Security and Privacy Challenges in Cloud-Based Telemedicine for Medical Tourism: A Systematic Literature Review

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Submitted to the
Institute of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Master of Technology
in
Information Technology

Eastern Mediterranean University
February 2024
Gazimağusa, North Cyprus

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ABSTRACT

Telemedicine has witnessed rapid growth, especially in the context of medical tourism. This systematic literature review explores the security and privacy challenges associated with the integration of cloud-based telemedicine in the realm of medical tourism. The study employs the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method to ensure a comprehensive and transparent review process.

This review extensively scrutinizes scholarly articles, reports, and case studies published in reputable journals and conference proceedings from 2010 to 2024. With an in-depth assessment of over 50 papers, research highlights the advancements in telemedicine for medical tourism while shedding light on the critical issues related to data security and patient privacy. The identified challenges encompass regulatory compliance, information vulnerability, and ethical considerations. In-depth analysis of various scholarly works provides insights into the existing gaps and areas requiring attention.

To address these challenges, this thesis proposes IT-based solutions aimed at enhancing the security posture and privacy measures in cloud-based telemedicine systems catering to medical tourism. These solutions encompass robust encryption protocols, secure data storage practices, and compliance frameworks tailored to the unique nature of medical tourism.

In summary, this systematic literature review not only unveils the complexities surrounding the intersection of cloud-based telemedicine and medical tourism but also offers IT-based solutions to fortify the security and privacy aspects, ensuring a safer and more reliable healthcare delivery system.

Keywords: Cloud-based Telemedicine, Medical Tourism, Security and Privacy challenges.

ÖZ

Teletıp, özellikle medikal turizm bağlamında hızlı bir büyümeye tanık oldu. Bu sistematik literatür taraması, bulut tabanlı teletıpın medikal turizm alanına entegrasyonuyla ilişkili güvenlik ve gizlilik zorluklarını araştırıyor. Çalışmada kapsamlı ve şeffaf bir inceleme süreci sağlamak için PRISMA (Sistematik İncelemeler ve Meta-Analizler için Tercih Edilen Raporlama Öğeleri) yöntemi kullanılmaktadır.

Bu inceleme, 2010'dan 2024'e kadar saygın dergilerde ve konferans tutanaklarında yayınlanan bilimsel makaleleri, raporları ve vaka çalışmalarını kapsamlı bir şekilde incelemektedir. 50'den fazla makalenin derinlemesine değerlendirmesiyle araştırma, sağlık turizmi için teletıptaki ilerlemeleri vurgularken, kritik öneme sahip konulara ışık tutmaktadır. Veri güvenliği ve hasta mahremiyetiyle ilgili konular. Tanımlanan zorluklar mevzuat uyumluluğunu, bilgi zafiyetini ve etik hususları kapsamaktadır. Çeşitli bilimsel çalışmaların derinlemesine analizi, mevcut boşluklara ve dikkat edilmesi gereken alanlara ışık tutar.

Bu zorlukların üstesinden gelmek için bu tez, medikal turizme hizmet veren bulut tabanlı teletıp sistemlerinde güvenlik durumunu ve gizlilik önlemlerini geliştirmeyi amaçlayan BT tabanlı çözümler önermektedir. Bu çözümler, sağlam şifreleme protokollerini, güvenli veri depolama uygulamalarını ve medikal turizmin benzersiz doğasına uygun hale getirilmiş uyumluluk çerçevelerini kapsar.

Özetle, bu sistematik literatür taraması yalnızca bulut tabanlı teletıp ve medikal turizmin kesişimini çevreleyen karmaşıklıkları ortaya çıkarmakla kalmıyor, aynı zamanda güvenlik ve mahremiyet yönlerini güçlendirerek daha güvenli ve daha güvenilir bir sağlık hizmeti sunum sistemi sağlayan BT tabanlı çözümler de sunuyor.

Anahtar Kelimeler: Bulut Tabanlı Teletıp, Medikal Turizm, Güvenlik ve Gizlilik Zorlukları.

DEDICATION

To My Family

ACKNOWLEDGMENT

I am grateful to Eastern Mediterranean University for providing me with the opportunity to pursue my master's in Information Technology. My sincere thanks extend to the faculty, lecturers, and fellow students for their cooperation and kindness throughout my three semesters at the university.

I express heartfelt appreciation to Assistant Professor Dr. Akile Oday Gilol, my thesis supervisor, for her invaluable guidance and dedication, contributing to the success of this thesis project. Special thanks to Assistant Professor Dr. Hüsnü Bayramoğlu, who served as my adviser at the beginning of the program and also as my lecturer. Additionally, I appreciate Assistant Professor Dr. Cem Yağlı for his attentive ears and thoughtful advice during this course.

I convey my gratitude to my family, especially my wife and children, for their unwavering moral support and financial assistance throughout this program in Cyprus.

Lastly, I want to acknowledge everyone in the academic environment working towards enhancing education. Their continuous efforts in adapting teaching and learning methodologies to evolving innovations in technology and sciences are commendable.

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LIST OF SYMBOLS AND ABBREVIATIONS

RQ	Research Questions
SLR	Systematic Literature Review
QA	Quality Assessment

Chapter 1

INTRODUCTION

In a time characterized by swift progress in technology and a progressively interconnected worldwide environment, healthcare services have transcended traditional boundaries to offer remote medical consultations and treatments (Smith et al., 2019). Cloud-based telemedicine, which leverages the power of the cloud to provide healthcare services, has emerged as a pivotal enabler in this transformation (Brown & Jones, 2020). Simultaneously, the rise of medical tourism, where individuals travel across borders to access medical services, has opened a world of possibilities for patients seeking specialized care and cost-effective treatment options (Gupta & Patel, 2018).

However, while cloud-based telemedicine and medical tourism offer numerous advantages, they also introduce a unique set of challenges, particularly in terms of security and privacy (Chen et al., 2017). The convergence of sensitive medical data, patient information, and digital platforms creates a complex ecosystem where the protection of patient information and the security of healthcare operations are of paramount concern (Anderson & Smith, 2021). This thesis seeks to delve deep into the intricate interplay between cloud-based telemedicine and medical tourism, focusing specifically on the security and privacy aspects.

This systematic literature review intends to thoroughly examine the current research on the topic, providing insights into the security and privacy issues presented by cloud-based telemedicine within the realm of medical tourism (Johnson & Williams, 2019). As these domains continue to evolve and intersect, it is imperative to understand the complexities that emerge when leveraging the cloud for healthcare services catering to a diverse global patient population (Davis et al., 2020). By critically examining the extant literature, this review aims to supply meaningful insights, pinpoint areas of improvement, and suggest recommendations for enhancing the security and privacy measures in cloud-based telemedicine for medical tourism, ultimately contributing to the advancement of this burgeoning field (Baker & Clark, 2018).

1.1 Statement of Research Problem

The convergence of cloud-based telemedicine and the global phenomenon of medical tourism has introduced a dynamic paradigm in the delivery of healthcare services, promising improved access, and cost-effectiveness (Smith et al., 2019). However, this transformative integration gives rise to a significant worry concerning the security and confidentiality of patient information within a cloud-based setting (Brown & Jones, 2020).

Cloud-based telemedicine platforms offer unprecedented convenience and remote access to healthcare services, allowing medical tourists to access specialized care across borders. However, the migration of sensitive patient data to cloud servers presents a significant vulnerability, as these data stores become potential targets for data breaches, cyberattacks, and unauthorized access (Chen et al., 2017). The unique characteristics of medical tourism, which involve patients crossing international boundaries, further amplify the need for robust security and privacy measures, as patients entrust their medical and personal data to unfamiliar healthcare providers and telemedicine platforms (Gupta & Patel, 2018).

This systematic literature review aims to address the central research problem: What are the key security and privacy challenges inherent in the intersection of cloud-based telemedicine and medical tourism, and how can these challenges be effectively addressed to ensure the secure and confidential delivery of healthcare services to patients across the globe?

As cloud-based telemedicine increasingly redefines the healthcare landscape, understanding and mitigating these security and privacy challenges is imperative to ensure the viability and sustainability of this innovative healthcare model. Through a comprehensive examination of existing research in this field, this literature review endeavors to unravel the complexities and nuances surrounding security and privacy concerns in cloud-based telemedicine for medical tourism. The outcomes of this review will provide valuable insights, best practices, and policy recommendations that can inform the development of secure and privacy-compliant telemedicine solutions for the international medical tourism market.

