretations changed as more was learned (Recker, 2021). For the most part, both researchers participated in coding and theme development to allow comparisons of interpretations and reduce the risk that the findings reflect only one person's viewpoint (Bell et al. 2022). The goal was to present a set of themes that address the research questions and provide

a realistic picture of how electronic health records are experienced and used in healthcare settings.

Table 3.4 Themes and Codes

Theme	Theme Description	Code	Code Description
CONT	Context: Establishing the context and use of EHR.	1EHR	The respondent is involved with EHR's daily during their job
INTE	Interoperability: How the EHR user experiences the system's interoperability.	1FND	The respondent perceives external information as findable
		0FND	The respondent perceives external information as not findable
		1UND	The respondent perceives external information to be understandable
		0UND	The respondent perceives external information to be not understandable
		1TRST	The respondent perceives external information as trustworthy
		0TRST	The respondent perceives external information as not trustworthy
		1ACT	The respondent perceives external information as actionable
		0ACT	The respondent perceives external information as not

			actionable
USAB	Usability: How the EHR user experiences the system's usability.	1EFCT	The respondent perceives the system to be effective
		0EFCT	The respondent perceives the system to be not effective
		1EFFI	The respondent perceives the system to be efficient
		0EFFI	The respondent perceives the system to be not efficient
		1SAT	The respondent is satisfied with the system
		0SAT	The respondent is not satisfied with the system
		1UCD	The respondent perceives the system as designed for them
		0UCD	The respondent does not perceive the system as designed for them
DT	Digital Transformation: How the EHR user experiences aspects of digital transformation surrounding the EHR	1WORK	The respondent has workarounds in place for issues
		0WORK	The respondent does not have/need workarounds in place for issues
		1ROUT	The respondent perceives interoperable EHR to be embedded in their routine work
		0ROUT	The respondent

			perceives using EHR as extra/unnecessary work
		1BENI	The user perceives benefits of interoperable EHR
		0BENI	The user perceives negative consequences from a non-interoperable EHR

3.5 Scientific Quality

In this study, scientific quality is about showing that the findings are trustworthy, well-grounded, and clearly connected to the data (Bell et al. 2022). Since the project was qualitative and interview-based, a focus was put on quality criteria that fit this kind of research. That included being transparent about how data was collected and analyzed, being careful with interpretation, and making it possible for a reader to understand how the research went from raw interview material to themes and conclusions. The quality of qualitative research is strengthened by clear reasoning, thoughtful design choices, and credibility checks that align with the study's purpose and context (Patton, 2015). All of which we aimed to cover, explain, and motivate in the previous method chapters.

In this case, credibility means that the findings we presented should feel reasonable and convincing in relation to what participants actually said (Recker, 2021). Credibility was sought by seeking concrete examples rather than only general opinions, and by using follow-up questions to clarify meaning when something was unclear. During analysis, continuous checks ensured that each theme was supported by multiple parts of the data and not based on a single quote or a single participant’s experience.

Reliability in qualitative research is usually discussed in terms of dependability and consistency (Recker, 2021). The goal was to keep the process clear and logical, and to document the choices made so the analysis would not feel baseless. Dependability was achieved by maintaining an organized workflow for interview guides, recruitment steps, transcription, coding, and theme development. Changes made along the way, such as adjustments to the interview guide after the pilot, will be documented, and memos will be made about coding decisions and theme definitions.

From a generalizability and transferability perspective, the study aimed to provide findings relevant to similar healthcare contexts. Transferability was supported by describing the empirical setting in sufficient detail, including the type of hospital environment, the roles represented among participants, and the general nature of the information system tasks discussed (Recker, 2021). This contextual description helps understand how the findings relate to the study's specific setting and indicates how they may be relevant in comparable healthcare environments.

Finally, confirmability is important, meaning that findings are intended to arise from the data rather than from researcher bias or personal preferences, and are reviewed by peers (Recker, 2021). This was made easier by being transparent about assumptions, by using direct quotes to show how interpretations were grounded, and by reflecting on how a researcher's background might have influenced what is noticed in the data.

3.6 Ethical Considerations

Because the research setting is sensitive and involves both professional responsibilities and information handling, ethical considerations were an important part of the research design. The main ethical focus areas in this project are informed consent, confidentiality and privacy, secure data handling, including GDPR, and research integrity throughout the process.

First, participation had to be voluntary and based on informed consent. This means participants received clear information about the study's purpose, what taking part involved, how long the interview would take, and how the material would be used. They were also told that they could stop the interview at any time and withdraw from the study without any negative consequences.

Second, confidentiality and privacy are important. Healthcare professionals may discuss work situations involving patient-related information. For that reason, the interviews were designed to avoid collecting patient-identifiable information. As we do not cover any patient data or information, we did not need any extra permissions, permits, or anything related to conducting this kind of research. Issues regarding patient data privacy are therefore not applicable to this research. At the same time, confidentiality was also necessary to protect participants as employees (Bell et al. 2022). Respondents shared critical experiences about systems, workarounds, or organizational issues that could create discomfort or risk if they became identifiable. For this reason, all participants have been anonymized in the research material and in the thesis. Names, units, and other identifying details will be removed or generalized, and quotes will be selected and edited carefully so they cannot be traced back to a specific person (Bell et al. 2022).

Third, the project had to follow GDPR and handle data responsibly. Audio recordings and transcripts were stored securely with restricted access, and only the research team had access to the raw data. The transcription was assisted by the AI tool Sunet Scribe, which has been approved by the university for this setting. Data was stored offline and was not shared outside the project. Personal data will be minimized, and only what was needed for the research purpose was collected. Participants were informed about what data was collected, how long it would be stored, and when it would be deleted. This also included careful handling of any contact information used for recruitment and scheduling.

This study adhered to basic research ethics regarding integrity and responsible conduct. Scientific honesty was essential, meaning the research team did not fabricate, alter, hide, or misrepresent data, and that findings were reported in a way that reflected participants' actual responses (Recker, 2021). Carefulness was also important, which means avoiding sloppy handling of recordings, transcripts, coding, or citations, and being precise when describing the method and the results (Recker, 2021). The study also aimed for openness in a realistic way by clearly describing how data was collected and analyzed, and by being transparent about limitations, while still protecting confidentiality and privacy (Recker, 2021). Credit was attributed by following the required LUSEM referencing style and avoiding plagiarism in both the research design and the final writing (Recker, 2021). Lastly, public responsibility mattered because research on HIS’s can be relevant beyond the immediate setting. This research presents findings in a responsible way that avoids harming participants or organizations and that focuses on learning and improvement rather than blame (Recker, 2021).

4 Empirical Results & Analysis

4.1 The Use of EHR

The use of EHRs among the respondents is widespread. Each one of the Respondents, R1-7 stated that they are in contact with these systems daily, describing them as being major parts of their workflows. This is partly because all respondents are healthcare professionals who use EHRs daily. For example, Respondent 5 describes their use as:

"I've been on electronic health records for 12 years, and before that, I used paper charts." - R5 5.4 Appendix 6

Multiple respondents also shared that they regularly come across incompatible systems, in other words systems that lack interoperability.

"When we're getting a patient from another health care system, whatever that may be, probably less than half, but usually like 40 to 50 percent of them are using either a different EMR that's not compatible with ours, or they're using paper charts, and that creates a big issue for us." - R1 1.24 Appendix 5

The quote here establishes not only the prevalence of EHRs in these professionals work, but also how big a problem non-compatible EHRs can be. The findings show that EHR systems are highly embedded in healthcare work and are viewed as necessary tools within everyday practice. However, the findings also indicate that healthcare remains characterized by fragmented digital infrastructures where interoperability challenges continue to affect communication, coordination, and access to information. The use of EHR systems is therefore widespread, but the level of integration between systems remains inconsistent.

4.2 The Interoperability of EHR

The respondents had a lot of different experiences regarding the interoperability of EHR. This subchapter will present how they experience the different aspects of usable interoperability.

