Leveraging European Health Data Space (EHDS) for Safer and Smarter European Travel

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Abstract: Health tourism is rapidly expanding, driven by the demand for high-quality medical and wellness services across borders. This growth introduces complex challenges related to data security, interoperability, and trust. The European Health Data Space (EHDS) aims to create a unified framework for secure health data exchange within the EU, offering significant potential to enhance safe and smart health tourism. This study develops a theoretical foundation through a multi-case approach (three cases) to examine how EHDS can be leveraged in this context. Data were collected through document analysis, semi-structured interviews, and participant observation. Qualitative content analysis and triangulation were used to ensure reliability. The findings highlight that technical interoperability alone is insufficient; robust cybersecurity and continuous professional education are essential for building trust and resilience. Furthermore, innovation clusters emerge as key enablers, fostering collaboration between healthcare providers, technology firms, and educational institutions. The study concludes by identifying research gaps and proposing future directions, including empirical evaluation of EHDS implementation, IoMT security and the impact of competence development initiatives. By integrating technology, policy and education, Europe can establish a secure and patient-centric digital health ecosystem that supports sustainable growth in health tourism.

Keywords: European Health Data Space, XiA Project, Digital Health, Traveler Trust, Health Tourism, Case Study

1. Introduction

The European Health Data Space (EHDS) aims to create a unified and secure health data ecosystem that supports cross-border care and the development of digital health services (Marcus *et al.*, 2022). At the same time, health tourism is growing at over 10% per year from 2023 to 2032 (Allied Market Research, 2023), increasing the need for seamless data exchange and strong cybersecurity (Rajamäki *et al.*, 2025). Technological solutions such as the Apotti–Maisa–Kanta systems and IoMT devices offer new opportunities, but their effective and secure use requires competence development and user-centered practices (Valvira, 2025). The XiA project addresses this need by developing microcredential-based training solutions that support EHDS implementation (XiA, 2025).

This multi-case study examines how EHDS can be leveraged to promote safe and smart health tourism and explores the role of clusters and competence development in this transformation through three complementary cases that offer different perspectives. The research questions (RQ) are: *'How can the European Health Data Space (EHDS) be leveraged to promote safe and smart health tourism? How is the role of clusters, ecosystems, and competence development conceptualized within this transformation?*

2. Theoretical Framework Through Literature Review

This literature review constitutes the first phase of the multi-case study, aimed at developing a theoretical framework (develop theory) to understand the phenomena under investigation. The review synthesizes key concepts related to the European Health Data Space (EHDS), health tourism, digital health technologies, cybersecurity, competence development and the role of clusters in digital health ecosystems. This theoretical foundation guides the subsequent case analysis and explains why the selected research questions are relevant.

2.1 Health Tourism and Cybersecurity

Health tourism has emerged as one of the fastest-growing segments of the global tourism industry, combining medical and wellness services with travel experiences. It encompasses both medical tourism—focused on clinical interventions such as surgeries, diagnostics and fertility treatments—and wellness tourism, which emphasizes holistic well-being through activities such as spa therapies, yoga and nature retreats (Carrera and Bridges, 2006; Dini and Pencarelli, 2022). The increasing digitalization of health services and the need for cross-border data exchange have become central to the development of health tourism. However, these advancements introduce significant cybersecurity challenges that must be addressed to ensure patient safety and customer trust (Huang *et al.*, 2023; Selvakumar & Lokesh, 2024).

Health tourism operates at the intersection of healthcare and travel, creating complex data flows that involve sensitive personal and medical information. The integration of Electronic Health Records (EHR) and Internet of Medical Things (IoMT) devices enhances continuity of care and patient experience, but simultaneously expands the attack surface for cyber threats (Stainton, 2022; Global Wellness Institute, 2024). Cybersecurity is, therefore, a critical enabler of trust in health tourism. According to López (2024), the primary risks include: 1) Data breaches and leaks, which can lead to identity theft and financial fraud. 2) Ransomware attacks, where critical health data is encrypted and held for ransom. 3) IoMT vulnerabilities, as connected medical devices transmit real-time health data and are susceptible to hacking and interception.

General Data Protection Regulation (GDPR) imposes strict requirements for data protection. It requires secure communication channels, encryption and harmonized consent management to safeguard patient privacy (Bradford, Aboy and Liddell, 2020). Building trust in health tourism requires a multi-layered approach that combines technical measures—such as advanced encryption and secure data transfer—with organizational strategies, including staff training and comprehensive cybersecurity policies aligned with international standards.

2.2 EHDS and Cross-border Healthcare

The European Health Data Space (EHDS) was established to create a secure and unified framework for the use of health data across the European Union. Its primary objectives include enabling individuals to access and manage their electronic health data, supporting continuity of care across borders and fostering secondary uses of health data for research, innovation and public health preparedness (European Commission, 2025b). EHDS aims to strengthen the EU's internal market by harmonizing legal and technical requirements for electronic health record (EHR) systems (European Parliament, 2025). This directly supports cross-border healthcare and health tourism by ensuring that patient summaries and prescriptions are accessible in other EU member states (European Commission, 2025a).