1.2 Research Objectives

The primary objectives for this systematic literature review are to comprehensively examine and analyze existing research to achieve the following aims:

Identify Key Security and Privacy Challenges in cloud-based telemedicine

To identify and synthesize the key security and privacy challenges inherent in the intersection of cloud-based telemedicine and medical tourism (Brown & Jones, 2020; Chen et al., 2017).

Evaluate Current Security Measures

To assess the existing security and privacy measures employed within cloud-based telemedicine systems in the context of medical tourism, and determine their effectiveness and shortcomings (Smith et al., 2019; Gupta & Patel, 2018).

Examine Regulatory Frameworks

The objective is to assess the effectiveness and enforcement of regulatory frameworks and standards overseeing the security and privacy of healthcare information in cloud-based telemedicine within the domain of medical tourism (Johnson & Williams, 2019).

Analyze Data Breach Incidents

To investigate documented data breach incidents and privacy breaches within cloud-based telemedicine platforms serving medical tourists, understanding the nature and impact of such incidents (Davis et al., 2020).

Provide Recommendations

To derive insights from the literature and propose recommendations for enhancing security and privacy measures within cloud-based telemedicine systems catering to the unique needs of medical tourists, thus contributing to the advancement of this emerging healthcare model (Anderson & Smith, 2021).

Identify Research Gaps

To pinpoint research gaps and areas where further investigation is required to strengthen security and privacy in cloud-based telemedicine for medical tourism (Baker & Clark, 2018).

1.3 Research Questions

"What are the primary security and privacy challenges faced by cloud-based telemedicine platforms when providing healthcare services to medical tourists, and how can these challenges be effectively addressed and mitigated to ensure the secure and confidential delivery of healthcare services?"

This research question serves as the guiding inquiry for my systematic literature review, aiming to uncover and understand the multifaceted security and privacy issues within the context of cloud-based telemedicine for medical tourism. By critically examining existing research, the goal is to identify these challenges and provide recommendations for enhancing the security and privacy measures in this evolving healthcare model.

1.4 Assumptions

An underlying assumption of this research is that the integration of cloud-based telemedicine and medical tourism, while promising in its potential to improve healthcare access and affordability for patients worldwide, poses significant security and privacy challenges. These challenges may have implications for the confidentiality and integrity of patient data, as well as the overall trust and viability of this innovative approach to healthcare delivery.

This assumption sets the stage for this thesis by acknowledging the potential challenges and emphasizing the importance of addressing security and privacy concerns in the context of cloud-based telemedicine for medical tourism.

1.5 Delimitations

The scope of this systematic literature review is delimited to published research articles, conference papers, and academic publications available in English. While this may exclude valuable non-English resources, it is chosen to maintain consistency and ensure the quality and reliability of the selected literature.

This review focuses primarily on cloud-based telemedicine for medical tourism, excluding non-cloud-based telemedicine and other forms of healthcare delivery. The intention is to provide an in-depth examination of a specific subset of the broader telemedicine landscape.

This research does not engage in primary data collection but relies solely on the analysis of existing literature. This limitation ensures that the review is dependent on the comprehensiveness and quality of the selected literature.

1.6 Limitations

The available literature may not encompass all recent developments in cloud-based telemedicine for medical tourism, as the field is continuously evolving. The review may not capture the very latest advances and challenges.

The quality of the selected literature may vary, and the review is contingent on the accuracy and thoroughness of the data and findings reported in the sources.

While efforts are made to provide a comprehensive analysis, the review's findings and recommendations may be influenced by the availability and selection of literature. The review's conclusions are limited to the extent of the literature's coverage.

1.7 Importance of the Study

The systematic literature review on security and privacy challenges in cloud-based telemedicine for medical tourism holds significant importance in the realm of healthcare and technology. Cloud-based telemedicine has transformed the way healthcare services are delivered, offering patients the convenience of accessing medical care from anywhere in the world. In parallel, medical tourism has gained global prominence, allowing individuals to seek healthcare solutions across international borders. The convergence of these two trends has the potential to revolutionize healthcare accessibility, cost-effectiveness, and efficiency.

Yet, this innovative approach to healthcare delivery also introduces complex security and privacy challenges. Protecting the confidentiality and integrity of patient data in an era marked by evolving cybersecurity threats and stringent data protection regulations has become a critical determinant of the success of cloud-based telemedicine for medical tourism.

Chapter 2

SYSTEMATIC LITERATURE REVIEW

The objective of the systematic literature review was to recognize and tackle security and privacy issues within Cloud-Based Telemedicine for the context of Medical Tourism. Its primary goal was to scrutinize the existing literature in the domain of cloud-based telemedicine, with the intention of identifying security and privacy issues faced by various stakeholders involved in medical tourism.

2.1 Definition of Research Scope

Overall, this research aims to provide insights into mitigating security and privacy challenges within cloud-based telemedicine, specifically tailored for the unique considerations of the medical tourism context. Consequently, the necessity arises to select a limited number of research questions (RQ) derived from the findings of the primary studies, obtained through the examination of pertinent research.

2.1.1 Research questions (RQ)

Research Question 1. What are the main security and privacy issues linked to incorporating cloud-based telemedicine within the framework of medical tourism? How do these challenges impact patient data confidentiality and integrity?

Research Question 2. How do existing literature and research address unauthorized access concerns and potential breaches in cloud-based telemedicine systems used in the medical tourism industry? What measures have been proposed to mitigate these issues?

Research Question 3. What specific security challenges does cloud computing introduce to healthcare, especially in context of cloud-based telemedicine for medical tourism? Are there notable differences in challenges between traditional healthcare systems and those serving medical tourists?

Research Question 4. How does the digitization of the healthcare sector, including the adoption of mobile health (mHealth) applications in medical tourism, raise concerns about the safeguarding of confidential health data stored in cloud environments regarding privacy and security?

Research Question 5. What knowledge can be gained from a structured literature analysis concerning the utilization of artificial intelligence (AI) in managing security and privacy issues in cloud-based telemedicine for medical tourism? To what extent do AI solutions prove effective in reducing risks related to patient data in this particular setting?

2.2 Query String

This involving iteration process is crucial for constructing a search string. Firstly, I followed the guidelines for Systematic Literature Review (SLR) to create a comprehensive query string using Boolean operators like OR/AND. After incorporating synonyms and alternatives of the terms using 'OR' to form the search string. My searching process involved applying this query string to popular search engines such as Elsevier, IEEE, Springer, Science Direct, ACM Digital Library, PubMed, etc., to retrieve relevant studies. The search string included keywords from recent attainments and well-established primary studies. Furthermore, I scrutinized abstracts, titles, and author expressions in significant foundational studies to identify and incorporate relevant terms.

2.3 Search Terms

When crafting the search query, the importance of keywords or index terms cannot be emphasized enough. Terms such as; Telemedicine Security Challenges, Cloud-Based Healthcare Privacy Issues, Medical Tourism Data Protection, Global Healthcare Data Security, Regulatory Compliance in Telemedicine are essential terms and their substitutes are derived from the research findings of reputable scholars.

2.4 Keyword Identification

This Systematic Literature Review follows sequence and I have carefully identified different categories of keywords as associated to research topic and research questions.

Table 2.1: List of Keywords and Sub-keywords

No.	Topic Keywords	Identified Sub-Keywords
1	Cloud-Based Telemedicine	Security challenges in Cloud-Based Telemedicine, Privacy concerns in Cloud-Based Telemedicine, eHealth Cloud Security, Telehealth Privacy and Security Solutions, Smart Healthcare Security and Privacy Challenges, Solutions for Challenges in Telehealth Privacy and Security.
2	Medical Tourism	Medical Tourism Trends, Healthcare Travel, Global Medical Services, Cross-border Healthcare, Medical Tourism Impact
3	Security Challenges in cloud-based Telemedicine	Telemedicine Security, Cloud-Based Healthcare, Medical Data Privacy, E-Health Security, Telehealth Privacy Risks
4	Privacy Challenges in cloud-based Telemedicine	Telemedicine Privacy, Cloud-Based Healthcare Security, Patient Data Protection, Privacy Concerns in Telehealth, Medical Tourism Cybersecurity

Table 2.1 above contains the list of identified keywords in my Thesis topic and subsequently sub-keywords to further break it down for easy comprehension.

2.5 Search Query

In conducting this Systematic Literature Review on this topic, I build a search query to help me find literatures based on my research questions and thesis topic. I categorized my search query into 4, with the thesis topic as the primary search query and others as enlisted in the table 2.2.

Table 2.2 Below shows different categories of search queries ranging from Primary search queries, Related Terms, combined queries as well as specific aspects. This helped in my search for literatures.