4.2.1 Finding the Information

Here are some examples of when finding external information can be difficult. R2 explains that what role you have can have an effect on access to information. As described in this quote from the interview.

"So from a nurse's perspective, I would say not very easy, right? Now, I think the physicians have a different level of access and that they can probably see." - R2 2.34 Appendix 3

Another situation that can make finding the information difficult just how the other healthcare professional chose to categorize the information. This was made clear by respondent 3 when asked about findability:

"Sometimes it takes a while to find it, and it all depends on how the other hospital approaches storing their information, like the location of the information, like pathology, for example, sometimes it's filed on their labs, sometimes it's filed on their studies, you know, and so it sometimes, it takes a while to find what you need." - R3 3.36 Appendix 4

Another situation where locating external information can be difficult is when having to rely on the patient to find the health records, like in this example.

"Sometimes It's hard because once again the patient's telling you where they went last so we're looking it up on the internet what's their phone number you know someone moves from Colorado here and so now you're relying on them to tell you where they went and then searching and then trying to find the doctor, trying to find a phone number so that you can call there and ask them for the old records. So it's sometimes hard to locate the patients or, you know, the doctor's retired." - R5 5.30 Appendix 6

Other respondents such as Respondents 4 and 6, shared the same experience when having to rely on the word of patients to find the records. This shows that findability is affected by several factors: access rights, differences in how organizations categorize information, and dependence on patients' ability to remember where previous care took place. Which means that finding external information is not only a technical matter of whether records exist, but also a practical matter of whether healthcare professionals know where to look, have permission to access the information, and can identify the correct source. Poor findability creates additional work before clinical information can even be used.

4.2.2 Understanding the Information

In terms of understandability a lot of the respondents expressed that in most cases, if the information was accessible to them it would be in the type of formats and language that they understood. For example R2 explains:

"*Yeah, I think if I have the access to be able to pull it over, like at the physician level, then it's in a format that I'm probably used to."* - R2 2.36 Appendix 3

This experience was similar or the same for respondents R3 and R7. However there seems to be one scenario where the accessible information isn't understandable and that is when the respondents had to deal with paper charts, for example R1 and R5 share similar stories of how paper charts can have handwriting that is difficult or impossible to to read:

"I think the bigger issue is that a lot can go wrong with paper charts because sometimes they don't even make it right, like there's more room for error when you're sending a person with a piece of paper, and hospitals are also not famous for their great handwriting as well."
- R1 1.23 Appendix 2

And from R2:

"it was very difficult to read the physician handwriting, you know, when it was on paper"
- R2 2.16 Appendix 3

This means that if the information is findable and in digital format, the content will most likely be understood by the health care professionals.

The findings suggest that understandability is generally not a major issue when external information is accessible in a familiar digital EHR format. Respondents 2, 3, and 7 indicate that digital information is usually understandable once they can access it. However, paper-based records create more problems, especially when handwriting is unclear or information is poorly documented, as described by Respondents 1 and 2. This shows that understandability depends not only on the content of the information, but also on the format in which it is presented. When information is digital and familiar, it is easier to interpret; when it is handwritten or inconsistently documented, its practical value decreases.

4.2.3 Trusting the Information

When it comes to trusting the accessible information R3, R1 and R7 say that they don't have any reason to not trust the information. These experiences come from situations when the health records are accessible through their EHR system. At the same time there are other situations where health records aren't in the system they have access to and certain respondents show to not always trust the available information. Like for example how R2 explains why they seem to double check the external information coming in:

"*I would say we always double check because I definitely have seen medical records before where maybe if it was a, you know, a printout from another facility that the wrong patient records have been scanned into the wrong patient chart."* - R2 2.38 Appendix 3

In situations where external information through EHR are not accessible, the respondent says that they may need to gather the information in other ways such as asking the patients directly or by being handed printed medical records. R6 shares that it can be problematic when having to rely on the patient to disclaim their medical history, saying:

"I would love to always trust my patients every time, but a lot of them will not tell the whole truth for various reasons." - R6 2.36 Appendix 7

Similar concerns were raised by other respondents like R5. The level of trust to the information varies greatly depending on the source. The information coming from compatible EHR systems is trusted more than when they are being faxed over by another medical professional, and less when having to rely on the patients themselves to present their record.

"I've learned sometimes the hard way that that not necessarily does the patient have a disease, it's that the doctor was lazy and just put three on everyone, so you can't always trust the data you're getting, you have to look at the bigger picture." - R5 5.36 Appendix 6

Trust depends strongly on the source and format of the information. Respondents 1, 3, and 7 generally trusted information when it was accessible through an EHR system, while Respondents 2, 5, and 6 described more uncertainty when information came from scanned documents, printouts, faxed records, or patient self-reporting. This shows that trustworthiness is not only about whether information is available, but whether healthcare professionals can judge its accuracy, origin, and relevance. When the source is unclear or the information may be incomplete, respondents described the need to double-check, interpret cautiously, or gather

information from other sources. This reduces the practical value of interoperability because information that cannot be trusted cannot be used confidently in clinical decision-making.

4.2.4 Acting on the Information

When discussing whether available information helps respondents carry out their work, or in other words whether it is actionable, Respondents 2, 3, 5, and 7 explained that information becomes useful when it has first been found, understood, and trusted. In those cases, the information can support clinical tasks and allow healthcare professionals to continue their work. Respondent 6 describes this in the following way:

> *"I would say like 50% of the time I can figure out everything that I need from records that someone has, and then 90% of the time I can find something I can use from those records."* - R6 2.30 Appendix 7

This quote shows that external records do not always provide a complete picture, but they can still contain useful information that supports clinical work. In this sense, actionability is not only about whether the information is perfect or complete, but whether it gives healthcare professionals enough relevant information to make progress in their task.

The findings therefore show a connection between findability, understandability, trustworthiness, and actionability. If one part of this chain fails, the practical value of external health information decreases. Information that cannot be found, interpreted, or trusted is less likely to support clinical action. However, when information is accessible, understandable, and reliable, it becomes possible for healthcare professionals to use it in their daily work. This suggests that actionability is the outcome of the previous dimensions of usable interoperability.

4.3 Usability of the Process of Accessing External Records

For this subchapter the empirical data that will be presented shows the respondents experiences of the different aspects of usability of the process of accessing external information. This subchapter is more focused on the use of the systems and processes themselves.

4.3.1 The Effectiveness of the Process

Effectiveness refers to whether the respondents are able to achieve their goal when trying to access external health records. The empirical data shows that the process is not always experienced as effective, especially when information is delayed, unavailable, or requires additional manual work.

> *"No, so we can't access the hospital stuff, and the hospital can't access our stuff. Seems like a really backward way to do it, yeah? And then fire departments that go on calls with us can't access our stuff, and we can't access theirs."* - R4 4.22 Appendix 5

This quote from Respondent 4 can be interpreted as the systems and processes being ineffective as the EHRs used by Emergency Medical Technicians, Hospitals, and Firefighters are not compatible and don't feature interoperability between each other. This specific point is also described by Respondent 5 in the quote below:

"Say I have someone in my chair that's having a seizure … and I have to call the squad. I have the chart, and then they pick them up, and they have a separate chart, and then he gets sent to the hospital, and then his primary care doctor sees him for follow-up … in one day there's three different charts there." - R5 5.26 Appendix 6

These findings show that the process of accessing external health records is not always effective because healthcare professionals cannot consistently achieve the goal of obtaining a complete and continuous patient record. Respondents 4 and 5 both describe situations where information is fragmented across separate systems used by emergency services, hospitals, fire departments, and primary care providers. This means that even when each organization documents care, the information does not necessarily follow the patient across the care process. As a result, healthcare professionals may have to work with incomplete records or create new documentation instead of building on existing information. In terms of usability, this indicates that the process is ineffective because the system does not fully support the clinical goal of accessing relevant patient information across care settings.

4.3.2 The Efficiency of the Process

Efficiency concerns the amount of time, effort, and resources required to complete a task. Several respondents describe the process of finding external information as unnecessarily complicated or time-consuming.

