Master Thesis

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Exploring expert perceptions regarding the diffusion of openEHR to hospitals in the Netherlands: A grounded theory approach

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Preface

Writing this thesis has been both a challenging and enriching journey. My interest in digital transformation, especially within healthcare, motivated me to explore the diffusion of openEHR to hospitals in the Netherlands. Throughout this process, I have gained invaluable insights into the complexities of healthcare interoperability, innovation diffusion and the role of strategic collaboration.

I would like to express my sincere gratitude to my supervisor, Dr. Amir Omidvari Abarghouei, whose guidance, support and critical feedback have been essential in shaping my research. Additionally, my appreciation extends to my co-reader, Mariel Jurriens, for taking the time to evaluate my thesis and for delivering stimulating lectures that supported the development and direction of this work.

Special thanks to all the experts who participated in this study. Their willingness to share their experiences, knowledge, and perspectives significantly contributed to the depth and relevance of this research.

Finally, I am deeply grateful to my family and friends for their continuous encouragement and patience throughout my academic journey. Their support has been a constant source of strength and inspiration.

I hope this thesis contributes meaningfully to the ongoing conversation about achieving sustainable, interoperable and innovative healthcare systems.

Enjoy reading,

Cassandra Bleuel
Rotterdam, June 2025

Abstract

Background and objectives: Interoperability of Electronic Health Records remains a persistent challenge within healthcare systems, critically impacting patient safety, care coordination and overall healthcare quality. The openEHR standard has gained international recognition for addressing challenges such as semantic interoperability by ensuring standardized clinical data storage. Despite its adoption in various countries, the diffusion of openEHR within Dutch hospitals remains limited. This study aims to explore how experts involved with openEHR perceive its diffusion into hospitals in the Netherlands.

Methodology: A qualitative research approach was employed using semi-structured interviews with fifteen experts from diverse backgrounds including healthcare institutions, IT vendors, governmental organizations, and research institutions involved with openEHR. The interviews were analysed using a grounded theory approach with thematic analysis structured around the Diffusion of Innovations theory (Rogers, 1962) and the Technology-Organization-Environment framework (Tornatzky & Fleischer, 1990).

Results: Five major themes emerged from the interviews: (1) the current status of openEHR in the Netherlands, (2) barriers to diffusion, (3) problems addressed by openEHR, (4) transition strategies, and (5) the role of stakeholders. Experts indicated that openEHR is currently in an early phase of diffusion within Dutch hospitals, characterized by limited awareness among clinicians and hospital executives. Identified barriers included technical abstractness, organizational resistance, insufficient internal expertise, and environmental factors such as fragmented national policy and competitive market dynamics. Conversely, openEHR's core strengths were highlighted, particularly its potential to enable semantic interoperability, vendor-neutral healthcare ecosystems and AI-driven innovations.

Participants recommended adopting a federated infrastructure approach combining bottom-up market initiatives and top-down government support. They emphasised the need for practical demonstrations, long-term strategic vision, coordinated national governance, and stronger stakeholder collaboration to successfully diffuse openEHR within Dutch hospitals.

Conclusion: This study finds that while openEHR holds significant promise for transforming healthcare interoperability in the Netherlands, substantial challenges remain. Addressing these challenges requires increasing awareness, simplifying technical complexities through tangible demonstrations, fostering effective leadership, and establishing cohesive national governance. An integrated approach combining local experimentation with strategic national alignment, supported by a federated model, appears essential to achieve openEHR adoption in Dutch hospitals, ultimately contributing to a more innovative, interoperable and future-proof healthcare system.

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Introduction

Health is one of the most valuable assets for both individuals and society. Good health enables individuals to achieve their full potential, contributes to a stronger society, and fuels the economy (Marshall, 2024). As the population ages and new diseases continue to emerge, the demand for healthcare services is increasing (da Fonseca et al., 2021). One aspect to address this growing challenge is through digital transformation in healthcare. Digital transformation in healthcare represents the adoption of digital technologies to drive innovation and enhance healthcare delivery (Holden & Karsh, 2010; Stoumpos et al., 2023).

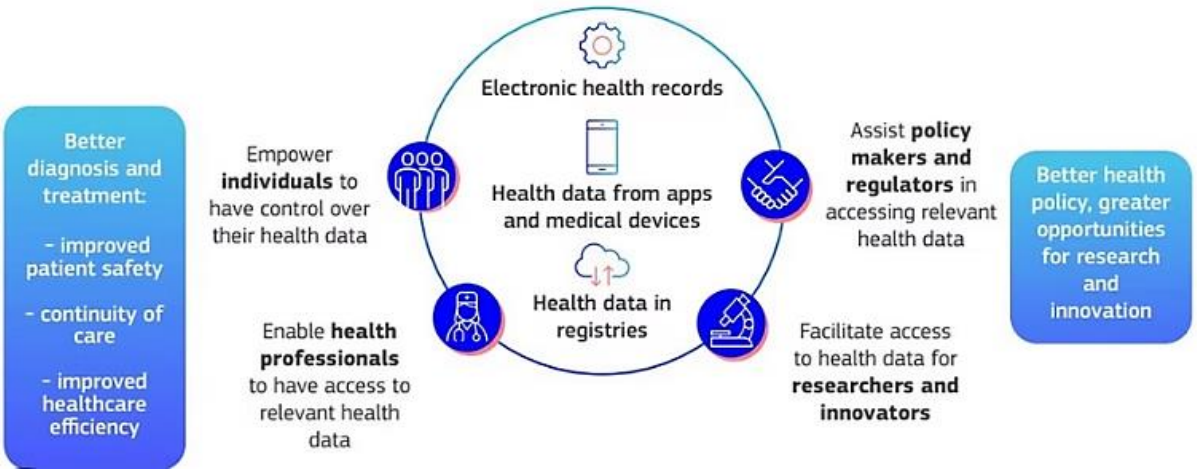
One digital technology that benefits healthcare is Electronic Health Record (EHR) systems. These enable healthcare organizations to store and manage clinical data effectively. Additionally, EHR systems enable healthcare providers to exchange data and work together to achieve better patient outcome and effective healthcare (Sreenivasan & Chacko, 2021). This ability to work together is known as interoperability. The aim of EHR systems is to enhance care coordination, reduce errors, mitigate potential risks to patient safety and improve patient outcomes (Cunha et al., 2023).

Despite the potential benefits, EHR systems continue to face challenges in their execution, for example in achieving interoperability. Patients often question why hospitals and general practices cannot seamlessly share medication lists, or why they are repeatedly get asked the same questions at every healthcare visit. Similarly, healthcare professionals express frustration over EHR systems that fail to communicate across institutions, lack interoperability, create administrative burdens and are not tailored to the usability needs of different medical specialties (Bouvier, 2024). A recent national survey conducted by the Dutch Federation of Medical Specialists found that 86% of specialists reported that data is often unavailable when needed for patient care, and 83% said they frequently have to make decisions without access to information from other healthcare providers (FMS, 2025). According to Sreenivasan and Chacko (2021), achieving better quality healthcare experiences requires the development of open frameworks for the secure and efficient exchange of EHR data between different healthcare providers.

Recently, the council of the European Union (EU) adopted the European Health Data Space (EHDS). The EHDS is a key pillar of the European Health Union and complements the General Data Protection Regulation (GDPR). The EHDS highlights that: “Digitalisation is essential for the future of healthcare. The digital transformation is crucial to provide better healthcare to citizens, to build stronger and more resilient health systems, to support long-term competitiveness and innovation in the EU’s medical industry, and to help the EU recover from the pandemic” (European Commission, 2025). Figure 1 illustrates the vision of the EHDS, emphasising that EHRs are essential for improving healthcare by integrating health data from apps, medical devices and registries, fostering innovation and shaping the future of healthcare.

Figure 1

Vision of the European Health Data Space (European Commission, 2025)



In addition to EU initiatives, the Dutch Authority for Consumers and Markets (ACM) sent an official letter to the Ministry of Health, Welfare and Sport (VWS). This letter contained an official advice to require openness of healthcare information systems to promote innovation within the Dutch healthcare sector (ACM, 2025).

Well-substantiated examples of openness of healthcare information systems are shown by Norway, Sweden and Finland. They are regarded as pioneers in adopting openEHR and moving toward an open ecosystem to promote innovation. The urgent need to share data between healthcare systems led to the establishment of national, document-based data exchange infrastructures across Nordic countries (Pohjonen, 2022).

OpenEHR, a platform designed by medical professionals to improve data standardization and exchange, seems like a promising approach. Its main idea is to standardize health-related concepts used in databases or EHR systems through a set of clinician-designed libraries, called archetypes (Cunha et al., 2022). Unlike other standards such as FHIR, SNOMED, HL7 and OMOP, openEHR focuses on long-term clinical data storage and capturing, enabling semantic interoperability and reusability. While FHIR and HL7 primarily focus on real-time data exchange and OMOP facilitates secondary use for research and analytics, openEHR provides the semantic foundation for structured clinical data storage. As Tsafnat et al. (2024) highlight, “An interoperable health system would use openEHR to collect data, FHIR to transmit data between systems and organizations and OMOP to find insights in the data”.

OpenEHR publishes technical standards for an EHR platform, defining how clinical data should be structured and stored. At the core of this approach are standardized data models which represent clinical concepts such as blood pressure, diagnoses or medication. These models, called archetypes, are developed by domain experts and made publicly available as open-source resources. This openness enables continuous improvement and refinement by experts worldwide, supporting the creation of a

unified and standardized representation of clinical data storage. As a result, openEHR is positioned as a potential enabler of a unified health information ecosystem.

In the Netherlands, openEHR has already been implemented in several EHR-related solutions, including a digital health platform by RSO Zuid-Limburg to enhance data interoperability among healthcare providers in the region Limburg (Better, 2025), an open healthcare data platform by CODE24 to facilitate interoperability and data availability across different healthcare systems (CODE24, 2025), and openEHR integration within Nedap's ONS platform, which supports data exchange in long-term and homecare settings (Nedap, 2025). However, hospitals in the Netherlands have not yet adopted openEHR within their systems. As a result, organizations involved with openEHR are likely aiming to expand adoption into the hospital in order to promote a broader interoperable and innovative health information ecosystem. Despite this interest, it remains unclear how experts within these organizations perceive the diffusion of openEHR to hospitals and what strategies they consider essential to facilitate the adoption and implementation in Dutch hospitals.

To address this gap, the research question guiding this study is as follows:

- ✓ How do experts involved with openEHR perceive the diffusion of openEHR to hospitals in the Netherlands?

This study focuses on experts from organizations involved in the development, implementation or promotion of openEHR, whose perspectives offer valuable insights into its diffusion within Dutch hospital systems.

Literature research

Digital transformation in healthcare

One of the multiple ways to describe the definition of digital transformation is "a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies" (Vial, 2019). According to the WHO (2025), the definition of digital transformation in healthcare is "the field of knowledge and practice associated with the development and use of digital technologies to improve health". Digital transformation impacts various aspects, including the adoption of digital resources, the development of digital growth strategies, the restructuring of internal organizational structures and the definition of relevant metrics and objectives (Verhoef et al., 2021). Digital transformation in healthcare involves adopting new technologies to facilitate the transition to secure high-quality care (Haggerty, 2017). Although, according to Gopal et al. (2018), healthcare has the lowest level of digital innovation compared to industries like insurance, finance, retail and media, which has led to limited labour productivity growth (Gopal et al., 2018). In a review of 45 years of literature on digital transformation

in healthcare, Marques and Ferreira identified seven key technology-related areas of research: 1) Integrated Management of Information Technology in Health; 2) Medical Images; 3) Electronic Medical Records; 4) Information Technology and Portable Devices in Health; 5) Access to E-Health; 6) Telemedicine; and 7) Privacy of Medical Data (Marques & Ferreira, 2020).

Lastly, according to Häyrinen et al., one of the needed increased levels of digital transformation in healthcare is Electronic Medical Records, also referred to Electronic Health Records. These systems serve as, "a repository of patient data in digital form, stored and exchanged securely, and accessible by multiple users" (Häyrinen et al., 2008).

Electronic Health Records

Electronic Health Records serve as digital repositories where all relevant patient information is stored. They help prevent the inappropriate administration of medical care and ensure that patients receive quick and comfortable treatment (de Grood et al., 2016). Although EHRs have great potential to enhance quality and safety in healthcare, studies indicate challenges in their adoption. According to Simon et al., despite the benefits, one in four physicians report dissatisfaction with the use of EHR systems (Simon et al., 2007).

One of the biggest challenges in digital health remains interoperability across systems. According to Fonseca et al. interoperability requires "new digital health systems that must interact with existing ones, and there should be a standard electronic language between hospitals (or clinics) to facilitate communication and data exchange, as well as formal agreements on how the system should work in a standardized way" (da Fonseca et al., 2021).

To address these challenges and establish a more interoperable, patient-centric lifelong health record with future-proof data, a non-profit organization developed a promising solution: openEHR, a set of technical open standards for EHR platforms.

openEHR

openEHR standards are designed to support long-term preservation of detailed clinical information, while accommodating the continuous evaluation of medical science. Medical concepts within openEHR are structured into archetypes, which are collaboratively developed and maintained by a global network of domain experts, including biomedical researchers, physicians and bioinformaticians. A main principle of these archetypes is the separation of clinical content from technical storage. These standardised archetypes are openly available through the Clinical Knowledge Managers an international repository. The openEHR Clinical Modelling Program ensures the continuous refinement of these models through periodic review cycles, covering their full lifecycle from initial proposal to official publication and further versioning. By leveraging this shared knowledge base, Clinical Data Repository

instances built on openEHR can quickly adapt to emerging medical concepts and unexpected use cases, as was demonstrated during the COVID-19 pandemic (Delussu et al., 2024).

The openEHR approach has gained attentions from both academia and industry, leading to the adoption in multiple countries with de goal of improving the semantic interoperability of medical information systems. Countries such as, Australia, Germany, Norway, Brazil, Sweden, the UK, China, Portugal, Denmark, Russia, Japan, Indonesia and others (Min et al., 2018a). Additionally, the feasibility of openEHR has been demonstrated across various domains, including genomics, clinical data sets, registries, decision support systems, and EHRs (Min et al., 2018b).

Target group

The target group for this study consist of experts actively involved in the development, promotion and implementation of openEHR. These experts work at openEHR vendors, open-source initiatives, public-private networks, government bodies, research institutions and healthcare organizations piloting openEHR. They hold critical positions that influence the diffusion of openEHR within Dutch hospitals.

According to da Fonseca et al. (2021), the success of digital health initiatives depends on various systemic and organizational factors, including infrastructure design, user acceptance, and governance practices. They identify four stakeholder groups that shape these outcomes: healthcare professionals, entrepreneurs, policymakers and patients. The experts interviewed in this study primarily align with the first three of these stakeholder groups, as they are involved in designing, implementing and advocating for interoperable EHR systems in the Netherlands.

Building on da Fonseca's stakeholder framing, this study also integrates Rogers' (1962) Diffusion of Innovation (DOI) theory, which introduces the concept of change agent, individuals who actively promote or facilitate the diffusion of innovation. In this context, the experts in this study can be understood as such change agents: they develop technical solutions, advise on policy, and work toward embedding openEHR within existing healthcare systems. By exploring their views, this study investigates how the diffusion of openEHR is perceived and which conditions are considered essential for diffusion of openEHR to the Dutch hospital domain.

Theoretical framework

A theoretical framework provides the foundation for a study by connecting relevant theories, concepts, and models to the research focus. It serves as a blueprint that shapes the research design, questions, and analysis, ensuring a structured and meaningful approach (Grant & Osanloo, 2014; Varpio et al., 2020).

Through a systematic literature review, Sadoughi et al. (2019), provided an overview of the theories used to explain the adoption of electronic health record. The adoption models presented in Table 1 provide the most widely used technology adoption theories and their associated factors. Based on

these theories, the most relevant and impactful theories for this study were selected to develop a grounded theoretical framework for understanding the diffusion of openEHR to Dutch hospitals through the perspective of experts.