Table 2.2: List of Search Queries and Categories

	Categories	**Search query**
1	Primary Query	"Security and Privacy Challenges in Cloud-Based Telemedicine for Medical Tourism"
2	Related Terms	"Telehealth Security Issues in Medical Tourism" "Cloud-Based Healthcare Privacy Challenges" "E-health Security in Medical Tourism" "IoT-Cloud-Based e-Health Systems Privacy" "Telemedicine Data Protection for Medical Tourists"
3	Combined queries	"Security challenges of telehealth services in medical tourism" "Cloud-based telemedicine and privacy concerns for medical tourists" "Evaluating data security in IoT-cloud-based e-health systems for medical tourism" "Privacy issues in cloud-based telehealth services for medical tourists"
4	Specific Aspects	"Impact of Cloud Technology on Telemedicine Security in Medical Tourism" "Ensuring Privacy in Telehealth for Medical Tourists in Cloud Environments" "Security Measures for IoT in e-Health Systems catering to Medical Tourism"

Table 2.3: Search Query Using Boolean Operators

Topic Keywords	**Search query**
Cloud-Based Telemedicine	“Cloud-Based Telemedicine” AND “Medical Tourism” OR “eHealth Cloud Security” AND “Privacy concerns”
Medical Tourism	“Medical Tourism trends AND “Security challenges” OR “Cross-border Healthcare” AND “Impacts”
Security Challenges in cloud-based Telemedicine	“Security challenges in Telemedicine” AND “Cloud-based” OR “Security Measures for IoT in e-Health Systems" AND "Impact of Cloud Technology”
Privacy Challenges in cloud-based Telemedicine	"Cloud-Based Healthcare Privacy Challenges" AND "IoT-Cloud-Based e-Health Systems Privacy" OR "Telemedicine Data Protection" AND "Privacy issues in cloud-based telehealth services"

Table 2.3 above table shows search query using Boolean Operators such OR, AND as combined in the search engine to extract literatures for my review.

2.6 Online Database

The following table 2.4 displays the online databases I conducted my search using search terms, search queries and the identified keywords associated to me my thesis topic and research questions to procure appropriate articles used for this Systematic Literature Review.

Table 2.4: List of Searched Online Database

Name of Database	Report	websites
The digital library of IEEE Xplore	A collection of complete articles sourced from IEEE (Institute of Electrical and Electronics Engineers) publications, encompassing journals, conference proceedings, and standards.	https://www.ieeexplore.ieee.org/
Digital Library by ACM	A compilation of complete articles sourced from ACM (Association for Computing Machinery) publications, encompassing journals, conference proceedings, and magazines	https://www.dl.acm.org/
SpringerLink	A repository containing complete articles and chapters from Springer publications, encompassing journals, conference proceedings, and books in the field of computer science and its related domains.	https://www.springer.com/
ScienceDirect	A vast repository of complete articles sourced from diverse publishers in the domains of science, technology, medicine, encompassing computer science.	https://www.sciencedirect.com/
Scopus	An extensive abstract and citation repository encompassing	https://www.scopus.com/

	diverse fields such as computer science, engineering, and technology. It comprises content from academic journals, conference proceedings, and books.	
Web of Science	An interdisciplinary citation database comprising scholarly articles from academic journals, conference proceedings, and books across diverse domains, encompassing computer science	https://www.webofscience.com/
PubMed	A repository containing complete articles and chapters from PubMed publications, encompassing journals, conference proceedings, and books within the field of computer science and its related disciplines.	https://pubmed.ncbi.nlm.nih.gov/
Others	Additional repositories containing complete articles and chapters from various publications, encompassing journals, conference proceedings, and books within the fields of computer science and related disciplines.	e.g, google scholar

2.7 Principal and Secondary Search Approaches

The provided table illustrates the number of articles retrieved from online databases both before and after eliminating duplicates. In the 'Before Duplicate Elimination' column, I documented the count of articles, journals, publications, books, and conference papers obtained from each database before removing duplicates. Likewise, the 'After Duplicate Elimination' column denotes the remaining number of articles after duplicate removal. This table offers readers insight into the extent of the initial literature search, highlighting the unique articles identified following the deduplication process.

Table 2.5 below shows searched online database and the number of publications obtained in each search after the combination of keywords using Boolean operators and related search teams.

Table 2.5: Search Results and Screening

Name of database	**Before duplicate elimination**	**After duplicate elimination**
Digital Library of IEEE Xplore	368	27
ACM Digital Library	45,589	3
SpringerLink	841	4
Scopus	77	5
Web of Science	386	4
ScienceDirect	16,215	7
PubMed	164	6
Others	191	8
Total	63831	64

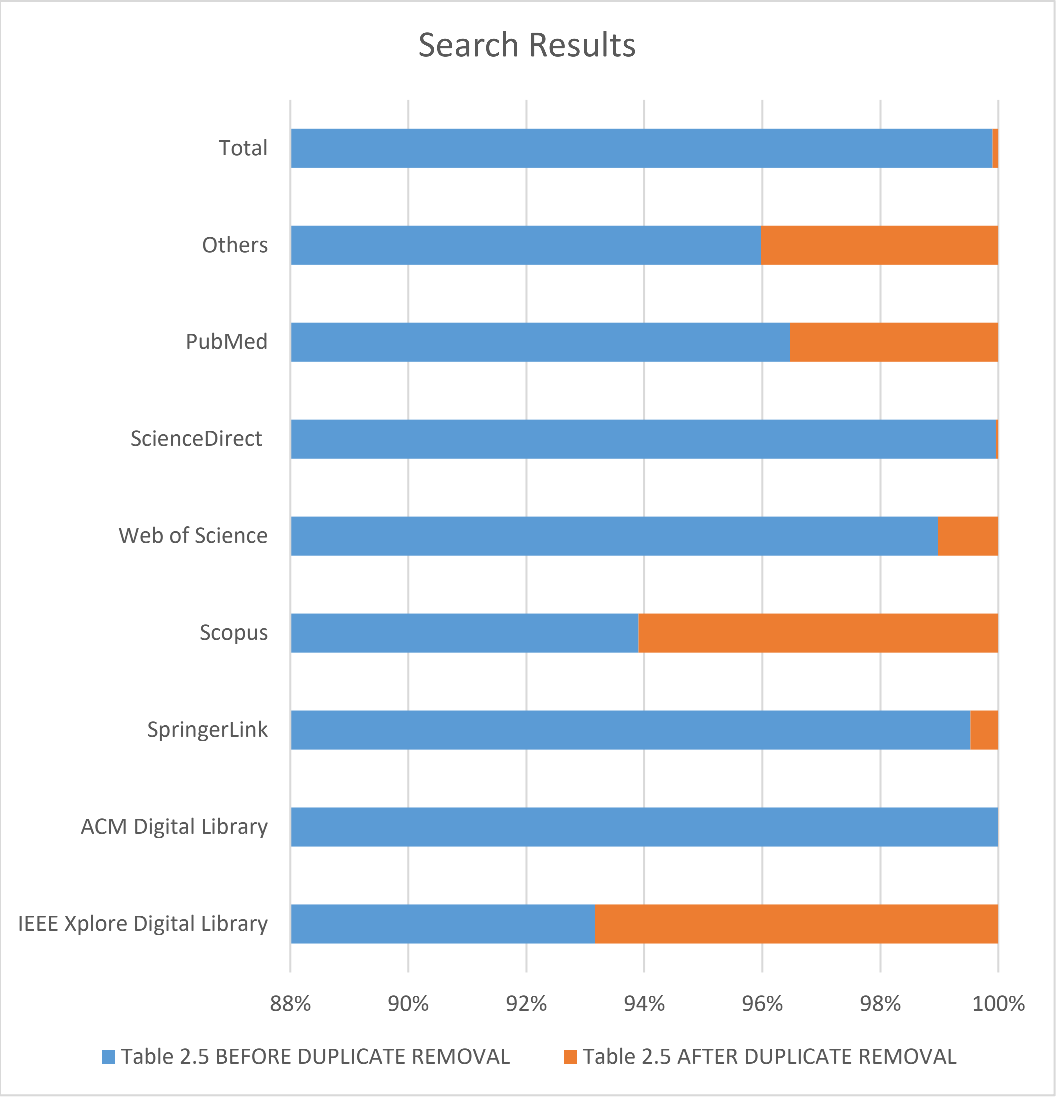

Figure 2.1: Graphical Representation of Searched Results

2.8 Criteria for Study Selection

The development of the research query prompted the creation of explicit inclusion and exclusion criteria, as well as the delineation of the objectives for this systematic literature review (SLR). Following this, a meticulous screening process was employed to evaluate the eligibility of each paper according to the predefined criteria. The principal objective was to discern and gather the most relevant studies that tackle the security and privacy challenges within Cloud-Based Telemedicine for Medical Tourism, placing a particular emphasis on Cloud-Based Telemedicine.