EHDS operates within a broader regulatory ecosystem that establishes the legal and technical foundations for secure health data exchange across the EU. Its key component is GDPR, which governs the protection of personal data and significantly influences cross-border data transfers (EDPS, 2025). The electronic identification and trust services (eIDAS) Regulation, as a complement to GDPR, ensures secure electronic identification and trust services, enabling reliable authentication in health data transactions. MyHealth@EU represents the first practical implementation of EHDS principles, providing essential services such as electronic prescriptions and patient summaries to support continuity of care across borders (European Commission, 2025b).

Interoperability constitutes a cornerstone of EHDS implementation. Within this framework, the European Electronic Health Record Exchange Format (EEHRxF) plays a central role, incorporating recommended standards such as Health Level Seven (HL7) Fast Healthcare Interoperability Resources (FHIR) and Integrating Healthcare Enterprise (IHE) profiles to enable secure and seamless cross-border health data exchange ('EHDS - HL7 Europe', 2024). Given the sensitivity of health data, EHDS emphasizes robust cybersecurity measures and ethical principles to maintain trust among stakeholders (European Parliament, 2025). This is particularly relevant for health tourism and the use of Internet of Medical Things (IoMT) devices, where secure data flows are essential for patient safety.

EHDS harmonizes consent management across member states in compliance with GDPR. Patients must have transparent control over their data, including the ability to grant or revoke consent for secondary uses. Despite its benefits, EHDS faces challenges such as linguistic diversity, varying national legislation, and technological disparities. However, it also presents opportunities to enhance travel safety, support service innovation, and improve healthcare continuity for mobile EU citizens.

The Xt-EHR (Extended EHR@EU Data Space for Primary Use) project lays the foundation for implementing the European Health Data Space (EHDS), particularly for the primary use of health data (Xt-EHR, 2025). The primary objective of the project is to ensure that EU citizens can securely and seamlessly access and utilize their electronic health records across different Member States, thereby supporting the vision of EHDS and promoting the development of digital health in the EU. Table 1 contains excerpts from definitions produced by the project, intended to promote shared understanding.

Table 1: General definitions (Carradinha, *et al.*, 2025)

Term	Definition
Cross-border eHealth services	Cross-border eHealth services refer to the services that can be exchanged through the MyHealth@EU infrastructure, which in 2024 supports the Electronic Prescription and Dispensation, and Patient Summary. The next services planned to become available include: Laboratory Results Report, Medical imaging studies and reports and Hospital Discharge Report.
Cross-border healthcare	Healthcare provided or prescribed in a Member State (MS) other than the MS of affiliation.
Cross-border Telemedicine	Refers the delivery of health care services using Information and Communication Technologies (ICT), where patients and health providers are located in two different countries.
Teleconsultation	A form of remote medical consultation in which health professionals use ICT to provide clinical advice, diagnosis, or treatment to patients or other healthcare providers at a distance. This can include real-time (synchronous) consultations using video or audio links or store-and-forward (asynchronous) methods, where medical data, such as images or patient records, are shared for later review and response.
Electronic Prescription (eP)	Electronic health data constituting a prescription for a medicinal product. A prescription means a prescription for a medicinal product or for a medical device issued by a member of a regulated health profession within the meaning of Article 3(1)(a) of Directive 2005/36/EC who is legally entitled to do so in the MS in which the prescription is issued.
MyHealth@EU	MyHealth@EU is a common EU digital infrastructure designed to ensure secure and efficient connectivity and interoperability among MSs to support crossborder healthcare. Therefore, it enables natural persons to share their personal electronic health data with healthcare providers while traveling abroad, ensuring continuity of care.
Interoperability	Ability of organisations as well as software applications or devices from the same manufacturer or different manufacturers, to interact through the processes they support, involving the exchange of information and knowledge, without changing the content of the data, between these organisations, software applications or devices.

The successful implementation of EHDS and the secure integration of digital health technologies in health tourism depend not only on technical interoperability but also on the development of human competencies. Digital transformation in healthcare introduces complex socio-technical challenges that require multidisciplinary expertise. Professionals must navigate regulatory frameworks such as GDPR and EHDS, implement secure data exchange protocols, and manage emerging technologies like IoMT and AI-driven diagnostics. These demands necessitate continuous professional development and flexible learning pathways tailored to diverse roles, including clinicians, IT managers, and administrative staff (Tavares, Sousa and Proença, 2024). From the perspective of the tourism business, the secondary use of health data can provide significant added value in several ways, provided that it is carried out in accordance with the EU's EHDS framework and data protection legislation (Vovk *et al.*, 2025).