"*It's not effective at all … you want information that you might not get for a few days. And then you have to call the patient back, or you have to compare and, you know, so no, it's not efficient at all."* - R5 5.22 Appendix 6

This quote shows that the process of accessing external information can require additional time and follow-up work. The respondent describes a situation where the needed information is not available when it is needed, which forces the healthcare professional to return to the task later. This reduces efficiency because the process is interrupted and creates extra steps, such as calling the patient back or comparing information afterwards. R7 connects inefficiency to the design and logic of the system itself:

"The system is not [efficient], you can't work on your intuition because it's not that logical. You really have to know what you're doing." - R7 1.22 Appendix 8

This suggests that the system does not support an intuitive workflow. Instead of allowing users to navigate naturally, the system requires specific knowledge and experience. This makes the process more effortful, especially for users who are less familiar with the system. A system that is not logical to the user increases the cognitive effort required to complete a task, which negatively affects efficiency. Another example of inefficiency is described by R3:

"I wish you could just basically import data from the system outside of ours, but all you can do is look at it, and if you want to integrate it into your own record, then you need to manually transcribe it." - R3 2.30 Appendix 4

This quote shows that even when external information is visible, it is not necessarily easy to integrate into the respondent's own system. The need to manually transcribe information creates additional administrative work and could increase the risk of errors. This illustrates that usability problems do not only affect access to information, but also how efficiently information

can be reused in the healthcare professional's own workflow. R2 also describes how users adapt to inefficient systems through workarounds:

"I would say it's a workaround for an ineffective, inefficient system, but … I think everybody's just trying to make the platform they've been given be more effective." - R2 2.44 Appendix 3

The use of workarounds suggests that the platform does not fully support the users' needs, forcing them to create informal ways of making the process more manageable. While these workarounds may help the respondents complete their tasks, they also indicate that the system itself is not efficient enough. Overall, the respondents' experiences show that the process of finding and using external information is often inefficient. Delays, unintuitive system design, manual transcription, and dependence on workarounds all increase the amount of time and effort required. This suggests that the issue is not only whether information can be accessed, but whether it can be accessed and used in a way that supports an efficient healthcare workflow.

4.3.3 The Satisfaction of the Process/System

Satisfaction refers to how the respondents experience the process or system emotionally and practically. The empirical data shows that several respondents express frustration, dissatisfaction, or concern regarding the systems they use. R4 describes a limitation in the system that prevents proper documentation:

"There's things that we can do in the field that we can't chart properly in ESO because those options aren't turned on for us." - R4 2.14 Appendix 5

This quote shows that dissatisfaction can arise when the system does not allow users to accurately document the work they actually perform. If healthcare professionals are unable to chart certain actions properly, the system may fail to reflect clinical reality. This can create frustration because the technology limits rather than supports the user's work. R7 describes another consequence of system dissatisfaction:

"I have an eight-hour workday. And the system makes me work overtime."
- R7 1.26 Appendix 8

This quote directly connects poor usability to workload. The respondent does not only describe the system as inconvenient, but as something that extends the workday. This suggests that dissatisfaction is linked to the practical consequences of inefficient digital systems. When systems require extra time, they can contribute to stress, overtime, and possibly reduced job satisfaction. R3 gives a broader reflection on the difference between paper charts and digital systems:

"I'm old enough to have spent a lot of my career on paper charts. And I definitely think we were more present when we were with the patient and so that was one benefit and the other benefit was you left the office and that was that...so on the flip side of that is the computer very much is sort of like this third entity in the room now and we spend a lot of time looking at the screen rather than at the patient which is what we used to do." - R3 2.12 Appendix 4

This quote shows that dissatisfaction is not only related to technical functions, but also to how digital systems affect the relationship between healthcare professionals and patients. The respondent describes the computer as a "third entity in the room," suggesting that EHR systems

can interfere with the human interaction that is central to healthcare work. Respondent 4 had these insightful words to share.

"Frustrating and irritating 100%, but the only thought that really goes through my head is, are you ~~fucking~~ kidding me. I need a new system that works right, because this is ridiculous."
- R4 2.30 Appendix 5

The quote here from R4 shows not only the level of dissatisfaction but also the emotional toll using these faulty systems can have on a Healthcare Professional. Together, these quotes show that dissatisfaction with EHR systems can emerge in several ways. Respondents are dissatisfied when systems limit documentation, create overtime, or reduce presence in patient interactions. This suggests that usability problems do not only affect system use, but also the broader experience of performing healthcare work.

4.3.4 The Human-Centeredness of the Designs

Human-centeredness refers to whether the systems appear to be designed around the needs, workflows, and experiences of the people using them. Several respondents suggest that the systems they use are not always designed with healthcare professionals in mind. R5 expresses this clearly when talking about their system and process of getting external information:

"We're not integrated, so they're not thinking of the doctors, they're, you know, they're not thinking of the user of it." - R5 5.28 Appendix 6

This quote shows that the respondent connects lack of integration with a lack of human-centered design. The problem is not only that systems are technically separate, but that the design does not appear to reflect the needs of the doctors using them. This suggests that poor interoperability may also be experienced as poor usability. R7 gives a more direct description of what a human-centered system would look like and shows how theirs is not:

"I would like the IT department to ask me what I want, and then they should build what I want. It shouldn't be the other way around. I want a system that's intuitive, that follows my workflow as it should be, and a system where I don't have to use a lot of shortcuts just to try and bypass the slowness." - R7 1.64 Appendix 8

This quote strongly emphasizes the importance of involving users in system design. The respondent wants a system that follows their workflow, rather than forcing them to adapt to the system. The mention of shortcuts also shows that users may create their own informal methods to compensate for poor design. R6 initially reflects positively on whether the system was designed with users in mind, but then corrects themselves:

"I think it was designed with us in mind, it doesn't ask for any information that I'm like okay like why would you ask… no, that's actually a lie, it does. I'm so sorry, so it definitely asks for things that are absolutely ridiculous." - R6 2.40 Appendix 7

While the respondent first suggests that the system may be designed for them, they quickly identify features that feel unnecessary or poorly aligned with their work. This indicates that even systems that appear functional may still contain elements that users experience as irrelevant or frustrating. Overall, the respondents' experiences suggest that EHR systems and the processes for accessing external information are not always sufficiently human-centered. Respondents 5 and 7 especially describe systems that require healthcare professionals to adapt

to the technology, rather than technology being adapted to clinical workflows. Respondent 6 also shows that even when a system appears to be designed for users, it may still include functions or required information that feel unnecessary in practice. This indicates a gap between system design and clinical work. From a usability perspective, this is important because systems that do not reflect users' needs, tasks, and workflows may increase frustration, slow down work, and encourage shortcuts or workarounds.

4.4 Outcomes of EHRs

4.4.1 Routinization

Routinization refers to the extent to which digital systems have become a normal and established part of everyday work. The respondents' descriptions show that EHR systems are deeply embedded in healthcare practice, but also that problems with interoperability have also become routine. R2 and R7 have aligning experiences regarding how these systems absolutely are embedded in their work, R7 shares:

"Yeah absolutely I mean I can't work without the system."
- R7 1.54 Appendix 8

R3 however, describes how frequently incompatible systems appear in their work which is an experience shared with R7, and explains how manual handling of external information has become part of daily routine work:

"Every single day, there'll be at least a couple of patients who had their labs drawn somewhere else. And then our medical assistants have to manually transcribe, which is problematic because mistakes can be made for one thing. And it's also time-consuming."
- R3 2.14 Appendix 4

This quote demonstrates that the use of external information is highly routinized, but that the process itself often depends on inefficient manual practices. The findings suggest that EHR use is strongly routinized, but not always in the intended way. Respondents 3 and 7 show that healthcare professionals have incorporated EHRs and external information handling into their daily work, but they have also incorporated the limitations of these systems. Incompatible systems, paper charts, and manual transcription are not described as unusual exceptions, but as recurring parts of clinical practice. This means that routinization does not necessarily indicate successful digital transformation. Instead, the findings show that inefficient or fragmented practices can also become normalized when healthcare professionals repeatedly adapt to system limitations.