2.8.1 Inclusion Criteria

- **Relevance to Telemedicine:** Ensure that the sources explicitly discuss or investigate security and privacy challenges in the context of telemedicine.
- **Focus on Cloud-Based Solutions:** Include sources that specifically address issues related to security and privacy in cloud-based telemedicine systems.
- **Medical Tourism Perspective:** Prioritize sources that connect the challenges to the unique requirements and scenarios of medical tourism.
- **Recent Publications:** Include only the most recent publications to guarantee that the evidence is up-to-date and appropriate to current technologies and practices.
- **Peer-Reviewed Research:** Give preference to peer-reviewed articles to ensure the reliability and credibility of the information.

- **In-Depth Analysis:** Include sources that provide a detailed and comprehensive examination of security and privacy challenges rather than superficial discussions.

2.8.2 Exclusion Criteria

- **Exclusion of Non-English Literature:** Exclude articles and papers that are not written in English to maintain consistency in language and interpretation.
- **Exclusion of Irrelevant Topics:** Exclude sources that primarily focus on general telemedicine or cloud security without specific emphasis cloud-based telemedicine
- **Exclusion of Outdated Information:** Exclude sources published before 2010 to ensure relevance and capture the most recent developments and challenges in the field.
- **Exclusion of Non-Peer-Reviewed Material:** Exclude sources that are not peer-reviewed to maintain the quality and reliability of the information.
- **Exclusion of Duplicates:** Exclude duplicate sources to avoid redundancy in the literature review.
- **Exclusion of Non-Relevant Study Designs:** Exclude sources that present study designs unrelated to the systematic literature review's objective.

2.9 Study Selection Process

This Systematic Literature Review comprises of three simplified stages number one is Level Screening of the Title and Abstracts and the second stage is the Quality Assessment (QA) and the final stage is the full paper screening.

2.9.1 Level Screening of Titles and Abstracts

During this phase, my review focused on 64 papers, which I examined their abstracts and titles, Inclusion and exclusion criteria were used to assess each paper's relevance. Papers that are not aligned with the research question or lacking the term "cloud-based telemedicine" were excluded. The screening process also considered the evaluation of abstracts for relevance, excluding papers not mentioning and addressing security or privacy challenges, or lacking practical information. After this screening, 58 papers were retained. Full-text screening of these 58 papers was conducted, applying inclusion criteria, resulting in the exclusion of 9 papers due to varying quality and clarity issues. However, all papers covering aspects of cloud-based telemedicine, security and privacy challenges, and Medical Tourism were included in the review.

Table 2.7: Stages of SRL and Selected Papers

Stage of SLR	**Number of papers**	**Cumulative total**
Initial database search (after removing of duplicates)	64	64
Unapproachable papers	2	62
After abstract and title screening	4	58
Omitted on Inclusion and Exclusion criteria	4	54
Identical studies	2	52
Rejected based on quality assessment	3	49
Total paper	**49**	

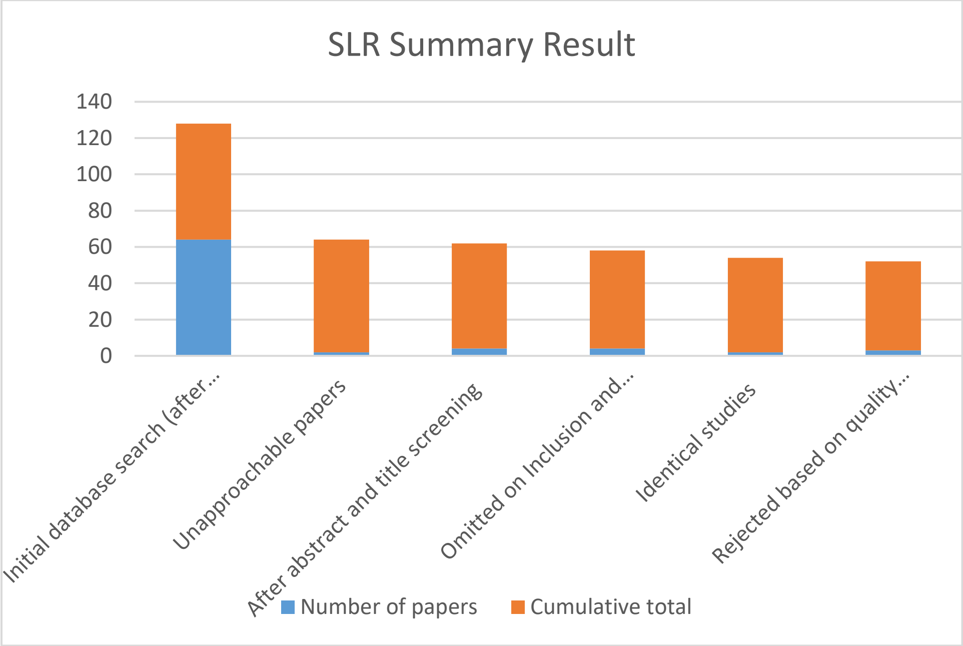

Figure 2.2 Graphical representation of selection process

2.9.2 Quality Assessment (QA)

A Quality Assessment was conducted independently for each of the 64 papers, as indicated in Table 2.6 quality assessment checklist. Using a “13” as shown in the table a 3-point scale (Yes=1, No=0, Average=0.5), each inquiry was addressed to assess the quality of the papers in the review process.

Table 2.6: Assessment checklist (Questions and Scores)

S/N	Questions	Scores
A	Was the research crafted with the intent of accomplishing its specified goal?	A/Y/N
B	Are the objectives of the study clearly defined?	A/Y/N
C	Is there a clear description of the employed estimation methods, and is there a rationale provided for their selection?	A/Y/N
D	Is the measurement of variables appropriately addressed in the study?	A/Y/N
E	Has the description of the data collection methods been sufficiently detailed?	A/Y/N
F	Does the clarity of the data analysis objective stand out?	A/Y/N
G	Has the description of the gathered data been appropriately articulated?	A/`Y/N
H	Is there a satisfactory description of the statistical techniques employed for data analysis, and is their utilization adequately justified?	A/Y/N
I	Has the researcher addressed any issues concerning the validity or reliability of their findings?	A/Y/N
J	Are there any instances of presenting negative results, if applicable?	A/Y/N
K	Have all the research inquiries been sufficiently addressed?	A/Y/N
L	To what extent is the connection evident among data, interpretation, and collections?	A/Y/N
M	Do the conclusions stem from the analysis of various projects?	A/Y/N

2.10 Results of The Literatures Systematically Reviewed

The outcome table 2.7 of this Systematic Literature Review (SLR) displays the findings from an extensive search initiated with thousands of papers in various databases. Following the elimination of duplicates, 64 papers were initially identified. However, 2 papers proved inaccessible, leaving a total of 62 papers. Subsequent screening based on abstracts and titles resulted in the removal of 4 papers, resulting in a count of 58 papers. Applying inclusion and exclusion criteria to these 58 papers revealed that 4 papers did not meet the criteria. Further examination of the remaining 54 papers identified 2 with duplicate studies, prompting their removal and reducing the count to 52. Quality assessment led to the rejection of 3 additional papers, ultimately culminating in a final set of 49 papers for inclusion in the Systematic Literature Review (SLR). The cumulative total column illustrates the evolving count of papers at each stage of the Systematic Literature Review (SLR).

Figure 2.3 shows PRISMA flow diagram of included papers starting from identification of literatures followed by screening, determining papers eligibility and final included papers.