Table 1

A comprehensive overview of adoption theories and justification for in- or exclusion in this study, based on Sadoughi et al. (2019)

No.	Technology adoption theory; Developer(s) (Year)	Main constructs / Factors	Justification for inclusion or exclusion in this study	Level of Analysis
1	**Social Network Analysis (SNA);** Milgram, Granovetter, Barnes, Mitchell (1930s)	- Node size - Density - Link strength	**Excluded**: because it focuses on network interactions rather than technology adoption behavior. OpenEHR adoption requires a framework analyzing organizational and industry-level adoption, not social networks.	Individual, group, network
2	**Diffusion of Innovations (DoI) / Innovation Diffusion Theory (IDT);** Rogers (1962), Rogers & Shoemaker (1971), Rogers (1995)	- Compatibility of technology - Complexity of technology - Relative advantage - Trialability - Observability	**Included**: **Chosen because it explains how openEHR adoption spreads over time and identifies early adopters, laggards, and industry-wide trends in hospitals.**	Group, firm, industry, society
3	**Institutional Theory;** Selznick, DiMaggio, Scott, Zucker (1970s)	- Institutional emergence - Conformity - Change - Isomorphism	**Excluded**: because it focuses on how institutions shape norms and policies, rather than technology adoption processes at the organizational level.	Group, firm, industry
4	**Theory of Reasoned Action (TRA);** Fishbein (1967), Fishbein & Ajzen (1975)	- Behavioral intention - Behavior	**Excluded**: because it primarily explains individual behavior, whereas openEHR adoption is influenced by organizational, regulatory, and technological factors.	Individual
5	**Theory of Planned Behavior (TPB);** Ajzen (1985), Ajzen (1991)	- Behavioral intention - Behavior - Perceived behavioral control	**Excluded**: because openEHR adoption is not just about individual behavior, but also organizational and industry-wide influences.	Individual
6	**Theory of Interpersonal Behavior (TIB);** Triandis (1977)	- Habit - Intentions - Facilitating conditions	**Excluded**: because openEHR adoption is driven more by policy, technical, and business factors, rather than habitual behavior.	Individual
7	**Stakeholder Theory;** Freeman (1984)	- Firm performance - Stakeholder interests	**Excluded**: because, while stakeholder perspectives matter, the theory does not explain how technology adoption occurs within EHR systems.	Firm
8	**Technology Acceptance Model (TAM);** Davis (1986, 1989)	- Behavioral intention to use - System usage	**Excluded**: because TAM focuses only on individual user acceptance (e.g., doctors and nurses), while this study examines organizational adoption of openEHR.	Individual
9	**Technology-Organization-Environment (TOE) Framework;** DePietro, Wiarda, & Fleischer (1990)	- Environmental context - Technological context - Organizational context	**Included**: **Chosen because it explains both internal (company capabilities) and external (regulatory, industry) factors that affect openEHR adoption in Dutch hospitals.**	Firm / Organization
10	**Modified TAM (TAM2);** Venkatesh & Davis (2000)	- Behavioral intention to use - System usage - Perceived usefulness - Social influences	**Excluded**: because, while it includes social factors, it is still user-centric and not designed for organizational or industry-wide adoption.	Individual
11	**Unified Theory of Acceptance and Use of Technology (UTAUT);** Venkatesh et al. (2003)	- Performance expectancy - Effort expectancy - Social influence - Facilitating conditions	**Excluded**: because UTAUT explains individual technology adoption rather than organizational or system-level perspective.	Individual

12	**Modified UTAUT (UTAUT2);** Venkatesh et al. (2012)	UTAUT + - Hedonic motivation - Price value - Habit	**Excluded**: because UTAUT2 focuses on consumer adoption and user behavior, whereas openEHR adoption is a strategic decision influenced by industry regulations and interoperability concerns.	Individual

As shown in Table 1, two models have been selected for this theoretical framework, namely DOI and TOE. Together, these models provide a comprehensive foundation to identify and analyse factors influencing the diffusion and adoption of openEHR in Dutch hospitals from the perspective of experts.

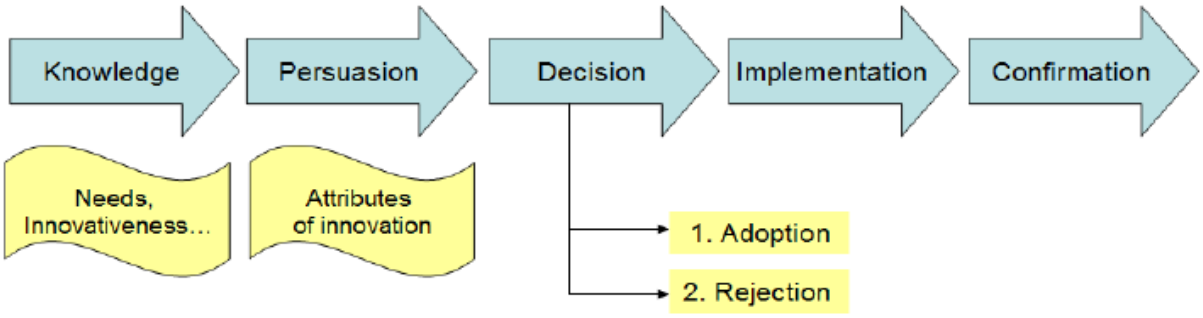
Diffusion of Innovation theory

"Over the past two decades, the DOI theory has been one of the most applied theoretical models used to investigate the organizational adoption of information system innovation" (Sadoughi et al., 2019). The diffusion of innovation theory (DOI), developed by Rogers, describes the main elements that contribute to the adoption and diffusion of innovations and explains how an innovative idea spreads over time (Rogers, 1962). Rogers proposes five main elements that influence the spread of a new idea: the innovation itself, adopters, communication channels, time, and a social system. Rogers says that diffusion of innovation heavily relies on social impact; the adoption must be widely adopted in order to self-sustain. The adopters consist of five different categories: innovators, early adopters, early majority, later majority and laggards. The diffusion of innovation is dependent on the type of adopters and the 'innovation-decision process' (Rogers, 1962).

The innovation decision-making process describes five stages a decision maker goes through when deciding to adopt the innovation. These five stages are knowledge, persuasion, decision, implementation and confirmation (see Figure 2).

Figure 2

The five stages of the innovation-decision process in DOI theory, based on Rogers (1962)



In the innovation decision-making process, the first stage is knowledge stage, where the decision-maker is initially introduced to an innovation and begins to understand the innovation. This is followed by the persuasion stage, where the decision-maker develops either a positive or negative attitude toward the innovation. According to Rogers (1962), several attributes shape this attitude, including relative

advantage, compatibility, complexity, trialability (experimental options) and observability (the ease for others to see results of adopting an innovation). Additionally, Rogers identifies three specific organizational characteristics that potential adopters evaluate before deciding whether to adopt an innovation. For organizations these are 1) Tension for change; the organization's motivation and ability to change (linked to relative advantage), 2) innovation-system fit; how well the innovation aligns with existing systems (compatibility) and 3) assessment of implications; the perceived impact and visibility of the innovation's outcomes (observability). These attributes interact holistically in the adoption process. For instance, if an innovation is extremely complex, the likelihood of adoption may decrease. However, if it provides a strong relative advantage and high compatibility with existing systems, organizations may still proceed with adoption despite the steep learning curve.
Following the persuasion stage, the third stage is the decision stage, where the decision-maker chooses to adopt or reject the innovation. If adoption occurs, the process moves into the implementation stage, where the innovation is actively put into practice. Finally, in the confirmation stage, the decision-maker seeks additional information after adoption to either reinforce their decision or reconsider the innovation.

According to Rogers (1962), innovations in organizational settings are typically adopted through one of two types of innovation decisions: collective or authority innovation decisions. In the first type, adoption occurs through consensus among multiple stakeholders within the organizations. In contrast, authority innovation decisions are made by a small group of leaders, often influenced by governance policies (Rogers et al., 1962).

Additionally, as discussed in the literature review, Rogers introduces the concept of "change agents"; individuals or entities that promote or facilitate the adoption of innovation. In this study, the question that arises based on Rogers' language is: How do 'change agents' perceive the 'decision-making process' of early adopters?

Complementary to the diffusion of innovation theory, the TOE framework focuses more on structural, organizational and market-related factors, which is interesting for understanding how these elements relate to the adoption and implementation of openEHR in Dutch hospitals and shape decision-making processes.

Technology Organization Environment

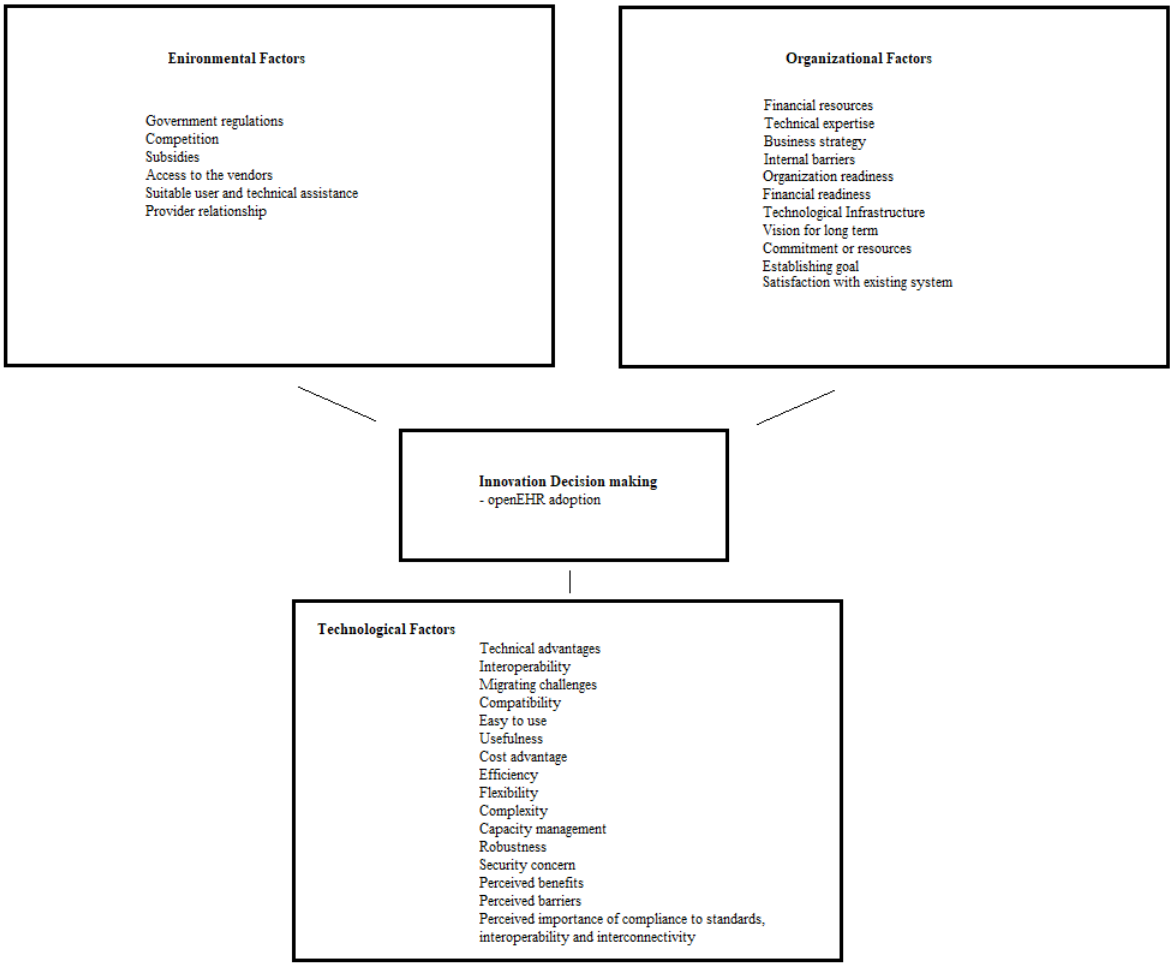
The second theoretical model that is used for the theoretical framework of this study is the Technology Organization Environment (TOE) framework (Tornatzky et al., 1990). The TOE framework has been widely applied in various studies to evaluate the adoption of technology innovations, including hospital information systems, Green IT and Software-as-a-Service etc. (Cruz-Jesus et al., 2019). To understand how external and internal factors influence the adoption of new technologies at the organizational level,

TOE provides a grounded theoretical model. It asserts that the decision to adopt technological innovation is based on environmental and organizational factors as well as technological characteristics. Therefor a grounded theoretical model for the adoption of openEHR in Dutch hospitals.

TOE identifies three different elements which influence adoption decisions for technological assumption and execution. These three elements are 1) technological factors, 2) organizational factors and 3) environmental factors. E.g. 1) technical advantages or interoperability and migrating challenges, 2) financial resources and technical expertise or business strategy and internal barriers and 3) government regulations, competition or subsidies (Tornatzky et al., 1990).

Figure 3

Created TOE framework for this study



TOE has been applied to explain the adoption of innovations across various industries, such as retail, financial services, healthcare, manufacturing and wholesale (Baker, 2024).

TOE provides a grounded theoretical model for this study. In combination with DOI, they form a comprehensive theoretical framework for this study. These models work well alongside each other, as they complement different aspects of the diffusion and adoption process. DOI explains how openEHR adoption spreads across organizations. And TOE provides insights into the structural, organizational,

and external factors that influence adoption decisions, such as IT infrastructure, regulatory policies and market conditions. By integrating these models, this study provides a holistic perspective on the diffusion of openEHR in EHR systems of Dutch hospitals perceived by experts, capturing innovation diffusion along with organizational and environmental factors in the adoption process.

Table 2

Created Table overview of theoretical framework of this study

Theory/Model	Key constructs	Relevance to study	Application to openEHR adoption in Dutch Hospitals
Diffusion of Innovation (DoI) (Rogers, 1962)	- Innovation adoption process (Knowledge, Persuasion, Decision, Implementation, Confirmation) - Adopter categories (Innovators, Early Adopters, Early Majority, Late Majority, Laggards) - Change agents	Explains how and why organizations adopt new technologies over time	- Identifies how openEHR adoption spreads among Dutch hospitals - Helps categorize experts related to openEHR organizations as change agents influencing adoption
Technology-Organization-Environment (TOE) Framework (Tornatzky & Fleischer, 1990)	- Technological Factors (Interoperability, Data Migration Challenges) - Organizational Factors (Financial Resources, IT Expertise, Business Strategy) - Environmental Factors (Regulations, Market Pressure, Incentives)	Explains structural, organizational, and market-related influences on technology adoption	- Identifies external pressures and internal challenges affecting openEHR implementation - Provides insights into how hospitals can integrate openEHR with existing EHRs

Methodology

Research design

This study adopted a qualitative research design using semi-structured interviews to gain in-depth insights into the perceptions of openEHR experts regarding the diffusion of openEHR to Dutch hospitals. Given the complexity of healthcare IT diffusion and adoption, an exploratory approach was appropriate to understand the perspectives, barriers, and facilitators influencing the diffusion and adoption processes. To systematically explore these perceptions, this study adopted a grounded theory approach, allowing for a structured and flexible analysis of emerging themes.

Sampling

Participants were selected through purposive sampling. Participants were carefully chosen based on their role within the Dutch health information ecosystem and experience with openEHR. An openEHR expert was defined as an individual who has worked with openEHR in their daily professional activities for at least two years. This criterion ensured that all participants possessed substantial knowledge and practical experience relevant to this study's objectives. These individuals were affiliated with a diverse range of organizations, including vendors, public-private initiatives, research institutions, government bodies, and hospitals piloting openEHR. To broaden the pool of relevant participants, snowball sampling was used alongside purposive sampling, allowing initial participants to refer other

knowledgeable experts within their professional networks. Recruitment took place via openEHR-related events, professional networks, and direct outreach. Data saturation was considered achieved when no new themes or insights emerged during the final interviews, in line with grounded theory principles. In total, 15 experts that met the selection criteria were interviewed.

Data collection

Data was gathered through semi-structured interviews conducted between March and April. These interviews took place either at the participants' workplaces or via videoconferencing. Each interview lasted approximately one hour and was conducted under strict confidentiality to ensure participant privacy. Prior to the interviews, informed consent was obtained from all participants, which included permission for video and audio recording as well as assurances of anonymity and data security (Appendix A). With participants' consent, all interviews were recorded and later transcribed pseudonymously using the transcription software from Microsoft Teams. To ensure accuracy, automated transcriptions were manually reviewed and corrected as needed. To maintain theoretical grounding, the interview guide was based on the DOI and TOE frameworks (Appendix B). Interviews were conducted in either Dutch or English, depending on participant preference.