4.4.2 Workarounds

The respondents describe several workarounds that are used when systems do not provide access to the needed information. These workarounds include moving on without previous records, manually searching for information, calling providers, relying on patients, or starting the clinical assessment from the beginning. R4 describes one workaround in a very direct way:

"I just gave up on the fact that I can't access a previous chart. I just move on."
- R4 2.32 Appendix 5

This quote shows how lack of access can lead healthcare professionals to continue their work without external information. The workaround is not necessarily ideal, but it allows the respondent to proceed despite the system limitation. This illustrates how users adapt to digital barriers in order to keep the workflow moving. R1 describes how workarounds become normalized:

"It's frustrating, but it's one of those things where you just kind of get used to it, and you find workarounds because it's so common." - R1. 1.30 Appendix 2

This quote shows that workarounds are not rare exceptions, but recurring responses to common system problems. The phrase "you just kind of get used to it" suggests that frustration becomes part of everyday work. This is important because it shows how poor interoperability can become normalized within healthcare practice. R5 describes another workaround, where the professional has to begin with the current examination as the first reliable data point:

"Start from scratch. Data point one is the exam. You know, if you're worried about something, you follow up, you do extra tests, you have them come back sooner, but that's data point one, and go from there." - R5 5.38 Appendix 6

This quote shows that when previous information is unavailable or unreliable, healthcare professionals may compensate through additional clinical work. This could include extra tests, follow-ups, or earlier return visits. While this allows care to continue, it may also increase workload and reduce the benefits that EHR systems are supposed to provide. Together, these quotes show that workarounds are an important part of how healthcare professionals deal with limitations in digital systems. They allow work to continue, but they also reveal gaps in the digital infrastructure. The need for workarounds suggests that the systems do not always fully support the users' tasks.

4.4.3 Benefits

Despite the challenges described in previous sections, several respondents also emphasize the benefits of EHR systems and digital transformation. These benefits include improved readability, easier access to information, better documentation, better decision making and potential reductions in administrative burden. R5 describes the overall impact of EHR systems very positively:

"I think it has revolutionized healthcare." - R5 5.48 Appendix 6

This quote shows that, despite frustrations, the respondent views EHR systems as a major improvement in healthcare. The word "revolutionized" suggests that digital records have fundamentally changed how healthcare work is performed. R2 emphasises that good access to medical records effects the decisions being made in care:

"Having access, you know, to the full medical record helps you make different medical decisions" - R2 2.52 Appendix 3

On top of that R3 also compares digital records favorably to paper records:

"I started with the paper records, and so this is a huge improvement to be able to just go to care everywhere and read other people's notes, and you know, and such that that is a huge improvement, so I'm pretty happy with it." - R3 2.32 Appendix 4

This quote highlights one of the central benefits of digital transformation, the ability to access and read other professionals' notes more easily than before. Compared to paper records, digital systems can make information more available and understandable. This supports the idea that EHR systems have improved certain aspects of healthcare work. R1 also reflects on the potential benefits of newer digital tools, especially AI:

"Overall, I think it's been a net positive some of the pros, I think is that it cuts down on the burden of documentation for doctors in general, if we can outsource some of that to AI, and it gives us more time to focus on like other aspects of patient care so like the face-to-face visits and actually talking to people and then it cuts down on a lot of the time that we have to spend outside of doctors visits doing extra like admin work." - R1 1.12 Appendix 2

The quote above from Respondent 1 shows that digital transformation is not only about the conventional functions of EHR systems, but also about the continued development of them that may reduce administrative work. The respondent connects digitalization with the possibility of spending more time on patient care and less time on documentation. This suggests that healthcare professionals do see value in digital transformation when it supports their workflow and reduces unnecessary burden. The respondents describe EHR systems as beneficial, especially when compared to paper charts. Digital records improve readability, provide more detailed information, and can support information sharing. However, these benefits are limited when systems are not interoperable or human-centered. The findings therefore suggest that EHRs have improved healthcare work, but that its full potential depends on better integration, usability, and alignment with healthcare professionals' needs.

5 Discussion

5.1 How EHRs are Used

The findings show that EHR systems are the everyday work of the healthcare professionals interviewed. All respondents reported regular or daily use, which aligns with previous research that presents EHRs as central e-health technologies for storing, managing, and accessing patient information (Wang et al. 2023; Modi et al. 2022). However, the more important point is that frequent use does not necessarily mean that EHRs are fully integrated across healthcare settings.

The respondents experienced EHRs as necessary for local clinical work, but also described recurring problems when patient information came from another healthcare system, organization, or paper-based record. Respondent 1's example of patients arriving with incompatible EMRs or paper charts illustrates this tension. EHRs may be routine within one organization, while the wider information environment remains fragmented across organizational and technical boundaries.

This distinction matters because EHR use can otherwise be mistaken for successful digital integration. The respondents clearly depend on EHRs, but this dependence also makes interoperability problems more visible and consequential. When information cannot move smoothly across systems, healthcare professionals must manage the gap between what the EHR is supposed to support and what the surrounding infrastructure actually allows. This aligns with research showing that EHRs can support documentation, coordination, and decision-making, while their value still depends on how well they fit clinical work (Shen et al. 2025; Makhni et al. 2026).

The findings, therefore, support the sociotechnical perspective used in this thesis. EHRs are not experienced as isolated software, but as systems embedded in workflows, routines, communication practices, and organizational boundaries. This reflects the idea that HIS includes both human and technical actors, and that health IT outcomes depend on the interactions among technology, people, workflows, and organizational conditions (Winter et al., 2023; Sittig & Singh, 2010). In practice, the issue is not only that incompatible systems exist, but that healthcare professionals must absorb the consequences of that incompatibility in their daily work.

5.2 The Usable Interoperability of the EHRs

The findings show that interoperability is not experienced by healthcare professionals as a simple question of whether systems can exchange information. Instead, the value of

interoperability depends on whether exchanged information can actually be used in clinical work. This supports the distinction made in Chapter 2 between technical interoperability and usable interoperability. While interoperability is often defined as the ability of systems to exchange and use information across boundaries, the respondents' experiences show that technical exchange alone is not enough. For interoperability to support clinical practice, information must be findable, understandable, trustworthy, and actionable.

Findability was one of the clearest points where the gap between technical and usable interoperability became visible. The findings show that information may exist within the healthcare system, but it still fails to support clinical work if healthcare professionals cannot locate it quickly and reliably. Respondent 2 shows that findability can depend on professional role; Respondent 3 shows that it can depend on how other organizations categorize information; and Respondent 5, with experiences similar to those of Respondents 4 and 6, shows that responsibility for locating records may shift to patients and individual professionals. This supports Ehrenstein et al.'s (2019) view that finding information is a necessary stage of interoperability, and aligns with Patel et al. (2025), who show that navigation problems and unclear information structures can limit HIE use. Findability therefore, appears as a foundational condition for usable interoperability: if healthcare professionals cannot locate the right information at the right time, technical exchange remains disconnected from clinical practice.

Understandability appears less as a general barrier and more as a conditional one. When external information is accessible in a familiar digital EHR format, Respondents 2, 3, and 7 suggest that it is usually understandable, which indicates that healthcare professionals often have the clinical knowledge needed to interpret the information once it is presented in a recognizable way. However, Respondents 1 and 2 show that this changes when information is paper-based, handwritten, or poorly documented. This supports Palojoki et al.'s (2024) point that semantic interoperability is not only about exchanging data, but about preserving meaning across systems, formats, and contexts. In this study, the main understandability problem is therefore not the medical content itself, but whether the format allows that content to remain clear and usable. When information loses clarity through handwriting, scanning, or inconsistent documentation, it may be technically available but still lose practical value in clinical work.