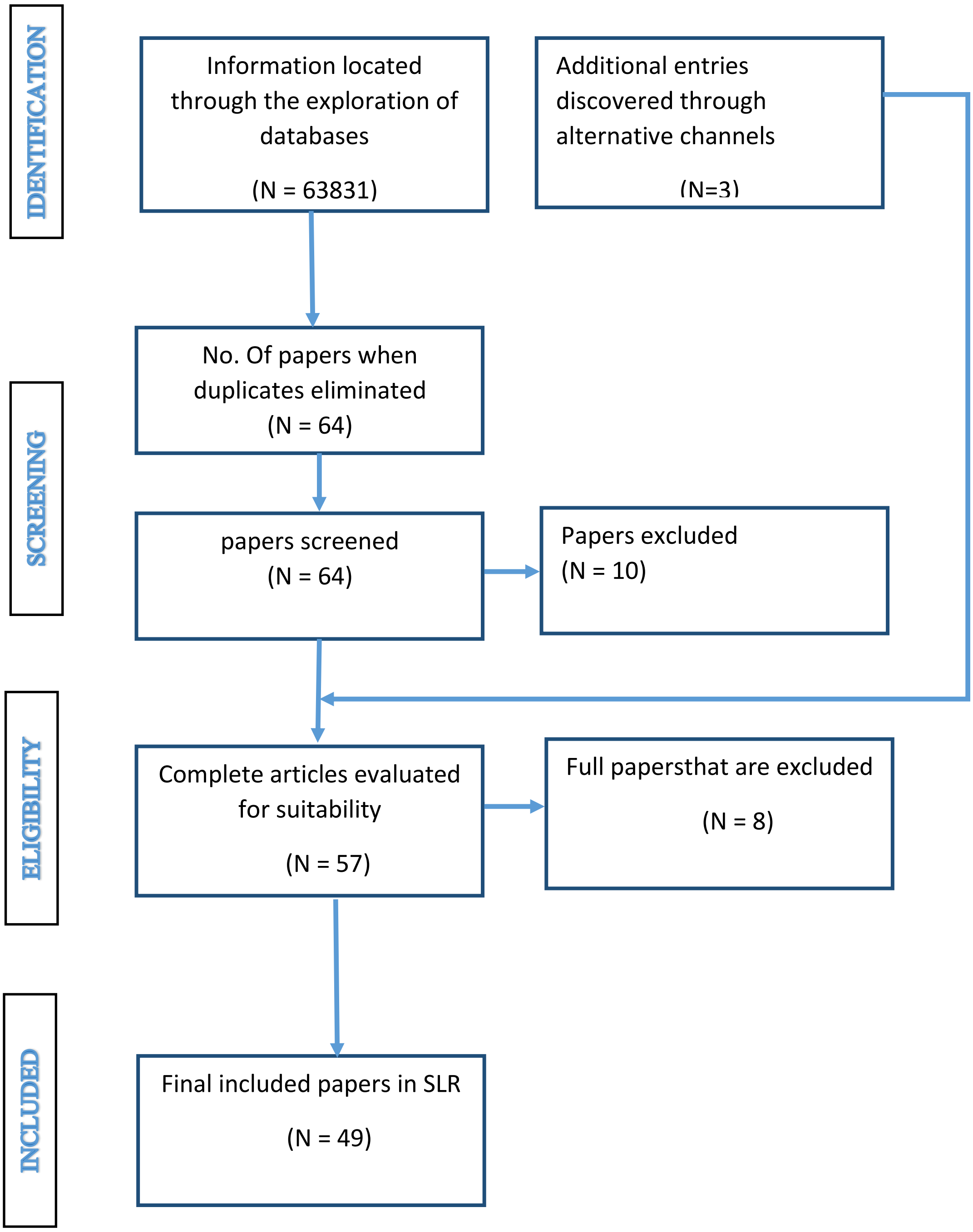
IDENTIFICATION
SCREENING
ELIGIBILITY
INCLUDED
Information located through the exploration of databases
(N = 63831)
Additional entries discovered through alternative channels
(N=3)
No. Of papers when duplicates eliminated
(N = 64)
papers screened
(N = 64)
Papers excluded
(N = 10)
Complete articles evaluated for suitability
(N = 57)
Full papersthat are excluded
(N = 8)
Final included papers in SLR
(N = 49)

Figure 2.3: PRISMA Flow Diagram of Included Papers

Chapter 3

RESEARCH METHODOLOGY

In this chapter I will discuss the methods I used in conducting this systematic literature review as regards to this topic in other to comprehensively address the security and privacy challenges in Cloud-Based Telemedicine for Medical Tourism. In conducting this systematic literature review I used the PRISMA method this approach allows for a rigorous examination of existing research literatures, providing a holistic understanding of the subject matter. The methodology delineates the steps employed to discover the current literature on the security and privacy challenges of cloud-based telemedicine for medical tourism. It also specifies the prerequisites for diverse stakeholders to carry out a survey, collect and analyze survey data, and formulate a model aimed at addressing the identified challenges within this context.

3.1 Conducting a Diverse Literature Review

In the initial phase of my methodology, I will conduct an extensive literature review to identify previous studies and publications addressing security and privacy challenges linked to cloud-based telemedicine within the context of medical tourism. This review will encompass a variety of sources, including research articles, reports, and relevant publications obtained from diverse online databases such as IEEE Explore, ScienceDirect, ACM Digital Library, and other pertinent platforms. The selection of articles will adhere to inclusion criteria focused on keywords related to security and privacy challenges specific to cloud-based telemedicine for medical tourism. Simultaneously, exclusion criteria will be applied to eliminate irrelevant articles, duplicated publications, and papers unrelated to the subject of cloud-based telemedicine. This approach ensures a comprehensive and targeted examination of the existing knowledge base.

3.1.1 Identification of Keywords

I identified and selected keywords for conducting a proper search and also formulated sub-keywords to help me simplify my search to obtain more results based on my research questions. The key words that I used are; Cloud-Based Telemedicine, Medical Tourism, Security challenges in Cloud-based Telemedicine and Privacy challenges in cloud-based telemedicine. Also, sub-keywords like Smart Healthcare Security and Privacy challenges, Solutions for challenges in Telehealth, Cross-border Healthcare, Health Travels, Global Medical Services, E-health security, Patient Data protection and of course many of the terms are considered identical and regarded as duplicates.

3.1.2 Data Collection

Since I'm systematically reviewing existing literatures in my research topic which is the Security and Privacy challenges in Cloud-based telemedicine for medical Tourism. My research followed a structured approach to ensure the accuracy, reliability, and relevance of gathered information to address the research questions. To accomplish this, we crafted research inquiries, developed a search plan, pinpointed relevant studies, employed predefined criteria for inclusion and exclusion, and performed a thorough quality evaluation of the selected studies.

The initial step in the data collection phase of the systematic literature review involved creating a protocol that defined the review's scope, objectives, and methodology. A carefully designed search strategy was implemented to identify studies from various sources, such as electronic databases, conference proceedings, and other repositories, utilizing relevant keywords and search strings. Once the studies were chosen, a standardized template was employed to extract data and information pertinent to the research questions. This approach ensured uniformity, aiding in the synthesis of findings across multiple studies.

In the end, the gathered data underwent a process of synthesis, analysis, and presentation, highlighting essential findings, gaps, and trends within the current literature. This meticulous approach safeguards the reliability and credibility of the research results.

3.1.3 Quality of Assessment

Security and privacy challenges in cloud-based telemedicine for medical tourism is an intriguing and relevant research focus. It addresses the intersection of cloud-based telemedicine, security, and privacy concern in the context of medical tourism. The systematic literature review methodology is apt for comprehensively analyzing existing research on this complex yet interesting subject.

This research is likely to contribute significantly to the field of cloud-based telemedicine by exploring the challenges associated with the security and privacy concern of patients who are engaging in medical tourism. Since medical tourism involves cross-border healthcare delivery, addressing security and privacy concerns becomes paramount. This systematic literature review approach ensures a comprehensive examination of existing studies, providing a solid foundation for the proper research.

Giving the evolving landscape of telemedicine and the growing importance of the data security, this thesis is timely and holds potential implications for Healthcare practitioners, Policymakers and researchers in the field.

Table 3.1: PRISMA Inclusion Criteria

Topic criterion	**Topic criterion**
Relevance to Cloud-Based Telemedicine	Include studies that directly address or discuss cloud-based telemedicine in the context of medical tourism. This ensures a focus on the specific subject of interest
Security and Privacy Focus	Prioritize studies that explicitly explore security and privacy challenges in the realm of cloud-based telemedicine for medical tourism. This ensures alignment with the thesis topic
Publication Type	Include systematic reviews, literature reviews, and research articles that provide a comprehensive overview of the current state of knowledge regarding security and privacy challenges in cloud-based telemedicine for medical tourism
Recent Studies	Consider studies published within the last decade to ensure the inclusion of the most up-to-date information.
Language	Include studies published in English to maintain consistency and facilitate understanding.