2.3 Clusters and Digital Health Ecosystems

The concept of clusters, popularized by Porter (1998), refers to geographically proximate groups of interconnected companies, institutions and organizations operating within a specific field. Clusters enhance productivity, stimulate innovation and facilitate new business formation through localized externalities such as knowledge spillovers, shared infrastructure and specialized labor pools (Andersson *et al.*, 2004). Building on Porter's (1998) framework, contemporary cluster theory emphasizes systemic interaction among multiple actors—industry, government, academia and civil society—captured in the Quadruple Helix model (Carayannis, Barth and Campbell, 2012). This model extends the traditional Triple Helix (university–industry–government) by incorporating citizens and end-users as active participants in innovation processes. In digital health ecosystems, this inclusion is critical for ensuring patient-centric solutions and fostering trust in technologies such as EHDS and IoMT. However, clusters are not static entities; they evolve through life cycles encompassing embryonic, growth, maturity, and transformation stages (Teräs, 2008). Their sustainability depends on adaptability, critical mass and openness to global knowledge flows—concepts equally relevant to health data ecosystems that must integrate cross-border interoperability and cybersecurity standards.

Clusters function as innovation orchestrators, aligning technological development with educational initiatives and service delivery. Teräs (2008) highlights that successful clusters exhibit strong leadership, social capital and strategic management, enabling them to mobilize resources and coordinate diverse actors. Digital health must be examined through a sociomaterial approach, in which technology and social practices are seen as inseparably intertwined (Marent and Henwood, 2023). These attributes translate into: 1) Innovation: Development of secure

EHR systems, IoMT devices, and AI-driven diagnostics. 2) Education: Competence-building through modular learning frameworks such as XiA's Micro-Content Learning Blocks (MCLBs), aligned with EQF and ECSF standards. 3) Service Development: Integration of health tourism offerings with digital health infrastructures, ensuring continuity of care and data security across borders. The interplay between these dimensions creates a socio-technical ecosystem where technology and human capacity co-evolve. Clusters provide the structural conditions for this convergence by facilitating partnerships among healthcare providers, technology firms, universities and policy-makers.

2.4 Theoretical Synthesis

EHDS serves as a cornerstone for secure and interoperable health data exchange across borders, yet its successful implementation requires a multidimensional approach that goes beyond technical compliance. While interoperability standards provide the structural basis for cross-border care, they cannot alone guarantee trust or resilience in digital health ecosystems. Cybersecurity must be embedded as a systemic prerequisite, ensuring that sensitive health data remains protected throughout increasingly complex care pathways. Equally critical is competence development, which functions as a strategic enabler for sustainable transformation. Furthermore, innovation clusters act as systemic facilitators, orchestrating collaboration among healthcare providers, technology firms and educational institutions to accelerate the integration of EHDS principles into practice. Examples include Nordic Health Cluster and European Connected Health Alliance, which leverage the Quadruple Helix model to foster co-creation and knowledge exchange (Carayannis, *et al.*, 2012). By aligning technology, policy and education, Europe can establish a secure, patient-centric digital health ecosystem that supports the growth of health tourism while safeguarding trust and compliance.

3. Applied Multi-Case Study Approach

This study employs a multiple case study methodology with abductive reasoning, as illustrated in Figure 1.

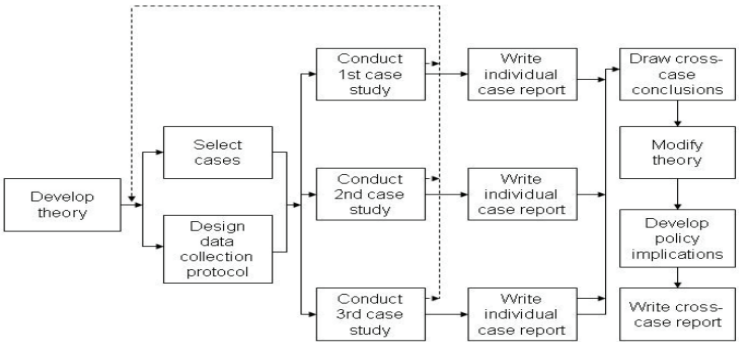

Figure 1: Case study method of this study (adopted from Yin, 2018).

3.1 Justification for Case Selection

The selection of cases is based on the research objectives, the theoretical framework, and Yin's (2018) logic for multiple case studies. The main goal of this study is to examine how Finland's digital health ecosystem supports cross-border care pathways from the perspective of the European Health Data Space (EHDS) and cybersecurity. The chosen cases represent key dimensions of the ecosystem and provide complementary perspectives:

- Case 1 'Health tourism to Finland and the importance of cybersecurity': Finland is an attractive destination for health tourism, which creates a need to examine patient data transfer, IoMT technologies, and cybersecurity. This case was chosen because it combines healthcare and tourism perspectives and highlights the role of cybersecurity in building trust.
- Case 2 'The Apotti–Maisa–Kanta ecosystem and continuity of care for Finnish travelers': This case focuses on the technical infrastructure and its role in cross-border data exchange. It was selected because Apotti–Maisa–Kanta forms the core of Finland's digital health ecosystem, and its interoperability with EHDS is critical for travel safety and continuity of care.
- Case 3 'The role of the XiA project in developing skills and interoperability': The XiA project was selected because it provides a strategic perspective on harmonizing education and skills at the EU level. The project supports EHDS implementation and cross-border data exchange by developing

microcredential-based training modules.