Trustworthiness shows that usable interoperability depends not only on access to information, but also on confidence in its origin, accuracy, and relevance. Respondents 1, 3, and 7 generally trusted information when it came from accessible EHR systems, while Respondents 2, 5, and 6 expressed greater uncertainty about information from printouts, scanned documents, faxed records, or patient self-reporting. This supports Gierend et al.'s (2024) emphasis on provenance, since healthcare professionals need to know where information comes from and whether it can be relied on. The findings suggest that when provenance is unclear, interoperability creates extra verification work rather than direct clinical value. Information may be available, but if healthcare professionals feel the need to double-check it or interpret it cautiously, it becomes less immediately usable for decision-making. Trustworthiness, therefore, acts as a filter between access and action: only information deemed reliable can fully support clinical work.

Actionability is the point at which usable interoperability either delivers clinical value or breaks down. Respondents 2, 3, 5, and 7 indicate that external information becomes useful only when it can first be found, understood, and trusted, whereas Respondent 6 shows that records do not need to be complete to be actionable as long as they contain enough information to support the next clinical step. This aligns with Sarkar's (2022) argument that health data must be

transformed into actionable information, and with Unertl et al. (2012), who show that the usefulness of HIE depends on workflow, role, and information needs. In this study, actionability is therefore not simply a property of the information itself, but the outcome of how well the information fits the healthcare professional's task at that moment. If the information supports decision-making, care planning, medication review, or coordination, interoperability becomes meaningful in practice. If it does not, the information may exist digitally but still fail to contribute to clinical work.

This section shows that usable interoperability is best understood as a sequence of conditions rather than a single technical capability. The findings suggest that information becomes valuable in clinical work only when it moves from being available to being findable, understandable, trustworthy, and finally actionable. This supports the thesis's argument that interoperability should not be judged only by whether systems exchange data. It must also be judged by whether healthcare professionals can turn that data into reliable clinical action. In this sense, usable interoperability is the practical link between EHR infrastructure and meaningful support for clinical work.

5.3 Usability of the Process of Finding External Information

The findings show that the usability of EHR systems is closely connected to the process of finding and using external patient information. In Chapter 2, usability was understood through effectiveness, efficiency, satisfaction, and human-centered design. The empirical findings show that all four dimensions are relevant for understanding how healthcare professionals experience the process of accessing external health records. The issue is not only whether information exists within the healthcare system, but also whether healthcare professionals can access and use it in a way that supports or has an effect on their work in real clinical settings.

Effectiveness is limited when the process prevents healthcare professionals from completing the clinical task that external records are supposed to support. Respondents 4 and 5 show that information can be documented by each actor involved in care, yet still fails to be a complete and continuously accessible patient record when emergency services, hospitals, fire departments, and primary care systems are separated. In other words the systems are often not effective. In this context, the goal is not merely to create a local record, but to access and use relevant patient information across care settings. Yen and Bakken's (2012) user-task-system-environment perspective helps explain why this matters: the system must be evaluated in relation to the actual clinical task and work environment, not merely by whether documentation exists somewhere. From a Task-Technology Fit perspective, the findings also suggest a mismatch between what healthcare professionals need to do and what the technology enables (Goodhue & Thompson, 1995). The process may therefore be functional for isolated documentation, but ineffective for coordinated clinical work when information does not follow the patient across settings.

Efficiency becomes a problem when external information is technically reachable but requires too much time, effort, or cognitive work to use. Respondent 5 shows that delays can interrupt the clinical process and force follow-up work, while Respondent 3 shows that information may be visible but still inefficient to reuse when it must be manually transcribed. Respondent 7 adds that unintuitive system design increases the knowledge required to navigate the process, making efficiency depend more on user experience than on system support. These findings connect directly to ISO's definition of efficiency as the resources required to achieve a goal (ISO, 2018).

They also align with Yen and Bakken's (2012) view that health IT usability should be evaluated through how users perform tasks within specific systems and work environments. From this perspective, inefficiency is not only a matter of slow technology but also of a poor fit between the system, and the clinical workflow. Even when information exists, delays, manual transcription, and unintuitive navigation shift work onto healthcare professionals rather than supporting them. The findings also show that poor efficiency can lead to workarounds. Respondent 2 explicitly described these adaptations as "a workaround for an ineffective, inefficient system," explaining that healthcare professionals try to make the platform they have been given more effective. This suggests that workarounds are not simply individual preferences, but responses to usability problems. When the official system does not adequately support the task, users create informal ways to complete their work. This strengthens the connection between usability and later outcomes, especially workarounds and routinization.

Satisfaction is important here because the respondents' dissatisfaction with these systems is sometimes very strong and is not just a reaction to inconvenience, but to how the system changes the experience of clinical work. Respondent 4 shows that frustration can arise when the system impedes accurate documentation, while Respondent 7 links dissatisfaction to overtime and an increased workload. Respondent 3 adds another dimension by describing the computer as a "third entity in the room," showing that EHR use can affect the relationship between healthcare professionals and patients. This aligns with ISO's understanding of satisfaction as the user's subjective experience of system use (ISO, 2018), and it also supports DeLone and McLean's (2003) view that satisfaction is linked to system quality, information quality, use, and net benefits. In this study, dissatisfaction signals that usability problems not only make the system unpleasant to use but can also reduce the perceived value of the system by increasing burden, limiting documentation, and disrupting patient interaction.

Human-centered design helps explain why the respondents experience some EHR and usability processes as poorly aligned with clinical work. Respondent 5's statement that the systems are "not thinking of the doctors" suggests that lack of integration is experienced not only as a technical limitation, but also as a usability problem rooted in design. Respondent 7 makes this more explicit by arguing that systems should be built around clinicians' workflows rather than forcing clinicians to rely on shortcuts, while Respondent 6 shows that even functional systems may include requirements that feel irrelevant in practice. This connects to ISO 9241-11 view of human-centered design as part of usability, where systems should be developed through an understanding of users, tasks, and environments (ISO, 2018). It also aligns with Yen and Bakken's (2012) review of health IT usability, which emphasizes that usability must be evaluated in relation to users, tasks, systems, and environments. From this perspective, the findings suggest that usability depends not only on connecting systems, but on designing those connections around the realities of clinical work. When systems do not reflect clinicians' needs and workflows, they risk producing inefficiency, frustration, workarounds, and limited routinization rather than meaningful support for care.

External information may exist and even be technically accessible, but if the process is ineffective, inefficient, frustrating, or poorly aligned with clinical workflows, the burden shifts onto healthcare professionals. The findings therefore suggest that usable interoperability requires more than connected systems; it requires a process that supports clinical goals, reduces unnecessary effort, and fits the realities of healthcare work. In this sense, usability is what turns access to information into practical support for care.

5.4 Routines, Workarounds & Benefits of EHR

Routinization is important because the findings show that EHR use has become the norm, but not necessarily in a way that reflects a successful digital transformation. Respondents 1 and 3 show that healthcare professionals have incorporated EHRs and external information handling into everyday work, which aligns with Vial's (2019) and Tratkowska's (2019) view that digital transformation involves digital technologies becoming embedded in organizational routines. However, the findings also complicate this idea. What has become routine is not only the use of EHRs, but also the repeated handling of incompatible systems, paper charts, fragmented information flows, and manual transcription. This connects to Normalization Process Theory, which explains how practices become embedded in everyday work (May et al. 2009), but the findings show that normalization can include inefficient practices as well as intended ones. In this sense, routinization is not automatically evidence that digital transformation is successful. Instead, it reveals that healthcare professionals may normalize the extra work required to make incomplete digital infrastructures function in practice.

Workarounds show how healthcare professionals keep care moving when EHR systems and interoperability processes fail to support their tasks. Respondent 4's decision to "move on" without previous records, Respondent 1's description of getting used to workarounds, and Respondent 5's strategy of starting from the current exam as "data point one" all show that workarounds are practical responses to system limitations rather than isolated user choices. This connects to Blijleven et al. (2022), who argue that workarounds emerge when there is a mismatch between EHR design and clinical work, and to Blijleven et al. (2017), who show that these adaptations can affect workflows, safety, effectiveness, and efficiency. At the same time, the findings also reflect Van Offenbeek et al.'s (2024) point that workarounds can temporarily solve problems while reinforcing the underlying system misfit. In this study, a paradox is that workarounds make fragmented systems usable enough for healthcare professionals to continue their work, while also allowing the same interoperability and usability problems to persist in everyday practice. This means that workarounds are not only outcomes of poor system fit, but also mechanisms through which imperfect digital transformation becomes sustained in practice.