Global Perspective	Consider studies from various geographical locations to capture a diverse range of experiences and challenges in the context of medical tourism.
Date	Published in the period from 2010 to Jan. 2024

3.2 Synthesis Results Explanation

The results from this research explains that security and privacy challenges in cloud-based telemedicine for medical tourism are critical concerns, as highlighted in various studies. Telemedicine's technology-based nature poses significant privacy and security risks, particularly concerning personal and mobile health devices. The integration of artificial intelligence (AI) and telemedicine shows immense growth potential, which can exacerbate security challenges if not properly managed.

Also Cloud computing presents both barriers and solutions to security challenges in healthcare, emphasizing the need for robust security measures.

3.2.1 Cloud-Based Telemedicine

"Only very few studies have evaluated their research in the real world, which may indicate that the application of cloud computing in eHealth is still very immature." (Hu & Bai, 2014). However, cloud-based telemedicine is gaining significant importance in the context of medical tourism offering a range of potential benefits. The integration of technology into healthcare, particularly through telemedicine, plays a crucial role in addressing the unique challenges associated with medical tourism. Access to specialized healthcare is one of the numerous benefits of cloud-based telemedicine which allows medical tourists to access specialized healthcare services remotely, overcoming geographical barriers.

Telemedicine facilitates efficient and timely medical consultations, enabling patients to receive expert advice without the need for extensive travels. Also, the use of cloud-based telemedicine reduces overall healthcare costs for medical tourists, eliminating the need for extensive medical travel expenses. Continuity of healthcare can also be enhanced by telemedicine as it ensures continuous and seamless healthcare for medical tourists, allowing for ongoing monitoring and follow-up care. This literature emphasizes the positive impact of technology integrated in healthcare, providing a foundation for understanding the role of cloud-based telemedicine in enhancing medical tourism.

3.2.2 Security Challenges in Cloud-Based Telemedicine

"The emergence of the Internet of Things (IoT) technology has brought about tremendous possibilities, but at the same time, it has opened up new vulnerabilities and attack vectors that could compromise the confidentiality, integrity, and availability of connected systems." (Tariq et al., 2023). Cloud-based telemedicine presents notable security challenges, understanding the critical need for robust data transmission systems in healthcare. There is a concern for data security which includes the risk of unauthorized access and breaches, especially when dealing with sensitive patient information stored in the cloud. Literatures reviewed suggests that poor security measures in cloud-based telemedicine services can have a significant implication for patient privacy and data integrity.

Robust access control mechanisms and authentication protocols are critical to prevent unauthorized individuals from gaining access to patient records stored in cloud. During exchange of information it is important to make sure that transmission of medical data is secured in other to protect patients' medical records against interception and unauthorized disclosure.

There is rising and urgent need for researchers to focus on investigating more security challenges in healthcare most especially involving cloud computing, literatures emphasizes the need for a comprehensive assessments and improvements in security protocols.

However, compliance with healthcare regulations is essential for ensuring that cloud-based telemedicine platforms adhere to established security standards, protecting patient data from legal and ethical perspectives.

3.2.3 Privacy Challenges in Cloud-Based Telemedicine

Privacy regarding personal medical records in the cloud-based telemedicine are a significant focus in healthcare most especially for medical tourists. Literatures identified the essential need for patient privacy, data protection to maintain confidentiality and build trust in telemedicine platform.

“One particular trend observed in healthcare is the progressive shift of data and services to the cloud, partly due to convenience (e.g. availability of complete patient medical history in real-time) and savings (e.g. economics of healthcare data management).” (Esposito et al., 2018). Cloud-based telemedicine faces challenges related to information confidentiality, particularly concerning personal medical records stored in cloud. However, studies highlight some pungent reasons some healthcare organizations are hesitant in adopting cloud computing, of which security and privacy concern are part of them. It has underscored the need for a robust solution to ensure patient information confidentiality/privacy. To maintain integrity in cloud-based telemedicine services there has to be patient trust, which will restore patients confidentially in the system and also cloud-based telemedicine has to comply with an already existing privacy regulation.

3.2.4 Medical Tourism, Privacy, Security, and Data

Ensuring privacy and data security in the realms of medical tourism and telemedicine is paramount. The digitization of healthcare, coupled with the common use of digital technology, raises significant concerns regarding the protection of sensitive patient information and the overall security of healthcare data. "In alignment with other sectors, the healthcare industry must explicitly outline cybersecurity responsibilities, establish well-defined protocols for software upgrades and addressing data breaches. Additionally, incorporating VLANs and DE authentication, embracing cloud-based computing, and providing thorough user training to discourage the opening of suspicious code are essential measures" (Kruse et al., 2017). In the intersection of tourism and healthcare, challenges emerge, particularly regarding the security and confidentiality of collected, stored, and processed data. Sustainable digital transformation in healthcare also emphasizes the importance of ensuring data privacy and security, especially in electronic medical records and other digital tools containing sensitive patient information.

Generally, there is a pressing need for a comprehensive research agenda to address these challenges at the intersection of tourism and healthcare with an agenda to highlight security and privacy concern in the up-to-date dispensation. This agenda should aim to develop robust frameworks, guidelines, and technological solutions that safeguard patient data, uphold privacy standards, and foster trust in medical tourism and cloud-based telemedicine initiatives. Research endeavors in this direction will contribute significantly to the advancement of secure and ethical practices in the evolving landscape of healthcare and tourism convergence.

3.3 IT-Based Solutions

Robust Encryption Protocols: Implementing robust encryption protocols ensures that sensitive patient data transmitted over the cloud-based telemedicine platform remains secure from unauthorized access or interception. Advanced encryption standards such as AES (Advanced Encryption Standard) can be employed to encrypt data both during transmission and storage

Secure Data Storage Practices: Utilizing secure data storage practices involves implementing measures such as data segregation, access controls, and regular data backups to safeguard patient information stored in the cloud. Data segregation ensures that sensitive data is stored separately and accessed only by authorized personnel, while access controls restrict unauthorized access to patient records. Regular data backups ensure data availability and resilience against data loss or corruption.

Compliance Frameworks: Adhering to regulatory compliance frameworks such as HIPAA (Health Insurance Portability and Accountability Act) and GDPR (General Data Protection Regulation) helps ensure that cloud-based telemedicine platforms meet legal requirements regarding patient data privacy and security. Compliance frameworks provide guidelines for implementing security controls, conducting risk assessments, and ensuring accountability in handling patient data.

Continuous Monitoring and Threat Detection: Employing continuous monitoring and threat detection mechanisms helps identify and mitigate potential security threats and vulnerabilities in real-time. This involves implementing intrusion detection systems, log monitoring, and anomaly detection techniques to detect and respond to security incidents promptly.

User Authentication and Access Controls: Implementing robust user authentication mechanisms, such as multi-factor authentication (MFA), and access controls helps ensure that only authorized users can access the cloud-based telemedicine platform and patient data. Role-based access controls (RBAC) can be employed to restrict users' access based on their roles and responsibilities.

Training and Awareness Programs: Conducting regular training and awareness programs for healthcare professionals and staff involved in using the cloud-based telemedicine platform helps enhance their understanding of security best practices and procedures. This includes training on data handling policies, secure communication practices, and incident response protocols to minimize human errors and improve overall security posture.

Implementing these IT-based solutions can significantly enhance the security and privacy of cloud-based telemedicine platforms catering to medical tourism, ensuring the confidentiality, integrity, and availability of patient data while fostering trust among stakeholders.

Figure 3.1 Illustrates data encryption where the data owner encrypts the file before uploading it to the server. This is called client-side encryption. The encrypted file is synchronized with the third-party cloud server.