Data analysis

A thematic analysis was conducted using open, axial and selective coding. The coding process was structured around the DOI and TOE frameworks to maintain theoretical consistency. Initially, open coding was conducted in parallel with data collection, supported by ATLAS.ti, to identify emerging themes and concepts. This allowed insights from earlier interviews to inform subsequent discussions. Following this initial phase, axial coding was performed to organize and group initial codes into broader thematic categories. The final step involved selective coding interpreting relationships between themes, providing the overarching themes presented in the results, offering a cohesive understanding of the dynamics influencing openEHR diffusion to Dutch hospital (Appendix C).

Ethical considerations

This study follows ethical research standards to ensure participant confidentiality and data protection. Participants were fully informed about the study and provided written consent (Appendix A). All personal identifiers were removed from transcripts, and data was securely stored. Reflexive practices were used throughout to reduce potential researcher bias. The interview strategy was informed by qualitative best practices, including insights from Hermanowicz (2002), to enhance the richness and reliability of the data.

Results

Overview

This section presents the findings which were gathered from analysing the interviews with experts. First the cases from the interviews are described as well as a table overview with the demographics of each participant. Then, five major themes are discussed that emerged from the data analysis of the interview data. The themes reflect the perceptions of experts regarding the potential diffusion of openEHR into Dutch hospitals. The five themes are: the current status of openEHR toward the diffusion into Dutch hospitals, barriers to the diffusion of openEHR, problems addressed by openEHR, transition strategies and long-term vision or openEHR, and important stakeholders in the diffusion of openEHR. Each theme is illustrated with direct quotations form participants. An overview of the coding scheme, including the selective, axial, and open codes, is provided in Table 4. The complete codebook with representative quotations, can be found in Appendix C.

Case description

The demographics of the participants are summarized in Table 3. All participants have been given an anonymized ID number which does not reflect the order of participation and identifying information has been removed to ensure confidentiality. In total, fifteen experts involved with openEHR were interviewed. All participants had professional backgrounds in health and IT, disrupted in primary backgrounds in either health, IT or both. This distribution reflects their career path, participants started in one domain a later transitioned into the combined field of health informatics. Five participants had a primarily IT background, four came from clinical domains, and six had integrated health IT expertise from the beginning of their careers. Participants represented a diverse set of stakeholders, including C-level executives, software and infrastructure architects, medical doctors, standardisation experts, and information architects. Their professional backgrounds spanned hospitals, IT vendors, governmental bodies, and founding openEHR organizations. All participants have extensive experience with EHR systems, and they had at least two years of experience with openEHR. With some involved in the earliest development and standardisation of openEHR in the Netherlands. Almost all participants were male, mostly because of the gender imbalance commonly observed in the IT sector. Further, the participants differed in age and experience, with the lowest experience being two years and the highest over 20 years in openEHR.

Table 3

Participant demographics and roles

ID	M/F	Role description	Years IT Experience	Years Healthcare Experience	Years openEHR Experience	Type of Organization	Interview Duration H:MM
01	M	EHR standardisation expert	40	60	20	National standardisation institute (VWS, ex-TNO)	1:16
02	M	C-level Software Architect & Engineer	30	25	15	Founding member of openEHR & openEHR Vendor	1:26
03	M	C-level Business Developer	40	40	20	openEHR Vendor	0:58
04	M	Medical Doctor & Software Developer	8	15	6	Founding member of openEHR & Hospital	1:08
05	M	C-level EHR Standardisation Expert	40	40	10	Founding member of openEHR & openEHR Vendor	1:09
06	M	Healthcare Manager	10	8	5	openEHR Vendor	1:25
07	M	C-level Business Manager	10	5	5	openEHR Vendor	1:24
08	M	C-level Medical Doctor & IT Specialist	35	45	15	openEHR Vendor	1:10
09	M	Medical Doctor & Facilitator of openEHR Pilots	2	20	2	Hospital piloting openEHR	1:14
10	F	Director, Health IT Adviser	35	35	10	Founding member of openEHR & Vendor	1:04
11	M	Infrastructure Developer	15	2	2	IT Vendor	1:23
12	M	Standardisation Expert	12	12	5	EHR Vendor	1:03
13	M	Medical IT Specialist	10	12	10	Hospital piloting openEHR	1:26
14	M	Software Architect	35	20	6	openEHR Vendor & Government	1:27
15	M	Information Architect	10	8	3	Hospital & IT Vendor	1:10

Table 4

Thematic structure overview, based on selective, axial and open coding

Selective Code	Axial Code	Open Code
1 Current openEHR	**1.1 Core of openEHR**	Long history and international adoption of openEHR standard; Standardization as a core strength of openEHR
		Two-level modeling using archetypes; Flexibility and reusability; Decoupling of clinical concepts from IT
		Modular development without needing coding changes
	1.2 Knowledge-phase (DOI)	Insufficient knowledge among healthcare professionals about openEHR; Limited awareness among hospital executives
		Hospitals lack awareness of openEHR's benefits; Unclear differentiation between openEHR and existing EHR solutions
		Government role crucial in enhancing awareness
		Need for leadership combining medical and technical expertise
	1.3 Increasing openEHR	Growing momentum and interest internationally
		Positive adoption trends for openEHR
2 Barriers	**2.1 Technological barriers**	Complexity and abstraction of openEHR standard challenging adoption, it's a steep learning curve
		Need for clear, practical demonstrations (proof of concepts, pilots) to reduce abstractness and complexity
	2.2 Organisational barriers	Vendor lock-in and high investments in current systems inhibit switching; Current systems considered stable and reliable, reducing incentive to switch
		Insufficient expertise available to bridge clinical and technical aspects; Need for leadership combining medical and technical expertise
	2.3 Environmental barriers	VWS is still searching for a clear position, often sending mixed signals and a wide growth of initiatives; need for governance
		Smaller innovative companies lacking trust from healthcare organizations; competitive market dynamics
		Government focus primarily on standardizing interfaces rather than data storage

3 Problems addressed by openEHR	**3.1 Technological solutions**	Interoperability and data exchange problems solved through standardized data storage
		Data longevity: Ensures data remains readable and usable over time
		OpenEHR perceived as the optimal standard for future healthcare IT sustainability
		Legacy EHR systems are no longer sustainable
	3.2 Organizational solutions	Increases data control and independence from software vendors
		OpenEHR essential for effective AI implementation
	3.3 Environmental solutions	Enhances flexibility in choosing and switching application providers (nationally and internationally)
		Best-of-breed approach becomes feasible, promoting specialized applications and innovation by smaller vendors
		International collaboration and interoperability for trust and incentives
4 Vision and Strategy	**4.1 Long-term vision**	Hospitals need to go through a strategic transformation to move to sustainable IT
		Many institutions lack the courage or long-term vision to invest today for benefits in 5-10 years
		Modular open platforms enable participation of small vendors and best-of-breed systems
	4.2 Transition strategies	A stepwise approach (small pilots) enables adoption without disrupting existing systems; Use a (bottom-up) openEHR CDR as an additional module, not as a replacement
		Futureproofing via local CDR for data archiving, scientific research, and AI is a motivator
		Clear alignment and coordination from government for all stakeholders (top-down)
	4.3 Federated model	Change requires both top-down and bottom-up traction; Federated model supports local data control and regional collaboration
		It is important to think federally for true interoperability
		Federated model is a good approach to ensure interoperability and aligns with the EHDS
5 Stakeholders	**5.1 Government**	Government plays a critical role by setting quality standards and providing legal/policy direction
		There is insufficient national leadership and tempo to guide adoption, more top-down coordination, mandates, and incentives (e.g., subsidies) are needed
		VWS is still searching for a clear position, often sending mixed signals, and too focused on current legacy systems (e.g., ZIBs)
		So far, focus has been mostly on interface-level (FHIR) standardization rather than data storage (e.g., openEHR)
	5.2 Stakeholders and collaboration	The system works only when all stakeholders participate, interoperability and shared standards require collective commitment
		Peer influence and opinion leaders are crucial (e.g., 'sheep over the dam' effect)
		Healthcare professionals and clinical informatics play a key role in building enthusiasm among boards
		Cultural and social dynamics strongly influence decision-making, even more than rational arguments

1. The current status of openEHR toward the diffusion into Dutch hospitals

This section describes the current state of openEHR in relation to the diffusion within Dutch hospitals. It explores three key areas that emerged from the interviews: (1) the perceived core strengths of openEHR, (2) its position within the DOI framework, and (3) growing international developments and early signs of momentum in the Netherlands.

1.1 Core of openEHR

Participants consistently highlighted several technical and organizational features that separated openEHR from other health IT standards. A frequently mentioned strength was the clinical knowledge which is captured within the openEHR standard. One participant explained this integration of clinical knowledge:

> *"In the early 90's openEHR originated as a research-driven, academic initiative in London. This researched focused on developing an EHR architecture through empirical research rather than top-down standardization." (ID01)*

This academic and clinical foundation was seen as unique feature of openEHR.

> *"Because of its history the standard already captures a significant number of clinical concepts." (ID04)*

"As far as I know, this is the only standard which captures the clinical knowledges into the standard like this." (ID05)

"*openEHR allows for clinical modeling, data structures that are actually created by doctors and nurses" (ID13)*

In addition, this captured clinical knowledge within the standard enables a two-level modelling approach, which separates clinical content from technical infrastructures. This separation allows the data layer to evolve independently of the applications layer, enabling flexibility and innovation. As participants explained, this structure enables rapid development without the need for deep technical knowledge of the database:

"You can relatively easily build an application on top of an openEHR database without needing to understand the full database structure … that's where a lot of innovation can happen." (ID02)

"You can change your data models without changing your code or database." (ID04)

Another participant added that this enables future-proof scalability and adaptability:

"This is future-proof. You can build EHR applications on top and reuse the data however you want." (ID13)

Lastly, a further benefit of this two-level modelling is that it allows healthcare organizations to maintain ownership and control over their own clinical data:

"That you have control over your own data, that is by far the biggest advantage of openEHR." (ID05)

This control, combined with the openness of openEHR results in one of the commonly describe biggest benefits, namely a vendor-neutral environment, which is seen as essential to promote collaboration, innovation and sustainability:

"It's open, it's flexible and it allows us to keep control." (ID08)

"With openEHR, your data is no longer bound to the software of one vendor. That's the biggest game changer." (ID13)

"You store the data in a way that remains useful in the future, that's what openEHR enables." (ID15)

1.2 Diffusion of Innovation: openEHR positioned in the knowledge-phase

According to twelve of the fifteen participants, openEHR is currently situated in the knowledge phase of Rogers' DOI model. At this early stage, knowledge of the innovation is limited, and stakeholders are still becoming familiar with the existence, relevance, and potential value of openEHR.

"We are in an early phase for adopting openEHR in hospitals." (ID02)

"There are no large-scale adoptions yet." (ID03)

While a small group of clinical informatics experts are familiar with the concept, most hospital boards and healthcare professionals don't know or have to grasp what openEHR is, what it offers and how it differs from existing EHR solutions.

> *"There's still too much unfamiliarity, especially among hospital boards." (ID09)*
>
> *"Hospitals are still barely aware of what openEHR actually does." (ID08)*
>
> *"If organizations truly understood what openEHR could mean, they would have already started exploring it. But they simply don't know what it is." (ID01)*

Participants also mentioned that the complexity and technical abstraction of openEHR, particularly concepts like archetypes and templates, make it difficult to communicate and limits the understandability among non-technical stakeholders. One participant noted:

> *"The two-level modelling are clinical defined concepts captured into something abstract, which are called archetypes these are hard to understand for non-technical people…" (ID01)*
>
> *"You need quite a bit of IT understanding to see what problem openEHR actually solves." (ID04)*

These responses indicate that, awareness is growing among experts, although openEHR has not yet reached a stage of widespread experimentation or diffusion into most Dutch hospitals.

1.3 Growing momentum and international development of openEHR

Although openEHR is still in the early stages of diffusion, participants frequently mentioned the observed growing international momentum.

> *"Yes, Norway, Sweden, Australia, Germany, Spain, Estonia and Slovenia implemented openEHR all with great successes." (ID03)*

In the Dutch context, participants acknowledged that the market remains conservative, although it is slowly becoming more open to new, disruptive digital solutions. Interest is increasing also due to dissatisfaction with current limitations and non-future-proof legacy systems:

> *"The market is increasingly looking for disruption in how systems are built." (ID08)*
>
> *"The influence of openEHR on how we think about health IT is growing." (ID04)*

Despite these signals, most implementations in the Netherlands remain small in scale and limited in scope. Participants described an increase in pilots, but insufficient to drive broader hospital adoption.

> *"It's slowly increasing with several experiments, but it's still too small and happening in too few organizations." (ID15)*
>
> *"It's building up, but we are still in a too early stage for widespread adoption in hospitals." (ID02)*

2. Barriers to the diffusion of openEHR

Despite the promising features of openEHR and increasing international momentum, participants identified a range of barriers that hinder the diffusion to Dutch hospitals. These barriers span

technological, organizational and environmental domains, aligning with the structure of the Technology-Organization-Environment (TOE) framework.

2.1 Technological barriers: Complexity, abstractness and real-world demonstrations

All participants unanimously conceived the technological factors as the least major obstacle. However, despite this agreement, participants still perceived the complexity and abstract nature of openEHR as a barrier, as briefly mentioned earlier. Concepts such as archetypes, templates and two-level modelling are unfamiliar to most healthcare professionals and difficult to translate into practical benefits:

> *"The abstraction and complexity of the standard is a huge barrier, although it is a steep learning curve." (ID04)*

Participants described this learning curve as an initially period of intense learning and hands-on experiences, followed by faster progress as their understanding of the layered architecture of openEHR develops more easily.

> *"The complexity is challenging, what openEHR actually tries to do is to get the complexity of the real world into models and that gives you complex models, so that makes it complicated to understand what exactly happens when you start using openEHR." (ID04)*
>
> *"It's an abstract specification and a steep learning curve … you need hands-on experience to eventually understand it." (ID03)*

This technical sophistication was viewed as a deterrent for healthcare professionals and decision-makers, particularly those without an IT background. As one expert noted:

> *"Understanding archetypes, templates, and two-level modelling requires domain-specific expertise" (ID10).*

Additionally, to this necessity understanding, participants highlighted the need for simplification and more direct alignment between openEHR and real-world applications, especially for clinicians.

> *"Simplification is needed, the data layer for end users in healthcare is not relevant, they just want working applications." (ID05)*

Without this translation openEHR remains theoretical and inaccessible to many stakeholders. To bridge this gap, participants emphasized the importance of concrete, use-case-driven examples that demonstrate how openEHR can solve real clinical problems. These examples could help overcome resistance and presents the value of openEHR.

> *"It is important for stakeholders to clearly demonstrate how openEHR meets clinical needs." (ID02)*
>
> *"Organizations need concrete examples to overcome these abstractions." (ID08)*

2.2 Organizational barriers: Fear, locked-in and leadership without long-term vision

A significant barrier related to the organisational factors of hospitals was a widespread fear of transition. Participants pointed to hospitals hesitancy due to perceived risks, tightly integrated existing systems and fiascos from the past involved in switching systems. As one participant stated:

> *"They don't dare to make the switch, they don't know enough about it and they are not convinced enough yet." (ID05)*

This was further reinforced by the perception that current systems are seen as stable and reliable, reducing the urgency or need to transition:

> *"Most CEOs will choose the safe route, they will stick with the existing vendor." (ID02)*

In addition, long-term contracts, heavy investment and integrated workflows with existing EHR systems, hinders diffusion significantly:

> *"They are locked into their current systems… invested capital in current systems is the biggest blocker." (ID01)*

Participants also mentioned that existing vendor systems are tightly coupled with hospital finance mechanisms, such as DBCs (diagnosis-treatment combinations). This financial integration further complicates a potential transition to an openEHR-based system, as it would require a rethinking of administrative and financial workflows.

Furthermore, most participants emphasized the lack of in-house expertise at the intersection of healthcare and IT. Participants stated that many organizations lack staff who can effectively bridge clinical, managerial and technical domains. This shortage called to the need of leadership with this knowledge.