Lastly, in terms of perceived benefits, respondents generally recognize the value of EHRs and digital transformation, but distinguish this value from the limitations of current system integration. Respondent 5's view that EHRs have "revolutionized healthcare" and Respondent 3's description of digital access as a "huge improvement" show that EHRs create clear value when they improve readability, access, documentation, and information sharing. Respondent 1's reflection on AI also suggests that healthcare professionals see further potential when digital tools reduce documentation burden and free time for patient care. This aligns with DeLone and McLean's (2003) concept of net benefits, in which the value of an information system is measured by its impact on users and organizations. It also aligns with Li et al. (2022), who show that EHR interoperability is commonly associated with safety, quality, time savings, cost reductions, and workflow improvements. However, the findings also show that benefits are conditional rather than automatic. EHRs create value when information is accessible, readable, integrated, and useful, but their benefits are weakened when systems remain incompatible, require manual transfer, or force users into workarounds. In this sense, the respondents' experiences suggest that digital transformation has improved healthcare work, but that its full value depends on whether EHR systems become both interoperable and usable in everyday clinical practice.

The outcomes show that digital transformation is happening, but incomplete. EHRs have become embedded in healthcare work, which reflects digital transformation in practice, but the findings show that embeddedness alone is not enough. When poor interoperability and usability become routine, digital transformation risks normalizing extra work rather than reducing it. The respondents' experiences, therefore, suggest that the real measure of digital transformation is not whether EHRs are used, but whether they make clinical work more coherent, usable, and beneficial. This thesis depends on whether interoperable information can move through the full chain from access to practical clinical value.

6 Conclusion and Reflections

This thesis examined how healthcare professionals experience the interoperability and usability of Electronic Health Records in their everyday clinical work. The purpose was to understand how healthcare professionals perceive the practical use of exchanged patient information, particularly whether this information is findable, understandable, trustworthy, and actionable, and whether the process of accessing it is effective, efficient, satisfactory, and aligned with users' needs.

The thesis was guided by the following research questions:

RQ1: How do healthcare professionals experience the usability of interoperable EHR information in clinical work?

RQ2: How do these experiences shape clinical routines, workarounds, and perceived benefits of EHR use?

The study shows that healthcare professionals experience EHRs as essential systems in their daily work. EHRs are widely used and deeply embedded in clinical practice. However, the findings also show that the presence of EHR systems does not automatically mean that patient information is usable across healthcare settings. Healthcare professionals may still face difficulties when information is stored in incompatible systems, presented in unclear formats, delayed, incomplete, or difficult to access.

In relation to the first research question, the study shows that the usability of interoperable EHR information depends on more than technical access. Information becomes usable when healthcare professionals can find it, understand it, trust it, and act on it in their clinical workflow. The study therefore shows that interoperability has practical value only when exchanged information can be used in real clinical situations.

In relation to the second research question, the study shows that healthcare professionals' experiences of EHR usability shape routines, workarounds, and perceived benefits. EHR use has become a normal part of healthcare work, but so have problems associated with fragmented systems, manual data entry, and repeated searching. Workarounds allow healthcare professionals to continue their work when systems do not fully support them, but they also show that the digital infrastructure does not always fit clinical practice. At the same time, respondents recognize clear benefits of EHRs, especially when digital records improve access, readability, documentation, and coordination.

6.1 Contribution

The main value of this thesis is that it shows the importance of understanding interoperability from the perspective of healthcare professionals. This thesis highlights specific issues and perspectives on EHR usability and interoperability, for example the strong dissatisfaction with EHR systems, and need for more user-centered design. The study also contributes by showing that interoperability should not only be evaluated by whether systems can exchange information, but by whether healthcare professionals can actually use that information in practice. The thesis also provides value by connecting interoperability, usability, and digital

transformation into a single analytical framework. This allows us to see how technical systems affect everyday clinical routines, workarounds, and perceived benefits.

The thesis further contributes by highlighting the concept of usable interoperability. This concept helps explain why exchanged information must be more than technically available. It must also be accessible, understandable, reliable, and useful in the moment of care. By focusing on healthcare professionals' experiences, the thesis provides qualitative insight into how EHR systems support or hinder clinical work.

6.2 Future work

Future research could expand this study by examining usable interoperability in more specific organizational or national contexts. Since this thesis focused on broader healthcare professionals' experiences across different settings, future studies could compare how interoperability and usability differ between healthcare systems, specialties, or EHR platforms.

Further research could also investigate how different professional roles experience interoperable EHR use, as respondents in this study indicated that access to information and workflow challenges may vary by role and responsibility. Another important area for future work is the relationship between workarounds and patient safety; particularly how informal practices emerge when interoperable systems do not align with clinical workflows.

Finally, future studies could examine how ongoing policy developments, such as the European Health Data Space, affect the practical usability of interoperable health information systems. This would provide additional insight into how large-scale digital transformation initiatives are experienced in everyday clinical work.

References

Alzghaibi, H., & Hutchings, H. A. (2025). Barriers to the Implementation of Large-Scale Electronic Health Record Systems in Primary Healthcare Centers: A mixed-methods study in Saudi Arabia, *Frontiers in Medicine*, vol. 12, article 1516714, https://doi.org/10.3389/fmed.2025.1516714

Alonge, M., Agumalu, S. A., & Nepal, R. (2024). Advancing Data Interoperability in the U.S. Healthcare System, ResearchGate, https://www.researchgate.net/publication/387947740_Advancing_Data_Interoperability_in_the_US_Healthcare_System [Accessed 15 May 2026]

Atherton, J. (2011). Development of the Electronic Health Record, *Virtual Mentor*, vol. 13, no. 3, pp.186-189, https://doi.org/10.1001/virtualmentor.2011.13.3.mhst1-1103

Barker, W., Chang, W., Everson, J., Gabriel, M., Patel, V., Richwine, C., & Strawley, C. (2024). The Evolution of Health Information Technology for Enhanced Patient-Centric Care in the United States: Data-Driven Descriptive Study, *Journal of Medical Internet Research,* vol. 26, e59791, https://doi.org/10.2196/59791

Bell, E., Harley, B. & Bryman, A. (2022) Business Research Methods, sixth edition, Oxford: Oxford University Press

Blijleven, V., Koelemeijer, K., Jaspers, M. (2022). Workarounds in Electronic Health Record Systems and the Revised SEWA Framework: A Scoping Review. *Journal of Medical Internet Research*. https://www.jmir.org/2022/3/e33046/

Blijleven, V., Koelemeijer, K., Wetzels, M., & Jaspers, M. (2017). Workarounds Emerging From Electronic Health Record System Usage: Consequences for Patient Safety, Effectiveness of Care, and Efficiency of Care, *JMIR Human Factors,* vol. 4, no. 4, e27, https://doi.org/10.2196/humanfactors.7978

da Fonseca, M. H., Kovaleski, F., Picinin, C. T., Pedroso, B., & Rubbo, P. (2021). E-Health Practices and Technologies: A Systematic Review from 2014 to 2019, *Healthcare*, vol. 9, no. 9, article 1192, https://doi.org/10.3390/healthcare9091192

DeLone, W.H. and McLean, E.R. (2003). The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. *Journal of Management Information Systems*. https://uicphdmis.pbworks.com/w/file/fetch/53087340/The%20DeLone%20and%20McLean%20Model%20of%20Information%20Systems%20Success_%20A%20Ten-Year%20Update.pdf