The selected cases follow Yin's (2018) principle of theoretical replication: they are not random but chosen to offer different yet complementary perspectives on the research problem. This approach enables the use of pattern matching, explanation building and cross-case synthesis methods, thereby strengthening the validity of the study.

3.2 Units of Analysis

Before proceeding to the case study analysis, it is necessary to clarify which phenomena are examined in this research. According to Yin (2018), the selection of an appropriate unit of analysis derives from accurately formulated research questions. In this study, the unit of analysis is Finland's digital health ecosystem within the context of health tourism. This ecosystem comprises several interconnected elements: the Apotti system (social and healthcare information system), the Maisa portal (customer interface and consent management), the Kanta services (national health data management and EU integration), health tourism practices in Finland (medical and wellness tourism), cybersecurity solutions (including EHR, IoMT, and data transfer), and XiA's training strategies for competence development in EHDS implementation. The unit of analysis is not a single system, such as Apotti, but rather an integrated whole where technical infrastructure, services and the operational environment converge. This approach enables a multidimensional examination encompassing technology, data protection, cybersecurity and education; situates the analysis within a cross-border context through EHDS integration and travel safety; and provides practical insights by positioning Finland's model as an example for EU-level implementation.

3.3 Sources of Evidence and Analysis Methodology

Yin (2018) identifies six key sources of evidence for case studies: documents, archival records, interviews, direct observation, participant observation and physical artefacts. He emphasizes the importance of using multiple sources to achieve triangulation. In this study, data were collected and analysed partly through different methods across the cases (see Table 2). However, these methods complement each other: documentary sources formed the primary basis, which was supplemented in various ways in each case, and the documentary material consisted mainly of sources from 2025.

Table 2: Case Studies' Methods and Data Sources

Case	Objective and Method	Data Collection	Analysis Methods	Justification
Case 1: Ensuring cybersecurity in Finland's health tourism	Integrating cybersecurity into health tourism education in multidisciplinary higher education; focus on practical solutions	Individual case report available: Rajamäki, J. et al. (2025)		Multidisciplinary perspective and triangulation ensure reliability
Case 2: Apotti–Maisa–Kanta ecosystem as a model for cross-border interoperability	Examining how the ecosystem supports continuity of care for Finnish travelers abroad via EHDS	*Documents*: Official documentation of Apotti, Maisa, and Kanta (integration architecture, FHIR standards, MyHealth@EU): EHDS guidelines and EU interoperability standards: GDPR and eIDAS requirements *Direct observations:* author's experience in SOTE IT integrations	*Pattern matching*: EHDS objectives vs. current state *Explanation building:* technical solutions (FHIR, eIDAS, Kanta) *Triangulation*: documents + expert observations	Feasible within timeline; leverages existing documentation and expert knowledge
Case 3: XiA Project and its role in Finland's digital health ecosystem within the context of health tourism	Strategic perspective on harmonizing EHDS-related education and skills at the EU level	*Documents*: XiA project deliverables (WP3 Skills Gap, WP4 pedagogical models, WP5 content) *Interviews/discussions:* XiA WP leaders *Participant observation:* Consortium meetings and workshops, in which the first author has actively participated. *Direct observations* during curriculum development	*Pattern matching:* XiA solutions vs. EU competence frameworks (ECSF, EQF) *Explanation building:* modular model (MCLB + microcredentials) *Triangulation*: documents + observations + interviews	Author's access to XiA documentation and participation in meetings enable in-depth contextual analysis

4. Empirical Context and Cases

This section presents the case studies, each examining a distinct dimension of the phenomenon under study. First, the study examines Finland's health tourism and its cybersecurity challenges. The next case focuses on the Helsinki metropolitan area's solution for cross-border health data. The third case explores in greater detail the competence and skills gap among professionals identified in the first case. In all cases, the Unit of Analysis (UoA) is Finland's digital health ecosystem within the context of health tourism.

4.1 Case 1: Ensuring Cybersecurity in Finland's Health Tourism

Finland's health tourism is rooted in a long spa tradition and a strong wellness culture. Wellness tourism leverages the country's natural resources—clean environment, forests, lakes, sauna culture and seasonal lightoffering visitors holistic experiences (Lehto, 2021). Medical tourism, on the other hand, attracts international patients with high-quality healthcare services, quick access to treatment and specialized clinics such as Docrates Cancer Center and Orton Oy. The Medical Tourism Association Finland aims to position Finland as the leading medical tourism destination in the Nordic region (Medical Tourism Association Finland, 2025).