> *"Hospitals need leaders with knowledge of healthcare, IT and people management who they can follow, but this combination is really rare." (ID13)*
>
> *"There's curiosity about openEHR, but very few hospitals have the time or staff to actually try it themselves" (ID15).*

As well as that most professionals without this knowledge don't see the long-term vision and added value of openEHR. As one participant said:

> *"Hospitals or professionals that see the long-term value of owning and controlling their data will definitely drive openEHR adoption" (ID10)*
>
> *"Institutions with more knowledge in this field for example through R&D activities and prioritizing data ownership are more inclined to adopt openEHR" (ID04).*

2.3 Environmental barriers: Government, governance and market dynamics

In addition to technical and organisational challenges, participants also highlighted a range of environmental barriers affecting the diffusion of openEHR in Dutch hospitals.

2.3.1 Government Influence

The role of the Dutch government emerged as a critical factor influencing the diffusion of openEHR. A frequently mentioned issue for openEHR was the government's perceived preference for FHIR (Fast Health Interoperability Resources) over openEHR. One participant stated:

> *"The government has chosen FHIR, they have a big impact on whether adoption happens." (ID08)*

Participants acknowledged that while FHIR plays an important role in enabling interoperability at the level of data exchange, openEHR serves a different but complementary role in long-term data storage. However, the government's preference appears to have diverted attention and resources away from openEHR's potential, rather than both standards complementing each other as exchange and long-term data storage. One expert summarized this concern as follows:

> *"There is still a focus on standardization of exchange not of storage like openEHR, they are still focused on FHIR and ZIBs... They got it wrong from the start." (ID10)*

Nevertheless, several participants noted that efforts are already in progress to integrate openEHR with other standards, such as FHIR and ZIBs (Dutch Clinical Building Blocks).

Despite these efforts, the few government-led pilots and proof-of-concept projects with clear subsidy schemes were also identified as a major gap. Participants argued that tangible demonstrations, particularly in collaboration with care organizations, are essential for validating the viability of implementations with openEHR. As several participants said:

> *"Too few proof-of-concepts from government with healthcare organizations." (ID05)*
>
> *"There's currently no funding for hospitals to even start with openEHR. For FHIR we had subsidy programs, openEHR doesn't have that yet." (ID13).*

Despite this small scope of initiatives from the government, participants mentioned that these initiatives along with non-governmental initiatives were developed separately, which results in scattered approaches that risk stalling large-scale adoption. As experts said:

> *"We've got Nictiz and VZVZ, and other initiatives, all with the same goals, but no one is really in charge. There's no central coordination" (ID13)*
>
> *"There's a wild growth of regional initiatives all solving the same problems. It costs tons of money, and no one is coordinating." (ID15)*
>
> *"We need a national body with both expertise and authority to not only suggest, but to enforce decisions." (ID13)*

2.3.2 Governance and archetype management

Another environmental barrier identified by participants concerns the lack of governance for archetype development and reuse, which is highly important for interoperability among systems. Without alignment across hospitals, divergent modelling practices could increase, undermining the data consistency across organizations:

> *"You cannot scale openEHR in the Netherlands without some national decisions on archetypes." (ID15)*

Several participants proposed more coordinated use of the CKM (Clinical Knowledge Manager) and national archetype registries to guide implementation. Stronger governance was seen as indispensable for successful diffusion of openEHR to Dutch Hospitals. As one particpant noted:

> **"***Implementation strategy and governance must be clearly defined if we want it to work." (ID09).*

Without central governance structures, the potential for openEHR to serve as an interoperable data platform across Dutch hospitals remains limited.

2.3.3 Competitive market dynamics

The third environmental barrier relates to a prominent emerged theme namely, the competitive dynamics within the Dutch EHR market. Participants described the current market as dominated by a few large EHR vendors, whose influence poses significant challenges to innovation and openness. These vendors hold market power, often reinforced through long-term contracts and closed hospital systems. One participant said:

> *"They have signed long and heavy contracts… You don't just throw away this invested capital" (ID07).*

Several experts highlighted that these vendors have little incentives to open their systems or adopt open standards for data exchange. They benefit from maintaining proprietary systems, thereby obstructing interoperability. As one participant noted*:*

> *"Big companies don't have the incentive to move." (ID06)*
>
> *"You are now being blocked because that supplier owns the data." (ID05)*

Smaller and more innovative vendors are negatively affected by this competitive landscape and face structural limitations due to closed systems. These entities are often excluded from collaborating due to lack of interoperability or limited access to hospital data environments. In addition, participants observed that innovative startups face a lack of trust from healthcare institutions, which tend to favour proven, risk-averse solutions over newer, more open and innovative alternatives.

> *"Smaller vendors are restricted by larger, dominant providers, and hospitals don't easily trust new solutions" (ID10).*

3. Problems addressed by openEHR: Solutions, incentives and value propositions

Besides the considerable barriers of openEHR related to technological, organizational and environmental factors of hospitals. openEHR also uniquely solves some challenges, which can't be yet done by another existing standard. This section explores the value propositions and solutions openEHR offers. As one participants reflected:

"It won't solve all your problems, but what it solves, it does pretty well." (ID04)

3.1 Technological solutions, incentives and value propositions

The core technological benefit, already mentioned in 1.1 Core of openEHR, was the ability to solve interoperability issues by standardizing clinical data independently of specific software applications or databases, ensuring consistent semantics across hospitals. One participant put it simply:

"The exchange problem is then solved." (ID06)

"If everyone implements openEHR, you actually no longer have an integration problem." (ID04)

"Data is uniformly defined independent of the system or database, this enables exchange with multiple parties." (ID03)

Several interviewees perceived openEHR as the only viable long-term solution for health data architecture. As one participant summarized:

"*openEHR is the only way forward in healthcare and IT." (ID05)*

This perception reflects the ability of openEHR to promote future-orientated and sustainable data management. Participants highlighted the role in enabling sustainable and reusable data structures, allowing long-term data longevity and future readability across organizations.

"Flexibility of the systems and longevity are important, people born today can still read and understand the data." (ID08)

Others described the model as a foundation for health data archives, ensuring that information remains accessible and valuable in the long term.

"You store the data in a way that remains useful in the future. That's what openEHR enables" (ID10).

This perspective was linked to openEHR's value as a vendor-neutral standard, allowing the creation of sustainable health data archives and retain data ownership.

Incentives are essential to drive change. A widely acknowledged insight was that current EHR systems have reached the limits of their life cycle.

"The legacy EHR systems can't last another generation." (ID01)

Several respondents noted that existing infrastructures are becoming increasingly unmanageable, patched together, and resistant to further adaptation. One participant observed:

"The current systems are outdated and overly complex, it is mainly a matter of putting on band-aids… They are almost impossible to adapt." (ID04)

Interviewees pointed out that increasing dissatisfaction with legacy systems creates an opportunity to promote openEHR as a forward-looking alternative.

Although AI is a huge technological benefit, I classified artificial intelligence (AI) into organizational solutions, incentives and value propositions. Due to the fact that participants came up with a lot of enabled benefits for the organization through the potential use of AI by using openEHR.

3.2 Organizational solutions, incentives and value propositions

A core advantage cited of organizational factors was data control and ownership. In contrast to proprietary systems, openEHR empowers healthcare organizations to access, manage, and protect their data independently of software vendors. One participant highlighted:

"Hospitals control their own data, that's biggest advantage of openEHR." (ID05)

Owning your own data in an open standardized structure enables the ability to integrate applications and switch vendors without reconfiguring data structures.

"You don't have to modify your data if you switch vendors or apps, that's the power." (ID06)

"Hospitals can choose any vendor and switch easily, even internationally." (ID05)

One of the biggest incentives at this time is that participants strongly linked openEHR to the future of AI in healthcare. Participants highlighted that the implementation of AI in healthcare is critically dependent on the quality of the underlying data. In this context, openEHR was viewed as an essential enabler for effective and trustworthy AI applications.

"I think openEHR is essential for AI, because reliable AI starts with a solid data layer." (ID07)

The ability to ensure structured, reusable and longitudinal data is considered a prerequisite for advanced analytics and algorithm development:

"openEHR fixes the garbage in garbage out effect at the foundation." (ID08)

openEHR also enabling the construction of scalable data environments necessary for AI experimentation and big data analytics. One expert explained:

"If you move to an open ecosystem where everyone has the data in openEHR, you can combine flexibly." (ID06)

This flexibility allows healthcare organizations to analyze large and heterogeneous datasets across systems and institutions. Another participant highlighted openEHR's role in shaping global information models that can support cross-border AI innovation:

"openEHR plays a vital role in a global information model, enabling AI application and big data." (ID08)

3.3 Environmental solutions, incentives and value propositions

Participants recognized openEHR as driver for creating a more open and innovative health IT ecosystem. By separating application logic from the data layer and the openness of openEHR enables a 'best-of-breed' architecture allowing smaller and more innovative vendors to contribute niche solutions.

> *"Best-of-breed is only possible if your data layer is standardized and interoperable" (ID02)*

Several participants pointed out the potential for a more dynamic ecosystem.

> *"If the data sits in openEHR, smaller third-party apps can connect to it without needing custom integrations with every EHR system." (ID14)*
>
> *"Small vendors can also participate and collaborate, they are flexible and innovative, more vendors are good." (ID02)*

This fosters innovation and accelerates application development within healthcare.

> *"Ideally, we'll have a standardized open data layer and then use best-of-breed applications on top of that." (ID14)*
>
> *"Eventually, I think we'll move to modular EHRs, with small apps on top of a solid, open data core" (ID04).*

This allows specialized apps to be integrated more easily, operating on top of a shared open data foundation. This modular approach is seen as a natural fit with the inherent specialization of medical care. As one participant reflected:

> *"Healthcare is the best example of a specialist market… but in terms of systems, we don't do that. It's actually quite strange." (ID06)*

Finally, openEHR supports international collaboration, participants suggested that external reference points could function as motivational triggers. Successful examples from other countries, such as the Nordic region, are seen as proof that open ecosystems are feasible at scale.

> *"If Scandinavia and the world shows it works, maybe the environment will change, but it needs a trigger" (ID10).*

This also fosters trust in shared models such as archetypes, as another participant mentioned:

> *"The archetypes are validated by the international community, so you can trust it." (ID02)*

4. Long-term vision and transition strategies

Participants emphasized that the adoption of openEHR requires long-term thinking and a broader strategic transformation in hospital IT systems. This requires a clear long-term vision, investment and systemic change. It involves rethinking existing architectures and shifting from single vendor systems to open, future-proof infrastructures.

4.1 Long-term vision of openEHR

Most participants highlighted the need for hospitals to adopt a long-term mindset and invest in sustainable IT, even if the benefits may only become tangible after a decade. openEHR was seen as part of a broader strategic transformation toward future-proof healthcare systems.

> *"It is a long-term vision that will ultimately yield great results." (ID09)*
>
> *"If hospitals see the long-term benefit, then the benefit is going to come. If they are able to see that and invest in it, then there is a good chance to succeed." (ID02)*
>
> *"A full transformation is needed, it is essential that we redesign the system." (ID01)*

4.2 Transition strategies of the diffusion of openEHR

This section does not aim to propose new initiatives, but to provide insight in the two strategic approaches that emerged from the interviews. Namely, a bottom-up and a top-down approach. All participants unanimously agreed that openEHR is technically feasible. Although the opinions about the diffusion strategy strongly differed. Some participants emphasized the importance of starting from within the organization, a bottom-up approach. Others advocated for strong policy-level support and national coordination, a top-down approach. And one participant diverged from both perspectives, expressing the view that openEHR is not necessary and that the focus should remain solely on FHIR.

4.2.1 Bottom-up approach: Local implementation via Clinical Data Repositories

Eight of the fifteen participants mentioned a bottom-up strategy as the most realistic pathway under current circumstances. This perspective was driven by disappointment in the lack of national coordination and top-down systemic change. In this approach, participants explained that hospitals can begin by implementing local Clinical Data Repositories (CDRs) based on openEHR, specifically for secondary uses such as data archiving, scientific research and AI applications. This provides direct local benefits, such as data control, innovation capacity and future readiness, while still operating in parallel with legacy EHRs.

> *"Start small, run a separate CDR system next to your current one, it's low-risk and low-cost." (ID03)*

Such low-risk pilots can demonstrate concrete benefits and build institutional support. It allows hospitals to gain practical experience with openEHR. Participants highlighted the importance of involving clinical staff, IT departments, and smaller vendors in the development process from the start. Building internal awareness and ownership was considered essential.

> *"You just have to start, get out of the talking phase and just do it. Then you'll see the benefits, otherwise it stays too broad. Don't get stuck in theory, built it, and show it works." (ID13)*

This initiative fosters an open ecosystem in which smaller vendors can engage with hospital openEHR-based CDRs, creating space for innovation to emerge. As more hospitals implement openEHR CDRs, cross-institutional interoperability and collaboration become feasible. Together, hospitals and market

players can lay a foundation for an innovative healthcare system, shaped by clinical needs and supported by a naturally evolving digital health market.

"It ultimately has to emerge from the market itself." (ID11)

4.2.2 Top-down approach: Government-led structural support

Six of the fifteen participants voted for a top-down approach. This approach stated that government action is necessary to unlock systemic change. Participants called for national incentives, to impose alignment on data exchange and availability. Participants highlighted the need for a unity approach:

"The government has the responsibility to guarantee data quality in healthcare." (ID01)

Participants expressed a need for direction, both in guiding hospitals and binding regulatory frameworks for existing EHR vendors.

"This is the way how we're going to do it, that is what we need from the government." (ID14)

"Government must provide direction and pressure, either with a stick or carrot." (ID15)

Participants emphasized the need for clear policy alignment, subsidies and coordinated governance. Governance emerged as a highly critical enabler for the successful adoption of openEHR. Structural initiatives such as the EHDS were seen as valuable frameworks for offering both strategic direction and operational support. They argued that without unified leadership and binding decisions, fragmented initiatives and inconsistent implementation strategies would continue to stall progress.

"We need a national body with both expertise and authority, to not only suggest, but to enforce decisions." (ID14)

4.3 Federated model

Regardless of whether implementation begins from the top down or bottom up, nearly all participants emphasized that a federated infrastructure aligns best with the Dutch healthcare context. Hospitals in the Netherlands place high value on autonomy, and the federated model allows them to retain control over their own systems while still participating in a broader data-sharing network.

"Hospitals do not want to give away their data to a central system, they want control, and value privacy." (ID01)

Even if all hospitals adopt the openEHR standard and technically exchange is feasible, data still needs coordinated infrastructure and governance to support discoverability, secure data routing, and compliance with regulations. Participants suggested that national government should coordinate and fund such infrastructure, while execution should be entrusted to technically competent and independent entities, such as Regional Cooperation Organizations (RSO's) and openEHR NL. These actors already possess relevant technical expertise and have taken action in the absence of formal governmental direction.

"The government should finance it, but let experts build it." (ID11)

RSO Zuid-Limburg was frequently mentioned as a pioneer example. This regional approach builds a federated data ecosystem where data remains at the source but is available for regional use in a vendor-neutral format, based on openEHR. When building a regional data ecosystem, it is important to think federally to later connect with national and international standards.

> *"Build regionally but think federally." (ID…)*

Yet, participants warned that without strict national coordination, a federated system could become fragmented and inefficient.

> *"Federation makes sense in the Netherlands. But without clear national agreements, it turns into a mess." (ID01)*

To prevent this, participants advocated for a single governance model that enables one federated infrastructure, overseeing architecture, security standards and semantic interoperability. This model would allow each hospital to manage its own CDR, while connecting to one federated infrastructure and a shared national governance.