Ehrenstein, V. Kharrazi, H. Lehmann, H. and Taylor, C. (2019) Obtaining Data From Electronic Health Records. *Tools and Technologies for Registry Interoperability, Registries for Evaluating Patient Outcomes: A User's Guide*, 3rd Edition, Addendum 2 [Internet]. Rockville (MD): Agency for Healthcare Research and Quality (US); 2019 Oct. Chapter 4. Available from: https://www.ncbi.nlm.nih.gov/books/NBK551878/

Everson J, Adler-Milstein J, Phillips RL, Bazemore AW, Patel V. (2025) EHR Interoperability Experiences Reported by Family Physicians. JAMA Netw Open. 2025;8(11):e2542460. doi:10.1001/jamanetworkopen.2025.42460

Friedman, A., Crosson, J. C., Howard, J., Clark, E. C., Pellerano, M., Karsh, B.-T., Crabtree, B., Jaén, C. R., & Cohen, D. J. (2014). A Typology of Electronic Health Record Workarounds in Small-to-Medium Size Primary Care Practices, *Journal of the American Medical Informatics Association,* vol. 21, no. e1, pp.e78-e83, https://doi.org/10.1136/amiajnl-2013-001686

Gierend, K., Krüger, F., Genehr, S., Hartmann, F., Siegel, F., Waltemath, D., Ganslandt, T., & Zeleke, A. A. (2024). Provenance Information for Biomedical Data and Workflows: Scoping Review, *Journal of Medical Internet Research,* vol. 26, e51297, https://doi.org/10.2196/51297

Goodhue, D.L. and Thompson, R.L. (1995). Task-Technology Fit and Individual Performance. MIS Quarterly. https://www.jstor.org/stable/249689

Harte, R., Glynn, L., Rodríguez-Molinero, A., Baker, P. M., Scharf, T., Quinlan, L. R., & ÓLaighin, G. (2017). A Human-Centered Design Methodology to Enhance the Usability, Human Factors, and User Experience of Connected Health Systems: A Three-Phase Methodology, *JMIR Human Factors*, vol. 4, no. 1, e8, https://doi.org/10.2196/humanfactors.5443

Holmes, J. H., Beinlich, J., Boland, M. R., Bowles, K. H., Chen, Y., Cook, T. S., Demiris, G., Draugelis, M., Fluharty, L., Gabriel, P. E., Grundmeier, R., Hanson, C. W., Herman, D. S., Himes, B. E., Hubbard, R. A., Kahn, C. E., Jr, Kim, D., Koppel, R., Long, Q., Mirkovic, N., Moore, J. H. (2021). Why Is the Electronic Health Record So Challenging for Research and Clinical Care?. Methods of information in medicine, 60(1-02), 32–48

Kalsy, M., Burant, R., Ball, S., Pohnert, A., & Dolansky, M. A. (2024). A Human Centered Design Approach to Define and Measure Documentation Quality Using an EHR Virtual Simulation, *PLOS ONE*, vol. 19, no. 8, e0308992, https://doi.org/10.1371/journal.pone.0308992

Kim M.O., Coiera F., Magrabi F. (2017). Problems with health information technology and their effects on care delivery and patient outcomes: a systematic review. *Journal of the American Medical Informatics Association: JAMIA* vol. 24,2 (2017): 246-250.

Kraus, S., Schiavone, F., Pluzhnikova, A., & Invernizzi, A. C. (2021). Digital Transformation in Healthcare: Analyzing the Current State-of-Research, *Journal of Business Research*, vol. 123, pp.557-567, https://doi.org/10.1016/j.jbusres.2020.10.030

Kruse, C. S., Kristof, C., Jones, B., Mitchell, E., & Martinez, A. (2016). Barriers to Electronic Health Record Adoption: A Systematic Literature Review, *Journal of Medical Systems*, vol. 40, no. 12, article 252, https://doi.org/10.1007/s10916-016-0628-9

Lehne, M., Sass, J., Essenwanger, A., Schepers, J., & Thun, S. (2019). Why Digital Medicine Depends on Interoperability, *npj Digital Medicine*, vol. 2, article 79, https://doi.org/10.1038/s41746-019-0158-1

Li, E., Clarke, J., Ashrafian, H., Darzi, A., & Neves, A. L. (2022). The Impact of Electronic Health Record Interoperability on Safety and Quality of Care in High-Income Countries: Systematic Review, *Journal of Medical Internet Research,* vol. 24, no. 9, e38144, https://doi.org/10.2196/38144

Lum, B., Weerasinghe, N., Chu, C. H., Perri, D., & Cranley, L. (2025). Examining Implementation Outcomes in Health Information Exchange Systems: A Scoping Review, *Journal of Biomedical Informatics*, vol. 163, article 104782, https://doi.org/10.1016/j.jbi.2025.104782

Makhni, S., Cerrato, P., Rico, J., et al. (2026). Meeting the Challenges of Electronic Health Record (EHR) Optimization, *npj Digital Medicine*, vol. 9, article 8, https://doi.org/10.1038/s41746-025-02178-w

Mangion, A., & Piller, N. (2025). What Is Digital Health, eHealth, uHealth and Healthcare 4.0?, *Informatics and Health,* vol. 2, no. 2, pp.137-142, https://doi.org/10.1016/j.infoh.2025.06.002

May, C. and Finch, T. (2009). Implementing, Embedding, and Integrating Practices: An Outline of Normalization Process Theory. *Sociology.* https://journals.sagepub.com/doi/10.1177/0038038509103208

Mishuris, R. G., Palmisano, J., McCullagh, L., Hess, R., Feldstein, D. A., Smith, P. D., McGinn, T. G., & Mann, D. M. (2019). Using Normalisation Process Theory to Understand Workflow Implications of Decision Support Implementation Across Diverse Primary Care Settings, *BMJ Health & Care Informatics*, vol. 26, no. 1, e100088, https://doi.org/10.1136/bmjhci-2019-100088

Modi, S., & Feldman, S. S. (2022). The Value of Electronic Health Records Since the Health Information Technology for Economic and Clinical Health Act: Systematic Review, *Journal of Medical Internet Research*, vol. 24, no. 9, e37283, https://doi.org/10.2196/37283

Moy, A. J., Schwartz, J. M., Chen, R., Sadri, S., Lucas, E., Cato, K. D., & Rossetti, S. C. (2021). Measurement of Clinical Documentation Burden Among Physicians and Nurses Using Electronic Health Records: A scoping review, *Journal of the American Medical Informatics Association*, vol. 28, no. 5, pp.998-1008, https://doi.org/10.1093/jamia/ocaa325

Oh, H., Rizo, C., Enkin, M., & Jadad, A. (2005). What Is eHealth (3): A Systematic Review of Published Definitions, *Journal of Medical Internet Research*, vol. 7, no. 1, e1, https://doi.org/10.2196/jmir.7.1.e1

Olakotan, O., Samuriwo, R., Ismaila, H., & Atiku, S. (2025). Usability Challenges in Electronic Health Records: Impact on Documentation Burden and Clinical Workflow: A Scoping Review, *Journal of Evaluation in Clinical Practice*, vol. 31, no. 4, article e70189, https://doi.org/10.1111/jep.70189

Palojoki, S., Lehtonen, L., & Vuokko, R. (2024). Semantic Interoperability of Electronic Health Records: Systematic Review of Alternative Approaches for Enhancing Patient Information Availability, *JMIR Medical Informatics*, vol. 12, e53535, https://doi.org/10.2196/53535

Patel, H., Savoy, A., Sanchez, S. L., Traylor, M., Nguyen, K. A., Boockvar, K. S., Fan, V. S., Locke, E. R., Gibson, B., Mixon, A. S., Byerly, S. H., Haggstrom, D. A., Damush, T. M., Weiner, M., & Russ-Jara, A. L. (2025). Clinicians' user experience with health information exchange technologies during simulated medication reconciliation, *Human Factors in Healthcare,* vol. 7, article 100073, https://doi.org/10.1016/j.hfh.2024.100073

Plass, M., Holzinger, A., Reihs, R., & Müller, H. (2026). Integrating AI into clinical practice. *Computerized Medical Imaging and Graphics*, 130, . https://doi.org/10.1016/j.compmedimag.2026.102758

Patton, M. Q. (2015) Qualitative Evaluation and Research Methods. 4th ed. SAGE, Thousand Oaks (CA)

Poissant, L., Pereira, J., Tamblyn, R., & Kawasumi, Y. (2005). The Impact of Electronic Health Records on Time Efficiency of Physicians and Nurses: A Systematic Review, *Journal of the American Medical Informatics Association*, vol. 12, no. 5, pp.505-516, https://doi.org/10.1197/jamia.M1700

Recker, J. (2021) Scientific Research in Information Systems: A Beginner's Guide. 2nd ed. Springer Nature Switzerland AG, Cham.