Finland's strengths include high-quality care, safety and reliability. However, challenges persist in terms of cost levels, limited accessibility and the need for more effective international marketing. Family-friendly services and nature-based destinations are key target segments, and social media plays a significant role in influencing destination choices (Lehto, 2021). The future of Finland's health tourism depends on its ability to combine strong wellness offerings with top-tier medical services cost-effectively and securely. Investments in technology, staff training and comprehensive cybersecurity policies are essential. In addition, international marketing and improved accessibility can further strengthen Finland's position in global health tourism.

As noted in section 2.1, digitalization is a central factor in the development of health tourism. Finland's digital health ecosystem plays a crucial role in supporting health tourism by ensuring secure and efficient healthcare services for international patients. At its core lies the Kanta system, which guarantees data security and interoperability for patient records, including those transferred from abroad. Advanced technologies such as Electronic Health Records (EHR) and the Internet of Medical Things (IoMT) enable real-time monitoring, personalized care and seamless integration with Finland's robust healthcare infrastructure.

Finland also strictly adheres to EU regulations such as GDPR and EHDS, making it a trusted destination for health tourism. Cross-border patient data transfer requires strong encryption, secure communication channels and interoperable systems. IoMT device security is critical, as these devices collect sensitive health data. Cyberattacks can compromise patient safety, so device protection and compliance with international standards are essential. Cybersecurity is therefore a critical component of the ecosystem, addressing challenges in cross-border data exchange, IoMT device security, and compliance with stringent regulations such as GDPR. Finland's emphasis on data protection, trust, and regulatory rigor enhances its attractiveness as a health tourism destination. Together with a strong digital infrastructure and robust cybersecurity practices, these factors position Finland as a reliable and competitive player in the global health tourism market.

Case 1, highlights a skills gap: many healthcare professionals lack adequate cybersecurity training, increasing vulnerability to data breaches and ransomware attacks. To address this, Finland needs multidisciplinary cybersecurity education initiatives.

4.2 Case 2: Apotti–Maisa–Kanta Ecosystem as a Model for Cross-border Interoperability

Apotti is a comprehensive social and healthcare information system applied in the Helsinki metropolitan area, covering about one-third of Finland's population. It consolidates patient and client data into a unified platform, facilitating integrated service delivery across multiple providers. Its design leverages international interoperability standards, such as HL7 FHIR, which form the foundation for cross-border data exchange within the European Health Data Space (EHDS) framework (Apotti, 2025b). Maisa serves as the citizen-facing interface for Apotti, providing functionalities such as secure communication with healthcare professionals, appointment scheduling and access to personal health records. A critical feature of Maisa is its support for electronic consent management, which aligns with EHDS principles and GDPR requirements by empowering patients to control the sharing of their health data across borders (Apotti, 2025a)

Kanta operates as Finland's national health data repository and acts as the primary integration point for cross-border interoperability (KELA, 2025).Through standardized interfaces and harmonized consent mechanisms,

Kanta enables Finnish travelers to authorize the use of their health data in other EU member states. Furthermore, Kanta is integrated into MyHealth@EU, the first operational implementation of EHDS, which supports services such as electronic prescriptions and patient summaries for continuity of care across borders (European Commission, 2025a).

The Apotti–Maisa–Kanta ecosystem exemplifies how national infrastructures can operationalize EHDS objectives by combining technical interoperability with patient-centric design. Its reliance on HL7 FHIR and the upcoming European Electronic Health Record Exchange Format (EEHRxF) ensures compliance with EU standards for secure and seamless data exchange (EDPS, 2025). However, technical interoperability alone is insufficient. Effective implementation requires robust cybersecurity measures, multilingual user interfaces and harmonized consent management to address the complexities of cross-border healthcare. These elements are essential for safeguarding patient privacy and fostering trust in digital health services (Rajamäki *et al.*, 2025). The ecosystem's strategic importance lies in its ability to serve as a model for other EU member states. By integrating secure infrastructure with user-friendly interfaces and regulatory compliance, Apotti–Maisa–Kanta demonstrates how national systems can contribute to the broader vision of EHDS, creating a unified, secure and patient-centric digital health environment across Europe.

4.3 Case 3: XiA Project and its Role in Finland's Digital Health Ecosystem Within the Context of Health Tourism

The XiA Project (Xpanding Innovative Alliance) is a European development initiative funded by the Erasmus+ program. Its primary goal is to support the implementation of the European Health Data Space (EHDS) by strengthening competencies in interoperability, cybersecurity and digital health. The project addresses existing skill gaps among healthcare professionals, technology providers, and citizens, leveraging the Quadruple Helix model, which fosters collaboration between public and private sectors, academia and civil society. XiA introduces Micro-Content Learning Blocks (MCLBs)—short, targeted learning units aligned with EQF levels 5–7. These blocks enable microcredentialing and digital badges, offering flexible and customizable learning pathways. Each block typically represents 0.1–0.2 ECTS credits and can be combined into larger qualifications, supporting lifelong learning and professional mobility (XiA, 2025).