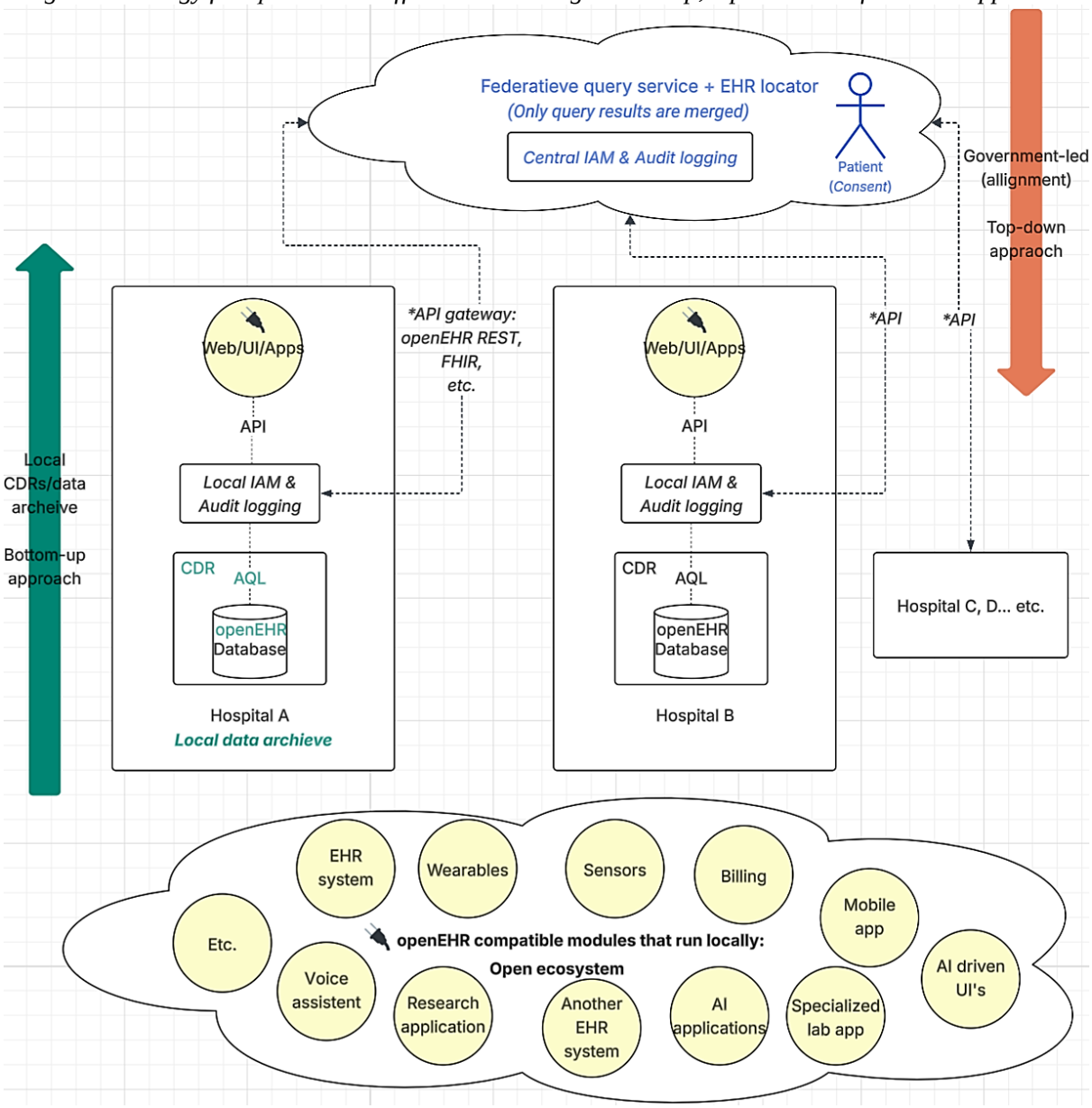
Participants pointed out that federated exchange also aligns well with principles the EHDS. One participant compared this vision to the financial sector, where individual banks retain control over their own systems, but transactions are routed securely and efficiently through a shared network such as SEPA and SWIFT:

> *"It's like banking. Banks have their own systems, but for transactions, we use one shared routing network. Healthcare should do the same."* (ID07)

Applying the model, participants said that a federated ecosystem would consist of a local openEHR CDR, a neutral federated infrastructure for data exchange, to secure authentication, logging, and consent and a national governance framework ensures semantic alignment, compliance and conformance.

Figure 4

Integrated strategy for openEHR's diffusion combining bottom-up, top-down and federated approaches



Note. Illustration of integrated bottom-up and top-down approaches, within a federated infrastructure. The architecture preserves local control while enabling national control and interoperability.

Figure 4 illustrates a comprehensive strategy for the diffusion of openEHR into Dutch hospitals by integrating three interdependent approaches from the interviews: bottom-up implementation, top-down policy support and a federated model. The figure demonstrates how local and national actors can collaborate through shared governance and infrastructure, while hospitals retain autonomy over their own data.

At the bottom-up level, hospitals initiate local CDRs based on openEHR for secondary uses, such as data archives, AI and research, gradually expanding use cases, support and capabilities. At the top-down level, national authorities, such as VWS, Nictiz, U-Zorg, provide strategic direction, financial

incentives, and regulatory frameworks to align all stakeholders and ensure semantic and technical interoperability.

The federated layer links these efforts with an infrastructure, ensuring secure data discoverability, access control, and semantic consistency across institutions. This layer includes a single EHR Locator to identify where relevant patient data is stored across institutions, and a Federated Query Service (FQS) to route standardized queries and aggregate results and, national governance standards. Together, this model fosters an open ecosystem while maintaining local control and enabling nationwide interoperability.

5. Stakeholders in the diffusion of openEHR

The successful diffusion of openEHR into Dutch hospitals is not solely a technical, organizational or environmental challenge, it is including everything and above all, a collective effort involving a broad range of stakeholders. Participants emphasized that achieving interoperability and shared standards can only accomplished when all relevant actors are actively engaged.

> *"It only works when everyone participates." (ID11)*

5.1 Government

The government is a frequently returning factor, participants consistently called for the enabling role of the government, as one participant stated:

> *"We need either incentives or pressure from the government. Otherwise, nothing changes." (ID13)*

Several participants viewed VWS as both a potential enabler and bottleneck, with considerable influence over the speed, consistency, and legitimacy of interoperability.

> *"We need a national body with both expertise and authority to enforce decisions." (ID15)*
>
> *"They have a huge influence over whether adoption happens or not." (ID06)*

The main responsibility of the government, according to several participants, is to define and provide quality norms for digital health interoperability.

> *"The government's task is to ensure quality." (ID11)*
>
> *"Government has to say: 'this is the quality standard, we require it by law...'". (ID01)*

However, many participants expressed frustration about the current lack of clarity, urgency and direction from VWS.

> *"There is little pace and sense of urgency noticeable from the government." (ID08)*
>
> *"Progress is minimal... this is going to take years." (ID07)*
>
> *"VWS is still searching for the role they want to play in this... They're sending mixed signals and are hesitant, which means that hospitals are not taking action." (ID14)*

Participants advocated not only for formal policymaking but also for proactive support through incentives such as subsidies:

> *"The government should not only ask, but also incentivise, for example via subsidies." (ID15)*

Finaly, some optimism was expressed regarding current initiatives. The organization Nictiz, funded by VWS, is exploring mapping ZIBs to openEHR and FHIR. Participants noted that no single standard can address all challenges for interoperability. Instead, a clear division of roles is needed:

> *"FHIR for exchange, openEHR for structured storage, and ZIBs as a shared source model that can bridge both." (ID02)*

Furthermore, Participants were optimistic about synergistic collaboration between FHIR and openEHR:

> *"It can coexist and complement each other." (ID04)*
>
> *"Serious initiatives are currently undertaken to integrate openEHR and FHIR." (ID14)*

Participants emphasized the need for a more proactive and coordinated approach to align national digital health goals with open, interoperable data architectures in line with the EHDS, for interoperability within the Netherlands and also across Europe or even worldwide.

5.2 Stakeholders and collaboration

Beyond government, participants stressed the interdependence between various stakeholder groups, they emphasized that these groups must align in both strategic direction and operational execution to achieve sustainable interoperability. A central theme in the interviews was the importance of bridging top-down leadership with bottom-up engagement. Strategic commitment from hospital boards and policymakers is essential, but operational traction from clinicians, clinical informatics experts, and IT departments is equally vital.

> *"The board of directors is decisive, but it has to get there. If you get healthcare professionals enthusiastic, you can make progress." (ID09)*

Especially, participants emphasized the importance of clinical informatics experts as key boundary spanners between medical and technical domains. These experts often go unrecognized but play a vital role in translating standards like openEHR into actionable implementations:

> *"People who understand the medical and technical side are indispensable in this process, technicians often do not understand the importance and workflow behind the medical domain and physicians do not understand the technical side, a combination is rare but very necessary." (ID13)*

Many participants highlighted the role of informal expert networks in advancing policy and practice. They mentioned the power of social dynamics, particularly peer influence and opinion leadership.

> *"Social influence is very important... people base decisions heavily on what others say in this environment." (ID09)*

This includes both horizontal diffusion (e.g., peer-to-peer communication) and vertical influence (e.g., clinicians influencing policymakers or vice versa).

> *"Opinion leaders and peers are very important, if once one sheep crosses the dam, others will follow..." (ID10)*
>
> *"Influence from clinicians to the board level is also important." (ID09)*

While formal policy channels are slow, informal networks and grassroots efforts from enthusiastic experts often prove more effective:

> *"Formal pathways are often slow and political, informal networks and enthusiastic experts are key to acceptance." (ID14)*
>
> *"The policy must be supported by substantive experts and bottom-up influence." (ID07)*

Moreover, successful early adopters, such as Maastricht UMC and RSO Zuid-Limburg, were seen as pivotal in creating momentum.

> *"You really need these pioneers like RSO Maastricht, then healthcare organizations will see it works." (ID08)*

Finally, several participants highlighted the potential of stronger collaboration with academic institutions to accelerate the diffusion of openEHR. Universities can play a key role in both generating evidence and educating future healthcare professionals and IT specialists.

> *"An elective on openEHR would be a great idea to spreading this knowledge, yes." (ID13)*

Electives on openEHR and interoperability, embedded in medical informatics or health technology programs, were seen as valuable for cultivating early awareness and practical skills. Moreover, research partnerships and pilot projects can offer the evaluation and visibility needed to support the broader diffusion of openEHR.

Discussion

This research provides a comprehensive analysis of the perceived opportunities and challenges surrounding the diffusion of openEHR in Dutch hospitals. Based on qualitative interviews with experts, it becomes clear that while openEHR offers a foundational approach to addressing persistent healthcare IT challenges, its large-scale adoption is constrained by barriers at multiple levels.

Key Findings

The findings reveal a shared perception among experts that openEHR remains in the early "knowledge phase" of Rogers' DOI framework. While a small group of clinical informatics professionals and technical stakeholders are familiar with the standard, broader awareness among hospital boards, executives, and clinicians is limited. This lack of awareness is further exacerbated by the conceptual and technical complexity of openEHR, particularly abstract elements like archetypes, templates, and two-level modeling, which makes the standard difficult to communicate outside specialized circles. As

a result, experts stressed the need for practical use cases, hands-on demonstrations, and simplified messaging to make openEHR's potential more tangible and accessible to decision-makers and end users.

Despite its limited uptake, experts viewed openEHR as a strategic foundation for future-proof healthcare IT. Its vendor-neutral architecture and structured clinical modeling enable long-term interoperability, flexible data reuse, and modular system design. This supports best-of-breed solutions, reduces vendor lock-in, and opens the ecosystem to smaller innovators. Crucially, openEHR was seen as essential for reliable AI, providing the structured, high-quality data needed to support automation and address growing capacity challenges.

Nevertheless, significant barriers hinder the diffusion of openEHR. Technologically, its abstract concepts and steep learning curve hinder understanding and adoption. Organizationally, resistance to change, existing vendor lock-ins, and a lack of in-house expertise, particularly at the intersection of healthcare and IT, pose major obstacles. Environmentally, experts pointed to the Dutch government's perceived preference for FHIR, inconsistent leadership, and fragmented national initiatives as sources of uncertainty that slow progress. While international examples show that openEHR can scale successfully, the Dutch landscape remains fragmented. Experts emphasized the need for a national implementation body with both authority and technical expertise to steer coordination and standardization efforts.

Additionally, experts agreed that one federated architecture is most appropriate for the Dutch healthcare system, given its decentralized nature while supporting interoperability. However, federation alone was seen as insufficient. Experts stressed the need for consistent national agreements on archetype management, authentication standards, and data protocols to avoid renewed fragmentation.

Finally, the findings underscore the critical importance of stakeholder collaboration and alignment. Early adopters such as Maastricht UMC and RSO Zuid-Limburg were frequently cited as vital proof points demonstrating the feasibility of openEHR. Broader alignment with complementary standards like FHIR and ZIBs, along with integration into the EHDS, was seen as essential to the diffusion of openEHR into Dutch hospitals.

Theoretical contribution

This study provides one of the first structured investigations into the perceived diffusion of openEHR within Dutch hospitals, contributing to both empirical insights and theoretical understanding of digital health standardization. By combining the DOI theory (Rogers, 1962) and the Technology-Organization-Environment framework (Tornatzky & Fleischer, 1990), this research offers a multidimensional perspective on why the uptake of openEHR remains limited and how its diffusion is perceived. The findings confirm that openEHR remains still in the "knowledge phase" of diffusion to Dutch hospitals,

with limited awareness beyond technical experts. The study highlights the critical role of "change agents," including pioneering hospitals like Maastricht UMC and regional initiatives like RSO Zuid-Limburg, which serve as accelerators in shaping the persuasion and decision-making stages. OpenEHR must be supported by these "change agents," to successfully cross the chasm between "early adopters" and the "early majority", according to Rogers (1962).

From a TOE perspective, the research sheds light on the dynamics between bottom-up initiatives and top-town alignment in shaping the diffusion of openEHR.The call for stronger national coordination aligns with recent policy evaluations, including the report *Renewal of governance for data exchange in healthcare* by the Dutch Senior Civil Service (2025), which advocates for a shift toward unified governance to support health data exchange. Similarly, the VWS-commissioned report presents a national federated model as ideally spot on the horizon (VWS, 2023). This vision is also consistent with the concerns raised by the Dutch Federation of Medical Specialists, who warned that poor data availability poses risks to patient safety, care quality and effective clinical care (FMS, 2025). These perspectives align with this study's findings that federation suits the Dutch healthcare context, provided it is guided by strong central coordination and governance to enable bottom-up innovation.

This research also aligns with international developments. As Pohjonen (2022) describes, Scandinavian countries successfully adopted openEHR through top-down mandates and national infrastructures, motivated by a sense of urgency and a clear vision. The EHDS also highlights countries such as Estonia, Denmark and Finland as examples of well-developed EHR systems (European Commission, 2025). In parallel, this study reinforces insights from Fonseca et al. (2021), who emphasize the need for digital systems that communicate semantically across institutions. Participants agreed upon this perspective, highlighting the unique role of openEHR in enabling a shared data layer decoupled from application logic, which facilitates semantic interoperability across healthcare systems.

Importantly, this research positions openEHR not as an alternative to FHIR, but as a complementary foundation. While there is an alignment on FHIR in the EHDS requirements, openEHR provides the structured data storage and semantic consistency essential for reuse, longitudinal care, and AI-readiness (European Commission, 2022). By combining FHIR and openEHR within a federated architecture, the Netherlands can align with EHDS ambitions while maintaining the institutional autonomy preferred in Dutch healthcare.

Strengths

This study demonstrates trustworthiness across several dimensions, as conceptualized by Lincoln and Guba (1985). Credibility is established through methodological triangulation, drawing on a diverse set of expert interviews with stakeholders involved in openEHR. The extensive use of direct participant quotations ensures that the findings are grounded in authentic and varied empirical perspectives

(Shenton, 2004). Recurring patterns across interviews suggest a high degree of thematic saturation, reinforcing the consistency of the results. The research is both timely and highly relevant, addressing the increasing demands for interoperability and digital transformation in healthcare, and aligns with major policy initiatives such as the EHDS (European Commission, 2025).

Transferability is supported by detailed descriptions of the Dutch healthcare system, the openEHR standard, strategic approaches that emerged from the interviews, and the roles of government and other stakeholders. This allows readers to assess the applicability of insights to other settings (Lincoln & Guba, 1985; Shenton, 2004). By linking Dutch developments to international examples, such as the Scandinavian strategies, the findings offer lessons that may inform similar health systems considering open standards. Furthermore, the EHDS framework enhances the broader relevance of this study for other decentralized healthcare systems aligning with the semantic interoperability.

A theoretical foundation, integrating Rogers' DOI theory (2003) and the Technology-Organization-Environment framework (Tornatzky & Fleischer, 1990), provides a multidimensional and conceptually rigorous analysis of the factors influencing the diffusion of openEHR. The use of a grounded theory methodology, with iterative coding and careful documentation of analysis procedures, ensures dependability by enhancing consistency and transparency throughout the research process (Charmaz, 2020). This is further reinforced by the distribution of coded segments across all participants, demonstrating that insights were drawn from a balanced range of expert inputs rather than being dominated by a few voices (Appendix E). All data were managed and coded using ATLAS.ti, allowing for a structured and auditable analytic workflow.