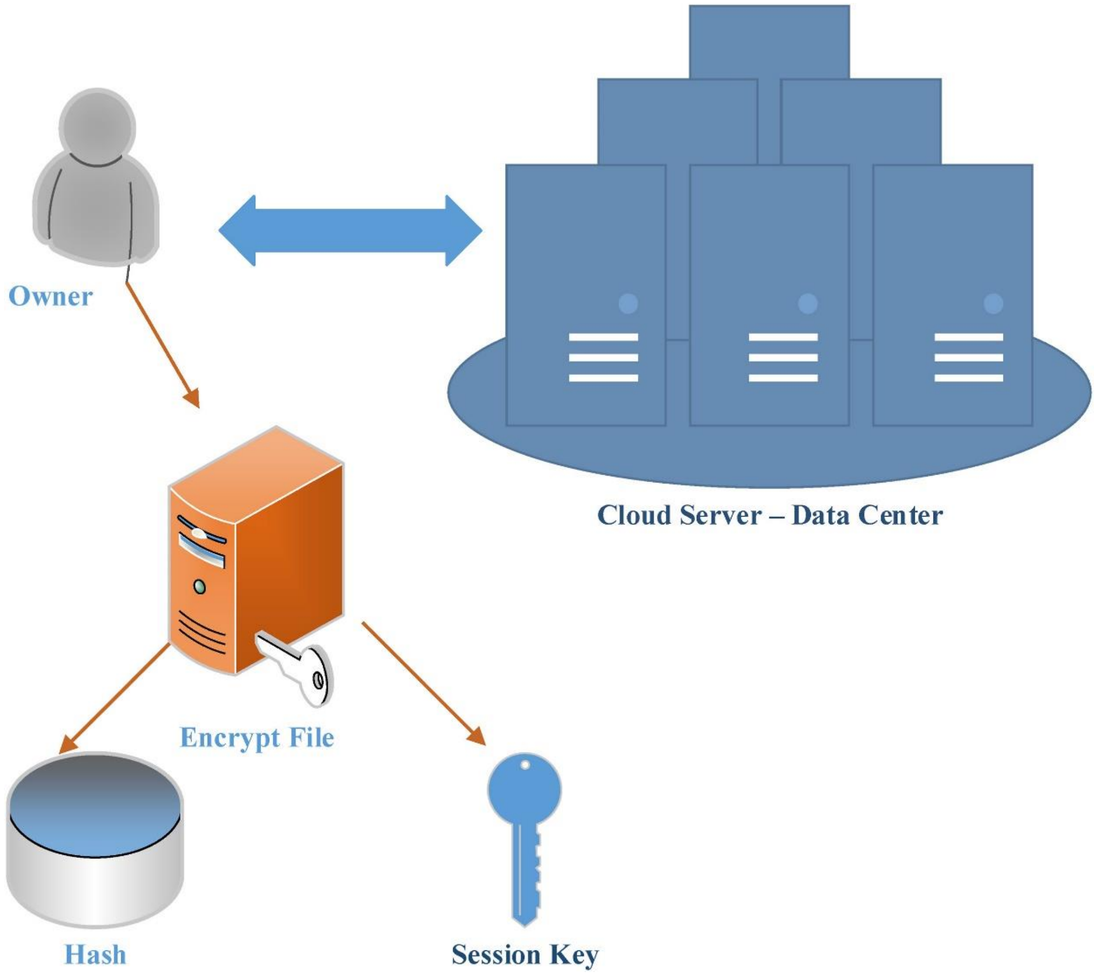

Figure 3.1: Client-Side Encryption

Figure 3.2 Illustrates the decryption key is evaluated using the key stored in a data store. If both keys match, the user can decrypt and download the file. Otherwise, they cannot access the files.

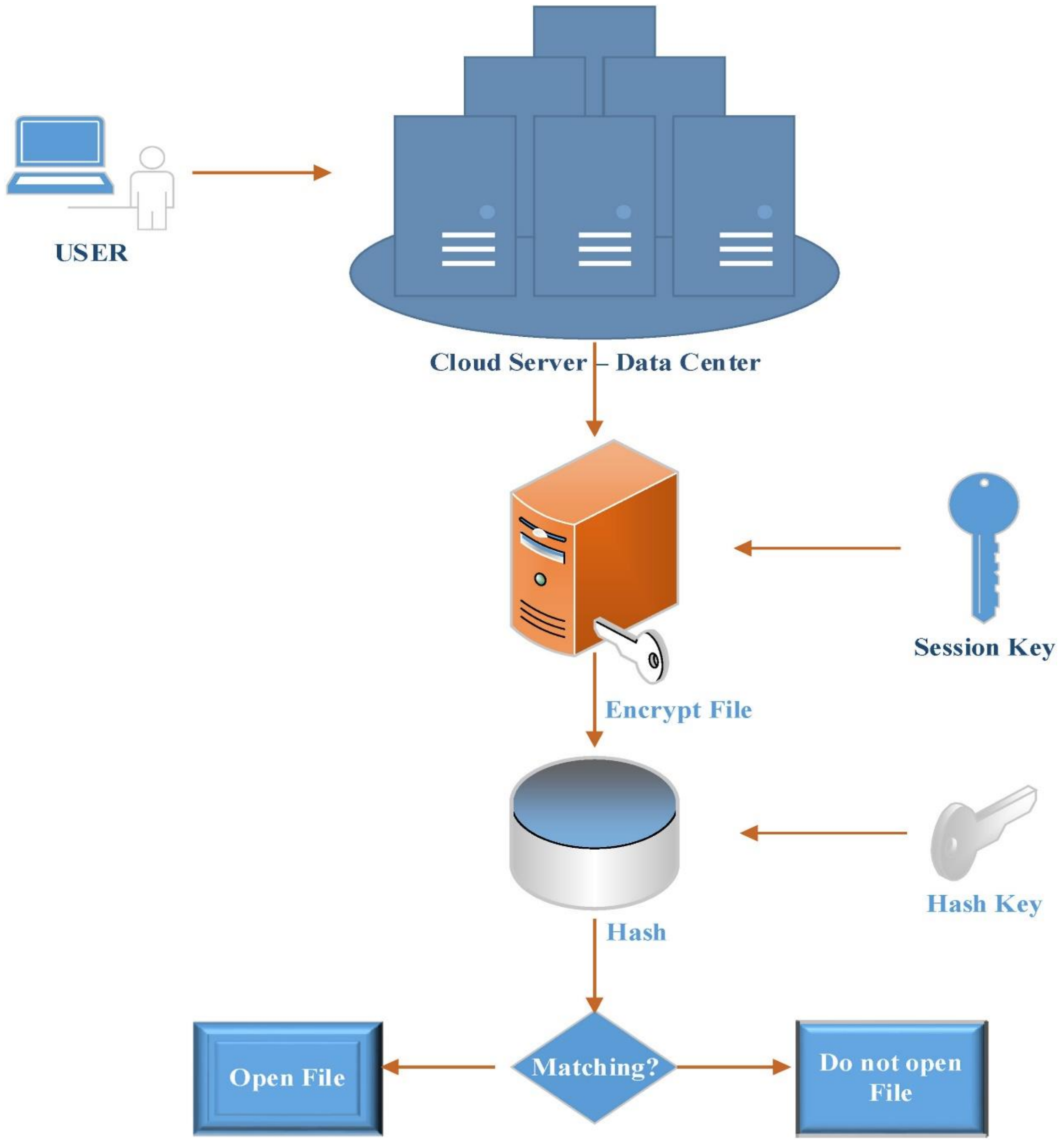

Figure 3.2: owner decryption process

Chapter 4

CONCLUSION AND FUTURE STUDIES

4.1 Conclusion

In summary, this systematic examination has illuminated the intricate challenges surrounding security and privacy at the intersection of cloud-based telemedicine and medical tourism. While the synergistic potential between these domains offers unprecedented global healthcare opportunities, it simultaneously introduces complex security and privacy concerns that warrant meticulous attention.

These challenges span a spectrum from data breaches and unauthorized access to regulatory variations across international borders. The integration of cloud technology into telemedicine introduces new vulnerabilities, necessitating robust cybersecurity measures to protect sensitive patient information. The global nature of medical tourism further complicates privacy compliance due to varying regulations in different jurisdictions.

To tackle these issues, it is crucial for stakeholders, including healthcare providers, technology developers, policymakers, and international regulatory bodies, to collaboratively devise comprehensive strategies. These strategies should encompass the development and implementation of stringent security protocols, encryption mechanisms, and authentication procedures to fortify the confidentiality and integrity of patient data in cloud-based telemedicine systems.

Furthermore, efforts should be directed towards establishing harmonized international standards and regulations governing the privacy aspects of cross-border telemedicine. A cohesive and universally accepted framework will facilitate seamless information exchange while ensuring compliance with privacy laws across diverse regions.

Looking ahead, additional research is needed to explore innovative technologies such as blockchain and homomorphic encryption, which may offer enhanced security solutions for cloud-based telemedicine. A continuous dialogue between stakeholders is essential to adapt and evolve security measures in tandem with the dynamic landscape of technology and healthcare practices.

By proactively addressing security and privacy challenges, stakeholders can unlock the full potential of cloud-based telemedicine for medical tourism, ensuring that the benefits of global healthcare collaboration are realized without compromising the confidentiality and privacy of patient information. This systematic review provides valuable insights into these challenges, contributing to the ongoing discourse on enhancing the security and privacy aspects of cloud-based telemedicine, especially in the context of medical tourism. As we navigate the evolving healthcare landscape, the fusion of cloud-based telemedicine and medical tourism holds great promise, offering a future where patients can confidently access high-quality healthcare services remotely, transcending geographical boundaries.