Cybersecurity is a core theme integrated across multiple learning families. The Security & Privacy family covers GDPR compliance, anonymization techniques, secure data exchange and privacy-preserving interoperability. Additional modules address data quality, EHR systems and ethical and legal frameworks, including the AI Act and EHDS regulations. Learners acquire practical skills such as implementing security protocols, managing audit trails, and applying privacy-preserving techniques in cross-border data exchange.

XiA demonstrates that technical interoperability alone is insufficient for successful EHDS implementation; competence development and education are equally critical. The project supports the Apotti–Maisa–Kanta ecosystem, enhancing the ability of professionals and citizens to use EHDS services securely. Training modules include GDPR-compliant consent management, secure data transfer and FHIR-based interoperability. Through persona analysis, XiA ensures that content is tailored to diverse user groups needing access to health data abroad. EU-wide localization strategies make materials culturally and linguistically appropriate, fostering usability and trust. For example, Finnish travelers using the Maisa portal abroad could benefit from multilingual guidance on granting EHDS-compliant consent in emergencies.

5. Cross Case Analysis and Findings

All cases emphasize the importance of technical interoperability for achieving EHDS objectives. Apotti–Maisa–Kanta demonstrates practical implementation through FHIR standards and MyHealth@EU integration, while XiA addresses interoperability from a competence perspective, ensuring that professionals understand and apply these standards effectively. Also, cybersecurity emerges as a critical success factor in every case. Health tourism relies on secure EHR systems and IoMT devices to maintain patient trust (Selvakumar & Lokesh, 2024; Huang et al., 2023), while XiA incorporates cybersecurity training into its microcredential framework to strengthen user confidence in cross-border data exchange. Both Apotti–Maisa–Kanta and XiA highlight the role of user-friendly interfaces and multilingual support for consent management. This is essential for travelers navigating EHDS-compliant processes abroad, reinforcing patient autonomy and GDPR compliance. XiA's focus on modular learning and microcredentials complements the technical infrastructure provided by Apotti–Maisa–Kanta. Together, they create a socio-technical ecosystem where technology and human competence evolve in tandem.

The cases collectively illustrate that technical solutions alone cannot guarantee EHDS success. Interoperability must be supported by robust cybersecurity and continuous competence development. For Finland, this integrated approach positions the country as a model for EHDS implementation, combining: 1) Secure infrastructure (Apotti–Maisa–Kanta), 2) Service innovation in health tourism (leveraging EHR and IoMT), 3) Human capacity building (XiA's modular training and microcredentials). These synergies suggest a roadmap for scaling EHDS adoption across Europe: align technical standards, embed cybersecurity in all layers of service delivery, and institutionalize competence development through EU-wide educational frameworks.

Innovation clusters play a central role in accelerating the transformation of digital healthcare, as they foster collaboration between academia, industry, the public sector, and end-users. Clusters provide a structural and relational framework for integrating various initiatives—such as educational projects, service innovations, and regulatory infrastructures. The following examines how clusters act as a connecting mechanism for three interrelated cases: First, health tourism in Finland benefits from cluster-based synergies among healthcare providers, technology companies, and research institutions. Clusters enable the integration of advanced digital solutions—such as telemedicine, AI-assisted diagnostics, and secure data transfer—into patient pathways, enhancing the attractiveness and competitiveness of Finnish healthcare services in international markets. Second, the implementation of the EHDS and national platforms such as Kanta, Apotti, and Maisa illustrates the regulatory and infrastructural dimensions of cluster ecosystems. Clusters act as intermediaries that translate policy frameworks into operational solutions, ensuring interoperability, data security, and patient-centered services. Through shared governance, clusters help align local innovations with European standards, creating scalable models for cross-border health data exchange. Third, the XiA project demonstrates cluster-driven capacity building through the Quadruple Helix model, enabling cross-sectoral learning and interoperability in digital healthcare. Leveraging cluster networks promotes knowledge exchange and co-creation, ensuring that educational content meets technological and regulatory requirements. In summary, clusters serve as orchestrators of innovation, connecting educational initiatives, service development and regulatory compliance. Their integrative capacity makes systemic transformation in digital healthcare possible.