Confirmability is achieved through transparent documentation of coding decisions, and regular critical examination of analytical choices, ensuring that findings remain close to the data and that neutrality is maintained (Lincoln & Guba, 1985). While the study's focus on experts involved with openEHR may introduce some selection bias, this is transparently acknowledged and justified by the research question, which explicitly targets the perceptions of this group.

Limitations

Despite its strengths, this study has several limitations that should be acknowledged in assessing trustworthiness (Lincoln & Guba, 1985; Shenton, 2004).

Most notably, the research is based on a specific target group, experts already involved with openEHR. This initial purposive sampling combined with snowball sampling strategy may lead to an overrepresentation of favorable perspectives and an underrepresentation of potential barriers or critical viewpoints from other stakeholders, such as hospital boards, IT leaders unfamiliar with openEHR, or proponents of competing EHR standards (Creswell & Poth, 2018). As such, the study does not aim to provide a balanced comparison of EHR standards, but rather a focused investigation of how openEHR

experts perceive the diffusion process in Dutch hospitals. This design choice is consistent with the research question, but it limits the confirmability and transferability of the findings to broader perspectives (Lincoln & Guba, 1985).

Secondly, the research reflects an early stage of openEHR diffusion in Dutch hospitals. With only a few pioneering hospitals implementing openEHR, most insights are based on expectations and perceptions rather than large-scale, operational experiences. While this aligns with the exploratory and qualitative nature of the study, it constrains the generalizability of the findings (Shenton, 2004).

Third, due to the technical complexity of the topic and the expert-specific nature of the data, no peer debriefing process was conducted during data analysis. While this limits external validation of interpretation, the use of transparency and careful documentation aimed to mitigate this shortcoming.

Finally, although reflexivity and transparency were emphasized throughout the research process, the author's prior engagement with digital health and EHR systems may introduce confirmation bias (Charmaz, 2020). While steps were taken to remain critically self-aware, such as triangulating findings and quoting participants directly, complete neutrality cannot be guaranteed (Lincoln & Guba, 1985).

Practical contribution: Bundling forces together

The findings of this study offer several important practical implications for healthcare institutions, policymakers, vendors, and other stakeholders aiming to achieve interoperability and build an open healthcare ecosystem. Beyond theoretical significance, the results highlight strategies and system-level conditions for the diffusion of openEHR to Dutch hospitals.

A central implication is the need for clear, pragmatic implementation strategies that combine bottom-up innovation with top-down alignment. Experts emphasized that bottom-up efforts foster the development of an open ecosystem by connecting hospitals and enabling opportunities for smaller, market-driven innovative vendors. At the same time, top-down enforcement of storage standardization was identified as the most effective approach for long-term alignment and scalability.

As illustrated in Figure 4, these complementary approaches can be integrated within a federated architectural framework. A federated infrastructure allows hospitals to maintain control over their data while enabling national-level interoperability, security and semantic consistency. Experts recommend that a centrally governed infrastructure layer, managed by a neutral body, such as RSO Zuid-Limburg in coordination with VWS, should oversee essential services like authentication, audit logging, terminology services and query routing. This federated model can be piloted regionally but should be scaled nationally through coordinated policy and governance.

National collaboration and the development of one shared infrastructure are recommended. To achieve meaningful progress, stakeholders must bundle their forces, collaborate, and work collectively towards

a single federated model. It is acceptable to start in one region, but it is crucial that all parties connect to and expand this initiative, avoiding further fragmentation and ensuring one unified, scalable and national infrastructure.

Moreover, this federated approach aligns with the EHDS standards, which aim to standardize cross-border health data exchange and foster innovation across EU member states. By harmonizing openEHR governance, tooling, and archetype management with EHDS objectives, the Netherlands can enhance international compatibility and future-proof its health IT ecosystem. Participants underscored the need for a national openEHR governance body, potentially supported by openEHR NL and VWS or Nictiz, to oversee the national archetype library, Clinical Knowledge Manager (CKM) use, and implementation tooling.

Ultimately, the adoption of openEHR should be viewed not merely as a technical upgrade, but as part of a broader transformation of the health data ecosystem. For this transformation to succeed, practical action is needed at institutional, system, and policy levels. Implementation requires not only standards and software, but also human alignment, leadership commitment, and a shared, long-term vision for digital transformation in healthcare.

Recommendations for future research

To build on the foundations laid by this study, four directions for future research are proposed.

First, future research should investigate governance models for federated health data infrastructures that balance institutional autonomy and centralized coordination. As the Dutch healthcare system moves toward large-scale interoperability and alignment with the EHDS, comparative studies are needed to identify governance frameworks that enable sustainable, open ecosystems while ensuring national coherence and alignment with European initiatives (European Commission, 2025).

Second, further research is needed into the economic implications of openEHR adoption. This includes comprehensive analyses of return on investment (ROI), transition costs, and the long-term financial sustainability of open ecosystems. Comparative policy studies can help clarify the economic feasibility and sustainability of different implementation models, providing evidence for decision-makers and supporting the business case for openEHR (Creswell & Poth, 2018).

Third, future studies should broaden the stakeholder perspective beyond openEHR experts such as hospital boards, IT leaders not yet familiar with openEHR, clinical end-users and representatives from competing EHR vendors. Including these diverse perspectives will yield a more comprehensive understanding of organizational priorities, adoption barriers and the comparative value of openEHR relative to other standards, therefor improving the transferability and practical relevance of these research findings (Shenton, 2004).

Finally, longitudinal case studies and technical evaluations of pioneering initiatives, such as RSO Zuid-Limburg, can offer valuable lessons on implementation practices, governance maturity and clinical impact over time. Such empirical work will inform best practices and guide the design of health data ecosystems that are open by default, flexible by design, and governed for long-term sustainability and patient benefits (Charmaz, 2020).

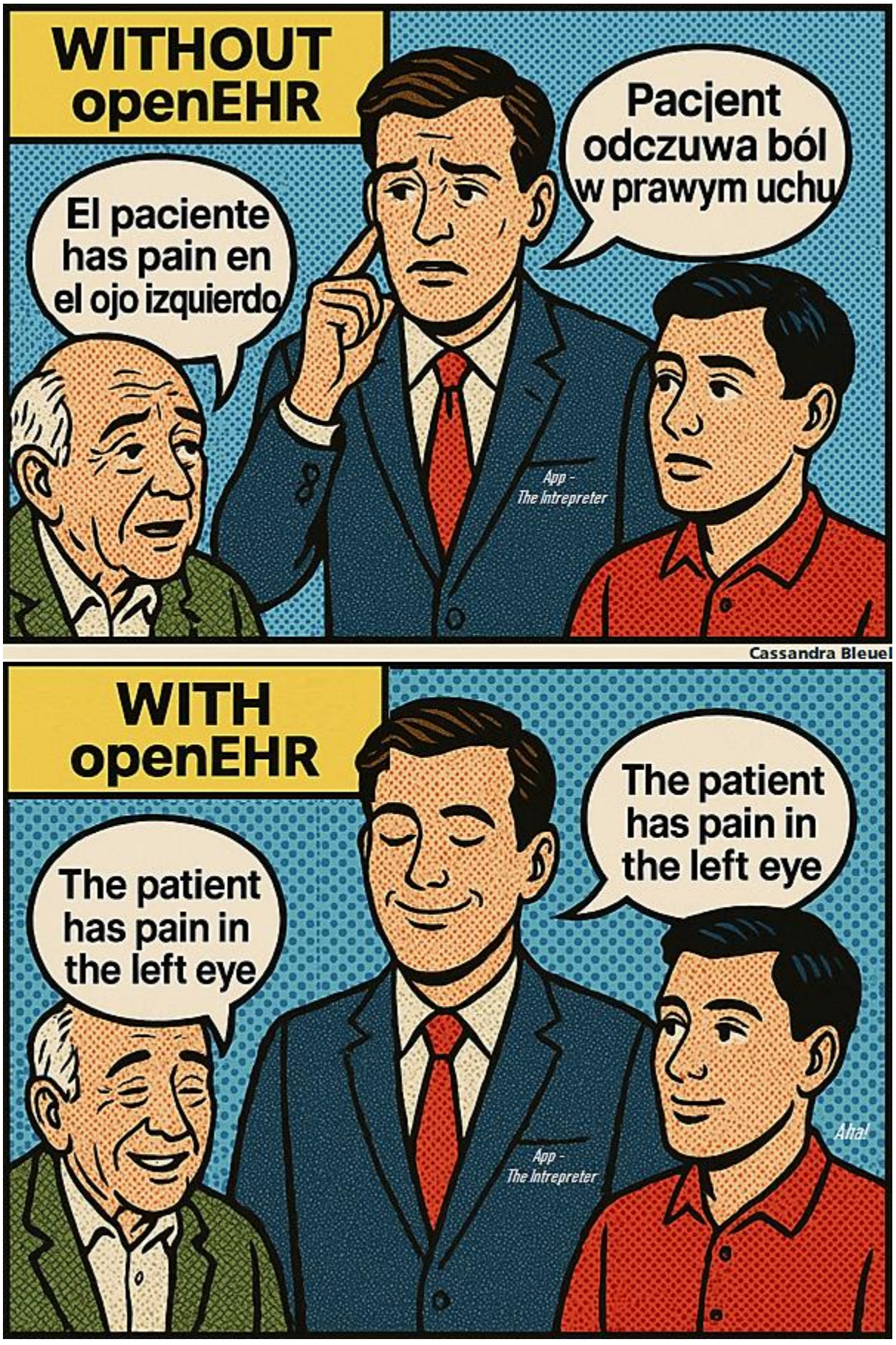
Conclusion

This study explored the perceived diffusion of openEHR into Dutch hospitals through the lens of experts actively involved in EHR standardization. Guided by the research question: "How do experts involved with openEHR perceive the diffusion of openEHR to hospitals in the Netherlands?". By applying a grounded theory approach and integrating Roger' Diffusion of Innovation theory (1962) and the Technology-Organization-Environment framework (Tornatzky & Fleischer, 1990), this research uncovered the technical, organizational, and environmental dimensions of this diffusion process.

The findings indicate that openEHR remains in an early stage of diffusion within hospitals, with limited awareness beyond technical circles. While experts recognize its strong technical foundation, especially its ability to decouple data from applications, enabling semantic interoperability, vendor neutrality, and AI-readiness, its complexity and lack of familiarity among healthcare professionals and decision-makers continue to pose significant barriers. Organizational challenges such as resistance to change, vendor lock-in and a shortage of clinical-technical leadership further hinder diffusion. Environmentally, limited clarity from the government and a lack of national coordination create uncertainty among hospitals, while fragmented initiatives continue to stall broader alignment and diffusion.

Despite these barriers, the potential of openEHR to support a more future-proof health data infrastructure is widely acknowledged. Experts emphasized the value of combining bottom-up experimentation through local openEHR CDR pilots, that lay the foundation to create an open ecosystem for innovation and healthy market dynamics. Combined with top-down national coordination and incentives. A federated infrastructure, allowing local control while enabling national interoperability, was seen as the most suitable model for the Dutch context. Moreover, early adopters like Maastricht UMC and RSO Zuid-Limburg play a pivotal role in demonstrating feasibility and fostering momentum in the Netherlands.

To enable broader diffusion, stakeholders must collaborate across sectors, invest in joint governance, and develop unified standards for semantic interoperability. With stronger leadership, coordinated efforts, and alignment with the EHDS, the Netherlands has the opportunity to transition toward a more interoperable, innovative, and sustainable health information ecosystem. After all, data should go where the patient goes. That is the ultimate goal of interoperability, openEHR offers a powerful standard to help get us there.



Thank you to all participants and readers of this thesis. May it contribute, in some way, to illuminating the future of healthcare.

References

Baker, J. (2024). The technology–organization–environment framework. In *Encyclopedia of Information Science and Technology* (5th ed.). https://doi.org/10.1007/978-1-4419-6108-2_12

Better. (2025, January 31). openEHR is being recognised as a standard that will drive digitalisation in healthcare forward. *Better Blog*. https://www.better.care/blog-en/openehr-is-being-recognised-as-a-standard-that-will-drive-digitalisation-in-healthcare-forward/

Charmaz, K. & Thornberg, R. (2020). The pursuit of quality in grounded theory. *Qualitative Research in Psychology, 18*(3), 305–327. https://doi.org/10.1080/14780887.2020.1780357

CODE24. (2025, March 13). Start with an open platform for healthcare data. *CODE24 Blog*. https://blog.code24.nl/en/start-with-open-platform-for-healthcare-data

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches* (4th ed.). SAGE Publications.

Cruz-Jesus, F., Pinheiro, A., & Oliveira, T. (2019). Understanding CRM adoption stages: Empirical analysis building on the TOE framework. *Computers in Industry, 109*, 1–13. https://doi.org/10.1016/j.compind.2019.03.007

Cunha, J., Duarte, R., Guimarães, T., & Santos, M. F. (2022). Permissioned blockchain approach using open data in healthcare. *Procedia Computer Science, 210*, 242–247. https://doi.org/10.1016/j.procs.2022.10.144

Cunha, J., Duarte, R., Guimarães, T., & Santos, M. F. (2023). OpenEHR and business intelligence in healthcare: An overview. *Procedia Computer Science, 220*, 874–879. https://doi.org/10.1016/j.procs.2023.03.118

Delussu, G., Frexia, F., Mascia, C., Sulis, A., Meloni, V., Del Rio, M., & Lianas, L. (2024). A survey of openEHR clinical data repositories. *International Journal of Medical Informatics, 191*, 105591. https://doi.org/10.1016/j.ijmedinf.2024.105591

Dutch Federation of Medical Specialists (FMS). (2025). *Poor availability of patient data is a threat to patient safety*. https://demedischspecialist.nl/nieuwsoverzicht/nieuws/slechte-beschikbaarheid-van-patientgegevens-gevaar-voor-patientveiligheid

Dutch Senior Civil Service. (2025). *Final report: Renewal of governance for data exchange in healthcare*. Government of the Netherlands. https://www.algemenebestuursdienst.nl/documenten/publicatie/2025/01/31/eindrapport-vernieuwing-besturing-gegevensuitwisseling-in-de-zorg

European Commission. (2025). *European Health Data Space (EHDS) regulation*. https://health.ec.europa.eu/ehealth-digital-health-and-care/european-health-data-space-regulation-ehds_en

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, 9*(9), 1192. https://pmc.ncbi.nlm.nih.gov/articles/PMC8470487/

Gartner. (2024). *Gartner Hype Cycle: Interpreting technology hype*. https://www.gartner.com/en/research/methodologies/gartner-hype-cycle

Gopal, G., Sutter-Crazzolara, C., Toldo, L., & Eberhardt, W. (2018). Digital transformation in healthcare - architectures of present and future information technologies. *Clinical Chemistry and Laboratory Medicine, 57*(3), 328–335. https://doi.org/10.1515/cclm-2018-0658

Grant, C., & Osanloo, A. (2014). Understanding, selecting, and integrating a theoretical framework in dissertation research: Developing a "blueprint" for your house. *Administrative Issues Journal: Education, Practice, and Research*, *4*(2), 12–26. https://www.researchgate.net/publication/266015734

de Grood, C., Raissi, A., Kwon, Y., & Santana, M. J. (2016). Adoption of e-health technology by physicians: a scoping review. *Journal of multidisciplinary healthcare*, *9*, 335–344. https://doi.org/10.2147/JMDH.S103881

Haggerty, E. (2017). Healthcare and digital transformation. *Network Security, 2017*(8), 7–11. https://doi.org/10.1016/S1353-4858(17)30081-8

Häyrinen, K., Saranto, K., & Nykänen, P. (2008). Definition, structure, content, use and impacts of electronic health records: A review of the research literature. *International Journal of Medical Informatics, 77*(5), 291–304. https://doi.org/10.1016/j.ijmedinf.2007.09.001

Hermanowicz, J. C. (2002). The great interview: 25 strategies for studying people in bed. *Qualitative Sociology, 25*(4), 479–499. https://doi.org/10.1023/A:1021062932081

Holden, R. J., & Karsh, B. (2010). The technology acceptance model: Its past and its future in health care. *Journal of Biomedical Informatics, 43*(1), 159. https://doi.org/10.1016/j.jbi.2009.07.002

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. SAGE Publications.