Reisman, M. (2017). EHRs: The Challenge of Making Electronic Data Usable and Interoperable, *P & T: A Peer-Reviewed Journal for Formulary Management*, vol. 42, no. 9, pp.572-575.

Sarkar, I. N. (2022). Transforming Health Data to Actionable Information: Recent Progress and Future Opportunities in Health Information Exchange, *Yearbook of Medical Informatics,* vol. 31, no. 1, pp.203-214, https://doi.org/10.1055/s-0042-1742519

Sembay, M. J., de Macedo, D. D. J., Júnior, L. P., Braga, R. M. M., & Sarasa-Cabezuelo, A. (2023). Provenance Data Management in Health Information Systems: A Systematic Literature Review, *Journal of Personalized Medicine,* vol. 13, no. 6, article 991, https://doi.org/10.3390/jpm13060991

Sittig, D. F., & Singh, H. (2010). A New Socio-technical Model for Studying Health Information Technology in Complex Adaptive Healthcare Systems, *Quality & Safety in Health Care*, vol. 19, suppl. 3, pp.i68-i74, https://doi.org/10.1136/qshc.2010.042085

Shaw, T., McGregor, D., Brunner, M., Keep, M., Janssen, A., & Barnet, S. (2017). What Is eHealth (6)? Development of a Conceptual Model for eHealth: Qualitative Study with Key Informants, *Journal of Medical Internet Research,* vol. 19, no. 10, e324, https://doi.org/10.2196/jmir.8106

Shen, Y., Yu, J., Zhou, J., & Hu, G. (2025). Twenty-Five Years of Evolution and Hurdles in Electronic Health Records and Interoperability in Medical Research: Comprehensive Review, *Journal of Medical Internet Research,* vol. 27, e59024, https://doi.org/10.2196/59024

Snyder, M. E., Nguyen, K. A., Patel, H., Sanchez, S. L., Traylor, M., Robinson, M. J., Damush, T. M., Taber, P., Mixon, A. S., Fan, V. S., Savoy, A., Dismore, R. A., Porter, B. W., Boockvar, K. S., Haggstrom, D. A., Locke, E. R., Gibson, B. S., Byerly, S. H., Weiner, M., & Russ-Jara, A. L. (2024). Clinicians' Use of Health Information Exchange Technologies for

Medication Reconciliation in the U.S. Department of Veterans Affairs: A qualitative analysis, *BMC Health Services Research*, vol. 24, no. 1, article 1194, https://doi.org/10.1186/s12913-024-11690-w

Stoumpos, A. I., Kitsios, F., & Talias, M. A. (2023). Digital Transformation in Healthcare: Technology Acceptance and Its Applications, *International Journal of Environmental Research and Public Health,* vol. 20, no. 4, article 3407, https://doi.org/10.3390/ijerph20043407

Tummers, J., Tekinerdogan, B., Tobi, H., Catal, C., & Schalk, B. (2021). Obstacles and Features of Health Information Systems: A systematic literature review, *Computers in Biology and Medicine*, vol. 137, article 104785, https://doi.org/10.1016/j.compbiomed.2021.104785

Tratkowska, K. (2019). Digital Transformation: Theoretical Backgrounds of Digital Change, *Management Sciences*, vol. 24, no. 4, pp.32-37, https://doi.org/10.15611/ms.2019.4.05

Unertl, K. M., Johnson, K. B., & Lorenzi, N. M. (2012). Health Information Exchange Technology on the Front Lines of Healthcare: Workflow Factors and Patterns of Use, *Journal of the American Medical Informatics Association*, vol. 19, no. 3, pp.392-400, https://doi.org/10.1136/amiajnl-2011-000432

Unni, P., Staes, C., Weeks, H., Kramer, H., Borbolla, D., Slager, S., Taft, T., Chidambaram, V., & Weir, C. (2017). Why Aren't They Happy? An Analysis of End-User Satisfaction with Electronic Health Records, *AMIA Annual Symposium Proceedings*, vol. 2016, pp.2026-2035, https://pmc.ncbi.nlm.nih.gov/articles/PMC5333231/

van Offenbeek, M. A. G., Vos, J. F. J., van den Hooff, B., & Boonstra, A. (2024). When Workarounds Aggravate Misfits in the Use of Electronic Health Record Systems, *Information Systems Journal*, vol. 34, no. 2, pp.293-326, https://doi.org/10.1111/isj.12478

Vehko, T., Hyppönen, H., Puttonen, S., Kujala, S., Ketola, E., Tuukkanen, J., Aalto, A. M., & Heponiemi, T. (2019). Experienced Time Pressure and Stress: Electronic Health Records Usability and Information Technology Competence Play a Role, *BMC Medical Informatics and Decision Making*, vol. 19, no. 1, article 160, https://doi.org/10.1186/s12911-019-0891-z

Vial, G. (2019). Understanding Digital Transformation: A Review and a Research Agenda, *The Journal of Strategic Information Systems*, vol. 28, no. 2, pp.118-144, https://doi.org/10.1016/j.jsis.2019.01.003

Wang, W., Ferrari, D., Haddon-Hill, G., & Curcin, V. (2023). Electronic Health Records as Source of Research Data, in O. Colliot (ed.), *Machine Learning for Brain Disorders*, New York, NY: Humana, chap. 11, https://doi.org/10.1007/978-1-0716-3195-9_11

Windlinger, L., & Tuzcuoglu, D. (2021). Usability Theory: Adding a User-Centric Perspective to Workplace Management, in R. Appel-Meulenbroek & V. Danivska (eds), *A Handbook of Management Theories and Models for Office Environments and Services*, Abingdon: Routledge, pp.173-183, https://doi.org/10.1201/9781003128786-15

Winter, A., Ammenwerth, E., Haux, R., Brigl, B., Hellrung, N., Jahn, F., & Lagemann, T. (2023). Basic Concepts and Terms, in A. Winter, E. Ammenwerth, R. Haux, B. Brigl, N.

Hellrung, F. Jahn & T. Lagemann (eds), *Health Information Systems: Technological and Management Perspectives*, 3rd edn, Cham: Springer, chap. 2, https://doi.org/10.1007/978-3-031-12310-8_2

Yen, P.-Y., & Bakken, S. (2012). Review of Health Information Technology Usability Study Methodologies, *Journal of the American Medical Informatics Association*, vol. 19, no. 3, pp.413-422, https://doi.org/10.1136/amiajnl-2010-000020

Non-academic References

European Commission. (2025). European Health Data Space Regulation (EHDS), https://health.ec.europa.eu/ehealth-digital-health-and-care/european-health-data-space-regulation-ehds_en [Accessed 14 May 2026]

ISO. (2018). *ISO 9241-11:2018 Ergonomics of Human-System Interaction — Part 11: Usability: Definitions and Concepts*, International Organization for Standard

Appendix 1: AI contribution statement

Grammarly AI was used in the refinement of this assignment for spelling, grammar, punctuation, and overall readability.

Sunet Scribe AI was used in the production of this assignment for the purpose of helping facilitate the transcription of interviews with Doctors.

ChatGPT was used as a supportive language tool during the thesis, for ensuring alignment with thesis conventions and best practices, academic wording, and discussing general thesis structure.

The authors remained responsible for all content, analysis, source selection, interpretations, and final decisions.