6. Conclusions

The study demonstrates that the successful implementation of EHDS in the context of health tourism requires more than technical interoperability—it demands a holistic approach that integrates secure infrastructure, robust cybersecurity and continuous competence development. As an answer to the main research question, '*How can the European Health Data Space (EHDS) be leveraged to promote safe and smart health tourism, and what role do clusters and competence development play in this transformation?*', the cross-case analysis of Finland's digital health ecosystem, health tourism practices and the XiA project reveals three critical insights:

1. Interoperability as a foundation for cross-border care: systems like Apotti, Maisa and Kanta illustrate how standardized frameworks (e.g., HL7 FHIR, MyHealth@EU) enable seamless data exchange across borders. However, technical solutions alone cannot guarantee continuity of care without harmonized consent management and multilingual user interfaces.
2. Cybersecurity as a Prerequisite for Trust: Health tourism introduces complex data flows involving Electronic Health Records (EHR) and Internet of Medical Things (IoMT) devices. These technologies enhance patient experience but also increase exposure to cyber threats such as ransomware and phishing. Ensuring trust requires advanced encryption, secure communication channels, and compliance with GDPR and EHDS regulations.
3. Competence Development as a Strategic Enabler: The XiA project highlights the importance of education and capacity building through modular learning and microcredentials. Embedding cybersecurity and interoperability training into higher education curricula and professional development programs ensures that healthcare professionals, tourism operators, and ICT specialists can operate confidently in a cross-border digital health environment.

This study highlights several areas that warrant further investigation to strengthen the integration of the European Health Data Space (EHDS) into health tourism. First, empirical research is needed on the practical implementation of EHDS in cross-border care pathways, including user experience and consent management in multilingual contexts. Second, the cybersecurity of IoMT devices and real-time data exchange remains an underexplored domain, requiring advanced risk assessment methodologies and harmonized standards. Third, future studies should examine user-centric design and cultural adaptation of EHDS interfaces, as these factors significantly influence trust and adoption. Fourth, the role of innovation clusters in digital health ecosystems deserves deeper analysis to understand how collaborative networks accelerate interoperability, education, and

service innovation. Fifth, there is a need to evaluate the impact of competence development initiatives, such as XiA and CyberSecPro, on workforce readiness and EHDS adoption across member states. Finally, emerging topics such as AI-driven cybersecurity solutions and their ethical implications in health tourism should be explored to ensure resilience against evolving threats. Addressing these research gaps will provide actionable insights for policymakers, educators and industry stakeholders, fostering a secure and patient-centric digital health environment in Europe.

Ethics Declaration

Ethical clearance was not required.

AI Declaration

Artificial intelligence was utilized in the writing process to support literature review synthesis, facilitate comparative analysis between findings and previous research, and assist in the formulation and translation of academic text. AI tools such as Keenious and Copilot enabled efficient information retrieval, structured drafting, and linguistic refinement, thereby enhancing the clarity, coherence, and overall quality of the manuscript. While all conceptual contributions and interpretations remain the responsibility of the authors.

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References

Allied Market Research (2023) *Medical tourism market size, share & trends forecast to 2032*. Available at: https://www.alliedmarketresearch.com/medical-tourism-market (Accessed: 16 December 2025).

Andersson, T., Schwaag-Serger, S., Sörvik, J., Wise, E. (2004) *Cluster policies whitebook*. IKED-International Organisation for Knowledge Economy and Enterprise Development. Available at: https://portal.research.lu.se/files/5954460/1304064.pdf (Accessed: 11 November 2025).

Apotti (2025a) 'Client Portal Maisa', *Apotti*. Available at: https://www.apotti.fi/en/client-portal-maisa/ (Accessed: 12 November 2025).

Apotti (2025b) 'Oy Apotti Ab', *Apotti*. Available at: https://www.apotti.fi/en/apotti/oy-apotti-ab/ (Accessed: 12 November 2025).

Bradford, L., Aboy, M., Liddell, K. (2020) 'International transfers of health data between the EU and USA: a sector-specific approach for the USA to ensure an 'adequate'level of protection', *Journal of Law and the Biosciences*, 7(1), p. lsaa055.

Carayannis, E.G., Barth, T.D., Campbell, D.F. (2012) 'The Quintuple Helix innovation model: global warming as a challenge and driver for innovation', *Journal of Innovation and Entrepreneurship*, 1(1), p. 2. Available at: https://doi.org/10.1186/2192-5372-1-2.

Carradinha, M. *et al.* (2025) 'D9.1 Requirements and use cases on the availability of health data in cross-border telemedicine services'. Available at: https://www.xt-ehr.eu/deliverables/ (Accessed: 13 November 2025).

Carrera, P.M., Bridges, J.F. (2006) 'Globalization and healthcare: understanding health and medical tourism', *Expert Review of Pharmacoeconomics & Outcomes Research*, 6(4), pp. 447–454. Available at: https://doi.org/10.1586/14737167.6.4.447.

Dini, M., Pencarelli, T. (2022) 'Wellness tourism and the components of its offer system: a holistic perspective', *Tourism Review*, 77(2), pp. 394–412.

EDPS (2025) *Interoperability | European Data Protection Supervisor*. Available at: https://www.edps.europa.eu/data-protection/our-work/subjects/interoperability_en (Accessed: 12 November 2025).

EHDS - HL7 Europe (2024), 13 June. Available at: https://hl7europe.eu/standards/ehds/ (Accessed: 13 November 2025).