Marques, I. C. P., & Ferreira, J. J. M. (2020). Digital transformation in the area of health: Systematic review of 45 years of evolution. *Health and Technology, 10*(3), 575–586. https://doi.org/10.1007/s12553-019-00402-8

Marshall, L. (2024). *What builds good health? An introduction to the building blocks of health*. The Health Foundation. https://doi.org/10.37829/HF-2024-HL02

Min, L., Atalag, K., Tian, Q., Chen, Y., & Lu, X. (2021). Verifying the feasibility of implementing semantic interoperability in different countries based on the openEHR approach: Comparative study of acute coronary syndrome registries. *JMIR Medical Informatics, 9*(10), e31288. https://doi.org/10.2196/31288

Min, L., Tian, Q., Lu, X., An, J., & Duan, H. (2018a). An openEHR based approach to improve the semantic interoperability of clinical data registry. *BMC Medical Informatics and Decision Making, 18*(1), 15. https://doi.org/10.1186/s12911-018-0596-8

Min, L., Tian, Q., Lu, X., & Duan, H. (2018b). Modeling EHR with the openEHR approach: An exploratory study in China. *BMC Medical Informatics and Decision Making, 18*(1), 75. https://doi.org/10.1186/s12911-018-0650-6

Ministry of Health, Welfare and Sport (VWS). (2023, February 22). *Study on a national network of infrastructures for data exchange in healthcare*. Government of the Netherlands. https://www.rijksoverheid.nl/documenten/rapporten/2023/02/22/onderzoek-landelijk-netwerk-van-infrastructuren-voor-gegevensuitwisseling-in-de-zorg

Nedap. (2025). *Support throughout the entire care process*. https://nedap-ons.nl/

Netherlands Authority for Consumers and Markets (ACM). (2025, January 28). *Letter to the Ministry of Health: Require vendors of health information systems to open up for more innovation*. https://www.acm.nl/nl/publicaties/brief-van-acm-aan-vws-verplicht-leveranciers-zorginformatiesystemen-te-openen-voor-meer-innovatie

Bouvier, P. (2024, December 5). What is openEHR? *openEHR Blog*. https://openehr.org/about/what_is_openehr

Pohjonen, H. (2022). Norway, Sweden, and Finland as forerunners in open ecosystems and openEHR. In E. Hovenga & H. Grain (Eds.), *Roadmap to successful digital health ecosystems* (pp. 457–471). Academic Press. https://doi.org/10.1016/B978-0-12-823413-6.00011-2

Rogers, E. M. (1962). *Diffusion of innovations*. Free Press.

Sadoughi, F., Khodaveisi, T., & Ahmadi, H. (2019). The used theories for the adoption of electronic health record: A systematic literature review. *Health and Technology, 9*(4), 383–400. https://doi.org/10.1007/s12553-018-0277-8

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information, 22*(2), 63–75. https://doi.org/10.3233/EFI-2004-22201

Simon, S. R., Kaushal, R., Cleary, P. D., Jenter, C. A., Volk, L. A., Orav, E. J., Burdick, E., Poon, E. G., & Bates, D. W. (2007). Physicians and electronic health records: A statewide survey. *Archives of Internal Medicine, 167*(5), 507–512. https://doi.org/10.1001/archinte.167.5.507

Sreenivasan, M., & Chacko, A. M. (2021). Interoperability issues in EHR systems: Research directions. In K. C. Lee, S. S. Roy, P. Samui, & V. Kumar (Eds.), *Data analytics in biomedical engineering and healthcare* (pp. 13–28). Academic Press. https://doi.org/10.1016/B978-0-12-819314-3.00002-1

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, 20*(4), 3407. https://doi.org/10.3390/ijerph20043407

Tornatzky, L. G., & Fleischer, M. (1990). *The processes of technological innovation*. Lexington Books.

Tsafnat, G., Dunscombe, R., Gabriel, D., Grieve, G., & Reich, C. (2024). Converge or collide? Making sense of a plethora of open data standards in health care. *Journal of Medical Internet Research, 26*(1), e55779. https://doi.org/10.2196/55779

Varpio, L., Paradis, E., Uijtdehaage, S., & Young, M. (2020). The distinctions between theory, theoretical framework, and conceptual framework. *Academic Medicine, 95*(7), 989–994. https://doi.org/10.1097/ACM.0000000000003075

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research, 122*, 889–901. https://doi.org/10.1016/j.jbusres.2019.09.022

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems, 28*(2), 118–144. https://doi.org/10.1016/j.jsis.2019.01.003

Appendix A

Informed Consent

Title of the Master Research: Exploring the perceptions of organizations involved with openEHR regarding the diffusion of openEHR to Dutch hospital EHR systems
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Datum: 26/02/2025
Classification: Qualitative research participation (interviews)

Introduction
You are invited to participate in a research study conducted by Cassandra Bleuel as part of the MSc Medical Business and Innovation program at Rotterdam School of Management. The purpose of this study is to explore how organizations involved with openEHR perceive the diffusion of openEHR to EHR systems in Dutch hospitals. This research aims to gather insights into the perspectives of organizations involved with openEHR regarding potential adoption strategies, decision-making processes and determining factors related to the adoption of openEHR in Dutch hospitals.
Your participation is voluntary. You may choose to participate or withdraw at any time without any consequences. And you can always request to have your data removed. This consent form explains what the study involves and how your data will be used.

What participation involves
If you agree to participate, you will be asked to:
- Take part in a 1-hour interview conducted via Microsoft Teams.
- Share your experiences, opinions, or insights on openEHR diffusion to Dutch hospitals.
- The session will be automatically transcribed using Microsoft Teams live transcription feature or, if conducted in person, audio-recorded for accurate documentation.
- Your participation is completely voluntary. You can stop at any time without explanation.
- If you do not want to answer a question during the interview, you are not required to do so.
- A video or audio recording of the conversation will be made.
If you prefer not to be recorded or transcribed, please inform the researcher before the interview begins.

Potential risks and discomforts
We do not anticipate any risks or discomforts while participating in this study. However, if you feel uncomfortable at any point, you may pause or withdraw without any consequences.

Benefits
- After participating in the study, you will gain insight into your results.
- Your participation contributes to research aimed at improving interoperability and digital transformation in Dutch hospitals.
- There are no immediate or financial benefits for participating in the study. However, sharing your experiences will shed more light on challenges and opportunities in openEHR diffusion.

Confidentiality & Data protection
Your responses will remain confidential. Data will be securely stored and only accessed by the researcher. If any direct quotes are used in publications, your identity will remain fully anonymous unless you provide explicit permission otherwise.

Publication of findings
I will write a thesis about the results of the study, which will be published in the repository of Erasmus University (accessible only with an Erasmus ID) and may be shared with professionals in the field or LinkedIn.

Consent confirmation

I have read the information letter. I understand what the study is about and what data will be collected from me. I was able to ask questions, and my questions were adequately answered.

By signing this form, I:

1. Consent to participate in this research and to use my personal data.
2. Understand that participating in this research is completely voluntary, that I can stop at any time and I can always request to have my data removed.
3. Understand that my data will be anonymized for publication, educational purposes, and further research.

How to provide consent:

You can confirm your consent by one of the following methods:

- **Verbal consent** – You may verbally confirm your participation at the start of the recorded interview.
- **Email confirmation** – You may reply to this email with "I consent to participate in this study."
- Signed consent form – Please sign below and return the form via email.

Date: _____

Participant name: _____

Signature: _____

Thank you for your participation! If you have any questions or concerns, please contact me.

Appendix B

Interview Guide

Introduction (5 min)

"Before we begin, I want to let you know that this interview is confidential, anonym, and voluntary. You can skip any question, and if you're okay with it, I'd like to record it for transcription purposes"

- Thank you for taking the time to participate and for your quick response...
- A short introduction about myself and the study; why, enthusiast/passionate, thesis, etc.
- Interest in company, how is it for you to work with openEHR?
    - Additional information about the interviewee...

0. Icebreaker till (5 min)

How is it for you to work with openEHR... (make it personal)

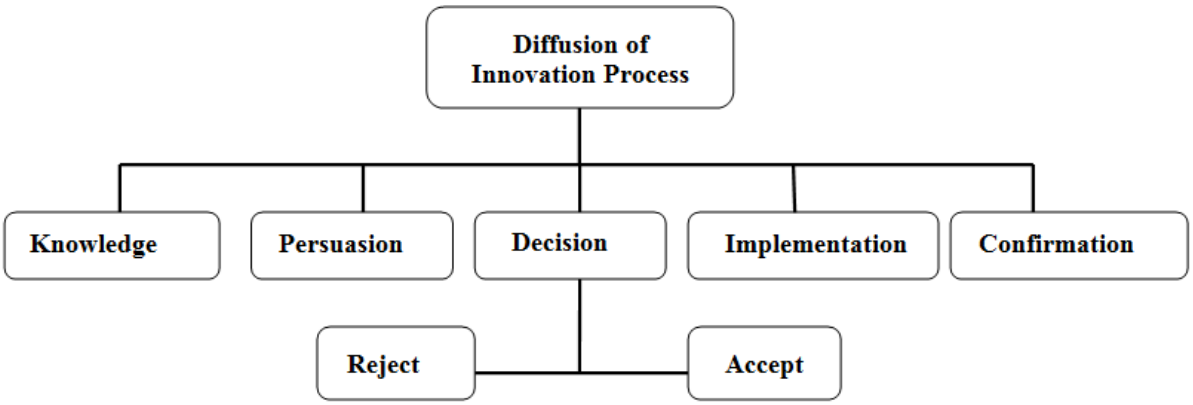
"What first got you interested in working with openEHR"

- Can you introduce yourself?
- How long have you worked with openEHR?
- What's your role in your organization?
- How is your organization involved with openEHR? *(Development, implementation, promotion?)*

1. For the Diffusion of Innovation; DOI Framework – by Rogers in 1962 (10 min)

"Let's start to talk about how openEHR spreads."

- According to the **DOI framework**, adoption follows stages: **Knowledge, Persuasion, Decision, Implementation, and Confirmation**. > **(Interactive Exercise 1: DOI Curve)**



- *Where do you think Dutch hospitals currently stand in this process?*
- *What needs to happen to push them forward?*
- *Is adoption increasing, stagnating, or declining? Why?*
- *What is the biggest challenge in moving hospitals forward?*

2. For T,O,E aspects, TOE developed by Tornatzky and Fleischer (1990)

Technological Factors (10 min)

"Let's start with the technology itself."

- In your opinion, what are the biggest **technological advantages** of openEHR?
- What are the **main technical challenges** hospitals face when implementing openEHR?

Organizational Factors (10 min)

"Now let's shift to how hospitals internally handle adoption."

- How ready do you think Dutch hospitals are to adopt openEHR?
- Who are the **key decision-makers** driving or blocking adoption?
- What internal barriers **slow adoption down**?

Environmental Factors (10 min)

"Finally, let's look at external influences."

- How do **government policies** impact openEHR adoption?
- How does the **competitive Dutch EHR market** influence adoption?
- How important is **collaboration with stakeholders**?

Interactive Exercise 2: TOE Framework

Show TOE diagram and discuss their ranking (Figure 3).

3. Future outlook & Closing (10 min)

"Looking ahead..."

- Do you think openEHR is the future? Why or why not?
    - If you could fast-forward 10 years, how do you think hospitals will be using EHR systems?
    - *Add: "What do you think will happen if hospitals do or don't adopt openEHR in the next 5-10 years?"*
- "If you could advise hospitals on openEHR adoption, what would you tell them?"

Thank the Interviewee for their time and valuable insights

- Is there anything else you would like to add that we have not covered?

Ask if they'd like a summary of the research findings

Ask for feedback on the interview, their experience ("Was this helpful? Any suggestions?")

Is there anything else you'd like to mention before we end this interview?

Appendix C

Codebook

Selective Code	Axial Code	Open Code	Quote
1 Current openEHR	**1.1 Core of openEHR**	Long history and international adoption of openEHR standard; Standardization as a core strength of openEHR	In the early 90s, openEHR originated as a research-driven initiative in London. (ID01)
			Because of its history, the standard already captures a significant number of clinical concepts. (ID04)
			Code24 delivers software based on openEHR, but some organizations don't even know it's built on top of openEHR.
			We believed in openEHR as a standard.
		Two-level modeling using archetypes; Flexibility and reusability; Decoupling of clinical concepts from IT	Two-level modeling… on one hand, it's clinician-oriented and captures medical concepts abstractly, these are called archetypes.
			As far as I know, this is the only standard that captures clinical knowledge like this. (ID05)
			The two-level modelling are clinical concepts captured into something abstract… hard to understand for non-technical people. (ID01)
			You can combine archetypes, extend or override them depending on the use case, it's flexible enough to support many types of data.
			It's an open platform and open system, not open source, the key is that the standards are open and publicly available.
			It decouples clinical concepts from IT, the technical side is separated, while staying clinically focused.
			openEHR allows for clinical modeling, structures created by doctors and nurses. (ID13)
		Modular development without needing coding changes	Like Lego blocks: openEHR archetypes and templates are the ingredients for a recipe… validated by the international community.
			You can build an application on openEHR without knowing the whole database, that's where innovation happens. (ID02)
			You can change the data models without modifying any code or table structures, this is the value of modular building blocks. (ID04)
			You can change your data models without changing your code or database. (ID04)
			With openEHR, your data is no longer bound to vendor software. That's the game changer. (ID13)
	1.2 Knowledge-phase (DOI)	Insufficient knowledge among healthcare professionals about openEHR; Limited awareness among hospital executives	We are in an early phase for adopting openEHR in hospitals. (ID02)
			There are no large-scale adoptions yet. (ID03)
			There's still too much unfamiliarity, especially among hospital boards. (ID09)
		Hospitals lack awareness of openEHR's benefits; Unclear differentiation between openEHR and existing EHR solutions	Hospitals are still barely aware of what openEHR actually does. (ID08)
			If they understood openEHR's value, they'd have started already, but they simply don't know it. (ID01)
			There needs to be more pain, and it must be clearer what openEHR solves, where and why. (ID04)
		Government role crucial in enhancing awareness	The government has a role in sharing knowledge with hospital boards. (ID01)
		Need for leadership combining medical and technical expertise	You need a good understanding of IT to see what problem openEHR is solving.
			You need quite a bit of IT understanding to see what problem openEHR actually solves. (ID04)
	1.3 Increasing openEHR	Growing momentum and interest internationally	Yes, Norway, Sweden, Australia, Germany, Spain, Estonia, and Slovenia implemented openEHR. (ID03)
			Yes, in Australia, Slovenia, Germany, Spain, Sweden, Norway, etc. there have been great successes. (ID05)
			The influence of openEHR on health IT thinking is growing. (ID04)
		Positive adoption trends for openEHR	I see some positive trends., momentum is building. (ID08)
			It's gaining traction, but we're still too early for full hospital adoption. (ID02)
			It's slowly increasing with several experiments, still too small and limited. (ID15)
			It's slowly increasing through experiments, but too small and few organizations. (ID09)
			The market is increasingly looking for disruption in how systems are built. (ID08)
2 Barriers		Complexity and abstraction of openEHR standard challenging	It's an abstract specification and a steep learning curve you need hands-on experience to eventually understand it. (ID03)