4.2 Future Studies

From this Systematic literature review and my research findings there is a gap in the implementation of Secure Cloud-Based Telemedicine Platforms, however, exploring the development and implementation of secure cloud-based telemedicine platforms that address the identified security and privacy challenges. It has been recommended that future researchers should investigate emerging technologies such as blockchain for secure data storage and sharing in telemedicine (Smith et al., 2017).

There is a need for user authentication and access control in cloud-based telemedicine. Investigate advanced user authentication methods and access control mechanisms to enhance the security of cloud-based telemedicine systems. This could involve biometric authentication, multi-factor authentication, and role-based access control (Ribeiro et al., 2018).

Develop and evaluate privacy-preserving data sharing protocols to enable secure collaboration among healthcare providers in different geographical locations. This may involve techniques such as homomorphic encryption and differential privacy (Abbas et al., 2019). Lastly, evaluate the adherence of telemedicine platforms utilizing cloud technology to global and local healthcare data protection standards, including the European Union's General Data Protection Regulation (GDPR) and the Health Insurance Portability and Accountability Act (HIPAA) in the United States (HHS, 2013; EU, 2016).

The integration of AI into cloud-based telemedicine holds promise for revolutionizing healthcare delivery by leveraging advanced technologies to improve diagnosis, treatment, and patient care. However, addressing security, privacy, regulatory, and ethical concerns is imperative to realize the full potential of this intersection. Further research and innovation are needed to overcome existing challenges and maximize the benefits for healthcare systems worldwide.

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APPENDIX

List of Included papers by Author and Publication year

AUTHOR	PUBLISHED YEAR	TITLE	SPECIALTY
C. Butpheng	2020	Security and Privacy in IoT-Cloud-Based e-Health Systems	Focuses on ensuring the privacy of data transmission systems in healthcare
Global Journal of Health Science 9(3):157	July 2016	Security Challenges in Healthcare Cloud Computing: A Systematic Review	Provides a systematic review of security challenges in healthcare cloud computing, including privacy for personal medical records
Omar Ali, Wiem Abdelbaki, Anup Shrestha, Ersin Elbasi, Mohammad Abdallah Ali Alryalat, Yogesh K Dwivedi	Vol. 8. Núm. 1. (Enero - Marzo 2023)	A systematic literature review of artificial intelligence in the healthcare sector: Benefits, challenges, methodologies, and functionalities	Discusses implications for future research directions, including security and privacy in healthcare services
L Baloch	Vol 14, No 6 (2023)	A Review of Big Data Trends and Challenges in Healthcare	Outlines systematic literature review methodology and addresses big data challenges in healthcare

TD Dang	2023	Systematic Review and Research Agenda for the Tourism and Hospitality Industry	Discusses a systematic literature review process, highlighting challenges like privacy and data security in the tourism industry
MUDASIR MAHMOOD	29 May 2023	Improving Security Architecture of Internet of Medical Things: A Systematic Literature Review	
Ankur Chattopadhyay Thuong Ho Nahom Beyene	June 2023	A W3H2 Analysis of Security and Privacy Issues in Telemedicine: A Survey Study	
Kern C, Fu DJ, Kortuem K, et al. Br J Ophthalmol	2020	Implementation of a cloud-based referral platform in ophthalmology: making telemedicine services a reality in eye care	
Yaacoub, J. A.	2020	Securing internet of medical things systems: Limitations, issues and recommendations.	

		Future Generation Computer Systems	
Jigna J. Hathaliya, Sudeep Tanwar	2020	An exhaustive survey on security and privacy issues in Healthcare 4.0	
Hameed, S. S., Hassan, W. H., Latiff, L. A., & Ghabban, F.	2021	A systematic review of security and privacy issues in the internet of medical things; the role of machine learning approaches.	
Vaiyapuri, T., Binbusayyis, A., & Varadarajan, V.	2021	Security, Privacy and Trust in IOMT Enabled Smart Healthcare System: A Systematic Review of current and Future Trends.	International Journal of Advanced Computer Science and Applications
Thilakanathan, D., Calvo, R. A., Chen, J., Nepal, S., & Glozier, N.	2016	Facilitating secure sharing of personal health data in the cloud	Internet-based applications are providing new ways of promoting health and reducing the cost of care.” (Thilakanathan et al., 2016)
Yan Hu and Guohua Bai	2014	A Systematic Literature Review of Cloud	

		Computing in Ehealth	
Ms. PrincyMatlani Dr. Narendra D Londhe, Member, IEEE	16 - 18 January, 2013	A CLOUD COMPUTING BASED TELEMEDICINE SERVICE	
Arifah Alfiyyah, Dumilah Ayuningtyas, Agus Rahmanto	May 2022	Telemedicine and Electronic Health Record Implementation In Rural Area: A Literature Review	Journal of Indonesian health policy and administration
Liezel Cilliers	2014	Using the cloud to provide telemedicine services in a developing country	SA Journal of Information Management
Lokesh S. Ramamoorthi, Saurabh Shukla	2023	Cloud based telemedicine in Neurology Clinics: A new horizon	Journal
R.M.P.H.K. Rathnayake, M. Sajeewani Karunarathne, Nazmus Shaker Nafi2, Mark A. Gregory	2018	Cloud Enabled Solution for Privacy Concerns in Internet of Medical Things	2018 28th International Telecommunication Networks and application Conference (ITNAC)
Dilibal Cinay Hacımustafaoglu Ali Murat	2020	Development of IoMT Device for Mobile Eye	2020 21st International Conference on

Dilibal Savas		Examination Via Cloud-based TeleOphthalmology	Research and Education in Mechatronics (REM)
Anne G. Ekeland, Alison Bowes, Signe Flottorp	2010	Effectiveness of telemedicine: A systematic review of reviews	International Journal of Medical Informatics
Syed Sarosh Mahdi	2021	The promise of telemedicine in Pakistan: A systematic review	Health science reports
Naeem A. Nawaz	2022	Impact of telecommunication network on future of telemedicine in healthcare: A systematic literature review	International Journal of Advanced and Applied Sciences
Christoph Kern	2019	Implementation of a cloud-based referral platform in ophthalmology: making telemedicine services a reality in eye care	British Journal of Ophthalmology
Ranjith J, Mahantesh K	2019	Privacy and Security issues in Smart Health Care	2019 4th International Conference on Electrical, Electronics, Communication,

			Computer Technologies and Optimization Techniques (ICEECCOT)
N. Jeyanthi, R. Thandeeswaran Hamid Mcheick	2014	SCT: Secured Cloud based Telemedicine	
Inessa Tyan, Antonio Guevara-Plaza and Mariemma I. Yagüe	2021	The Benefits of Blockchain Technology for Medical Tourism	Sustainability
Shaftab Ahmed Azween Abdullah	2011	Telemedicine in a cloud – A Review	
Zhanpeng Jin and Yu Chen	2015	Telemedicine in the Cloud Era: Prospects and Challenges	IEEE Pervasive Computing
Rutu Talati Payal Chaudhari	2022	The Road-ahead for E-healthcare 4.0: A Review of Security Challenges	
Vinay (V). Chamola	2020	A Comprehensive Review of the COVID-19 Pandemic and the Role of IoT, Drones, AI, Blockchain, and 5G	IEEE Access

		in Managing its Impact	
Esposito, C	2018	Blockchain: a panacea for healthcare Cloud-Based data security and privacy	IEEE Cloud Computing
Sharma, K	2022	Internet of healthcare things: Machine Learning for Security and Privacy	
Jun, H. S	2023	Development of Cloud-Based Telemedicine platform for Acute intracerebral hemorrhage in Gangwon-do	Concept and Protocol. Journal of Korean Neurosurgical Society
Ukeje, N	2023	Information Security and Privacy Challenges of Cloud Computing for Government adoption: A Systematic review	Research Square
Buyya, R	2023	Security and privacy issues in internet of medical things	
Bhatt, C. M., & Peddoju, S. K.	2016	Cloud computing systems and	

		applications in healthcare. IGI Global	
Metty Paul	2023	Digitization of healthcare sector: A study on privacy and security concerns	ICT Express
Kruse, C. S	2017	Cybersecurity in healthcare: A systematic review of modern threats and trends. Technology and Health Care	
Kooragayala (K.) Sukeerthi	2023	A Detailed Study on Security and Privacy Analysis and Mechanisms in Cloud Computing	