European Commission (2025a) *Electronic cross-border health services - Public Health*. Available at: https://health.ec.europa.eu/ehealth-digital-health-and-care/digital-health-and-care/electronic-cross-border-health-services_en (Accessed: 11 November 2025).

European Commission (2025b) *My rights over my health data - Public Health - European Commission*. Available at: https://health.ec.europa.eu/ehealth-digital-health-and-care/my-rights-over-my-health-data_en (Accessed: 11 November 2025).

European Parliament (2025) 'Regulation (EU) 2025/327 of the European Parliament and of the Council of 11 February 2025 on the European Health Data Space and amending Directive 2011/24/EU and Regulation (EU) 2024/2847 (Text with EEA relevance)'.

Global Wellness Institute (2024) '2024 Wellness Policy Toolkit: Wellness In Tourism', *Global Wellness Institute*. Available at: https://globalwellnessinstitute.org/industry-research/2024-wellness-policy-toolkit-wellness-in-tourism/ (Accessed: 12 November 2025).

Huang, C., Wang, J., Wang, S., Zhang, Y. (2023) 'Internet of medical things: A systematic review', *Neurocomputing*, 557, p. 126719.

KELA (2025) *The Social Insurance Institution of Finland - The Kanta architecture*. Available at: https://www.kanta.fi/en/system-developers/kanta-architecture (Accessed: 12 November 2025).

Lehto, T. (2021) *Hyvinvointi- ja terveysmatkailun kiinnostavuus kotimaanmatkailussa - Lapsiperheiden näkökulma*. Available at: http://www.theseus.fi/handle/10024/510747 (Accessed: 13 November 2025).

López, L. (2024) 'Cybersecurity Challenges in Tourism', *briguest.com*, 13 August. Available at: https://www.briguest.com/en/cybersecurity-challenges-tourism-emerging-threats-vulnerabilities/ (Accessed: 12 November 2025).

Marcus, J.S., Martens, B., Carugati, C., Bucher, A., Godlovitch, I. (2022) 'The European Health Data Space'. Rochester, NY: Social Science Research Network. Available at: https://doi.org/10.2139/ssrn.4300393.

Marent, B., Henwood, F. (2023) 'Digital health: A sociomaterial approach', *Sociology of Health & Illness*, 45(1), pp. 37–53. Available at: https://doi.org/10.1111/1467-9566.13538.

Medical Tourism Association Finland (2025) *Home | Medical Tourism Association Finland*. Available at: https://medicaltourismfinland.com/ (Accessed: 13 November 2025).

Porter, M.E. (1998) *Clusters and the new economics of competition*. Harvard Business Review Boston (6). Available at: http://biblioteca.fundacionicbc.edu.ar/images/d/de/Clusters_1.pdf (Accessed: 11 November 2025).

Rajamäki, J., Ofem, P., Kallio, A., Vakkuri, M. (2025) 'The Critical Role of Cybersecurity Education in Health Tourism', *International Conference on Tourism Research*, 8(1), pp. 234–242. Available at: https://doi.org/10.34190/ictr.8.1.3455.

Selvakumar, K., Lokesh, S. (2024) 'A cryptographic method to have a secure communication of health care digital data into the cloud', *Automatika: časopis za automatiku, mjerenje, elektroniku, računarstvo i komunikacije*, 65(1), pp. 373–386.

Stainton, D.H. (2022) 'What Is Health Tourism And Why Is It Growing? - Tourism Teacher', 25 June. Available at: https://tourismteacher.com/health-tourism/ (Accessed: 12 November 2025).

Tavares, A., Sousa, P., Proença, R. (2024) 'Exploring the dynamics between artificial intelligence and cybersecurity in Healthcare', *ARIS2 - Advanced Research on Information Systems Security*, 4(1), pp. 20–34. Available at: https://doi.org/10.56394/aris2.v4i1.44.

Teräs, J. (2008) *Regional science-based clusters: A case study of three European concentrations*. University of Oulu. Available at: https://oulurepo.oulu.fi/handle/10024/35489 (Accessed: 11 November 2025).

Valvira (2025) *Information systems for social welfare and healthcare*, *Valvira*. Available at: https://valvira.fi/en/information-systems-for-social-welfare-and-healthcare (Accessed: 12 November 2025).

Vovk, O. *et al.* (2025) 'Possibilities for secondary data use of electronic health records with WiseSpace de-identification', *Frontiers in Medicine*, 12. Available at: https://doi.org/10.3389/fmed.2025.1639342.

XiA (2025) 'XiA – Xpanding Innovative Alliance'. Available at: https://xia-project.iscte-iul.pt/ (Accessed: 12 November 2025).

Xt-EHR (2025) *Home*, *Xt-EHR*. Available at: https://www.xt-ehr.eu/ (Accessed: 13 November 2025).

Yin, R.K. (2018) *Case study research and applications: design and methods*. Sixth edition. Los Angeles London New Delhi Singapore Washington DC Melbourne: SAGE.