	2.1 Technological barriers	adoption, it's a steep learning curve	The abstraction and complexity of the standard is a huge barrier, although it is a steep learning curve. (ID04)
			openEHR tries to model real-world complexity, that results in complex models that are hard to understand. (ID04)
			Understanding archetypes, templates, and two-level modelling requires domain-specific expertise. (ID10)
			Just do it; work with it. Don't stay stuck in theory. Once you build, you see that it works and has value. (ID13)
			Organizations need concrete examples to overcome these abstractions. (ID08)
		Need for clear, practical demonstrations (proof of concepts, pilots) to reduce abstractness and complexity	Simplification is needed, data layer for end users in healthcare is not relevant, they just want working applications. (ID05)
			There's curiosity about openEHR, but very few hospitals have the time or staff to actually try it themselves. (ID15)
	2.2 Organisational barriers	Vendor lock-in and high investments in current systems inhibit switching; Current systems considered stable and reliable, reducing incentive to switch	They are locked into their current systems… invested capital in current systems is the biggest blocker. (ID01)
			You are now being blocked because that supplier owns the data. (ID05)
			You still depend on the movements of your existing EHR vendor. And they often see openEHR as a threat.
			The major EHR vendors don't benefit from open standards. They prefer to keep you inside their ecosystem.
			Big companies don't have the incentive to move. (ID06)
			Most CEOs will choose the safe route; they stick with the existing vendor. (ID02)
		Insufficient expertise available to bridge clinical and technical aspects; Need for leadership combining medical and technical expertise	Hospitals need leaders with knowledge of healthcare, IT and people management, rare combination. (ID13)
			We have no in-house developers. We don't build anything ourselves. That limits us from doing anything truly innovative.
			Hospitals don't have the people to build these things themselves. Everything is outsourced.
	2.3 Environmental barriers	VWS is still searching for a clear position, often sending mixed signals and a wide growth of initiatives; need for governance	Nictiz doesn't have a mandate. They propose standards, but vendors just say: we're not doing that.
			We've got Nictiz, VZVZ, and others, but no one is really in charge. There's no central coordination.
			We need a national body with both expertise and authority, to not only suggest, but to enforce decisions.
			We need a national body to enforce standards, not just suggest. (ID13)
			There's a wild growth of initiatives all solving the same problems, but there is no coordination. (ID15)
			There's no central coordination between the many initiatives with same goals. (ID13)
		Smaller innovative companies lacking trust from healthcare organizations; competitive market dynamics	Smaller vendors are restricted by dominant providers, and hospitals don't easily trust them. (ID10)
		Government focus primarily on standardizing interfaces rather than data storage	Still too much focus on interfaces instead of storage, that blocks adoption. (ID10)
			If they embrace openEHR it would be faster, but they are still focused on ZIBs... they got it wrong from the start. (ID10)
3 Problems addressed by openEHR	**3.1 Technological solutions**	Interoperability and data exchange problems solved through standardized data storage	If everyone implements openEHR, you actually no longer have an integration problem. (ID04)
			Data is uniformly defined independent of the system or database, this enables exchange with multiple parties. (ID03)
			It won't solve all your problems, but what it solves, it does pretty well. (ID04)
			The problem of data exchange is solved. (ID06)
		Data longevity: Ensures data remains readable and usable over time	Flexibility of the systems and longevity are important, people born today can still read and understand the data. (ID08)
			openEHR ensures that even future generations can read today's data. (ID08)
			You store the data in a way that remains useful in the future. (ID10)
		OpenEHR perceived as the optimal standard for future healthcare IT sustainability	openEHR is the only way forward in healthcare and IT. (ID05)
		Legacy EHR systems are no longer sustainable	The legacy EHR systems can't last another generation. (ID01)
			The current systems are outdated and overly complex, it is mainly a matter putting on band-aids… They are almost impossible to adapt. (ID04)
			Hospitals control their own data, that's biggest advantage of openEHR. (ID05)

	3.2 Organizational solutions	Increases data control and independence from software vendors	openEHR allows for a spread of risk, you're not tied to one application. (ID06)
		OpenEHR essential for effective AI implementation	I think openEHR is essential for AI, because reliable AI starts with a solid data layer. (ID07)
			"openEHR fixes the garbage in garbage out effect at the foundatiom. (ID08)
			openEHR plays a vital role in a global information model, enabling AI application and big data. (ID08)
			If you move to an open ecosystem where everyone has the data in openEHR, you can combine flexibly. (ID06)
	3.3 Environmental solutions	Enhances flexibility in choosing and switching application providers (nationally and internationally)	The foundation is designed for healthcare providers but simultaneously enables interoperability, that's its power.
			Hospitals can choose any vendor and switch easily, even internationally. (ID05)
			You don't have to modify your data if you switch vendors or apps, that's the power. (ID06)
		Best-of-breed approach becomes feasible, promoting specialized applications and innovation by smaller vendors	Best-of-breed becomes possible only when your data layer is standardized and interoperable. (ID02)
			Healthcare is the best example of specialist market… but in terms of systems, we don't do that. It's actually quite strange. (ID06)
			Small vendors can also participate and collaborate, they're flexible and more innovative, more vendors is good. (ID02)
			This is future-proof. You can build EHR apps on top and reuse the data however you want.
			Eventually we'll move to modular EHRs , apps on top of a solid open data layer. (ID04)
			If the data sits in openEHR, smaller third-party apps can connect to it without needing custom integrations with every EHR system. (ID14)
			Ideally, we'll have a standardized open data layer and then use best-of-breed applications on top of that. (ID14)
		International collaboration and interoperability for trust and incentives	If Scandinavia and the world shows it works, maybe the environment will change, but it needs a trigger. (ID10)
			The archetypes are validated by the international community, so you can trust it. (ID02)
4 Vision and Strategy	**4.1 Long-term vision**	Hospitals need to go through a strategic transformation to move to sustainable IT.	A full transformation is needed, it is essential that we redesign the system. (ID01)
		Many institutions lack the courage or long-term vision to invest today for benefits in 5-10 years.	It is a long-term vision that will ultimately yield great results. (ID09)
			If hospitals see the long-term benefit, then the benefit is going to come. If they are able to see that and invest in it, then there is a good chance to succeed. (ID02)
		Modular open platforms enable participation of small vendors and best-of-breed systems.	The platform should be an ecosystem of small applications using openEHR - a best-of-breed architecture.
			Healthcare is highly specialized - but we don't reflect that in our systems. That's a flaw.
	4.2 Transition strategies	A stepwise approach (small pilots) enables adoption without disrupting existing systems; Use a (bottom-up) openEHR CDR as an additional module, not as a replacement.	Begin small as an extra care system next to your current one - low-risk and low-cost. (ID03)
			You just have to start, get out of the talking phase and just do it. Then you'll see the benefits. (ID13)
			Start small, run a separate CDR system next to your current one - it's low-risk and low-cost. (ID03)
		Future-proofing via local CDR for data archiving, scientific research, and AI is a core motivator	It's a huge opportunity for AI and research, especially because it excludes identifying information.
			For data ownership hospitals can implement their own openEHR CDR next to existing one
			You don't have to abandon your current EHR to use openEHR.
		Clear alignment and coordination from government for all stakeholders (Top-down).	Government must provide direction and pressure, either with a stick or carrot. (ID15)
			The government has the responsibility to guarantee data quality in healthcare. (ID01)
	4.3 Federated model	Change requires both top-down and bottom-up traction; Federated model supports local data control and regional collaboration.	Hospitals do not want to give away their data to a central system, they want control, and value privacy. (ID01)
			Federation makes sense in the Netherlands. But without clear national agreements, it turns into a mess. (ID01)
			Open source allows small vendors to participate and collaborate.
		It is important to think federally for true interoperability	Build regionally but think federally. (ID10)
			The government should finance it, but let experts build it. (ID11)

			This is the way how we're going to do it, that is what we need from the government. (ID14)
			We need a national body with both expertise and authority, to not only suggest, but to enforce decisions. (ID14)
		Federated model is the best approach to ensure interoperability and aligns with the EHDS	
5 Stakeholders	**5.1 Government**	Government plays a critical role by setting quality standards and providing legal/policy direction.	The government's task is to ensure quality. (ID11)
			Government has to say: 'this is the quality standard, we require it by law...'. (ID01)
		There is insufficient national leadership and tempo to guide adoption, more top-down coordination, mandates, and incentives (e.g., subsidies) are needed.	They have a huge influence over whether adoption happens or not. (ID06)
			We need either incentives or pressure from the government. Otherwise, nothing changes. (ID13)
		VWS (Ministry of Health) is still searching for a clear position, often sending mixed signals, and too focused on current legacy systems (e.g., ZIBs).	The government should not only ask, but also incentivize, for example via subsidies. (ID15)
			VWS is still searching for its role... they're sending mixed signals.(D14)
			We need a national body with both expertise and authority to not only suggest, but to enforce decisions. (ID15)
			Progress is so minimal... this is going to take years. (ID07)
			If the government doesn't do it, we are dependent on how fast international players move.
		So far, focus has been mostly on interface-level (FHIR) standardization rather than data storage (e.g., openEHR).	FHIR for exchange, openEHR for structured storage, and ZIBs as a shared source model that can bridge both. (ID02)
			It can coexist and reinforce each other. (ID04)
			Serious initiatives are currently underway to integrate openEHR and FHIR. (ID14)
	5.2 Stakeholders and collaboration	The system works only when all stakeholders participate, interoperability and shared standards require collective commitment.	It only works when everyone participates. (ID11)
			Health insurers, vendors, and government need to collaborate , it's still too fragmented.
		Peer influence and opinion leaders are crucial (e.g., 'sheep over the dam' effect).	Opinion leaders and peers are very important; once one sheep crosses the dam, others follow. (ID10)
			If you can get professionals enthusiastic, you can make real progress.
			The board of directors is decisive, but it has to get there. If you get healthcare professionals enthusiastic, you can make progress. (ID09)
			Peer-to-peer influence at board level is also important. (ID09)
			You really need the pioneers; like Maastricht, RSO, etc. Then healthcare organizations will see it works. (ID08)
		Healthcare professionals and clinical informatics play a key role in building enthusiasm among boards.	People who understand the medical and technical side are indispensable in this process, technicians often do not understand the importance and state of affairs behind the medical domain and physicians do not understand the technical side, a combination is rare but very necessary. (ID13)
			Formal pathways are slow and political; informal networks and enthusiastic experts are key to acceptance. (ID14)
		Cultural and social dynamics strongly influence decision-making, even more than rational arguments.	Social influence is important… people base decisions heavily on what others say. (ID09)
			The policy must be supported by substantive experts and bottom-up influence. (ID07)
			An elective on openEHR would be a great idea, yes. (ID13)

Appendix D

Usage of artificial intelligence

In accordance with the AI Usage Guidelines of Erasmus University Rotterdam, the use of artificial intelligence in the development of this thesis has been limited to supporting tasks such as language editing, reference formatting, and visual structuring. All academic reasoning, analysis, and interpretation have been conducted independently by the author.

For more information, see:

Erasmus University Rotterdam. (n.d.). *AI usage guidelines*. https://www.eur.nl/en/about-university/policy-and-regulations/regulations-and-guidelines/ai-usage-guidelines

Appendix E

Distribution of coded segments across participants

Figure 5

Distribution of coded segments across participants

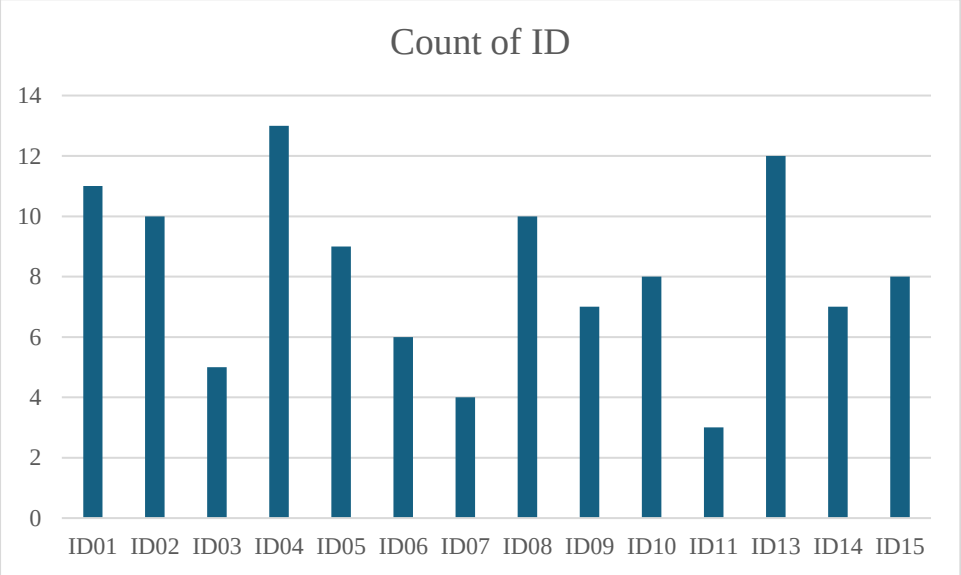


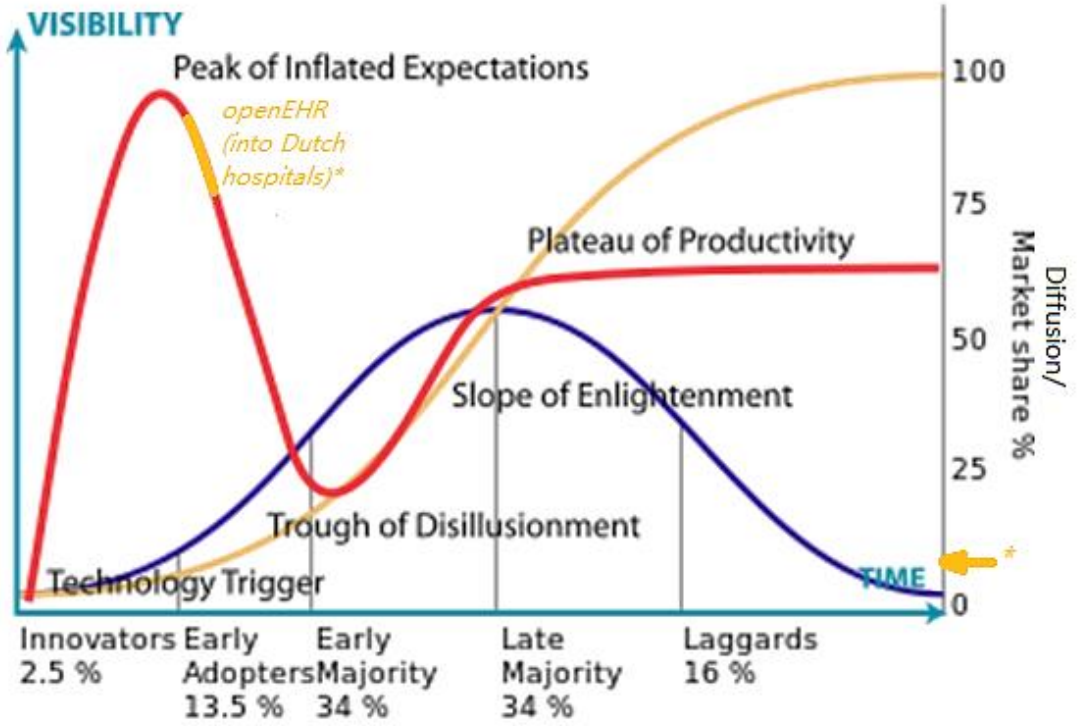
Figure 5 shows the distribution of coded segments per participant. It illustrates that all 15 experts contributed substantially to the findings, with no real interview dominating the results. This visual representation underscores that the thematic insights presented in the findings were drawn from a broad and balanced range of expert perspectives, enhancing the credibility and depth of the analysis.

Appendix F

Conceptual visualization of openEHR Diffusion in the Netherlands

Figure 6

Conceptual visualization of the diffusion of openEHR in Dutch hospitals, combining Gartner's Hype Cycle (2024) and Rogers' DOI model (1962). The placement of openEHR reflects the author's interpretation based on expert insights.



Note. This conceptual figure was created by the author to synthesize theoretical frameworks and empirical insights gathered through this qualitative research. It does not represent official metrics or validated data and does not contribute to the findings of this study.

This visualization was inspired by a quote from one of the participants:

> *"Sometimes it is overhyped, also by people who don't really understand it, and that's a pity, because it only sets us up for disappointment"* (ID04).

This resonated with me and sparked the idea to combine Gartner's Hype Cycle (2024) and Rogers' DOI (1962) into one conceptual model. I noticed an overlap between these two that seemed to reflect the dynamics described by participants. Participants placed openEHR in the *knowledge phase* of DOI and at the beginning of the early adopters stage, represented by pilots such as RSO Zuid-Limburg and Isala hospital. At the same time, participants observed that growing momentum and pointed out the hype surrounding openEHR, especially in tech communities. This led me to suggest that openEHR may currently be near or just past the "peak of inflated expectations" in the Hype Cycle. And time will tell,

weather it risks entering the “trough of disillusionment”, to continue toward the “slope of enlightenment” and eventually reach a “plateau of productivity”, where adoption becomes more stable and widespread.

While this figure is a personal and creative conceptual interpretation, not a formal part of the study’s findings, it reflects my own impression that openEHR diffusion in Dutch hospitals is perhaps only around 5% (see yellow arrow in Figure 6). This appendix serves solely to contextualize these perceptions and to make the eventual expectations or challenges of broader diffusion more tangible.